pull it up with a hook and sever it at its junction with the cartilage of the seventh costal cartilage.

The internal mammary vessels now appear about a finger's breadth from the border of the sternum. Ligate these doubly and divide them. The triangularis sterni muscle is now found under these vessels. Divide this close to the sternum.

Step 4. Displace the muscle and the pleura adhering to it laterally. The point of reflection of the pleura is frequently recognized by a pad of fat and may usually be easily separated from the pericardium. Expose the latter until its attachment to the diaphragm is visible. If at this point it appears that

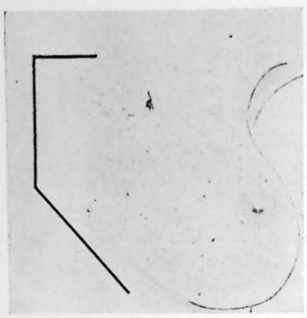

FIG. 1389

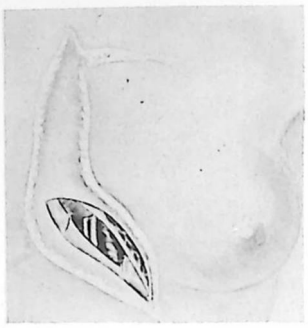

FIG. 1390

FIG. 1389. Kocher's method of exposure of the heart. Formation of osteoplastic flap.
FIG. 1390. Exposure of the heart by Kocher's method. The flap resulting from the incision shown in the previous illustration. The sixth costal cartilage has been resected. Between the divided ends of the cartilage the perichondrium is visible. The transversus thoracis muscle, the internal mammary artery and vein are exposed.

the pericardium may be promptly opened it may be done now; if not, proceed as follows:

Step 5. According to the position of the wound in the heart, enlarge the incision in the median line of the sternum upwards to the costal cartilage of the fourth, third or even second rib. Add to this vertical incision a horizontal cut about 8 cm. long dividing the fibers of the pectoralis major along their attachment to the rib, usually the third, from the upper border of which the fibers of the intercostal muscles are bluntly separated.

Step 6. Push off the pleura bluntly from the under surface of the fifth costal cartilage together with the triangularis muscle. Divide this cartilage close to its attachment to the sternum. Repeat the same procedure with the cartilage of the fourth and third ribs.

Step 7. Elevate the severed cartilages; push the triangularis muscle and pleura laterally. Break the flap consisting of the cartilages at their junction with the respective ribs, or, if necessary, by dividing the ribs further outward. Displace these outwards thus exposing the pericardium from the auricles

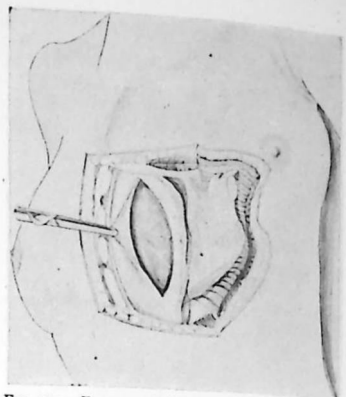

FIG. 1391. Exposure of the heart. Kocher's incision.

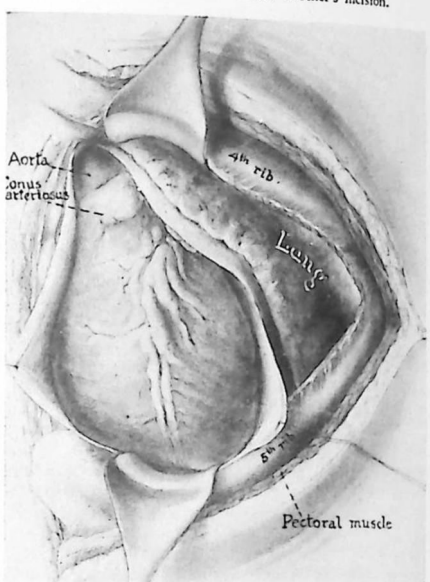

FIG. 1392. Exposure of heart by intercostochondral thoracotomy. (Courtesy of Dr. Claude S. Beck.)

(Fig. 1391) down to the apex. If the pleura is inadvertently opened, close it at once (Terrier and Raymond).

Step 8. Enter the opened pericardium and lift the heart out with two fingers. The apex is held by Museux forceps as recommended by Terrier and Raymond. Surgeons of today use by preference a transfixion suture in the apex. The first suture introduced into the wound should be left long so that when traction is put upon it a continuous suture may satisfactorily be placed (Rehn). To put a finger into the wound of the heart is dangerous practice (E. C. Cutler). Avoid inclusion of a coronary vessel in the suture. Fine

FIG. 1393. First step in method of controlling flow of blood through heart by compression of base; third finger is placed through great transverse sinus; fourth and fifth fingers are placed posteriorly in pericardial cavity; by compression with the fingers the venae cavae and the pulmonary veins can be occluded. (Courtesy of Dr. Claude S. Beck.)

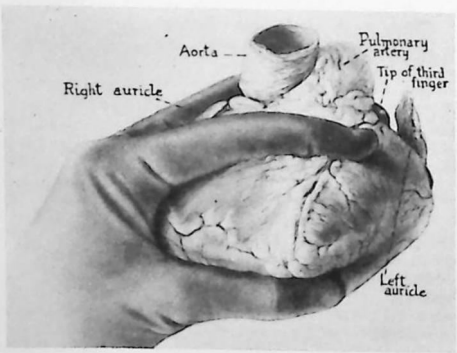

FIG. 1394. Second step in method of controlling flow of blood through heart by compression of base; the heart is steadied between the thumb and the index finger. (Courtesy of Dr. Claude S. Beck.)

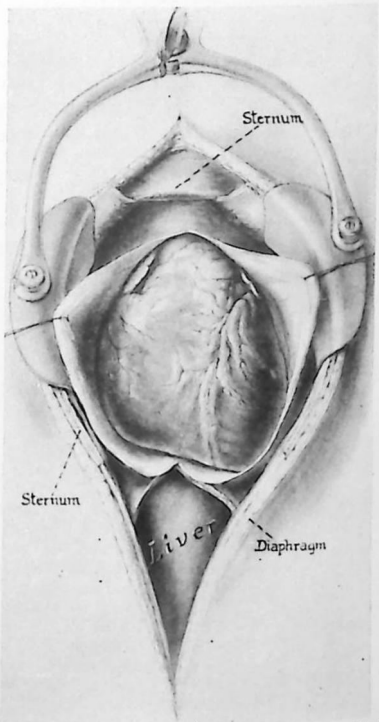

FIG. 1395. Exposure of heart by median sternotomy. (Courtesy of Dr. Claude S. Beck.)

silk should be the suture material. The whole hand, if need be, may be introduced into the pericardium when the occasion demands better exposure of the wound in the heart. Pass the sutures quickly, preferably during diastole. Pass the curved needle carrying the suture quickly and dexterously through the myocardium but not through the endocardium.

To control bleeding, Sauerbruch recommended the following grip. The left hand is placed in the region of the base of the heart. The third finger passes through the greater transverse sinus and anterior to the vena cava and pulmonary veins and posterior to the aorta and pulmonary artery. The fourth and fifth fingers rest on the auricles, posterior to these structures and the vena cava. As the third finger is approximated to the other two the flow of blood into the heart is stopped, and when this has been accomplished, pressure with the index finger and thumb may be exerted to steady the organ and deliver it into the field.

Fig. 1396. Doyen's rapid method of exposure of the precordial region. U-shaped incision with external hinge.

No definite rules can be laid down as to suturing, some prefer continuous sutures; others interrupted, the latter I believe, on the whole, are preferable. (Claude S. Beck uses the steps depicted in Figs. 1392-1393-1394-1395 in suturing of the heart.)

Step 9. The modern surgeon need not be reminded of the importance of strict asepsis in performing these operations. Cleanse the pericardial sac. Close it completely unless infections exist or faulty asepsis is suspected. On general principles, I prefer a small drain in the pericardium. Suture the pleura completely, if injured.

Step 10. Close the wound.

Comment: Many surgeons prefer Duval Barasty's Extrapleural Pericardiotomy (see p. 1208). Others resort to the Median Thoraco-Abdominal approach to the heart. Intratracheal anesthesia becomes a necessity in many cases.

Doyen's Rapid Method of Approach to the Heart for Wounds, Etc.

Step 1. Make a U-shaped incision in such a manner that a shutter-flap with an external hinge results (Fig. 1396). The cutaneous opening of the wound (missile, stab, etc.) should be circumscribed by the incision.

Step 2. Divide the pectoral muscles and expose the costal cartilages and ribs.

Step 3. Divide the third, fourth and fifth costal cartilages with Doyen's costotome raspatory (Figs. 1397-1398).

Step 4. Incise the third and fourth intercostal spaces. Divide the outer branches of the U-incision (third rib above and fifth rib below); avoid the intercostal vessels. Reflect the shutter thus formed outward; fracture the intervening ribs during its displacement.

Fig. 1397

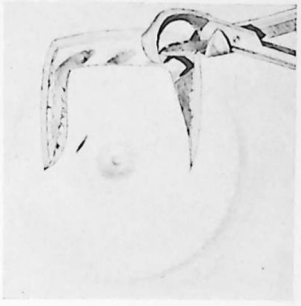

Fig. 1398

Fig. 1397. Doyen's rapid method of exposure of the precordial region. U-shaped incision with external hinge. Formation of a chondrocutaneous shutter; division of third costal cartilage. The orifice of the perforating wound made with a cutting instrument is seen on the inner side of the nipple.

Fig. 1398. The Doyen instrument (costotome raspatory) has cut through the third rib from which it has been disengaged and is now ready to be introduced for division of the next rib. (After Doyen.)

Step 5. Near the margin of the sternum expose the internal mammary vessels. The pericardium is incised at the point of perforation. Clean out clots. Suture the wound in the heart. Do not strangulate the tissues while suturing.

Step 6. Resuture the pericardium.

Step 7. Close the wound; insert a small wick drain.

CLAUDE S. BECK'S METHOD OF CONTROL SUTURES

When the pericardium is opened a suture to steady the heart is placed in the apex, the wound in the heart being momentarily disregarded. The impulse to control the bleeding instantly by placing a finger on the wound should not be heeded until the apex suture is placed. Unless the heart be steadied, the finger cannot be maintained in position. The apex suture is held under traction between the thumb and the third finger of the left hand, and the index finger is placed on the wound (Fig. 1399). The bleeding is thus controlled. The movements of the heart are transmitted to the left hand; both move in unison so that the index finger can be maintained effectively on the wound. This can be done regardless of its position on the ventricles. Two control sutures taking a deep bite of muscle are placed, one on each side of the finger at the level of the wound. They are crossed and then held under gentle traction by the assistant as the index finger is removed. The apex suture is dropped. An ex-

cellent exposure of the controlled wound is provided and ample time may be taken in placing the permanent sutures (Fig. 1400). Coronary vessels, if they lie adjacent to the wound, can be avoided in the sutures and a neat approximation can be obtained. The apex and the control sutures are removed.

The heat of the operation is over when the index finger is placed on the wound while the heart is steadied by a firm hold on the apex suture. If the idea be fixed in the surgeon's mind, first to place a suture in the apex, disregarding the wound momentarily, the suture can be placed in a few seconds and the subsequent procedure becomes remarkably simple. The flow of blood through the heart is not inter-

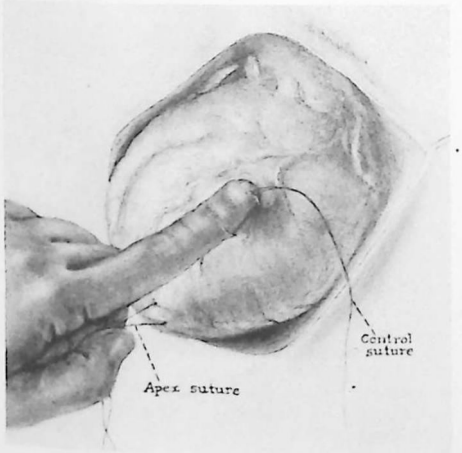

Fig. 1399. Method of suturing wound of the heart. The pericardium is incised and bleeding from the heart is disregarded until a suture is placed in the apex of the heart. This suture is held between the thumb and third finger while the index finger is placed upon, not in, the wound of the heart. The index finger can be maintained upon the wound because the finger moves with the heart. A suture is placed on each side of the wound. (Courtesy of Dr. Claude S. Beck.)

rupted and sufficient time may be taken to complete the procedure with deliberation. The surgeon should have noted the position of the wound under the finger so that the control sutures can be placed at the level of the wound. These should be placed also as near the margin of the wound as the overlying finger allows. Traction on them is most advantageously applied when they are held by the assistant an inch or two from the wound. The traction should not be so strong as to tear through the muscle. If it is found on removal of the index finger that the bleeding is not entirely controlled, the finger may be replaced on the wound and another control suture placed on each side at the point where the bleeding occurred. The four control sutures, two from each side, are crossed and held by the assistant. In this way a wound almost any size can be controlled, and a good exposure for placing the permanent sutures can be obtained.

The method has its advantages in that the flow of blood through the coronary

and the cerebral vessels is not occluded. It is well tolerated so that ample time may be taken to complete the procedure. An opportunity is afforded in placing the permanent sutures to avoid inclusion of adjacent coronary vessels. A neat approximation can be obtained.

New Blood Supply to Heart

Claude S. Beck has done experimental work with the object in view of creating a new blood supply to the heart by surgical means.[1] He has extended his work to human beings with reported apparent success. More material, of course, is needed to arrive at definite conclusions on this very interesting and important phase of surgical endeavor. (Figs. 1401-1402-1403).

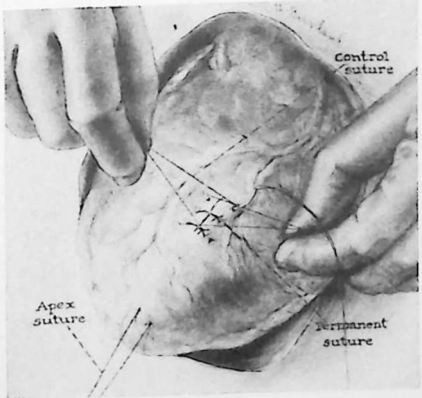

Fig. 1400. The control sutures are crossed and held by the assistant. The finger is then removed and gentle traction is applied to the control sutures. The wound is now exposed. There is no bleeding. Permanent sutures are placed in the wound. (Courtesy of Dr. Claude S. Beck.)

Comment. Ambrose L. Lockwood[2] in commenting on the surgery of the pericardium and heart reached the following conclusions:

"1. The heart is tolerant of severe trauma and manipulation.

"2. The danger of 'herztamponade' [compression of the heart] must be constantly kept in mind. One must appreciate that if the patient has lost much blood, with the lowered tension, the shock and the ability of the heart to withstand trauma, the wound in the heart may temporarily cease to bleed. As the patient's condition improves and the blood pressure rises, delayed primary hemorrhage may occur and the patient be found 'in extremis' again, if not constantly observed.

[1] Surg., Gynec., and Obst., Sept., 1935, Vol. 61, 407-410.
[2] Jour. A.M.A., Jan., 1929.

"3. Injury of the bundle of His is often fatal. Pressure on the bundle of His or kinking and rotation of the heart by interfering with conduction through the bundle in doing a cardiorrhaphy, may cause the heart to fibrillate or arrest its function entirely.

"4. Wounds of the heart heal by the formation of a cicatricial scar, not by true regeneration of muscle. Spontaneous rupture of the scar has frequently occurred following strain.

"5. The coronary arteries may be ligated without grave sequelae if the ligature is applied distal to the bifurcation; when applied proximally, the results are fatal.

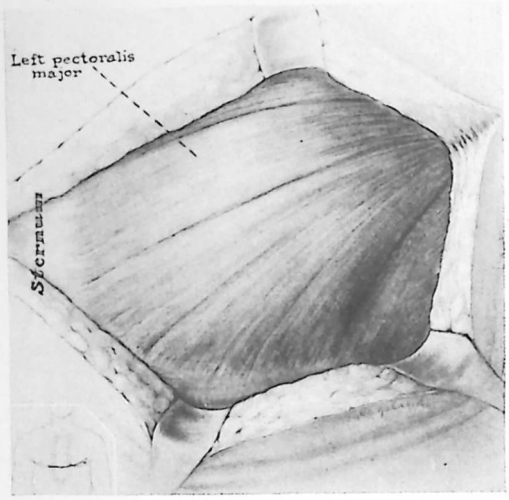

FIG. 1401. The inferior portion of the left pectoralis major muscle is exposed through a transverse incision. The incision in the skin is shown in the inset. (Courtesy of Dr. Claude S. Beck.)

"6. Digital control of bleeding from a laceration of the heart should be resorted to if necessary. Forceps should not be applied.

"7. No. 0 chromic catgut sutures or black silk carried on fine non-cutting needles are highly satisfactory for closure of wounds of the heart. Sutures should not be carried into the cavity of the heart. Care should be taken in inserting sutures and tying them to prevent cutting.

"8. The pericardium should be closed if one is reasonably sure of asepsis. If drainage of the pericardium is necessary for sepsis, it should, if at all possible, be dependent. Finally the pleura should be hermetically sealed, if opened.

"9. A supporting stay suture through the apex of the heart is most valuable if elevation or rotation of the heart is necessary.

"10. Gauze should not be employed within the pericardium.

"11. Sterile water only should be used to cleanse the pericardium. No antiseptics should be applied to the serous surfaces.

"12. Great care must be taken to avoid infection, bearing constantly in mind that most of the deaths after twenty hours have been due to infection.

"13. A select anesthesia should be employed.

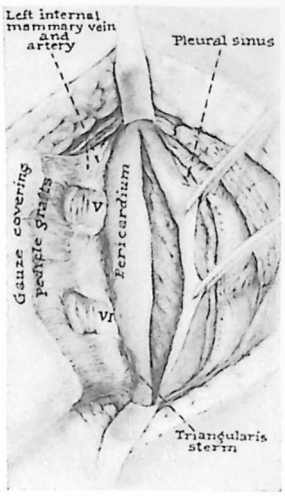

FIG. 1402

FIG. 1403

FIG. 1402. The pectoral muscle is dissected from the chest wall and is incised laterally to make a graft with the pedicle attached along the sternal margin. The fifth and sixth costal cartilages are removed. The mammary vessels are avoided. The parietal pericardium is opened. (Courtesy of Dr. Claude S. Beck.)

FIG. 1403. The lining of the parietal pericardium and the epicardium is roughened with a burr. The graft is divided into two parts. One is placed beneath the sternum to the right ventricle. The other is placed around the left ventricle. The pericardial cavity is left widely open so that adjacent vascularized tissues are in contact with the anterior aspect of the heart. (Courtesy of Dr. Claude S. Beck.)

"14. The great value of cardiac massage to overcome sudden arrest of heart action should not be forgotten.

"Pericardotomy for purulent pericarditis should be more frequently employed, and should be undertaken early in the disease.

"Cardiolysis in selected cases should be more commonly practiced."

D. C. Elkin[1] sutured the wound in the heart before removal of the blood in the pericardium. This made suture easier since the heart was beating weakly as a result of the tamponade. Elkin thinks this advisable since a suture can

[1] Jour. Thor. Surg. Vol. I, No. 2, p. 113, Dec., 1931.

be quickly and easily passed and be used both for hemostasis and traction. Pericardial effusion occurred but was rapidly absorbed. Drainage with the added danger of infection, therefore, seems unnecessary. Even though, in Elkin's report, the coronary vessel was uninjured, there were electrocardiographic changes similar to those found in coronary occlusion.

Elkin considers Beck's method of suture the "procedure of choice" if the wound be in an auricle, behind the sternum or posterior.[1]

INTRACARDIAC INJECTIONS

On many occasions intracardiac injections with cardiac massage have been used with success as a means of resuscitation. Gruel found 100 cases reported in the literature with 30 recoveries and recommended the use of intravenous glucose solution in conjunction with intracardiac adrenalin injections. Belden (1919) described his experiences with 45 cases observed over a period of twelve years. He used strophanthin, digifolin, camphor in oil, caffein and adrenalin, in doses never exceeding 1 cc. The immediate results were good in one-third of the cases, but not one of the patients lived longer than eight years. Bodon (1923) was able to locate 90 cases following intracardiac injections. The best results were apparently obtained with adrenalin, in doses not exceeding 1 cc. in a 1 to 1000 solution. Most authors recommend a thin needle about 8 cm. in length for the injections. Bodon recommends, as a preferred site of injection, the fourth intercostal space at the left sternal border. This site, he says, is the easiest approach to the heart (Fig. 1404).

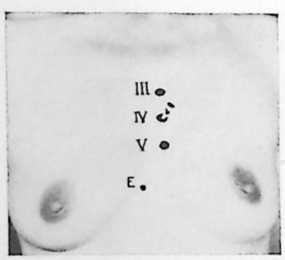

FIG. 1404. Intracardiac injection of adrenalin at the "point of election." Fourth intercostal space. III, V and E left (incisura costo-xifoidea sin representing other points of approach for injections of the heart). Modified from Dogliotti.

Hyman's study of resuscitation of the stopped heart by intracardiac therapy concerns about 250 reported cases in which a favorable outcome resulted in 25 per cent of the cases. He advocates intracardiac puncture into the right auricle instead of the right ventricle as it is commonly practiced today because the auricle is more responsive to mechanical stimulation than the ventricle. Also, following ventricular puncture the first contractions of the heart are always extrasystolic. These ectopic beats may persist and lead to ventricular fibrillation and immediate death. In auricular puncture the ectopic beats set up may be followed by auricular flutter or fibrillation but this is compatible with life and since the physiological block will slow the ventricular rate, the pacemaker of the heart situated in the right auricle may establish a normal rhythm. It is stressed that the renewed activity of the heart is not due so much to the chemical substance injected as it is to the mechanical irritation of the heart muscle (needle, massage, percussion). The needle puncture sets the mechanism of contractility into action.

[1] Annals of Surgery, 1932.

TECHNIC OF AURICULAR PUNCTURE

Step 1. Sterilize the skin.

Step 2. Insert a slightly curved needle four inches in length into the third interspace at the right sternal margin.

Step 3. Push the needle downward and toward the midline until the right auricle is reached. A flow of blood through the needle announces that the auricle has been entered.

Step 4. Inject 0.5 to 1 cc. of 1:1000 solution of epinephrine (adrenaline).

Comment: Where indicated, artificial respiration and cardiac massage should be resorted to in addition to intracardiac injection of epinephrine as soon as deemed advisable.

INDICATIONS FOR AURICULAR PUNCTURE

All cases of asystolic arrest of the heart resulting from surgical operations, hemorrhage, shock, anesthesia, status lymphaticus and asphyxia neonatorum. Cardiovascular and general systemic disorders usually do not respond to this procedure.

OPERATIONS ON THE VEGETATIVE NERVOUS SYSTEM IN ANGINA PECTORIS AND BRONCHIAL ASTHMA

(See chapter on operations of the sympathetic nervous system p. 550)

According to Nissen, the theoretical deductions which motivated the multitude of operations devised for the cure of angina pectoris and bronchial asthma have not yielded the results which were expected. This is due to the extraordinarily complicated construction of the vagosympathetic nervous system. The numerous anatomic connections of the vegetative nervous system, its marked tendency to regeneration, have not been accorded the attention they merit. The disappointments one now experiences in cases thus operated on proves the correctness of this view. Another important factor to be taken into consideration is that the removal of large portions of vegetative nerve segments do not leave the patient without ill effects.

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cases the staggered incision may be used. The linea alba was the site of incision in some instances while a portion or all of the rectus of the opposite side was divided in a few cases.

In gallbladder operations the skin incision is indicated by a scratch. The head of the table is elevated. The liver edge and costal margin are marked. The next line of incision is directed from the midline to the left to the liver margin extending to the rib margin.

Step 2. After the skin and fat have been divided, carefully brush away the fat from the anterior fascial aponeurosis for a width of 2 cm. From the upper border of this incision open the anterior aponeurosis from the midline to the lateral border of the rectus and continue the incision laterally upward between the fibers of the external oblique.

Step 3. Insert a narrow retractor into the lateral angle of the incision and pull the lower border of the external oblique and its fascia, which are then split laterally, from the border of the rectus. The aponeurosis anterior to the rectus has, at this time, usually retracted so that about 2 cm. of muscle is exposed; if not, dissect off the lower flap of the anterior aponeurosis.

Step 4. Insert a hemostat under the rectus and divide it along the lower edge of the exposed region, beginning at the lateral border.

Step 5. While the edges of the wound are held apart with retractors, incise the transversalis fascia and peritoneum at the upper level of the exposure. If it is desired to explore the ducts, the incision is continued through the linea alba; if not, the incision terminates at the linea alba.

Drains are brought out obliquely through the opening in the flat muscles at the lateral margin of the wound. The muscles tend to unite quickly, making the oblique drain preferable to one piercing it directly. The collapse of an oblique tract by forcing the inner against the outer wall is caused by intra-abdominal pressure exerted radially in all directions. Until he has become familiar with this procedure, the surgeon is likely to find himself spending more time on the abdominal wall than anything else; but in time it is done with as great facility and rapidity as through the Kammerer incision. Closure follows more surely and quickly. Exposure is much better and the small intestine is not likely to push out.

G. A. Sloan[1] described a combination of straight cutaneous and transverse fascio-muscular division for which he claimed the following advantages:

(1) Almost complete absence of tension on the sutures of the posterior fascia layers reduces the probability of postoperative adhesions to the abdominal scar. The danger of wound separation and hernia is almost entirely eliminated.

(2) Ample exposure is afforded for all operations in the upper abdomen.

(3) Four-fifths of the postoperative discomforts following longitudinal incisions are prevented.

(4) Closure is accomplished with great ease. Gas anesthesia is sufficient; deep anesthesia is not required. Convalescence is shortened, and a better scar is secured.

Comment. My preference is, as stated, for vertical incisions. In enlarging an incision downward steer clear of the urinary bladder. The less complicated an abdominal incision the better. I use the pararectus incision for

[1] "A New Abdominal Incision" (Surg. Gynec. & Obst., Mar. 1927).

interval appendicectomies; in women and in men where the diagnosis is doubtful the transrectus incision has served me best. The Pfannenstiel incision is reserved for cases where, for esthetic reasons, it is definitely indicated.

In extending an incision upward, do not go beyond the ensiform cartilage; you may inadvertently open the pleural cavity with resulting pneumothorax and subcutaneous emphysema. In suturing the posterior sheath do not puncture the epigastric vessels—a large hematoma will result behind the muscle from overlooking this precaution.

Where drains are used, see that these are not compressed by too tight suturing around them.

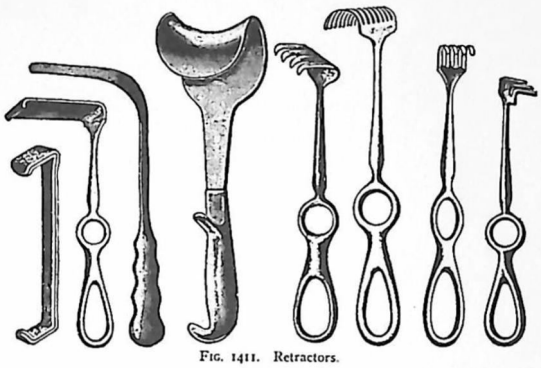


FIG. 1411. Retractors.

Wound infections are occasionally a source of discomfiture to both patient and surgeon alike.

EXPOSURE BY RETRACTION

To keep the wound open, a variety of retractors are marketed. Different types of retractors are preferred by different surgeons. Generally speaking, the types of retractors depicted in Fig. 1411 offer a selection to meet most needs. The simpler the retractor the better.

PAINFUL POSTOPERATIVE ABDOMINAL SCARS

Frederic W. Bancroft[1] points out that many patients complain of postoperative soreness in the region of scars, often very severe. These are sometimes diagnosed as postoperative adhesions. Often, at secondary exploration, insufficient pathologic change is found to account for the symptoms. Bancroft thinks some cases are due to neuromas in the abdominal scar.

The literature in regard to neuromas or neuritis of the abdominal scars is scant. This condition is more prevalent than is generally believed.

[1] Archives of Surgery, August 1930.

The microscopic proof of this lesion is extremely difficult, as the nerves traversing the scar tissue are extremely small and their identification in the excised tissue almost impossible.

The assumption that the symptoms and pathologic changes in Bancroft's four cases were due to neuroma or traumatic neuritis of the lower thoracic nerves is based on the following data: 1. In three cases the injection of procaine hydrochloride into the fascia of the right rectus muscle relieved the pain for various periods of time. 2. The patients in three cases were relieved from symptoms by excision of the scar tissue en bloc without opening the peritoneum. In the fourth case the peritoneum was opened to inspect the abdominal viscera, and there was insufficient pathologic change in the peritoneal cavity to account for the patient's symptoms. 3. The peripheral pain in amputation stumps has been definitely shown to be due to neuroma, and the microscope has confirmed this diagnosis.

Bancroft is convinced that injuries to the nerve are more common in abdominal wounds than is generally recognized. There are many cases of diminished tension of muscles when nerves have been cut. While there is no evidence of definite hernia, relaxed and atrophied muscles are seen which must cause some functional interference. It seems that the methods of operative approach to the abdominal cavity must be reconsidered. The tendency has been to attempt to follow muscle planes, and frequently to sacrifice ruthlessly the accompanying nerves. It is known that muscles heal kindly, even if cross-cut, provided there is no infection. It would therefore seem that surgeons should readjust their ideas to attempt to place incisions so that they run parallel with nerves. If this theory is adopted, how is one to approach the abdominal cavity? The following suggestions are made:

Whenever possible, incision through the right rectus muscle should be eliminated from the surgeon's armamentarium for the following reasons: 1. Percentage of hernias after a right rectus incision is higher than after most incisions. 2. Frequently weak wounds are encountered, wherein the portion of the rectus muscle medial to the scar is paralyzed or at least inhibited in action. 3. Injuries to the nerve are more apt to occur when this type of incision is made. In making a right rectus incision one frequently encounters the deep epigastric vessels. There is usually a considerable amount of hemorrhage, and it is impossible to isolate the nerves going to the muscle, so that it is easy to place a ligature about both vessels and nerve. Frequently, hematomas result from the injury to the vessel, and in some cases definite thrombosis has been noted along the course of the vessel, extending as far as the femoral vein.

In the upper right rectus incision the transversalis fascia runs directly from the intercostal margin to the mesial line as a well developed layer. It is difficult to close this layer by sutures. When the patient vomits or coughs, the spread of the ribs puts extreme tension on the suture line. Tearing of the fascia is frequently the forerunner of a ventral hernia.

If the surgeon prefers an incision to the right of the median line, either for exploration or for a better approach to the appendix, the Kammerer modification seems preferable to the usual right rectus incision. When the rectus muscle has been drawn to the mesial side, the nerves can be easily identified and retracted up and down, so as to allow a satisfactory exposure (Fig. 1412).

Moreover, if it is necessary to sacrifice a nerve, it can be done under the eye, so that no unnecessary ligature is placed about it. In this type of incision, deep epigastric vessels are not encountered, and therefore there is less hemorrhage.

Often the surgeon wishes to remove an appendix and at exploration finds pathologic changes in the region of the gallbladder. The problem then presents itself whether to enlarge the incision—with the possibility of a weak scar—or to close the lower incision and make a second one, with the resultant loss of time. Bancroft suggests that if a Kammerer incision has been made, the wound may be extended by a high oblique incision—one parallel to the McBurney incision—

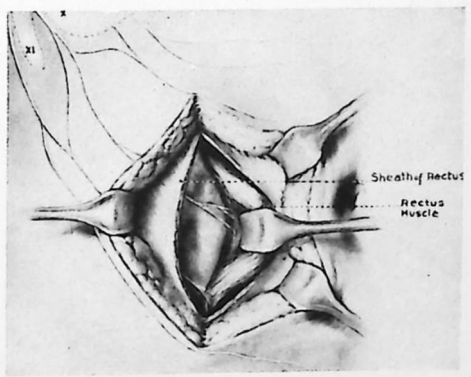


FIG. 1412. The Kammerer incision. The rectus muscle is drawn mesially. The nerves may be seen entering the rectus muscle and can be retracted either upward or downward. If more exposure is needed, they may be cut without ligation. (Courtesy of Dr. F. W. Bancroft.)

which begins at the rectus sheath and ends at the ninth costal cartilage in the mammary line. By this incision it is necessary usually to cut only one nerve, that at the upper angle of the Kammerer incision. This nerve can easily be seen at the first incision, and can be cut without danger of ligating it with the accompanying vessel. The extension of the incision runs parallel to the course of the intercostal nerves. A satisfactory exposure can be obtained thereby (Fig. 1413).

Bancroft concludes:

1. Injuries to the nerves in abdominal incisions followed by neuromas or neuritis are more prevalent than is generally recognized.

2. They are probably often produced by ligating a blood vessel with its accompanying nerve.

3. In the cases reported by Bancroft the right rectus incision was the procedure followed.

4. Diagnosis of neuroma may be made by testing out the sensory distribution

of a nerve and by causing a cessation of the pain by temporarily blocking the nerve by injecting procaine hydrochloride. In right rectus incisions this is accomplished by injecting procaine hydrochloride beneath the fascia of the right rectus muscle.

5. Incisions for abdominal exposure should be planned to avoid trauma to the nerves. Mass ligature of vessels in the vicinity of nerves should be carefully avoided.

FIG. 1413. Extension of right rectus incision (Kammerer) for exposure of gallbladder. B'-B extension is parallel to nerves so that only one nerve is cut during exposure. (Courtesy of Dr. F. W. Bancroft.)

Many persons have a great tendency toward keloid formation (Fig. 1414).

Comment. Incisions requiring special technical maneuvers should be done only by those thoroughly conversant with such steps. For general purposes, and unless otherwise specially indicated, a well-placed vertical incision (keeping in mind anatomical peculiarities of the region operated upon and coupled with painstaking attention to detail) is preferable to complicated and technically difficult procedures. The various incisions will be discussed under the respective operations.

CLOSING THE ABDOMEN

FOREIGN BODIES LEFT IN THE ABDOMINAL CAVITY

It is a well-known fact that surgical instruments, sponges, etc. are many times left in the body, particularly in the abdomen, following operations. They are often responsible not only for the failure of the operation but for the existence of conditions necessitating a second operation or in many cases for the invalidism and death of the patient.

In some instances the occurrence may be condoned since emergency operations are often performed without the deliberate procedure which really should

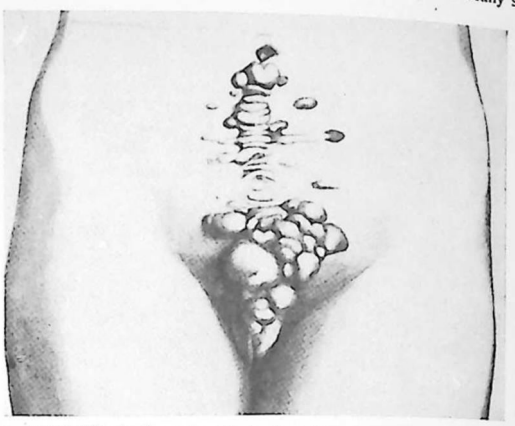


FIG. 1414. Keloids following laparotomy in female patient twenty years of age (after Lexer).

be associated with each surgical intervention. Under stress, a surgeon who does not accurately count his instruments, sponges, etc. may be excused if it was necessary to close the wound hurriedly. Also it may happen to an otherwise careful surgeon if the patient becomes moribund on the table necessitating the immediate discontinuance of the operation. The surgeon should not be condemned or criticized until all circumstances of such a case are known. Deliberate surgical neglect may be attributed to the surgeon if it is proved that he failed to check his armamentaria before and after the operation even though he had sufficient time, or if he did not inquire into all phases relative to the matter under discussion before closing the incision.

Many cases are recorded where a surgeon discovered too late that a foreign body had been left in the abdomen and rather than admit his mistake (for reasons legal and otherwise) left it in with the hope that it would become encysted or quiescent and not cause the patient any serious harm.

In every properly conducted hospital, a careful count is made, before and

after operations, of all instruments, sponges, etc., used, and it goes without saying that the conscientious surgeon will always satisfy himself that everything is checked up and correct before an operative wound is closed. But there is the human equation and a possibility of an error in counting, even by two persons, must be reckoned with. I have mentioned elsewhere in this work the method I have used successfully for many years, of attaching a metal ring to the end of each laparotomy sponge. In every suspicious case the abdomen should be subjected to x-ray studies before the patient is discharged from the hospital.

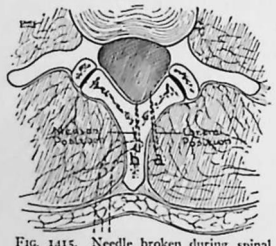


FIG. 1415. Needle broken during spinal therapy. (From The Lahey Clinic.)

Some surgeons insist that towel clips should never be used, but the towel, preferably, fixed in place by a suture. I often employ Doyen clamps.

No instruments with loose parts, that are likely to become detached, should be used.

As hemostatic forceps seem to be the surgical foreign body most often left behind, surgeons should pay particular attention to them.

Besides using rings, as stated above, attached to lap-sponges, I have been much impressed and occasionally used, successfully Crossen's[1] "saddle bag" arrangement. This contains, in one bag a strip of gauze, ten yards long and about three inches wide, which is attached to the bottom of one compartment of

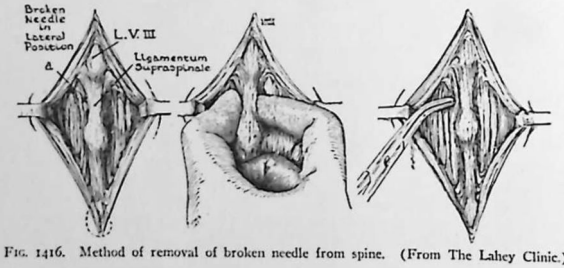


FIG. 1416. Method of removal of broken needle from spine. (From The Lahey Clinic.)

the saddle bag. It is used as needed and the soiled portion placed in the other compartment of the bag.

Many mishaps from an incorrect sponge count, and untold chagrin to both patient and physician may be avoided by a more general use of Crossen's "continuous-strip-sponges" in saddle bags.

The same author has also compiled and tabulated a list of a series of two hundred and forty foreign bodies, left in the abdomen and lost after vaginal operations, by various operators, covering the period between 1859 and 1908.

[1] Dr. H. S. Crossen, American Journal of Obstetrics (Vol. 59, January 1909, p. 250).

There is also the question of foreign bodies resulting from the breaking of a defective surgical instrument during an operation, with a piece remaining behind. Many such instances are known, especially in oral surgery. It is not unusual, in general surgery, for a needle to break in suturing tough tissues, or for a piece of a needle to snap off during the induction of spinal anesthesia. Lahey, of Boston, called attention to this latter accident (Figs. 1415-1416). Such

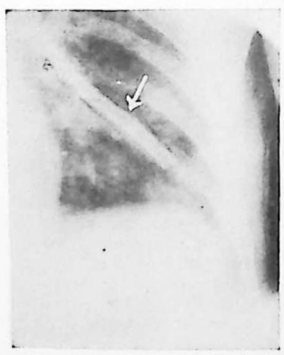


FIG. 1417. Drainage tube lost in the chest during an empyema operation. (Discovered three years later.)

FIG. 1418. Human falciform ligament.

small foreign bodies are apt to be overlooked, but often form a nucleus for later trouble.

Figure 1417 shows a drainage tube left in the chest of a patient over a period of three years. I once found a portion of an instrument that remained in the mastoid region for over ten years.

PROTECTION OF RAW SURFACES

In intra-abdominal operations raw surfaces invite adhesion formation. The surgeon's aim is to cover denuded areas by covering them with peritoneum, omentum or serosa from a contiguous viscus.

Omental, free or pedicled grafts, may be sutured over the denuded area. Approximation of serous surfaces such as after bowel denudations, are frequently resorted to.

In upper abdominal surgery, I often have recourse to the use of the falciform ligament either as a pedicled or free graft (Fig. 1418).

Recently, Dr. Clifford U. Collins concluded that "if a patient has attacks of vomiting without fever or an increase of the white blood count following a cholecystectomy, the condition of adhesions of the pyloric portion of the stomach to the fissure in the liver should be considered." Collins implants the omentum between the pyloric portion of the stomach, duodenum and the fissure of the

liver in order to prevent harmful adhesion formation. He claims no originality for the method and where no omentum is available he interposes the right portion of the transverse colon. For some years past I have endeavored to obviate the effects of undesirable adhesion formation under such conditions by mustering the falciform ligament into service. The procedure follows:

The ligament is detached completely from its moorings on the anterior abdominal wall. In separating the ligament the resulting raw surface on the posterior aspect of the anterior abdominal wall should be carefully sutured, otherwise undesirable bleeding might ensue.

Fig. 1419. The use of the completely detached falciform ligament to reinforce suture lines on the stomach. Low power magnification. (1) Mucosa of stomach; (2) Submucosa; (3) Muscularis; (4) and (4') Two focal areas of suppuration which are walled off by the apposed falciform ligament; (5) Serosa and subserosa of stomach; (6) Exudate of fibrin (undergoing very early organization) which is agglutinating the falciform ligament to the serosa; (7) falciform ligament.

The freed ligament may then be attached to the upper border of the peritoneum in the gallbladder bed. Additional tacking of the ligament to the hepatoduodenal ligament or other contiguous serous surfaces with a stitch or two, gives an efficient protective layer and prevents the viscera from adhering to the gallbladder bed after classical cholecystectomy.

During the respiratory excursions the stomach glides over the falciform ligament in its new position and does not adhere at an undesirable site.

In classical cholecystectomy I have also implanted the divided end of the cystic duct, into the lower third of the falciform ligament, thus covering the duct with peritoneum instead of permitting it to swing freely in the abdominal cavity.

Similarly, the ligament may also be completely detached and sutured over the inverted and closed duodenal stump following gastrectomy. On occasion I have also used the detached falciform ligament as a covering for the suture

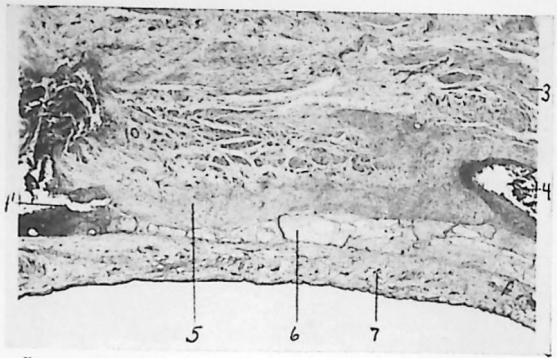


Fig. 1420. Same as preceding showing greater magnification of the two focal areas of suppuration.

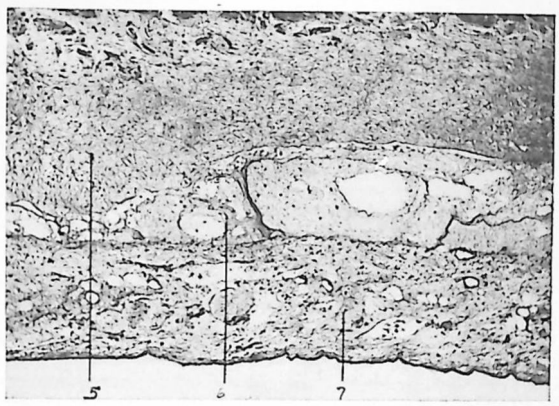


Fig. 1421. Same as preceding; high power magnification. (5) Serosa and subserosa of stomach; (6) Exudate of fibrin (undergoing very early organization) which is agglutinating the falciform ligament to the serosa; (7) falciform ligament.

lines used in perforated gastric or duodenal ulcers, or to cover anterior gastrojejunostomy suture lines or in tubovalvular gastrostomies (Figs. 1419-1420-1421).

CLOSING THE INCISION

The important desiderata in closing the abdomen are:

1. Snug union of related structures (peritoneum to peritoneum, fascia to fascia, etc.)

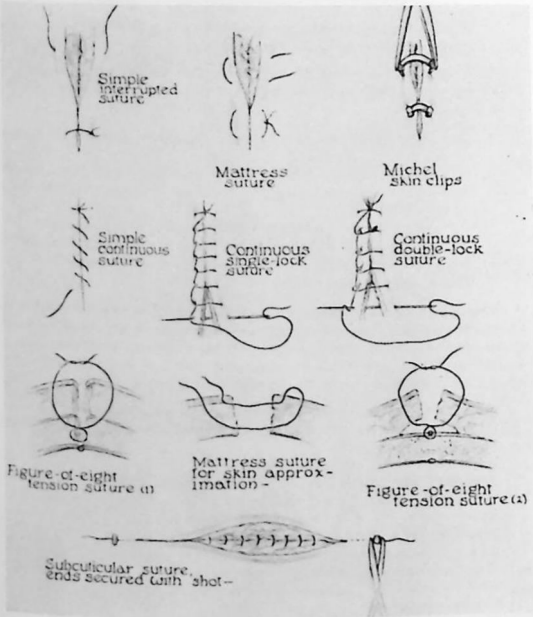


Fig. 1422. Methods of Suturing.

2. Avoidance of loci of lessened resistance and dead spaces.
3. Avoidance of infections.

Infractions on one or a combination of the above postulates predisposes

to hernia. To accomplish secure abdominal closure, a variety of methods have been suggested; however, the simpler the method, the better. My preference in closing the abdominal wound is as follows:

Step 1. Pack off the presenting bowels with lap sponges. Engage the edges of the peritoneum with artery forceps; the whole length of the opened peritoneum should be plainly in view. Leave nothing to chance.

Step 2. A full length catgut No. 1 suture carried on a full curved Mayo needle is used to close the peritoneum with a continuous suture. Most surgeons use a continuous suture; yet, I have seen Prof. Giordano of Venice, Italy, use routinely, interrupted sutures in closing the peritoneum. A tablespoon in the abdominal cavity can be used to advantage to keep protruding bowels

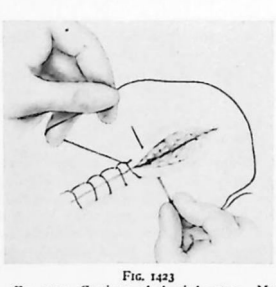


Fig. 1423

Fig. 1424

Fig. 1423. Continuous lock-stitch suture. Method of holding the suture while making the lock stitch.

Fig. 1424. Method of using pearl buttons and silkworm gut in closing the abdominal wall in an obese patient. The superficial sutures were removed on the tenth day; the tension sutures were permitted to remain longer.

out of the way while the peritoneum is being closed. Avoid disaster, by seeing, every time the needle passes through the peritoneum, that no bowel or omentum is picked up. Wherever possible, I endeavor to create an ectropion of the peritoneum so that no raw surfaces face the interior, inviting adhesion formation.

Step 3. Approximate the rectus muscle with one or two interrupted sutures.

Step 4. Close the fascia in the same manner as the peritoneum. The suture may be either interrupted or continuous. I prefer interrupted sutures.

Step. 5. The skin may be closed in a number of ways (Figs. 1422-1423):

(a) Interrupted sutures of silkworm gut; continuous sutures of silk or dermal (fiber sutures).

(b) Subcuticular (Halstead suture) (Fig. 1422) where esthetic factors have to be considered.

(c) Michel clips (Fig. 1422).

Tension sutures are used in obese persons. These embrace the entire thickness of the abdominal wall except the peritoneum (Fig. 1422).

Step 6. Cleanse the surface of the abdomen with peroxide of hydrogen. Apply dressings.

In obese persons particularly, pearl buttons and silkworm gut are frequently resorted to. The illustration (Fig. 1424) shows the manner in which these buttons are threaded with silkworm gut and their respective positions after the sutures are tied.

Benj. I. Golden[1] states that all wounds heal better when left open to the air, and also that gauze has a tendency to adhere to the serous exudate of a fresh wound resulting in irritation and inflammation.

He devised a shield (Figs. 1425-1426) of copper screening, 14 mesh size, which is cut about one inch longer than the wound, and 3 to 3½ inches wide.

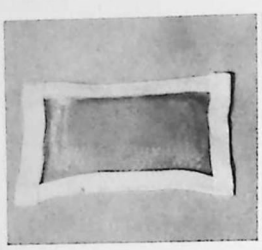


FIG. 1425. Copper screen shield prepared for application. (Courtesy of Dr. B. I. Golden.)

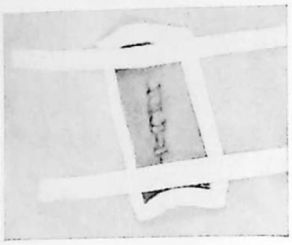


FIG. 1426. Copper shield in position covering a clean surgical wound. (Courtesy of Dr. B. I. Golden.)

Bias tape is stitched around the edges, to protect the skin from the sharp edges of the cut screen. The shield is taken in both hands, and the thumbs are used for pressure on the central part molding it so that its central portion is about one-half inch deep and the outer edges remain flat. After being sterilized, it is applied to the abdomen and held by two or three strips of adhesive.

This shield holds the bed clothing away from the wound and permits air to circulate freely. Golden observed no infection as the edges of a clean wound heal rapidly. The shield affords the patient much added comfort. Since the wound is visible at all times there is no necessity for redressing until the sutures are to be removed. The shields are economical and may be used many times.

Comment: Kocher believed silk to be the sovereign material for suturing. In certain cases, silver wire is used (vide infra). Too much time is often spent in closing the abdomen in patients who have undergone serious intra-abdominal procedures or in whom emergency operations have been performed. The condition of the pâtient is the best index in this connection. The young surgeon should remember that it is better to have a live patient with a postoperative hernia than a cadaver with a meticulously closed abdominal wound.

[1] The Amer. Jour. of Surg., Jan., 1934.

SUTURING, SUTURES AND LIGATURES

Suturing or surgical stitching means the sewing together of the edges of a wound or other solution of continuity of tissues so as to facilitate the reunion of these tissues.

Historical Notes. Before the merits of asepsis became established, the closing of wounds was considered very hazardous. Bacteria in the suture material were implanted in the tissues of the patient and mortality ran high (anthrax, tetanus, saprophytic infections, gangrene, etc.). The surgeon of old, however, realizing the necessity for controlling hemorrhage and closing wounds, continued to use suture materials, many of which are still used (silk, linen, wire and catgut.)

In 600 B.C. Susruta, an Indian surgeon and founder of a system of medicine that bears his name, recommended in his "Compendium of General Medicine" that cotton, strips of leather, fiber from the bark of trees, plaited horsehair and animal sinews be used for suturing and ligating. Celsus referred to the ligating of blood vessels to arrest hemorrhage indicating that the practice was not new in his time.

Galen was the first to identify catgut with surgery. In his "De methodo medendi" he recommends ligating a large strongly pulsating vessel in two places and excising the intervening portion. If silk threads are not available, he says, "choose from the material where you are living the least putrescible such as thin catgut which quickly falls from the vessel." Although twisted gut strings had been used for musical instrument strings centuries before, this is the first known reference to it as a ligature material.

"Catgut" is the name applied to cords twisted from sheep intestine. The general explanation is that the word was derived from the term "kitgut" or "kitstring," the cord or string used on a "kit" or fiddle; this term became confused with "kit" meaning a young cat and in this way the word "catgut" was coined.

The first intestinal suture recorded is described in the Ayur-Veda (2nd century A.D.) which states that after the edges of the wound were drawn together a "large black ant" was permitted to bite through the joined tissue; after the mandibles were locked the head of the ant was cut off and left in place. Certain Algerian tribes practiced this procedure as late as 1845.

Paulus Aegineta (7th Century A.D.) records that human hair as well as horsehair was employed for suturing. Hieronymus Fabricius ab Aquapendente preferred gold wire because it "is flexible and does not bite and erode the closed parts." He also used linen thread treated with gum tragacanth.

Ambroise Paré revived the practice of ligating bleeding vessels instead of cauterizing them after amputating a limb, as was the custom of the time.

Dr. P. S. Physick is given credit for re-introducing catgut. In 1816 he suggested animal ligatures in place of linen or silk because the latter remained in the wound too long (the direct relation between non-sterile sutures and ligatures with their ends emerging from the wound with the mortality rate resulting from the infection of clean wounds). Dr. Physick's observation of the action of wound discharges in dissolving leather straps and his experiments with buckskin ligatures in animals are illuminating. He also experimented with kid, parchment, varnished leather, tendon and intestine of fish as well as catgut. In 1840 Luigi Porta reported on a series of animal experiments that showed catgut to be the strongest and most homogeneous substance for ligatures.

Joseph Lister's "Observations on Ligature of Arteries on the Antiseptic System" in 1869, yielded important deductions. Silk threads steeped in a saturated aqueous solution of carbolic acid were used. In one experiment Lister arrived at two important conclusions, viz., the use of sterilized ligature and suture material, and the burying of the ligature in the wound with the ends cut short. Lister continued his suture studies in connection with his immortal work in antiseptic and aseptic surgery and decided that excess water was harmful to surgical catgut and the use of chromic acid made strands more resistant to absorption.

A ligature means a thread which is used in surgery to tie or bind a blood vessel so as to prevent hemorrhage. When other tissues are bound around for any purpose whatever, the material used for such binding is also called a ligature.

The main surgical principle underlying suturing is to keep the different layers of tissues in apposition until by normal processes the divided surfaces have again become continuous and united. In the present accepted methods of surgical technic, suturing is considered to be the best method of accomplishing this purpose; but there are other methods of effecting such union than by stitching. With these we are not concerned in this chapter.

In the closure or reuniting of any separated tissue a most important thing to remember is tension, or the tendency of such separated surfaces to remain disunited or even to increase the distance between them. Such tension differs in different regions. In the abdomen it is very great and particular attention must be paid to overcome and check it. In the extremities, the tension between separated tissues is much less. Again, tension varies with the depth of the wound and with the elasticity of the particular layer of tissue the edges of which have to be reunited.

Suture Material

Regarding the suture material, it may be absorbable or nonabsorbable. By an absorbable suture is meant one that is digested or chemically decomposed during the healing process by the tissue in which it is imbedded. By such time as the suture has entirely disappeared, the separated tissues which it has held together should have united firmly. The most commonly used absorbable suture materials now in use are catgut and kangaroo tendon. Non-absorbable sutures are not absorbed or decomposed by the tissues and it is necessary that the surgeon remove them when the wound has healed. Wire, silk, silkworm gut, linen, horsehair and various special preparations are used as non-absorbable suture material. They are mostly employed for the superficial tissues.

Selection of Proper Suture Material

The fundamental principles governing absorbable sutures are:

1. That the suture material can be readily and efficiently sterilized;
2. That it will not be absorbed before the tissues it holds together will have had time to unite firmly.

Absorbable material (catgut) is the most generally accepted and is universally used throughout the surgical world. For bone work and where heavy tension has to be met kangaroo tendon or silver wire is mostly employed; the former has a slow rate of absorbability.

1. **Sterilized catgut** should be used for the ligature of blood vessels and for deep sutures (i.e. those beneath the skin layer) in all operations where the area of operation is already septic.
2. **Sterilized catgut** should be used for the ligature of blood vessels and for deep sutures whenever the tissues involved are the seat of frequent or extensive involvement.
3. **Sterilized silk, linen,** the various types of cotton thread or Pagenstecher's celloidin thread, of suitable thickness may be used for the ligature of blood vessels and for deep or so-called buried sutures and ligatures in all operations where the field of operation is aseptic.
4. **Silkworm gut** of suitable thickness and length should generally be used for the closure of skin wounds with a few exceptions, such as the use of horsehair for the face and fine silver wire in certain cases of cleft palate.
5. **Silver wire or aluminum covered copper wire** of suitable thickness should generally be used for the approximation and fixation of bones, such as in the operation for fracture of the patella or of the long bones of the limbs. Vienna bronze-wire has given me much satisfaction in the union of bones. Other surgeons use it by preference (St. Jacques).

It is advantageous to use the smallest possible sizes of catgut sutures compatible with the mechanical conditions of good suturing. The advantages of using small sizes are:

1. They cause less trauma to the tissues at points of insertion than do large sutures.
2. They are less irritating to the tissues because they consist of less collagen, and therefore a smaller amount of foreign protein is presented to the tissues for digestion.
3. They permit smaller knots, and so constitute less of a foreign body.
4. They are less likely to be tied under excessive tension and, consequently, to interfere with circulation or cause necrosis of strangulated tissues.
5. They also permit better approximation of tissues.

One cannot definitely specify the sizes and kinds of sutures to be used in the tissues involved in various operations unless a complete description of the nature of the operative procedure is furnished. The same kind of tissue when involved in different types of operations may require an entirely different size and kind of suture. But in a general way the following outline proves efficient.

Appendix (ligation of)—No. 0 or No. 1 plain catgut.
Appendix (purse-string suture)—No. 00 Pagenstecher linen or No. 0 chromic catgut (20 day).
Arteries—No. 0 to 000 black silk.
Arteries (ligation of)—No. 0 or No. 1 plain catgut for small; No. 1 chromic catgut (20-day) for large arteries.
Cervix uteri—No. 1 or No. 2 chromic catgut (40-day).
Eye (canthal ligament)—No. 000 plain catgut.
Eye (conjunctiva)—No. 0 black silk.
Eye (lid)—No. 0 black silk.
Eye (muscle)—No. 000 chromic catgut (10-day).
Fascia—No. 1 chromic catgut (20-day).
Muscle—No. 1 plain catgut.
Nerves—No. 0 black silk.
Perineum (lacerated)—No. 3 chromic catgut (40-day).
Peritoneum—No. 1 plain catgut below the navel; No. 1 chromic catgut (20-day) in the upper abdomen because of the layer of deep fascia.
Prepuce (circumcision)—No. 00 or No. 0 plain catgut.

Rectum—No. 1 or No. 2 chromic catgut (40-day) or silk.
Skin—Small wounds, No. 000 or No. 00 silk or linen.
Large wounds, No. 00 or No. 0 non-absorbable sutures, silk or linen.
Skin (plastic)—No. 0 silk or linen.
Stomach and Intestines—No. 0 chromic catgut (20-day) or linen.
Subcutaneous fat—No. 00 or No. 0 plain catgut.
Tendons—No. 0 or No. 1 chromic catgut (20-day) or silk or linen.
Tension Sutures—For most situations, No. 1-3 silk or linen or silkworm gut.
Vagina—No. 1 or No. 2 chromic catgut (40-day), reinforced with tension sutures; also, silk or linen.

STERILIZATION

Sterilization of suture materials can of course be carried out by the surgeon himself if he does not wish to depend upon the assurance of others in regard to this necessary procedure. In practice, however, the preparation of sterilized suture material is left to commercial firms who have specialized in this kind of work. There are several such companies whose products are quite reliable as far as known methods of sterilization and absolute care and efficiency in their application are concerned. Nevertheless, it is questionable if, from the nature of the material (animal tissue) itself, it can be asserted with absolute certainty that catgut can be rendered completely sterile. More assurance can be given in the case of silk, linen, wire and other suture material, and on this account many surgeons prefer to use the latter materials whenever possible (John Erdman). But on the whole, the use of commercially prepared sterilized catgut sutures is quite satisfactory. They are put up in sealed glass tubes. Many surgeons prefer to sterilize the exterior of suture tubes by boiling or autoclaving. The terms "boilable" and "non-boilable" often applied to sutures refer entirely to the process desired in sterilizing the exterior of the sealed glass tubes in the hospital; the exterior of the tube is not sterile and the sterile suture material within may become contaminated when it is removed from the tube. The essential difference between boilable and non-boilable catgut is in the fluid used inside the tube. Catgut tubed in a solution containing moisture (water) remains soft and pliable. The boilable catgut is tubed in a fluid containing absolutely no moisture (water). The removal of water from the boilable varieties of catgut sutures and kangaroo tendons decreases their pliability so that they are slightly stiff when removed from the tube and must be moistened with sterile water to restore their pliability.

When removing boilable sutures from the germicidal solution the tube is broken in a sterile towel and the suture removed with sterile forceps or sterile gloved fingers. Non-boilable sutures should be used immediately after removal from the tubes, but if this is not practicable the sutures are at once placed between folds of a sterile towel wet with ethyl alcohol (95%) wrapped in a piece of sterile rubber dam until the surgeon is ready to use them.

There are a number of methods in use for restoring pliability to boilable catgut sutures, the principal of which are:

Immersion in 70% alcohol; exposure to a towel moistened with 70% alcohol; immersion in saline solution or exposure to a towel moistened with it. In the case of boilable kangaroo tendon sutures, they should be softened by soaking in sterile physiologic saline solution at about body temperature.

Absorption of Suture Material

The period of time required of catgut sutures to become absorbed depends upon their size, whether plain or chromicized, and very particularly upon the condition of the tissues in which they are introduced. The time of absorption specified on the label of the manufacturer applies only when the sutures are in normal tissue of aseptic wounds.

The following "Don'ts" or cautions, should be observed in the handling of ligatures in the hospital.

1. Never touch a sterilized tube with bare fingers. Use a sterilized forceps or gloved hand.
2. Never handle catgut or other suture unnecessarily—it is easily contaminated.
3. Never attempt to boil tubes marked non-boilable. If you do, the catgut will shrivel, disintegrate and, therefore, become useless.
4. Never place boilable catgut tubes in the sterilizer without first wrapping them in a towel; they will either float or come in contact with the flame exposed bottom of the sterilizer and often break.
5. Never pass hot tubes rapidly through cold air or attempt to open them while hot. Sudden changes in temperature may cause them to explode.
6. Catgut should not be permitted to come in contact with the skin edges of the wound during its use in the deeper structures.
7. Local pus infections anywhere in the body may cause bacteremia. Large quantities of catgut, or tissue strangulated by catgut, may readily favor localization of micro-organisms. This should be borne in mind when condemning catgut as the sole source of infection.
8. Catgut must be digested and absorbed by the tissues; if these are weakened, they should not be over-burdened.
9. Catgut absorbs at an inverse ratio to the surface area. For instance, two small strands will ordinarily absorb more quickly than one large strand.
10. Finer ligatures and a more carefully controlled technic of suturing will tend to accomplish the desired result (perfect union of tissues) and furnish less foreign proteins for the tissues to cope with.

In order to strengthen the resistance to absorption, catgut sutures may be subjected to a process of tanning and are then known as "chromicized sutures." Another advantage of this is that the sutures can be used in smaller sizes for the purpose of maintaining apposition of wounds, since their absorption is much slower than that of plain catgut under the same circumstances.

Needles

Fully curved, half-curved and straight surgical needles are used. The curved types are used for deep wounds and those difficult of access; straight needles are generally employed for superficial wound edges. Needle holders are used for curved needles (Fig. 1427).*

*Dr. Myer M. Marbel devised an "ever-ready" suturer (J.A.M.A. June 1916). This is an ingenious holder which threads the needle and ties the knot automatically; it cuts off the ends of the suture and is of marked advantage in all forms of so-called minor surgery. (Fig. 1428.)

Types of Suture

Sutures are further classified, according to the manner in which they are inserted in the tissues, as interrupted, continuous and tension sutures (Fig. 1422 p. 1248). The actual method of putting in these or other sutures correctly is a part of the surgical student's practical education.

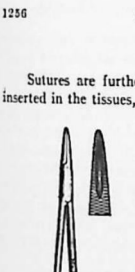


Fig. 1427. Needle Holder.

Interrupted sutures are inserted in the tissues in such a manner that each stitch is self-contained and tied independently of the other stitches.

Continuous sutures are inserted so as to consist of a series of stitches; the suture running continuously from one stitch to the other, and only the first and last of the series are tied.

Continuous Lockstitch. L. Torraca lauds the advantages of a continuous lockstitch in closure of wounds over the simple, continuous suture. The technic is shown in Figs. 1429-1430-1431.

A tension suture is a non-absorbable suture inserted at a distance from the incision and passed through the skin, subcutaneous tissue, fascia and muscle. A tension suture is not used to approximate tissues, but only to support the tissues and thus aid the rapidity and soundness of the process of repair.

Small "bites" of tissue should be taken and tying performed with the least amount of tension. Undue tension causes necrosis of the tissues by constricting circulation of the healing parts. Edges of tissues which cannot be approximated

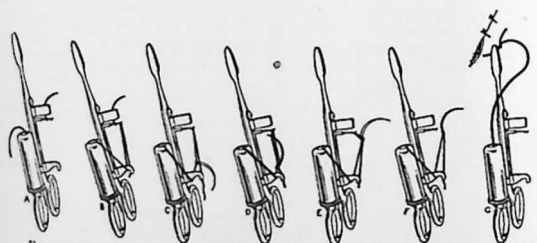


Fig. 1428. Marbel's ever-ready suturer. A, needle on hook threader; B, needle and catgut on hook threader; C, needle threaded; D, threaded needle sinking between lines for anchoring; E, needle half anchored; F, needle anchored; G, suturer in use.

by light traction ought not to be sutured. Above all, it is wise to adopt the rule "only to approximate and never to strangulate."

A factor of safety in a laparotomy wound can be provided by placing tension

sutures at a distance from the incised area, thus putting the strain on healthy tissues. For example, after suturing the peritoneum, interrupted, non-absorbable tension sutures may be inserted through the skin, subcutaneous tissues, fascia and muscle on one side, and passed up through these same structures on

Fig. 1429

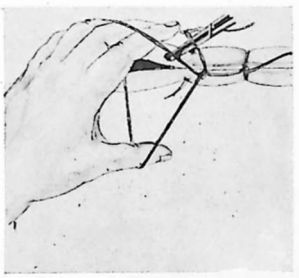


Fig. 1430

Fig. 1429. Torraca's continuous lock stitch. Render the suture tense about the fingers of the left hand which is held in supination as shown in the illustration. First crossing of the suture.
Fig. 1430. Torraca's continuous lock stitch. Moving the left hand into pronation accomplishes a second crossing of the ligature. Through the loop thus resulting a needle is passed.

the opposite side of the wound. Then the muscle, fascia and fat are approximated with many small-bite sutures of fine catgut. After closure of the skin, the tension sutures should be threaded into small rubber tubes before being tied, or some other means provided to prevent cutting into the skin under tension.

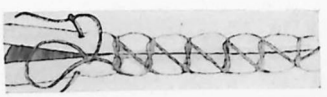


Fig. 1431. Torraca's continuous lock stitch completed.

Knots

It is essential that the surgeon should be quite dextrous in making certain knots which are used in tying sutures and ligatures. Such a knowledge can never be obtained by reading or watching others. The method of making these knots must be acquired by personal instruction and practice and mastered by constant repetition so that the fingers act subconsciously and mechanically in the proper way. The reef knot and the surgeon's knot are the most commonly employed in surgery. The reef knot, also called the flat knot and the square knot, consists of two simple knots placed in such a way that the end of the thread is carried in the

same direction through both loops (Figs. 1432-1433). The surgeon's knot is a variation of the reef or flat knot, differing only in that the first hitch consists of a compound knot instead of a simple knot. Its advantages are that when tying down the second hitch on to the first, slipping or sliding of the first hitch does not

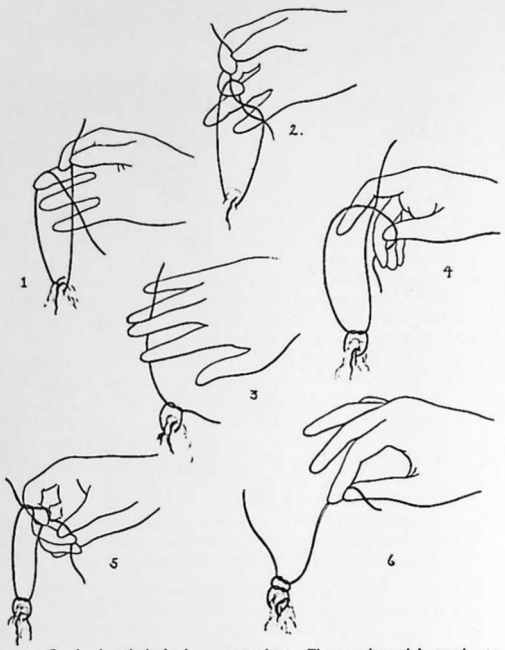


FIG. 1432. One hand method of tying a square knot. The opposite end is merely steadied.

occur and it is less likely to yield before an expanding force within the sutured tissues.

The knot is, perhaps, of more importance in the case of a ligature of an important blood vessel than of a suture. In this case sometimes a stay knot is employed having for its object also as large an area of obliteration of the lumen of the vessel as possible. Two separate ligatures are passed around the vessel, parallel to each other and side by side; the first hitch of a reef knot is tied in each ligature separately. Then the two ends are picked up on each side and these double ends

are tied as one into a simple knot after the manner of the second step of the reef knot.

Closure of a wound by continuous suture is best for bringing the margins of a wound into good approximation and keeping them so; but there is a disadvantage in continuous sutures in that if one part cuts out the approximation of the whole line is imperiled. According to the circumstances of the particular case it may be

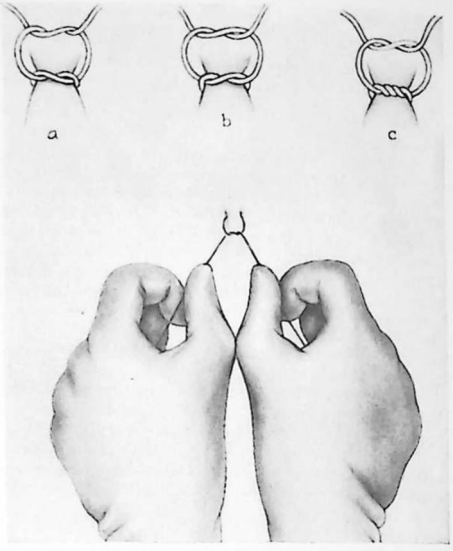


FIG. 1433. a. Square (true, flat or reef) knot; b. granny (false) knot; c, conventional reinforced surgeon's knot.

better to close each suture by a reef knot. When silkworm gut is used for closing the external layer of a wound, the best method of closing it is by the first stage of a true surgeon's knot. Never pull sutures too tightly when tying them or they may cut out and an unnecessary amount of scarring result; they should be just tight enough to keep the wound margins in apposition.

Through-and-Through Silver Wire Sutures

Reid, Zinninger and Merrel[1] laud the use of silver wire as a means of closure of the abdomen with through-and-through sutures in cases of acute abdominal emergencies. The method is not new. The entire thickness of the abdominal

[1] Annals of Surgery, Nov., 1933.

wall is embraced in the interrupted sutures (from skin to peritoneum inclusive). The most pliable wire should be used. Reid et al. procure it in one ounce lots which are rolled on a spool. The method is as follows:

Ten- to twelve-inch lengths of virgin silver wire, No. 20 gauge, are threaded on large, curved, cutting edge needles such as are ordinarily used for inserting 'traction' or 'tension' sutures. The short end is folded back over the eye of the needle and crushed flat with a heavy forceps so the wire will more easily go

FIG. 1434. Through-and-through silver wire suture. (Courtesy of Drs. Reid, Zinninger and Merrel.)

through the hole made by the needle. A clamp is fastened on the free end as is done with silkworm-gut 'stay' or 'tension' sutures. A series of clamps is placed on the edge of the peritoneum. All the silver wire sutures are then placed but not tied. For each suture the needle is started about one or one and a half inches from the edge of the incision and carried through the entire thickness of the abdominal wall, including the peritoneum. The suture is continued by bringing it out at a corresponding place on the opposite side of the incision. It is important that no kinks be allowed to get in the wire during this step as they are exceedingly difficult to get out smoothly. The needle is unthreaded and a clamp placed on the free end of the wire. A series of such sutures is placed about one and one-quarter

to one and one-half inches apart, five to eight being used to close the average incision. After all are placed, the clamps on the peritoneum are removed and the incision closed by pulling up and twisting each wire individually. Beginning at one end of the incision, the surgeon pulls up on the clamps at opposite ends of one suture. The first assistant puts a finger inside the abdomen and reports when the wire is pulled sufficiently tight to bring the peritoneal edges in firm contact. The wire is then twisted six to eight times just above one of the openings through which it emerges from the skin—not over the line of incision. Each wire is pulled up in succession and twisted (Figs. 1434-1435-1436-1437). It is extremely important that the desired tension be obtained before the twisting is started because the twisting is for the purpose of holding only and will not tighten the suture nor remove any slack in it. After all the sutures are fixed in this way, one or two

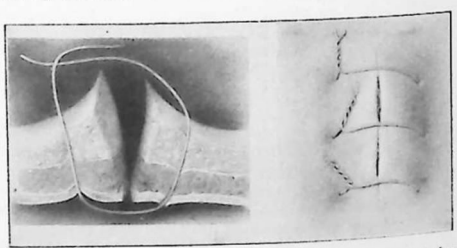


FIG. 1435. Diagram showing position of the wire and illustration of the wound after closure. (Courtesy of Drs. Reid, Zinninger and Merrel, Annals of Surgery.)

silk stitches may, if necessary, be placed in the skin between each two wires to prevent eversion or inversion of the skin edges. The wires are cut rather long, as they are easier to manipulate in the dressings if an inch or more of straight wire is free beyond the twisted part. No rubber tubing or other material is placed about the wires where they cross the incision or between the wires and the skin. There is usually some cutting of the skin under the wires before they are removed, but this has never constituted a serious complication of wound healing. Various modifications have been tried in an effort to prevent this cutting of the skin, but the method just described has been more satisfactory than any of the modifications. This entire procedure can be carried out in only a fraction of the time necessary for a formal closure of the incision in layers.

It is also possible by this method to close a wound which is under considerable tension or one in which the peritoneum fails to hold sutures but tears with each attempt to pull it together. The method is very valuable in all cases in which there is likelihood of infection.

While rupture of the abdominal wound in cases of gunshot wound of the abdomen occurred four times in the one year (1922), no case of rupture of an incision closed by silver wire during ten years was observed by Reid and his associates.

A separate closure of the peritoneum where this method is used is not necessary.

Objections and disadvantages of the method:

1. Patients, almost without exception, complain of pain in the incision; silver wire is more stiff than other suture material hence causes more discomfort.
2. There is usually some infection around the wire which may be minimal and the incision itself heals without infection; it is rare to have no discharge from the wire holes, although this is no greater than that which occurs around other types of "tension" or "stay" sutures in the same kind of cases.
3. There is usually some cutting of the wires into the skin, causing obvious cross-hatching of the incision (patients with tendencies to keloid formation may develop disfiguring scars).
4. The theoretical objections of incomplete closure of the peritoneum predisposing to hernia and obstructive intra-abdominal adhesions have not been borne out in fact.
5. Reid et al. have never seen a block slough of the tissue enclosed by the sutures.

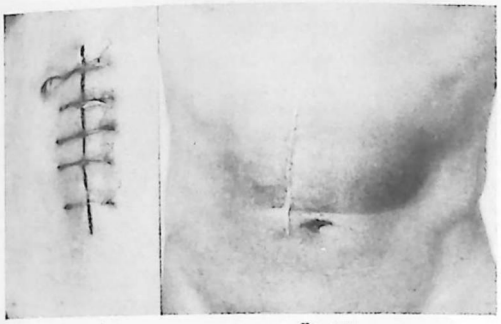


Fig. 1436 Fig. 1437

Fig. 1436. Photograph of wound five days after closure with silver wires.
Fig. 1437. Photograph of wound several months after through-and-through silver wire sutures. (Courtesy of Drs. Reid, Zinninger and Merrel, Annals of Surgery.)

ADVANTAGES

1. Secure closure. In spite of severe infection, Reid observed no case of postoperative rupture of the incision and no evisceration. In two cases of the 334 reviewed a loop of bowel or bit of omentum slipped out between the wires which were too far apart or not sufficiently tight. One additional case of this sort occurred in 1933 which is not included in this series.
2. The closure can be carried out very rapidly. This is obviously very advantageous in critically ill patients when speed of procedure is imperative.

3. The method may be used to close an abdomen under tension (cases of intestinal obstruction) when other sutures fail to hold.
4. The incision thus closed can be easily reopened by untwisting the wire in case a second operation is deemed advisable shortly after the original procedure. In such contingency, the wires can be pulled aside, the necessary procedure carried out, and the wires pulled up and retwisted.
5. In cases of peritonitis or potential infection (perforation of a hollow viscus), the closure with interrupted sutures allows peritoneal exudates to drain off between the sutures—no additional drains being necessary. The absence of suture material directly in the line of closure of a contaminated incision predisposes to better wound healing and reduces the liability to infection.
6. The closure is so secure that old and debilitated patients derive the benefit of leaving the bed early (five to seven days after operation).
7. The incidence of postoperative ventral hernia is no greater than after other, more formal types of closure in the same types of cases, so far as Reid has been able to determine, and in his series of cases where silver wire was used no eviscerations occurred.

Fig. 1438. Hyperadiposity of the abdominal wall.

Silver wire sutures used in this manner are ordinarily removed about sixteen to eighteen days after operation. If found too tight at any time, they can be loosened by untwisting them, allowing a little slack to be taken up by the wound, and retwisting them. Reid's et al. study of statistical data showed that the shortest time before all sutures were removed was ten days, and the longest any were allowed to remain was thirty-seven days. Ordinarily, part of the sutures are removed about the fifteenth or sixteenth day, and the remaining ones the seventeenth or eighteenth day, though at times all of them are removed at one stage.

Postoperative Rupture of Abdominal Wounds and Eventration (Evisceration).

Postoperative rupture of abdominal wounds often results from an inadequate closure of the peritoneum. Omentum and occasionally bowel forces itself between the loose sutures and in swelling acts as an expanding wedge which forces the tissues apart and prevents proper union, the process being aided by serous exudation or, perhaps, suppuration. A rupture may then be precipitated by the strain of vomiting or distention, especially when the fascia is involved. Massive adhesions and many postoperative hernias are similarly explained.

The late J. F. Baldwin of Columbus, Ohio, believed that too early removal of

the sutures is often responsible for postoperative eventration. It is also my belief that sutures are removed too soon. My practice is to remove abdominal wound sutures routinely on the eleventh day after the operation. Baldwin extended this period to fourteen full days routinely. At the end of fourteen days, should trouble be found in the wound, inflammation or suppuration, Baldwin counseled leaving the sutures in situ "until it is evident that all danger is past." To forestall eventration, he closes the peritoneum with a continuous suture of chromic catgut No. 2. The adjacent edges of the recti muscles are whipped together with a similar stitch and the aponeurosis closed with a third similar suture. Silkworm gut stay sutures are then inserted which take in the rest of the abdominal wall, no matter how thick, each stitch catching the preceding rows of catgut sutures down to and including a part of the rectus muscle. The skin is approximated by a continuous catgut suture. It is these stay sutures that are removed at the end of fourteen full days, or later as judgment may suggest. Since this procedure has been adopted, out of not less than 15,000 abdominal sections there has not been a single instance of eventration.

Fig. 1439. Enormous segment of skin, superficial, deep fascia and fat removed in one segment through author's crescentic incision for abdominal lipectomy on patient shown in the preceding illustration.

Often have I heard Dr. Karl Meyer comment on the hurried removal of sutures by interns alarmed at a serosanguinous discharge from the wound, when, as a matter of fact, this very discharge is a signal denoting an approaching disruption of the wound which should cause us to insist that the sutures be left alone and that their removal is sure to be followed by the very thing we are seeking to avoid.

OPERATION FOR PENDULOUS ABDOMEN

(Lipectomy—Adipectomy)

Often women develop excessively large pendulous abdominal walls (Fig. 1438). The skin and subcutaneous fat layer may become so disproportionate as to form a veritable "apron" in front of the thighs. German writers refer to the condition as "Hängebauch" (pendulous abdomen). This fat-apron may contain from 1-2,000 grammes of fat, or even more (Fig. 1439). Such conditions may often become trying to the patient; besides the weight, intertriginous conditions

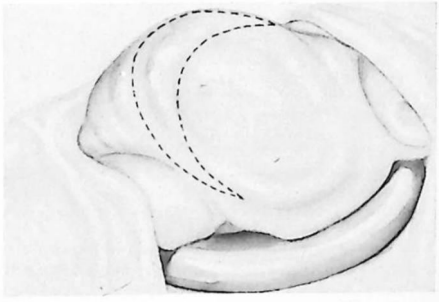


Fig. 1440. Author's crescentic incision for abdominal lipectomy.

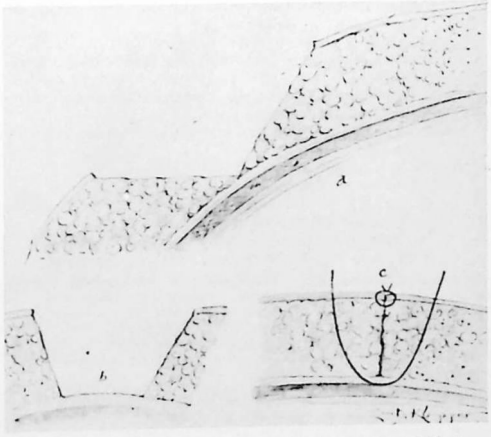


Fig. 1441. Hyperadiposity of the abdominal wall. Author's "wedge method" of resecting "fat apron." a. Correct direction of line of incisions. b. Wrong method of making excisions. Note that in (a) no fascia is exposed and in (b) an area of fascia is exposed not permitting proper approximation of the panniculus adiposus thus creating "dead spaces." c. Method of closure. One suture embraces the entire thickness of the fat layer and if there is a tendency to dead space formation a portion of the fascia is included in this stitch. The skin is united by interrupted sutures.

are apt to develop rendering the patient very uncomfortable. The condition is remedied by excision of the excessive cutaneo-adipose segment of abdominal wall.

Step 1. A crescentic incision depicted in Fig. 1440 has seemed to me to be best in this class of cases. The transverse crease usually present above the symphysis pubis is a good landmark for the lower incision to follow.

Step 2. Use a sharp knife. Carry the upper and lower incisions down to the fascia obliquely so that they meet at the fascia (Fig. 1441). If the incision is made perpendicularly, an exposed area of fascia results which, in order to be effectually covered, requires the undermining of the fat above and below, in order to properly approximate the edges of the wound. This should be avoided because it often results in fat necrosis and breaking down of the wound. Hemostasis must be meticulous and sponging of the exposed surfaces gentle.

Step 3. For tension sutures which embrace the entire thickness of the panniculus the button suture described under "Closing of the Abdomen" Fig. 1422, p. 1248, or interrupted silkworm gut sutures should be used. The skin may be united with clips or interrupted silk or Pagenstecher linen sutures. Where a tremendous mass has been ablated or where undue operative trauma was inflicted it is prudent to insert at each angle of the wound a wick of silkworm gut strands or a small cigarette drain which are to be removed after a day or two. Avoid dead spaces by obliterating irregular surfaces by interrupted catgut sutures.

Comment: This operation gives excellent results as long as the musculo-aponeurotic wall is not greatly taxed. If so, these should be reinforced. Adiposity does not recur in the area operated upon.

CHAPTER 33

SURGERY OF THE STOMACH

Historical Notes. Gastrostomy was proposed by Egelbert in 1837 and first performed by Sédillot in 1849.

Gastro-enterostomy.—(a) Anterior gastro-enterostomy (Wölfler's Operation) was suggested by Nicoladoni and first performed by Wölfler in 1881. (b) Posterior gastro-enterostomy (von Hacker's Operation) was suggested by Courvoisier in 1882 and performed by von Hacker in 1885. Gastroduodenostomy was done by Jaboulay in 1892. Gastro-enterostomy (Roux Operation) was done by Roux in 1897. Pyloric exclusion in conjunction with gastro-enterostomy, to frustrate vicious circle, was done by Doyen in 1893 and by v. Eiselsberg in 1895.

Jejunojejunostomy (Braun-Jaboulay) in conjunction with anterior gastro-enterostomy was done by Braun in 1892 and followed later by Jaboulay.

Pyloroplasty (Heineke-Mikulicz' Operation) was described by Heineke in 1886 and by Mikulicz in 1887.

Finney's Pyloroplasty or gastroduodenostomy was published in 1902.

Pylorectomy was suggested by Gussenbauer and Winiwarter in 1876 (experiments on dogs). The first pylorectomy was done by Péan in 1879 and by Rydygier in 1889. The first successful pylorectomy was done by Billroth (Billroth I) in 1881.

Partial gastrectomy was introduced by Billroth (Billroth I) in 1881 and the Billroth II (closure of the divided duodenum and stomach supplemented by gastro-enterostomy) in 1883.

Reichel's Operation of implantation of the open stomach into the jejunum was performed by Reichel in 1908. Pólya described the same operation in 1911. Reichel and Pólya's procedures were retrocolic. Balfour's modification of the Reichel-Pólya operation (1917) consists of an antecolic anastomosis supplemented by an entero-entero-anastomosis. Moynihan's modification of the Reichel-Pólya procedure was reported in 1920 and consists of a short loop antecolic anastomosis without entero-entero-anastomosis (Moynihan II). The Moynihan I modification is essentially as follows: Gastric resection. Division of a long loop of jejunum, the efferent loop of which is anastomosed with the stomach while its afferent opening is anastomosed with its lateral surface. The operation is retrocolic. In the Hoffmeister-Finsterer operation only the lower portion of the gastric opening is utilized for the implantation of jejunum.

Total gastrectomy was first performed by Connor of Cincinnati, 1883. The first successful total removal of the stomach was done by Schlatter in 1897.

Cholecystogastrostomy was done by Babcock in 1919.

Types of Gastric Operations (after G. Covina).

Gastrectomy

A. Partial.

B. Subtotal or Total.

Typical Resection

1. Pylorectomy
2. Midgastric resection (Riedel)
3. Prepyloric (Finsterer)
4. Pylorogastrectomy (Gastroduodenal resection).

Atypical Resection

1. Resection of the Lesser Curvature (saddle-form, cuneiform, longitudinal, falciform, rhomboid, etc.).

Gastric Resections and Gastroduodenostomy Operations (Péan-Billroth I).

1. Termino-terminal: Péan (1879); Rydygier (1880); Billroth (1881) typical pylorectomy.
   Variations: Goepel (1923); Horsley (1926); Babcock (1926) v. Haberer (1927) with resection of lesser curvature.
   v. Schmieden (1921); Luquet and Pauchet (1923); Schoemaker (1929).
2. Posterior Latero-terminal: Kocher (1895).

Anterior modifications.

Kustscha-Lissberg (1925); Pototschnig (1930).

3. Termino-lateral: v. Haberer (1922); Finsterer (1923); Winkelbauer (1927).
4. Latero-lateral: Alessandri-Oliani (1924); Leriche (1927).

Gastric Resections with Gastrojejunostomy Operations (Billroth II)

1. Anterior precolic: Billroth II (1885, atypical pylorectomy); (Schiassi operation en "Y," 1913).
   Retrocolic: Dubourg (1898).
2. Latero-lateral—Posterior—antecolic: v. Eiselsberg (1899), retrocolic Braun (1894), v. Hacker (1894).
   Marginal: v. Mikulicz (1887).
3. Latero-terminal—Posterior—retrocolic: Roux's operation en "Y" (1893).
4. Termino-terminal—Retrocolic: Rydygier's Operation en "Y" (1904) Moszkowicz (1908) Soresi (1921).
5. Termino-lateral—Total Antecolic—Krönlein (1887); Balfour; Moynihan II.
   Retrocolic: Reichel (1907); Pólya (1911).
   Sasse (1911) Moynihan I.
   Partial: Inferior stoma suggested by v. Hacker (1885); antecolic: v. Eiselsberg (1888); Cunéo's Operation en "Y" (1909).
   Retrocolic: Hoffmeister (1905), Wilms (1911), Finsterer (1911).
   Superior stoma: Schmieden (1921).

Anatomic Considerations. The Orifices of the Stomach. The cardiac orifice of the stomach is situated opposite the tenth dorsal vertebra in a position about half an inch to the left of the midline and three or four inches behind the sixth left costal cartilage. The pyloric antrum leads to the pyloric canal which terminates in the pyloric orifice. The latter normally admits the tip of the little finger. The patency of the orifice may be ascertained by invaginating the finger through the anterior wall of the stomach.

The Sphincters of the Stomach. (1) The cardiac sphincter (G. G. Shattuck) consists of a fairly widespread thickening of the circular muscle of the lower end of the esophagus and the upper part of the stomach. It is definite enough to be called a sphincter. On contraction it gives rise to a cardiac canal rather than a cardiac orifice. The sphincteric arrangement is situated entirely below the diaphragm. (2) The pyloric sphincter plays an important part in gastric digestion.

The Peritoneal Connections of the Stomach

(1) The gastrocolic ligament connects the greater curvature of the stomach with the transverse colon. It continues downward as the two anterior layers of

the great omentum. In it are contained the right and left gastro-epiploic vessels (Figs. 1442-1443-1444-1445).

(2) The lesser or gastrohepatic omentum is attached above to the portal fissure of the liver and partly to the diaphragm. The right free border of the lesser omentum forms the anterior boundary of the Foramen of Winslow. (Fig. 1446.) It contains in its thick portion (hepatoduodenal ligament) (a) the common bile duct; (b) the portal vein and (c) the hepatic artery. In the gastric attachment of this omentum are situated the pyloric (right gastric) and left coronary (left gastric) arteries.

(3) The gastrophrenic ligament courses backward from the cardiac end of the greater curvature to the diaphragm, and is joined on the posterior abdominal wall by a peritoneal fold known as the gastropancreatic ligament. This latter carries the coronary (left gastric) artery to the cardiac end of the lesser curvature of the stomach.

(4) The gastrosplenic omentum extends from the greater curvature in the region of the fundus, to the hilum of the spleen. It contains the left gastro-epiploic artery and the vasa brevia of the splenic artery.

All of these carry blood vessels, lymphatics and nerves.

Blood-Supply. The blood supply of the stomach is derived from the celiac axis which springs from the abdominal aorta and gives off three branches: (a) the gastric (left coronary); (b) hepatic and (c) splenic arteries. All of these give branches to the stomach (Fig. 1447).

GASTRIC ARTERIES

ARTERIES	SOURCE
Coronary (left gastric)	Celiac axis
Pyloric (right gastric)	Hepatic (Branch of celiac axis)
Gastroepiploica dextra	Gastroduodenal (Branch of hepatic)
Gastroepiploica sinistra	Splenic (Branch of celiac axis)
Vasa Brevia	Splenic (Branch of celiac axis).

GASTRIC VEINS

VEINS	EMPTIES INTO
Coronary (left gastric)	Portal vein
Pyloric (right gastric)	Portal vein
Gastroepiploica dextra	Superior mesenteric vein
Gastroepiploica sinistra	Splenic vein
Vasa Brevia	Splenic vein
Superior vein of Mayo	Pyloric vein
Inferior vein of Mayo	Gastroepiploica dextra veins

The Lymphatic System of the Stomach: (Figs. 1448-1449) A thorough knowledge of the disposition of the lymph nodes is essential, particularly in the treatment of carcinoma of the stomach. The lymphatics of the stomach take origin in two networks: one is situated in the mucous membrane, the other in the muscle. The mucous plexus from within the mucosa passes to the submucous plexus, which traverses the muscular coat obliquely and terminates in the subserous plexus. The latter also receives the lymphatics from the muscular coat; these are only indirectly connected with the lymphatics of the mucosa. It is for

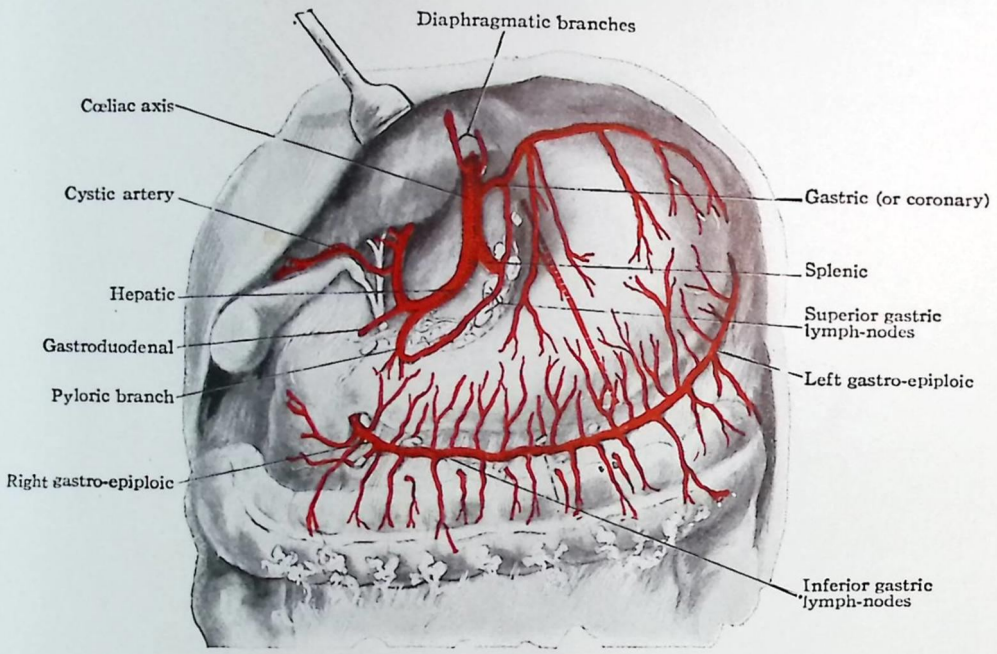


FIG. 1442. Blood supply and lymphatics of the stomach, and Hartmann-Mikulicz line.

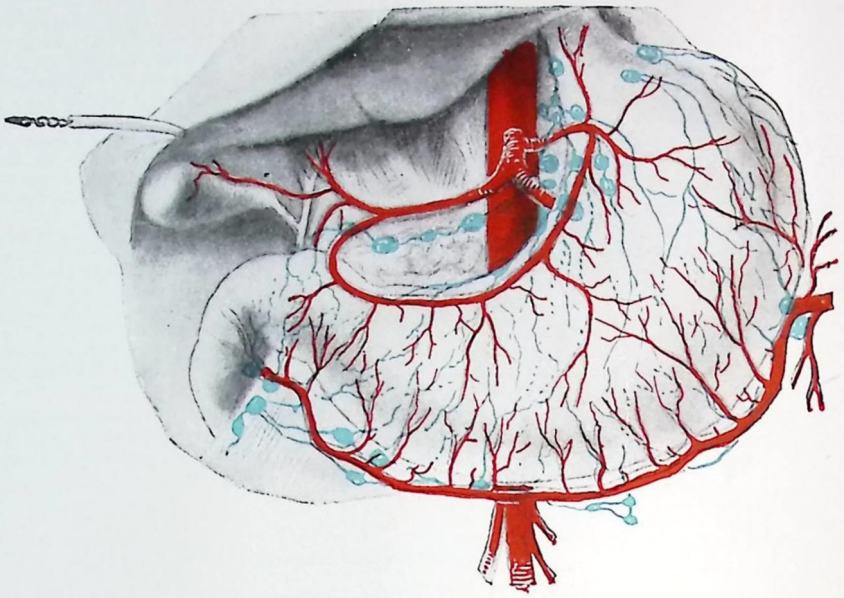


FIG. 1443

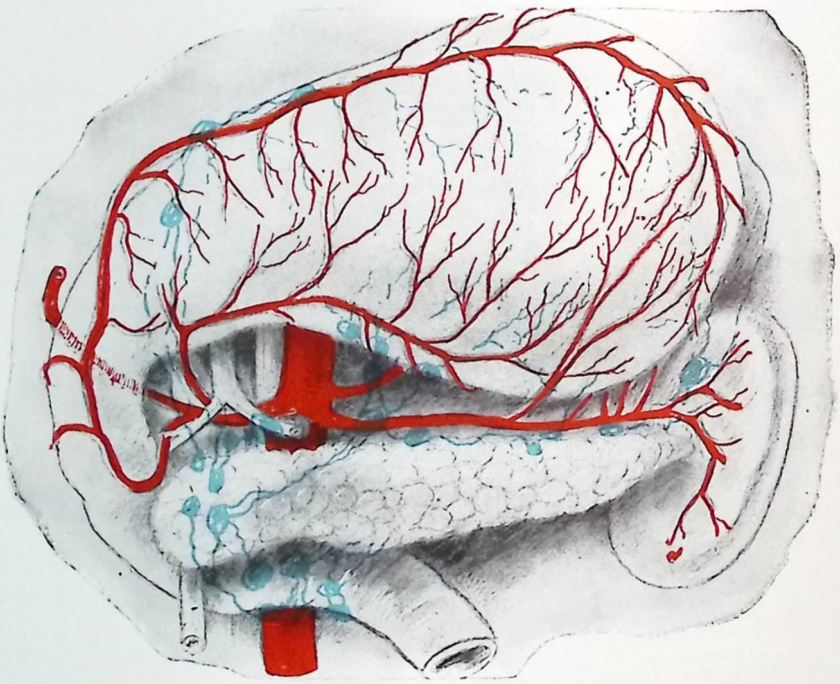


FIG. 1444

FIGS. 1443-1444. Lymphatics of stomach. A. Anterior. B. Posterior. Modified from Balfour.

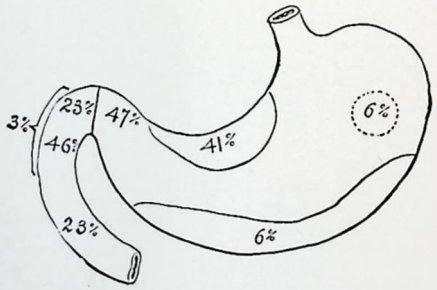


FIG. 1445. Frequency of ulcer. Stomach and duodenum. (Deaver.)

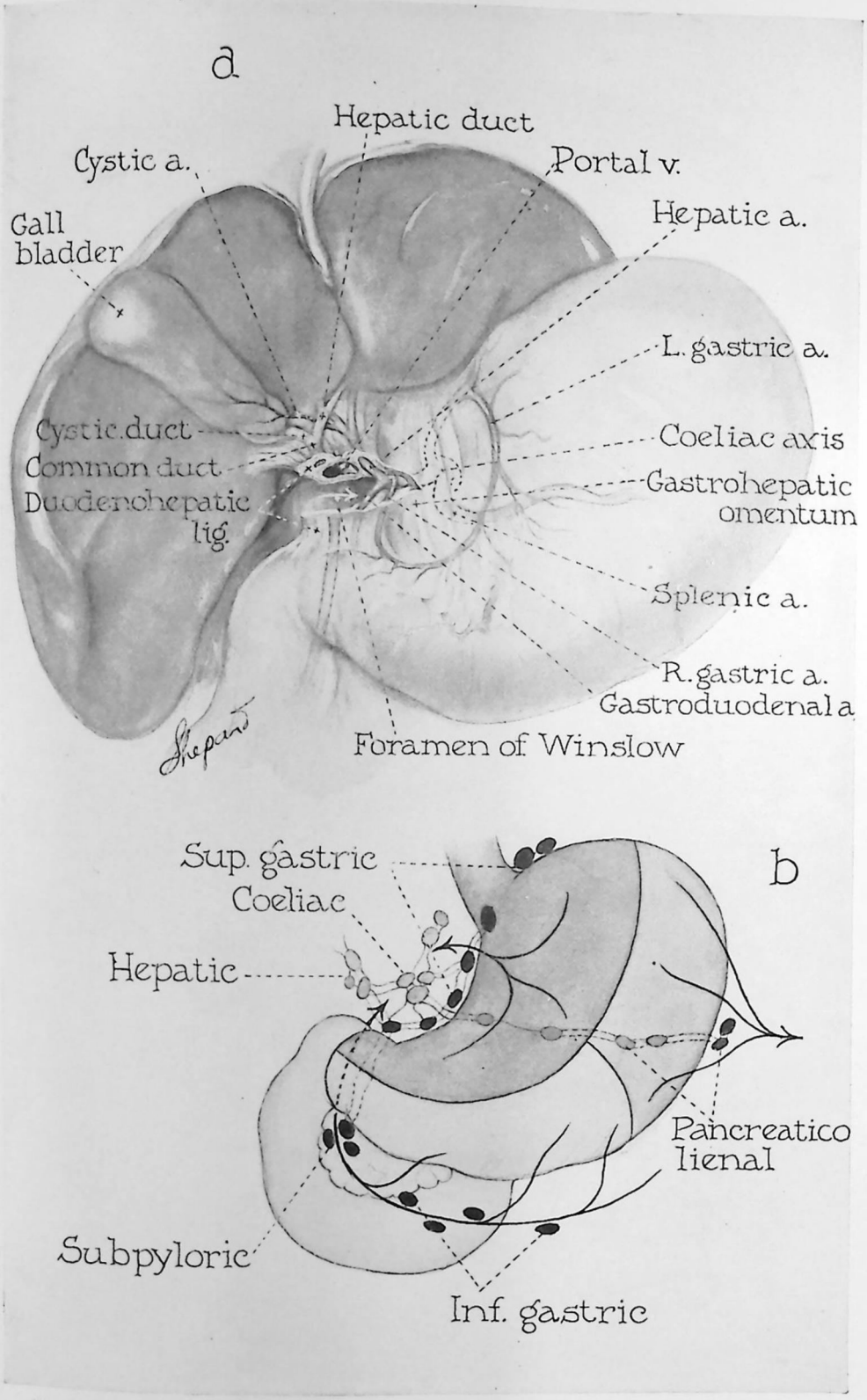


FIG. 1446. a. The foramen of Winslow and the gastrohepatic omentum. The duodenohepatic ligament has been divided and the structures therein indicated—the common duct, portal vein and hepatic artery. b. Lymph nodes and lymph drainage of the stomach.

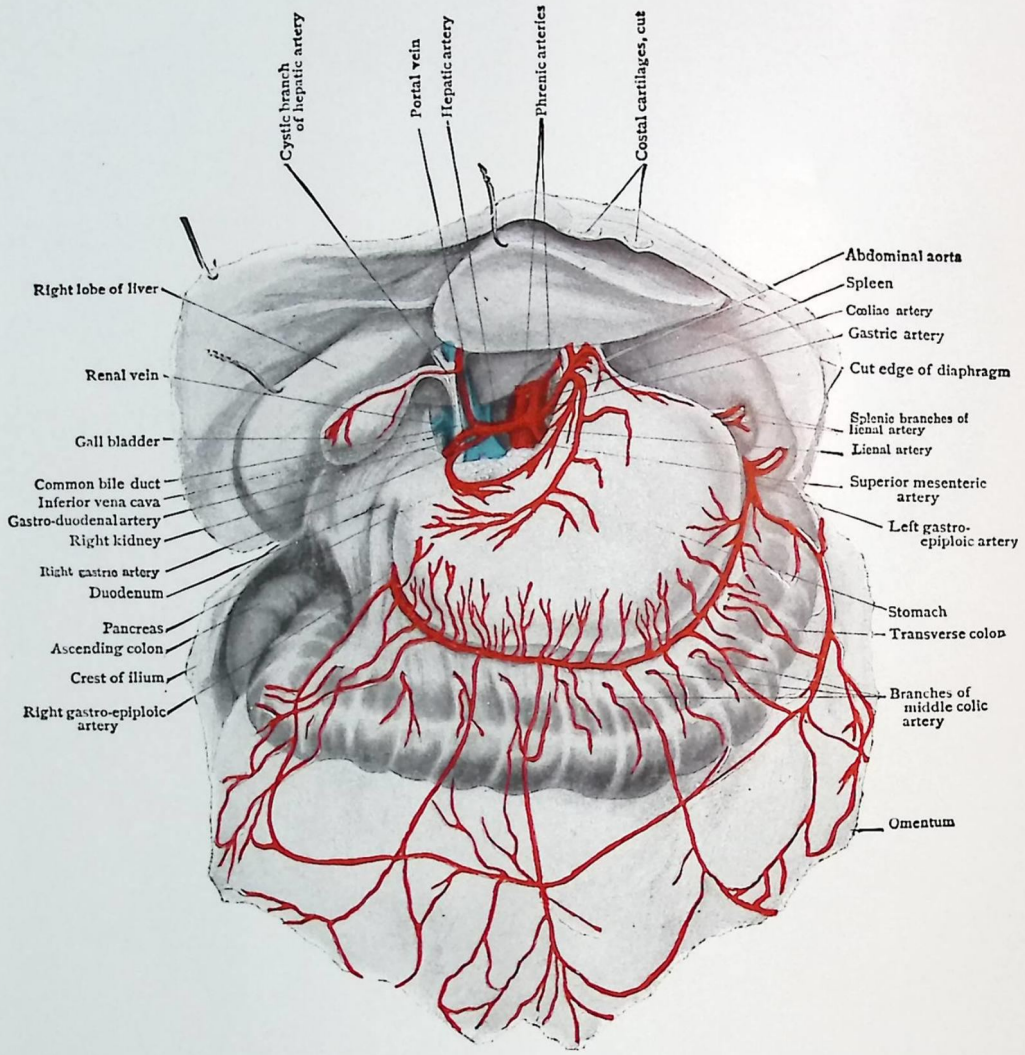


FIG. 1447. Stomach and its blood supply. (Piersol.)

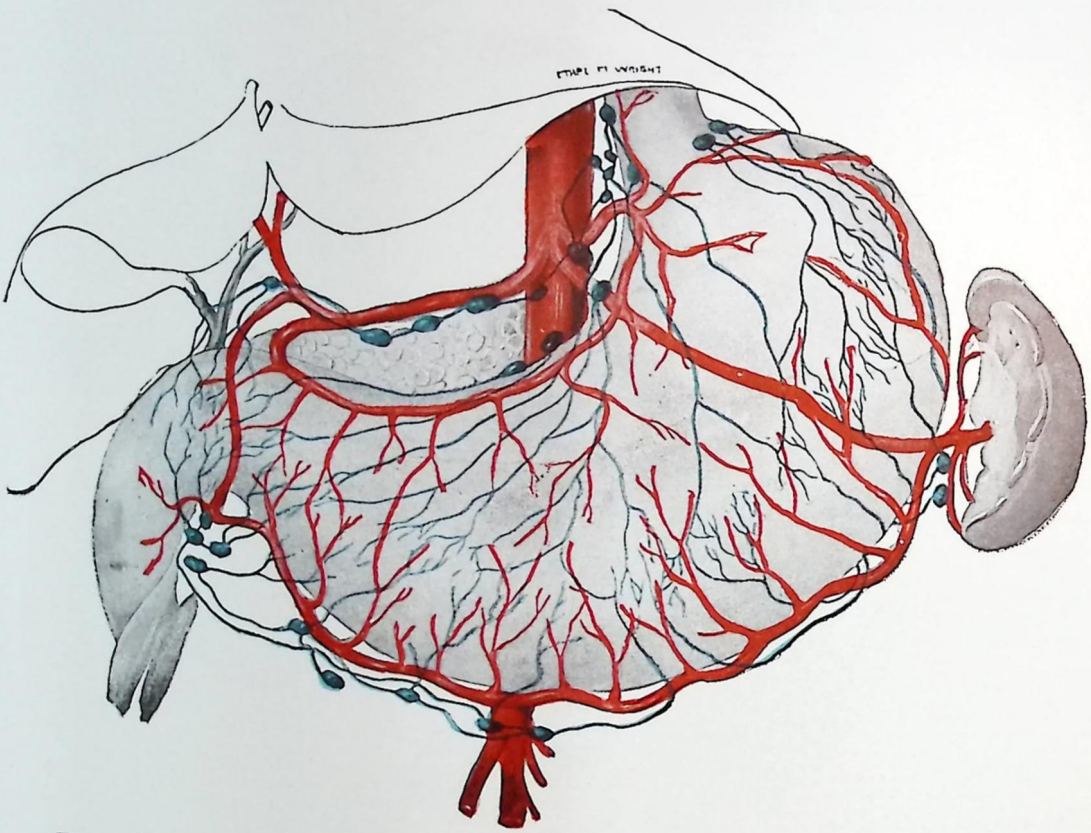


FIG. 1448. The arteries and lymphatics of the stomach. Anterior view. Diagrammatic. (Abdominal Operations, Moynihan, W. B. Saunders Co.)

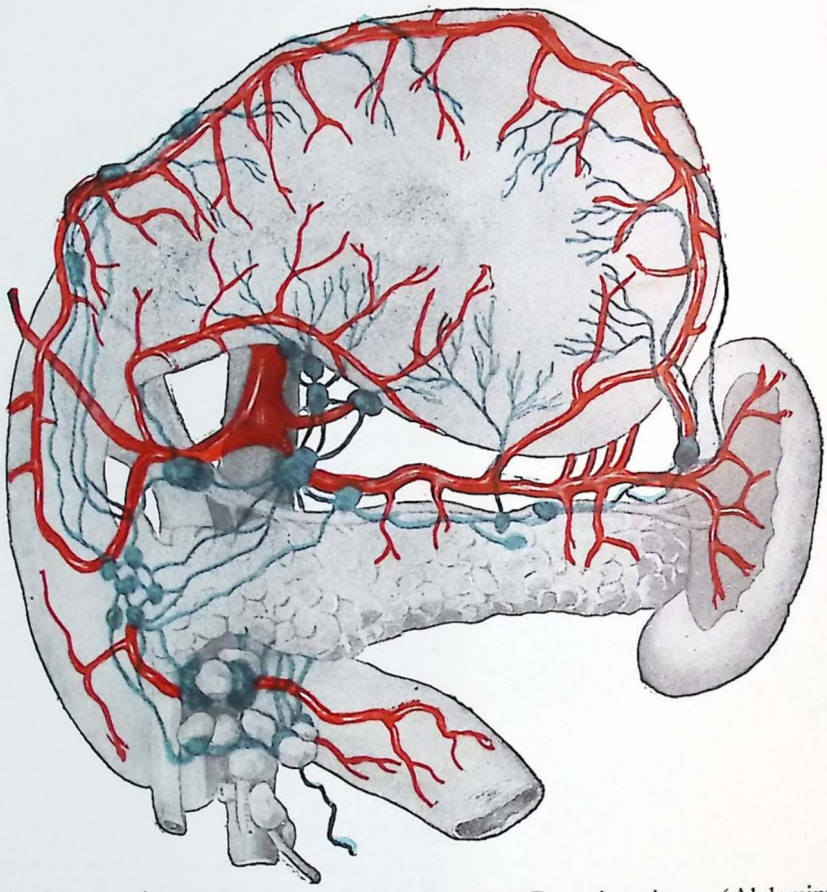


FIG. 1449. The arteries and lymphatics of the stomach. Posterior view. (Abdominal Operations, Moynihan, W. B. Saunders Co.)

the esophagus, and inspection of the interior of the stomach. Occasionally, the surgeon is called upon to remove foreign bodies under diagnoses different than

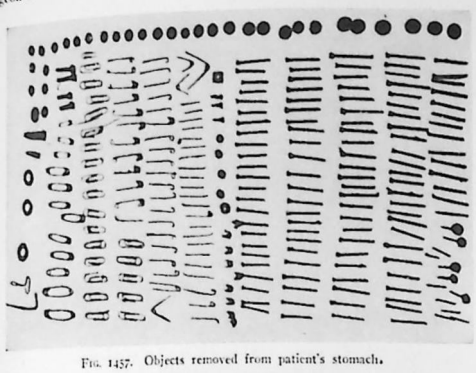


Fig. 1457. Objects removed from patient's stomach.

Fig. 1458. Phytobezoars in stomach diagnosed as carcinoma. Stomach filled with barium.

Fig. 1459. Same as preceding. Stomach empty. Outline of phytobezoars easily discernible.

the real cause of the symptoms. In one instance I removed (March, 1924)[1] 276 objects from the stomach of a professional "swallower" (Fig. 1457). The patient recovered.

[1] Internat. Clinics, Vol. III, Series 34.

On another occasion a patient was referred to me with a diagnosis of carcinoma of the stomach (Figs. 1458-1459) and at operation two large phytobezoars were removed. In this case a correct diagnosis was made prior to operation (Dr.

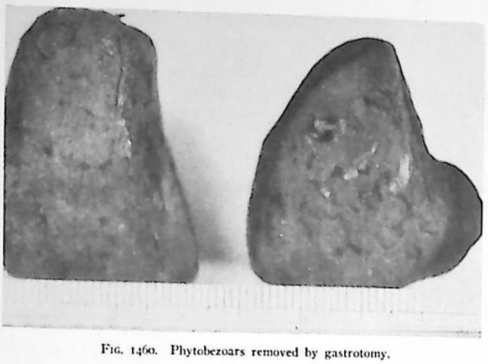


Fig. 1460. Phytobezoars removed by gastrotomy.

Phil Thorek) who elicited in the history that the patient had been eating persimmons to excess (Figs. 1460-1461).

Step 1. Make a vertical incision 4 inches long, about three-quarters of an inch to the left of the midline of the epigastric region. Clamp cloths to the edges

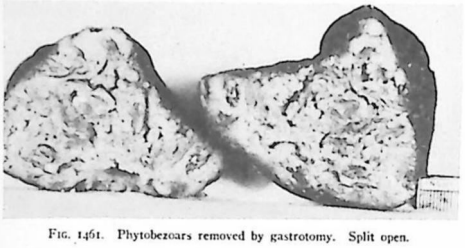


Fig. 1461. Phytobezoars removed by gastrotomy. Split open.

of the skin incision to avoid contamination. Incise the anterior sheath of the rectus muscle. Retract the rectus muscle outward.

Step 2. Incise the posterior layer of the rectus sheath and peritoneum, immediately back of the wound in the anterior sheath.

Step 3. Separate the involved portion of the stomach from the remainder of the peritoneal cavity by means of laparotomy pads. If a large exploratory

wound in the stomach is thought necessary, the incision should be made horizontally instead of vertically.

Step 4. After making an incision in the stomach of the right size and location, remove the foreign body by means of forceps. Before making the incision, however, insert a linen traction suture through the seromuscular layers just beyond each end of the proposed wound and lift up the line of incision. Locate the foreign body and enlarge the incision sufficiently so that no tearing or stretching of the stomach wall will be necessary in removing it.

Step 5. Close the wound with a row of through-and-through continuous sutures of No. 1 10-day chromic catgut, pulled tight enough to check bleeding, inverting the edges so that there is no protrusion of mucous membrane.

Step 6. Lay aside all articles that have touched the mucous membrane; put on a fresh pair of gloves; replace the outer layer of laparotomy pads with fresh ones. Insert continuous Lembert sutures with fine Pagenstecher linen.

Step 7. After removing the pads, bring the edges of the abdominal wound together with layer sutures.

No water is given per mouth for 12 hours, but may be administered by venoclysis. The patient is not fed for one or two days, depending upon the size of the stomach incision, the patient's need for nutrition and the presence of vomiting. This operation is not considered dangerous, if care is exercised so that the peritoneum does not become infected and if the wound in the stomach is properly sutured so that no bleeding or leakage takes place.

GASTROSTOMY

If we consider that the literature discloses more than thirty operative procedures for the performance of gastrostomy one must conclude that most surgeons are not entirely satisfied with the methods in vogue.

The two great pitfalls in gastrostomy as performed today are:

First, it is difficult to render the stomach watertight and consequently egress of gastric contents often causes excoriations and cutaneous macerations which render the patient most uncomfortable.

Second, the difficulties commonly encountered with operations in vogue.

INDICATIONS FOR GASTROSTOMY

1. Mechanical interference with deglutition from diverse causes.
   (a) Carcinoma of the oropharynx and esophagus.
   (b) Tuberculosis of the oropharynx and esophagus.
   (c) Stricture (benign) of the esophagus.
2. Syphilis of the esophagus.
3. Atony of the stomach not yielding to ordinary measures (extreme forms).
4. Laryngeal tuberculosis.
5. Carcinoma of the cardia of the stomach.
6. Carcinoma of the larynx.
7. Cardiospasm not yielding to ordinary treatment.
8. Dysphagias from any cause not yielding to medical intervention.
9. As an avenue for radium in carcinoma of the esophagus and stomach.

Historical Notes. Gastrostomy was one of the earliest operations employed by surgeons. Egelberg, a Norwegian military surgeon, advised its performance for cases of esophageal stricture, at the meeting of the Christiania Medical Society in

1837. However, he did not perform the operation. Bassow, in 1842, and Blondlot, 1843, performed it on dogs. Sédillot was the first to perform the operation on a human being in 1849 and later in 1853. Both patients died from peritonitis, a usual sequela of abdominal operations in pre-antiseptic days. After that, there were many unsuccessful attempts to perform this operation on a human being. The first successful attempt, however, was made by Sydney Jones in 1875. This was the thirty-third attempt to perform it on a human being. A little later, in 1876, a French surgeon, Verneuil, modifying Sedillot's method, performed it also successfully.

The operation performed by Verneuil was such a rarity that his patient made it a means of livelihood, going from city to city demonstrating his fistula. This method was used by many surgeons until 1886, when von Hacker proposed his technic. At that time one great obstacle usually met the surgeon, namely the opening of the stomach was not watertight and the acid gastric contents, escaping from the lumen of the stomach, contaminated the peritoneal cavity producing fatal peritonitis, or irritated the skin producing painful eczemas, so that many patients would prefer to starve from the original illness than to suffer from the excruciating pain produced constantly by the acid gastric contents irritating the eczematous skin.

To obviate this danger the early operators preferred to perform a "two-stage" operation. They sutured the anterior wall of the stomach to the anterior abdominal wall, leaving it for four or five days until secure adhesions were formed between the exposed surfaces. Then the stomach was opened. But, as already stated, these methods were not satisfactory because the gastric contents escaped through the new stoma. Different means were devised to make the stomach watertight.

(1) Formation of a cone of a part of the stomach, the cone being retained in position by various devices. To this class belong: (a) Hahn's method and its modifications (Heussner). (b) Ssabanejew-Frank's method and its modifications (Helferich, Jaboulay, Lucy).

(2) An attempt to make a sphincter of the abdominal wall: (a) Von Hacker; (b) Girard.

(3) An attempt to form a sphincter in the stomach wall itself: (a) Ullmann's method.

(4) Operations in which a canal is made on the anterior gastric wall so that the canal is lined with serosa: (a) Witzel's method, etc.

(5) Operations in which a canal is made in the thickness of the anterior gastric wall and which is not lined with serosa: (a) Marwedel's method, (b) Schnitzler's method, (c) Fisher's method.

(6) Depage, of Brussels, in 1903, and Janeway, an American surgeon, in 1913, in order to obviate the agglutination of the serous surfaces encountered in the Witzel and other procedures, formed a tube from the anterior wall of the stomach. This tube, being lined with mucous membrane, did not close and thus a distinct step in the right direction was taken.

(7) The next objection to overcome was to render the opening in the stomach leakproof. This was effectually accomplished by Professor Fontan of Toulouse who in 1896 described his method of valve-formation before the French Congress of Surgery stating: "The aim of my operation is to establish a gastric stoma so constructed that the escape of the gastric juice will be impossible. I have adopted this idea of a valvular operation based on Péniére's experiments. In my operation not only the mucosa but all the coats of the stomach enter into the formation of the valve. I build the valve in one sitting by the aid of a simple operative procedure. There has never been detected any leakage of gastric juice or of gastric contents following this operation, and there has never been present any excoriations. There has never been present any ulcerations."

(8) Formation of a tube from a loop of Jejunum implanted into the anterior wall of the stomach: Tavel's method.

Janeway described the method of Depage without knowing the latter's work in 1914. The Janeway-Depage method was modified by Pierre Rhéaume (see p. 1376) in 1930 and Quick and Martin in 1928.

(9) In 1893 L. Péniéres[1] described a method of gastrostomy by forming a valve "by a method of plaiting the mucous membrane" of the stomach, and in 1899 Watsudji, H.[2] borrowed the idea of Fontan's valve-formation and combined it with Von Hacker's procedure.

(10) In 1929 Julius Spivack borrowed the ideas of Janeway and Depage (tube formation) and Péniéres-Fontan's (valve-formation) combining the two and calling the procedure Tubo-valvular gastrostomy.

Comment: Of all the methods of gastrostomy thus far described, the tubo-valvular combination worked out by Péniéres-Fontan-Janeway-Depage and Spivack is the best. The Depage-Janeway idea of tube formation was not only adopted by Spivack, but Pierre Rhéaume of Montreal also took advantage of it and created a continent tubal duodenostomy (see p. 1376). It must be stressed, however, that tubovalvular gastrostomy requires much technical skill to perform and unless resorted to by one of much experience, it is better to resort to the simpler methods of gastrostomy described in the text.

What Should an Ideal Gastrostomy Be?

1. It should be lined with mucous membrane (Depage-Janeway operation).
2. It must not permit leakage of gastric juice and ingesta (Fontan operation).
3. No catheter should be needed between feedings.
4. Introduction of a tube for feeding, retrograde esophagoscopy, gastroscopy, retrograde bouginage and radium therapy should be easy.

Pitfalls Complicating Gastrostomy.

Aspiration pneumonia may occur even under local anesthesia.

The nearer a gastrostomy is to the cardia, the better.

Avoid venous stasis about the tube.

Dropping out of the tube as in the Witzel operation.

Injuries to the omentum.

Lindner reports a case of peritonitis as a result of necrosis of the omentum.

Infections are common. Saprophytic contamination (in carcinomatous tissue) adds greatly to infection.

Leakage of gastric juice through stitch-holes in the suture line of the stomach or tube, causing peritonitis (Anders and Kraske). The placement of sutures is important. If placed too closely, marginal necrosis results; if too far apart, dead spaces ensue.

Cutting out of sutures (Marvedel).

Contracted stomachs offer greater difficulty for the performance of gastrostomy.[3]

Prolapse of the mucous membrane of the stomach, particularly in the methods of Kader, Senn, Stamm, Hahn, Hans and others.

Acute dilatation of the stomach.

Persistent vomiting.

In an ordinary gastrostomy, if the whole thickness of the stomach is not taken in, fixing the rubber tube, the latter remains insecure.

Food may find its way between the tube and the stomach causing infection.

[1] Arch. Prov. de Chir. Paris 1893 11. 204.
[2] Mitteil d. Med. Ges. Tokio xiii 079.
[3] See author's method of remedying this condition, p. 1293.

Contamination of the fistulous tract may cause serious damage to the skin.

Prolapse of the stomach.

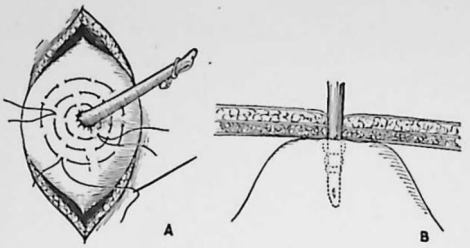


FIG. 1462. Gastrostomy. Stamm's operation. A. Three purse-string sutures of linen are placed around catheter fastened in stomach as shown in the illustration. When inverted they form a valve of the stomach wall. B. Operation completed showing catheter in place surrounded by inverted stomach wall. Note stomach attached to the parietal peritoneum.

Ciechomski reports a case in which incarceration in the fistula resulted after heavy lifting, two years after the gastrostomy was performed.

The types of gastrostomies used nowadays will be described.

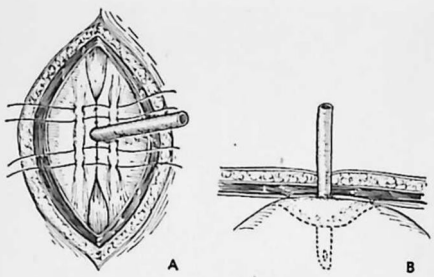


FIG. 1463. Gastrostomy. Kader's operation. A. After opening the stomach and fastening an appropriate sized catheter into it two sutures are placed above and below the entrance of the catheter into the stomach forming a vertical fold. These sutures are of the Lembert type and are passed through the muscularis and serosa. They are shown tied. The second row of sutures are shown placed ready to be tied. B. Cross section of completed operation.

Kader's or Stamm's Operation

Step 1. Open the abdomen and expose the stomach (Figs. 1462-1463).

Step 2. From the junction of the body of the stomach and its pyloric portion pull into the wound a fold of the stomach from near the greater curvature. Make an incision about the thickness of a lead pencil, dividing the serosa and muscularis.

Step 3. Pick up the mucosa and open the stomach. Introduce a soft rubber catheter into the opening thus made. Clamp the end protruding from the stomach.

Step 4. Fix the tube to the gastric wound with one or more interrupted chromic catgut sutures.

Step 5. Introduce a tier of Lembert sutures through the serosa and muscularis as shown in the illustration. Depress the stomach and the tube and the inversion (invagination) resulting will form a valve projecting into the interior of the stomach.

Step 6. Superimpose a second row of sutures to accomplish the invagination.

Step 7. Unite with Lembert sutures the stomach to the anterior abdominal wall (parietal peritoneum).

Step 8. Close the abdominal wall above and below the tube.

Shallow's Modification of Kader's Operation

Thomas A. Shallow[1] describes a modification of the Kader operation based on thirty-two gastrostomies.

Step 1. Make an incision four inches in length, under local anesthesia, at the upper margin of the left rectus muscle.

Step 2. Expose and identify the stomach.

Step 3. Place a stay stitch in the stomach and draw the stomach through the incision. Note the level of the cardiac entrance to the stomach and choose a point to the left of the cardiac entrance.

Step 4. Divide the stomach wall down to the mucous membrane, through a very small incision.

Step 5. Pick up the mucous membrane with a small rat-tooth forceps through this opening. Ligate the blood-vessels before the mucous membrane is divided just large enough to admit a 22 French soft-rubber catheter.

Step 6. Fix the catheter with a No. 1 catgut stitch so that three-eighths of an inch of the catheter is permitted to pass into the stomach cavity. The advantages of this very small opening are: prevention of hemorrhage, elimination of the hemostatic stitch layer, lessening the possibility of leakage of the stomach contents and prevention of regurgitation of liquid around the catheter.

Step 7. Place one or two purse string stitches around the tube. From now on the object is to throw a diamond shaped fold of the stomach wall around the tube, the upper and lower points of the diamond toward the greater and lesser curvature respectively, with the tube in the center of the diamond. Lembert stitches are used so that a small fold is thrown distal to the tube at the points of the diamond which are one to one and a half inches on each side of the tube. As the tube is approached a larger surface is included in the stitch so that at the level of the tube, the greater area of the stomach is included in the stitch and thrown around the tube.

Step 8. Attach the wall of the stomach to the parietal peritoneum. This step is necessary as a great many patients after they have been discharged from the hospital permit the tube to remain out too long and it is then necessary to dilate the channel. Such dilatation is effected by passing a probe through

[1] Annals of Surgery, July, 1932.

the opening and using uterine bougies of increased caliber to bring it up to the proper dimensions. If the stomach has not been fixed to the parietal peritoneum, this is much more difficult.

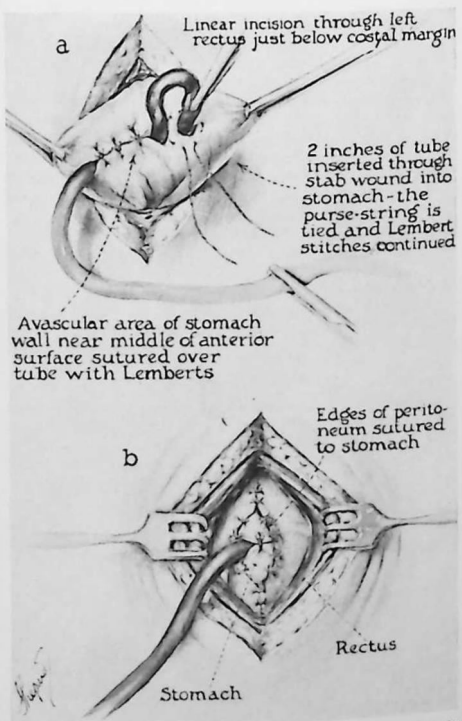


FIG. 1464. a. Gastrostomy (Witzel). Two folds of stomach wall are brought together over the tube leaving no gaps between sutures; after the tube is inserted it may be transfixed to the stomach mucosa. b. The abdominal wall is closed in the usual way above and below leaving a small opening for the tube to emerge.

Comment: While the procedure described may not seem to be necessary to the average surgeon who does the occasional gastrostomy, Shallow found that in lye strictures, particularly in children where the stomach is found

shrunken, it has been necessary to approach the fundus and use the diamond-shaped area in order to get a proper channel for the passage of the tube.

Fig. 1465. Witzel's gastrostomy seen from within.

Witzel's Gastrostomy

The incision, delivery of the stomach and orientation are the same as in the previously described procedure. Introduce two inches of tube (a catheter about No. 25 French) through a stab wound in the stomach. Tie a purse string around it (Fig. 1464 a); fix the catheter to the gastric wound with one or more catgut sutures. Lay the unattached portion of the tube along the surface of the stomach and bury it there either by a row of interrupted or a continuous Lembert suture passing through an avascular portion of the stomach wall. This results in a canal which is lined with serosa and extends along the surface of the stomach for about two or three inches. The outer opening of the canal is united with sutures to the parietal peritoneum of the anterior abdominal wall and the free portion of the tube is brought out of the abdominal wound (Figs. 1464 b-1465). Close the abdominal wall, above and below the tube.

Fig. 1466. Gastrostomy. Ssabanejew-Frank's operation. In the lower incision one observes the fundus of the stomach attached to the parietal peritoneum and posterior sheet of the rectus muscle. Through the incision above another portion of the stomach is brought out after running a tunnel under the skin.

SSABANEJEW-FRANK-ALBERT KOCHER GASTROSTOMY

Step 1. This operation consists of delivering a cone of stomach through a high upper left rectus incision and passing it through a subcutaneous tunnel.

Step 2. The apex of the cone is brought out through a short incision just above the left costal arch to the edges of which the open cone is fastened after closing the primary incision below it. (Fig. 1466.)

Comment: This operation is often difficult to perform. A prerequisite to its successful performance is a sufficiently large stomach—a condition which does not often pertain, in carcinoma of the esophagus, for example.

Tavel's Gastrostomy

In this operation a tube fashioned from a resected portion of the small intestine is fastened between the anterior abdominal wall and the stomach. While ingenious, this operation is difficult of performance and not recommended for general use.

Tubo-Valvular Gastrostomy*

In this technic the valve allows the food to be introduced into the lumen of the stomach, and hermetically closes the stomach whenever the intragastric pressure is increased, thus preventing an escape of the food through the tube (Figs. 1467-1468).

Step 1. A quadrangular area is outlined on the anterior wall of the stomach three inches long and two inches wide (if, however, the stomach is not large enough for this, it may be made two and one-half inches long and two inches wide). A forceps is placed at each angle of this quadrangular area (Fig. 1469 a).

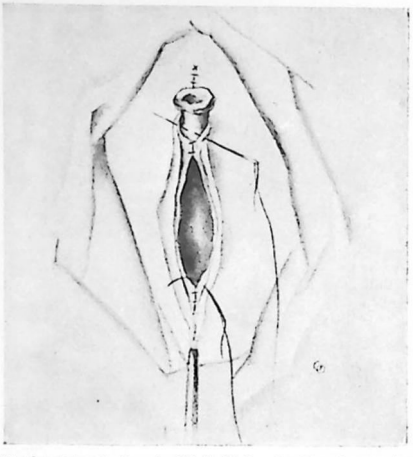


Fig. 1467. Fixation of the tube through which food is introduced into the stomach to the layers of the anterior abdominal wall in tubovalvular gastrostomy.

Step 2. A seromuscular suture is made at the upper points of the incision. The distance between these is from one to one and one-third inches. An artery-forceps or sound is placed behind the threads connecting the incisions. The ends of the thread are also tied, and an artery-forceps is placed on one end of the thread and with the other end of the thread on the needle the next step is performed.

Step 3. The two ridges thus formed are sutured together by a continuous seromuscular suture. Thus, the upper half of the flap is doubled. The artery-forceps or probe, lying behind the bridge of folded stomach wall is now withdrawn.

* For the history, evolution and priority claims of this operation see "Historical Notes," p. 1280.

Step 4. Two seromuscular vertical incisions connecting with the lower angles of the quadrangular area are made, and also a transverse incision connecting these lower angles with each other. In order to prevent the contraction of the seromuscular layer while making the transverse incision each lower angle of the flap is caught by an Allis forceps before the transverse incision is made. If large blood vessels are seen on the mucous membrane they may be ligated before the mucosa is opened. Some prefer to ligate only the blood vessels which lie close to the stomach-wall and not those which are close to the flap. However, they all may be ligated before the mucosa is incised.

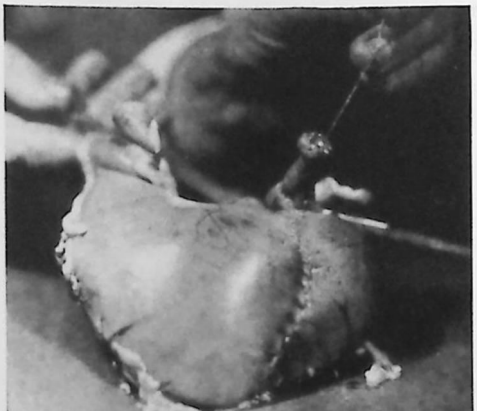


Fig. 1468. Tubovalvular gastrostomy. Note tube made from anterior wall of stomach. (Dépage-Janeway.)

Step 5. The exposed mucosa is cut and the flap reflected. A valve at the base of the flap is then clearly seen (Fig. 1469 b). Two buttonhole sutures are then made, one penetrating the upper two corners of the flap and the other passing through two points at the base of the flap. The ends of both are tied and clamped. The lower angle of the stomach-incision is grasped by Allis forceps. The ends of the two previously made sutures, which are the beginning and the end of the seromuscular suture which connected the ridges to each other, are now cut short, thus completing the formation of a Péniére-Fontan valve.

Step 6. An artery-forceps (or as I prefer, a short sound I devised having a small ring attached in the front, and at the top, and used for orientation) is inserted into the stomach through the tube thus formed. The opening into

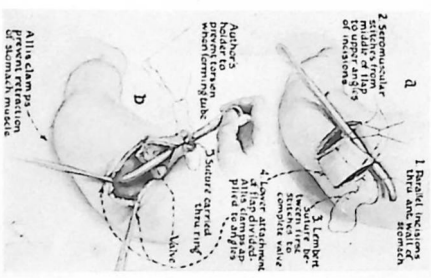


Fig. 1469. Tubovalvular gastrostomy. a. Formation of a Dépage-Janeway tube. The seromuscular stitches are both tied over authors sound before the continuous Lembert suture is applied. b. Beginning suture of Dépage-Janeway tube. A Lembert or through and through suture may be used.

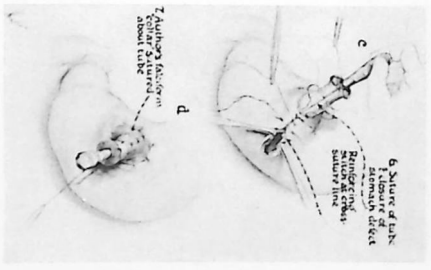


Fig. 1469. c. The Dépage-Janeway tube has been completed and the closure of the stomach is in progress. A reinforcing stitch is placed at the vulnerable point where the longitudinal suture line of the tube crosses the original incision. The "dog ears" are approximated on the tube opposite to the closing suture line.

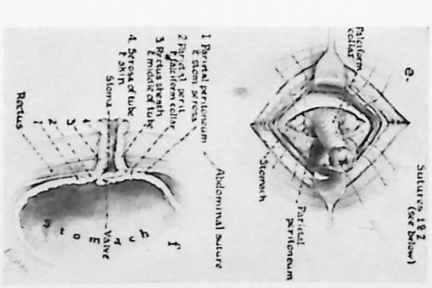


Fig. 1469. e and f. Abdominal implantation of the tube. The anterior wall of the stomach and the base of the tube are sutured to the parietal peritoneum. Firm anchorage of the tube is imperative.

the stomach is closed by an over-and-over suture, as also are the lips of the tube. When the first layer is completed it is reinforced by a second seromuscular layer (Fig. 1469 c). Thus a classical Dépage-Janeway tube results.

Step 7. The weak spot at the junction of the suture-line of the tube with that of the stomach is now reinforced by three interrupted seromuscular sutures or a "collar" of the falciform ligament is made (Fig. 1469 d); (vide infra).

Step 8. The anterior wall of the stomach is sutured to the parietal peritoneum. A bite is taken on the parietal peritoneum and the posterior sheath of the rectus muscle of one lip, then through the seromuscular layer of the stomach at a point just below and proximal to the base of the tube, and then through the peritoneum and the transversalis fascia of the other lip, and the ends are tied. The same is done to connect the peritoneum and the transversalis fascia of one lip with the stomach at a point lying below and distal to the base of the tube, and then through the peritoneum and the transversalis fascia of the other lip, and the ends are tied. Before tying the thread, care should be taken to see that the tube is not constricted. At this point I surround the "vulnerable point" with a graft obtained from the ligamentum falciforme hepatis to secure greater assurance against possible leakage. The rest of the peritoneal cavity is then closed in the usual manner.

Step 9. The wall of the tube is then sutured to the muscles and to the fascia in the same manner as described in Step 8 (Fig. 1469 e and f).

Step 10. The skin is attached to the tube in four places. The sutures penetrate the subcuticular layer of one lip of the skin and then the seromuscular layer of the wall of the tube, at a distance about half an inch from its open end, so that a portion of the tube will protrude above the surface of the skin, thus eliminating the danger of retraction of the mouth of the tube below the skin surface. The mucosa covers the portion of the tube which protrudes above the skin in the form of a rosette thus preventing the harmful action of the air upon the serous layer of the protruding portion of the tube.

A tube is thus formed, which is lined with mucosa and, therefore, the canal will not become obliterated. The valve at the base of the tube assures the watertightness of the stomach.

Confronted, as every surgeon is, with the imperative demand for gastrostomy, I have studied the operation carefully. It has been my lot to experience a leakage from the junction between the tube made from the anterior wall of the stomach at the point where it joins the stomach wall.

It now remained to reinforce the weakest point of the operative area, namely, where the tube joins the stomach. For this, R. W. McNealy makes use of the omentum through which he pulls the tube.

I felt that making use of the ligamentum falciforme hepatis as a protective layer over the suture line might answer the purpose. This I have carried out. This ligament, being composed of two layers of peritoneum closely united, seemed to me ideal for the formation of a "protective collar" around the tube and suture line. The thus gained serous surfaces of the collar promptly agglutinate with the parietal peritoneum of the anterior abdominal wall and with the serosa on the anterior wall of the stomach. Additional security from leakage from the base

is thus obtained and egress of gastric contents from the tracts made by the needle, to which I have previously alluded, is effectively prevented.

At first glance it might seem unjust to take a ligament of the liver and use it for the purpose of forming the "collar" described, but if we keep in mind that the falciform ligament, in the words of Gray ". . . gives no support to the liver" it at once becomes apparent that it might be mustered into valuable service in this connection.

Such agglutination of the serous surfaces of the newly formed "falciform collar" to the surrounding structures (along the suture line of the tube and to

Fig. 1470. The use of the completely detached falciform ligament to reinforce suture lines on the stomach. Low power magnification. 1. Mucosa of stomach; 2. submucosa; 3. muscularis; 4. and 4'. two focal areas of suppuration which are walled off by the attached falciform ligament; 5. serosa and subserosa of stomach; 6. exudate of fibrin (undergoing very early organization) which is agglutinating the falciform ligament to the serosa; 7. falciform ligament.

the anterior wall of the stomach as well as to the parietal peritoneum) aids normal healing of the structures.[1]

The falciform ligament "collar" above referred to requires some further comment: (Figs. 1470-1471-1472). The falciform ligament of the liver is a crescentic fold of peritoneum which is attached by its convex border to the inferior surface of the diaphragm and to the anterior abdominal wall (2.5 cm. or more to the right of the median plane) to within a short distance (2.5 to 5 cm.) of the umbilicus. Its opposite border is attached to the superior and anterior aspects of the liver; below this level it presents a free, round edge, stretching from near the umbilicus to the umbilical notch of the liver, and contains within its layers a stout fibrous cord called the round ligament which once was the umbilical vein.

Near the posterior part of the superior surface of the liver, the two layers, of which the falciform ligament is composed, separate and enclose a triangular

[1] Max Thorek, Amer. Jour. Surg., Vol. XXXI, No. 3, March 1936, pp. 467-470.

area on the posterior surface, in front of the superior end of the vena cava, uncovered by peritoneum. Traced backward, the right layer passes into the superior layer of the coronary ligament, the left into that of the left triangular

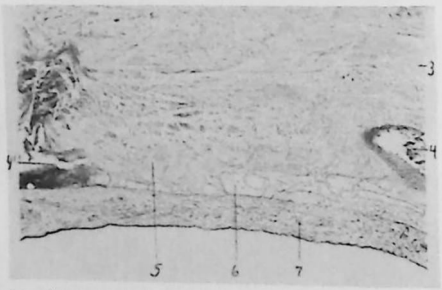


Fig. 1471. Same as preceding showing greater magnification of the two focal areas of suppuration.

ligament. It is called falciform because of its sickle shape. In structure the ligament is composed of two layers of peritoneum closely united; often enfolding in its areolar tissue greater or lesser quantities of adipose tissue. It is the fourth fold which is described as leaving the umbilicus.

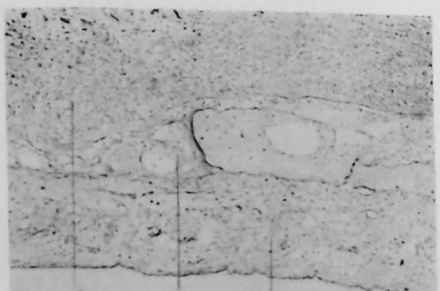


Fig. 1472. Same as preceding; high-power magnification. 5. Serosa and subserosa of stomach; 6 exudate of fibrin (undergoing very early organization) which is agglutinating the falciform ligament to the serosa; 7. falciform ligament.

As stated, this sickle shaped fold of peritoneum is attached to the anterior abdominal wall above the umbilicus and later to the diaphragm as far back as

the top of the fissure of the ductus venosus on the posterior surface of the liver. Small veins run along the round ligament connecting the hepatic system with that of the abdominal wall. While the falciform ligament starts in the embryo from the navel, in the adult it does not leave the abdominal wall for an inch or more above it. Anatomists agree that the falciform ligament contributes nothing or little as a support of the liver. It is, therefore, an obsolete structure like the urachus.

Efficient peritoneal covering of raw surfaces or suture lines in the abdominal cavity is the aim of the modern surgeon, yet frequently attained only imperfectly or not at all. For some years past I have been using the falciform ligament to obtain such covering. The ligament is separated from its attachments

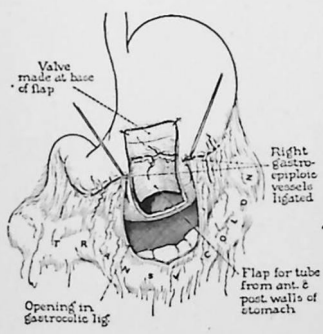


Fig. 1473

Fig. 1474

Fig. 1473. Author's method of obtaining tissue to fashion a longer Dépage-Janeway tube in cases of contracted, small stomachs (1932).

Fig. 1474. Dépage-Janeway tube formed. Operation nearing completion.

on the anterior abdominal wall. In separating the ligament the resulting raw surface on the posterior aspect of the anterior abdominal wall should be carefully sutured, otherwise undesirable bleeding would ensue.

Similarly, the ligament may also be completely detached and sutured over the inverted and closed duodenal stump following gastrectomy. On occasion I have also used the detached falciform ligament as a covering for the suture lines used in perforated gastric or duodenal ulcers, or to cover anterior gastrojejunostomy suture lines.

Figures 1473-1474 depict a method I originated in 1932 of obtaining tissue from the posterior wall of the stomach for the formation of a tube of sufficient length. This is particularly applicable in cases where the stomach is so contracted that there is not enough stomach wall so that the surgeon can form a tube of proper length.

Patients operated upon by the tubo-valvular method are more comfortable and generally the results are more gratifying than with the methods presently in

Fig. 1475. Tubovalvular gastrostomy. Patient introducing rubber feeding tube.

Fig. 1476. Patient pouring milk into funnel at most convenient level.

Fig. 1477. Glass tube elevated to facilitate entrance of milk.

vogue (Figs. 1475-1476-1477), provided however, as stated, the surgeon is fully conversant with the technical details and pitfalls of the procedure. If not, he should resort to some simpler type of gastrostomy described above, thereby avoiding disappointments or, perhaps, catastrophes.

SUSPENSION OF THE STOMACH

GASTROPEXY

Duret's Operation

Step 1. Incision in the median line. Open the peritoneum and expose the stomach in the lower part of the wound. Expose but do not open the peritoneum in the upper part of the wound (Fig. 1478).

Step 2. Insert a continuous suture (modified Lembert) uniting the stomach and the upper (undivided) portion of the peritoneum. Bring both ends of the sutures through the muscular component of the abdominal wall and tie them there.

Step 3. Close the wound.

Beyea's Operation

This consists of shortening the supports of the stomach. The lesser omentum (gastrohepatic ligament) is folded on itself transversely by means of interrupted catgut (chromic) sutures (Fig. 1478). Avoid picking up blood vessels in the sutures. The legends on the illustration describe the operation.

Rovsing's Operation

Step 1. Make a median incision from the ensiform cartilage to the umbilicus.

Step 2. Introduce substantial silk sutures as shown in the illustration (Fig. 1479). Do not tie these until the surface of the stomach and parietal peritoneum are scarified. Appose the stomach to the abdominal wall.

Step 3. Close the abdominal wound; place over it a gauze pad or glass plate covered with sterile gauze, the dimensions of which are somewhat greater than the stomach surface which has to be fixed. Over this pad or glass plate tie the sutures suspending the stomach. The sutures are left in situ for three or four weeks.

Coffey's Hammock Operation

This consists of suspending the transverse colon and the greater curvature of the stomach by a series of chromicized catgut, interrupted plicating sutures, carried through the great omentum and attached to the parietal peritoneum transversely between the umbilicus and the ensiform cartilage. If the stomach is only displaced and is not much dilated, one row of sutures placed about an inch below the attachment of the stomach will probably suffice. If the transverse colon shares in the descent (splanchnoptosis) it is best to use two rows of sutures, penetrating the entire thickness of the omentum just below its attachment to the colon (Fig. 1480). A broad line of adhesions result effectually preventing prolapse of the suspended viscera.

Perthe's and Vogel's Operation

This consists of suspending the prolapsed stomach by using the round ligament of the liver, suturing it to the stomach wall along the lesser curvature of the stomach and attaching it to the costal margin on the left side. When the

ligament is freed it is about 14-16 cm. long. To the free end of the ligament a silk suture is fastened, the free end of which is threaded into a ligature carrier. The ligament is fastened to the stomach by either implanting it in the stomach

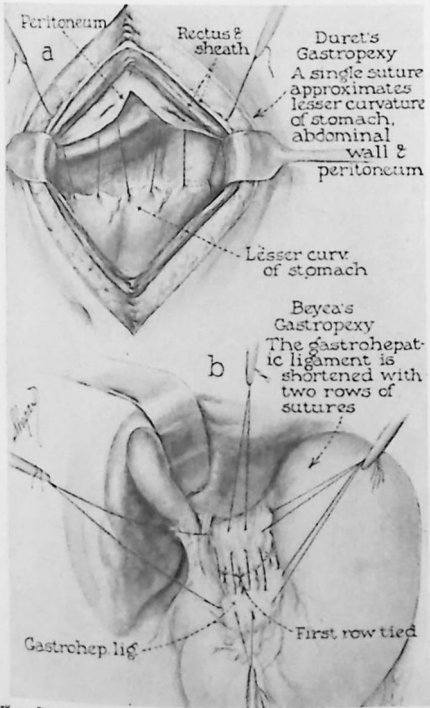


Fig. 1478. a. Duret's gastropexy. b. Beyea's gastropexy. Peritoneum open but not cut in upper portion. Ends of suture brought through rectus sheath and fascia and there tied.

wall or suturing it there. Its end is entered through the left rectus sheath and sutured to the costal margin and transverse abdominis muscle (Fig. 1481). It is not unlike the treatment of the round ligament in performing the Gilliam operation for a retrodisplaced uterus. The legends on the illustration depict the procedure.

Jentzer's Operation

Albert Jentzer of Geneva, Switzerland, prepared tendon tissue sutures for suspension of the stomach. He claims that this procedure materially shortens the operation, diminishes shock, avoids lateral scarring and postoperative hematomas and interferences with the solidity of the abdominal wall. The possible criticism that tendon sutures will in time become absorbed is not justified because by the time this takes place the desired effect of the operation has already been accomplished.

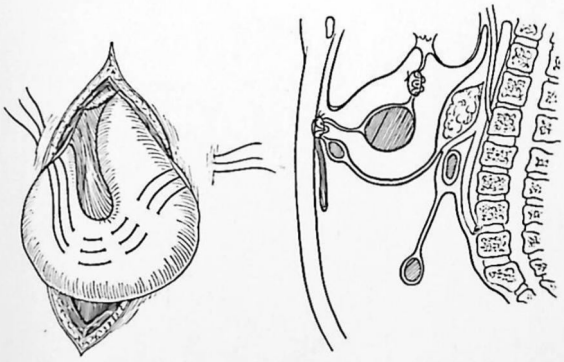


Fig. 1479 Fig. 1480

Fig. 1479. Rovsing's operation. Three rows of linen sutures shown inserted in the stomach wall and brought out on the surface of the anterior abdominal wall over a gauze pad or glass plate over which they are tied.

Fig. 1480. Gastropexy. Coffey's hammock operation. Diagram showing the shortening of the gastrohepatic omentum and suspension of the stomach and colon by attaching the gastrocolic and great omentum to the anterior wall with sutures.

Jentzer's procedure is based on Lambret's operation. Lambret of Lille suspends the stomach at the level of the greater curvature by means of strips of aponeurosis taken from the border of the fasciae of the abdominal muscles on both sides. These strips are pedicled above and are introduced into the abdominal cavity by their free ends, on both sides. They are attached all along the greater curvature of the stomach and these free ends are sutured to the round ligament of the liver at the point where it becomes detached from that viscus. This brings the stomach into its normal position.

Opinions with reference to the surgical treatment of gastroptosis are diverse. In certain quarters, the various operative procedures above outlined are frequently resorted to, in others general hygienic treatment and other measures are advised.

GASTROPLICATION

This consists of folding, plicating or plating either aspect of the stomach—anterior or posterior. It finds its indications, on occasion, in marked atonic

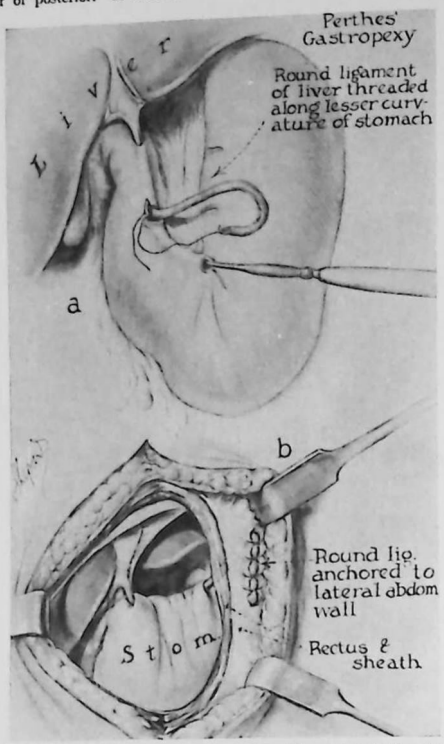


FIG. 1481. Perthe's gastropexy. Note course of round ligament of the liver along course of lesser curvature of stomach, through the abdominal wall to the point of anchorage to the costal margin and fascia of the transversus abdominis muscle.

dilatation of the stomach not due to obstruction at the pylorus. Sometimes it is resorted to in cases of gastroptosis. It was Heinrich Bircher of Aarau, Switzerland who performed the operation first in 1890 and described it the following year. His method follows:

Step 1. Open the abdomen by a straight incision beginning at the ensiform cartilage and extending to opposite the umbilicus.

Step 2. Deliver the stomach from the abdomen. A seromuscular suture connects two points, close to the pyloric end of the stomach and a similar suture those of the cardiac end. The ends of the respective sutures are tied.

Step 3. Place a probe behind the two knotted points, thus creating a furrow with two ridges on the surface of the stomach.

Step 4. Suture the crests of the parallel ridges thus constructed to each other by means of a continuous seromuscular suture. The stomach wall is thus doubled on itself.

Comment: The drawback of this method is that it reduces the size of the anterior stomach wall only, leaving the posterior wall unchanged. Again the plicating of the anterior wall causes a large portion of the stomach wall to protrude into its interior giving rise to a partition. To obviate these drawbacks R. F. Weir[1] devised the following modification of the original Bircher method.

Weir's Modification of Bircher's Method

Step 1. Make a furrow 1 inch deep on the anterior wall of the stomach by means of a glass rod or probe. The extent of this furrow depends upon the length of the stomach in terms of its transverse diameter. About 10 interrupted seromuscular sutures are then taken transforming the furrow into a canal.

Step 2. Remove the probe or glass rod and create a similar furrow or canal about one inch below the first one, in the same manner.

Step 3. Repeat this procedure until the distance between the greater and lesser curvature approximates about five inches.

Comment: It is obvious that Weir's modification eliminates the disadvantages of the Bircher procedure enumerated above. Moynihan supplements gastroplication with gastrojejunostomy.

Moynihan's Method

Step 1. Insert a series of interrupted seromuscular sutures running in the direction from the lesser to the greater curvature in such a manner that each suture takes three or four bites. The distance between these bites is about one inch. Knot the ends and cut the suture short.

Step 2. Perform a posterior gastrojejunostomy.

VOLVULUS OF THE STOMACH

This condition may be met occasionally. I reported such a case at the meeting of the American Medical Association in San Francisco, in 1923, the salient features of which follow:

Mrs. A. P., a widow, aged 77, had pneumonia during 1895 and again seven years ago; otherwise she was never ill and enjoyed good health, except for chronic constipation. There was no previous history of gastric ulcer or distress.

Two days previous to admission to the hospital (Dec. 19, 1922), the patient

[1] N. Y. Med. Jour., 1892.

partook of some indigestible food. The bowel action, for three days before that time, had been constipated. Toward evening she experienced rather sharp pains in the upper part of the abdomen, radiating from the right to the left hypochondrium. At the onset of these pains there was constant ejection of the stomach contents, which gradually subsided, to be superseded by nausea. From that time on the abdomen (below the umbilicus) became very much distended and, despite attempts at catharsis and enemas, as well as intramuscular administrations of pituitary extract and physostigmine salicylate, no bowel action could be

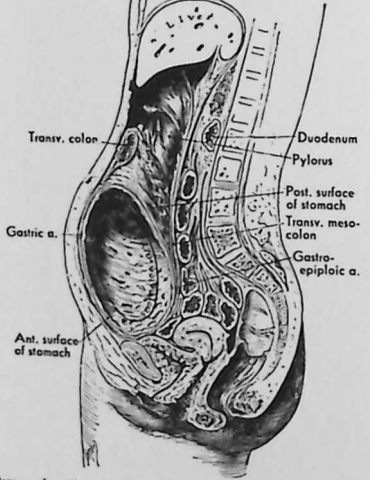


FIG. 1482. Degree of torsion of the stomach (270 degrees) in author's case; the relative position of the pylorus and cardia may be noted.

obtained. From the day of admission to the hospital, retching yielded a small quantity of mucus, tinged with blood.

Physical Examination: The general appearance of the patient was that of one suffering severe agony. The temperature was subnormal (96.8°F.); the pulse was of good quality, 88 and arhythmic. The head, neck and thorax were normal. There were no cardiac murmurs. The systolic blood pressure was 155; diastolic, 80; pulse pressure, 75. Uranalysis and blood examinations were essentially negative. The abdomen showed marked distention, commencing about two fingerbreadths above the umbilicus and extending down to the symphysis pubis and spreading laterally to the flanks. The recti abdomini muscles were rigid; no peristaltic waves were visible. Despite the emaciated condition of the patient, and consequent thinness of the abdominal wall, auscultatory phenomena could not be elicited. There was uniform, dull, tympanitic resonance all over the distended area. Attempts to pass a stomach tube were unsuccessful.

Acute intestinal obstruction and stricture at the cardiac end of the stomach were diagnosed.

Operation and Result: Under spinal anesthesia (tropacocaine), a median celiotomy was made. A large mass resembling a distended ovarian cyst appeared in the peritoneal opening. The thought occurring at that moment was the possibility of an incarcerated ovarian cyst with twisted pedicle and compression of certain segments of the intestinal tract, giving rise to intestinal obstruction.

Exploration by guiding the left hand over the mass into the pelvis, lifting it up and evacuating its contents by means of an ovarian trocar, revealed the true nature of the condition. We were dealing with the stomach. Its weight and enormous size made it difficult to deliver it into the wound. After packing the surrounding area with laparotomy sponges wrung out of warm salt solution, and evacuating the stomach contents (found to consist of undigested food particles and an enormous quantity of gastric fluid of turbid appearance and gastric odor), the tumor was reduced in size, permitting its delivery into the wound, where it was found to be completely twisted on its horizontal axis about 270 degrees, the pylorus being dragged to the left side while the cardiac end was completely twisted (Fig. 1482). The transverse colon was vertical and above the lesser curvature. The spleen was displaced forward and upward.

Detorsion was effected, after which the stomach was found to be extremely ptosed. I suspended it to the anterior abdominal wall by the Rovsing method of gastropexy. The patient experienced no pains during the operative manipulations. She was returned to bed in excellent condition. No shock.

No fluids were permitted by mouth for the first twenty-six hours. Dextrose and salt solution were administered by rectum. Gastric lavage was done, morning and night, for seventy-two hours. Gradually, liquids were allowed by mouth, followed by semisolid and solid foods, respectively. Complete recovery ensued.

Treatment. The treatment of volvulus of the stomach can only be surgical. A correct appreciation of the condition, either before operation or after opening the abdomen is essential, as delay in proper treatment or failure to recognize the findings may be fatal. When recognized early, evacuation of the stomach, detorsion and fixation are all that is necessary to afford complete relief.

The first operative procedures include: (a) Incision; (b) examination of the existing conditions and making a diagnosis; if not diagnosed already; (c) evacuation of the stomach contents, and (d) the detorsion proper. The volvulus can be considered as reduced only when the ramifications of the coronary arteries of the stomach are placed in their proper relation.

The complementary operations are either a gastropexy (anterior, partial), or Coffey's operation of gastropexy, which fixes the organ in a good place, or, if there is any concomitant stenosis, a gastro-enterostomy, jejunostomy or fistulization of the stomach. The actual condition of the patient must determine the choice of operation.

Niosi thinks detorsion and gastro-enterostomy preferable to gastropexy.

OPERATIONS FOR HOUR-GLASS STOMACH

In this condition the stomach is divided into two sections by a constriction which may be situated at any point between the pylorus and cardiac end of the stomach. The following operations come under consideration in an endeavor to remedy the condition.

1. Gastro-enterostomy—anterior or posterior.
2. Double gastro-enterostomy—Weiss and Foote's, operation which consists of joining the jejunum with each sac in the stomach.

3. Monprofit's operation: Double gastro-jejunostomy en "Y."
4. Gastrogastrostomy.
5. Partial gastrectomy.
6. Loreta's operation—Divulsion of the constriction.

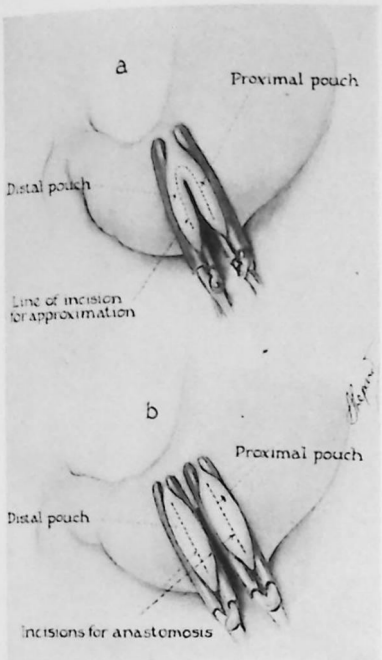


FIG. 1483. Gastrogastrostomy for hour-glass stomach. a. Pouches grasped in rubberized stomach clamps and approximated. b. Note line of incisions for anastomosis and follow technic described on page 1388.

Kammerer's operation is a modified gastroplasty and bears the same relation to gastroplasty as does Finney's operation to pyloroplasty. Kammerer describes his operation as follows: "Beginning at the lowest point of the constriction, a running suture was applied through the serous and muscular coats, bringing the vertical edges of both compartments of the stomach into close approximation along their posterior margins. An inverted V-shaped incision was now made

through the entire thickness of the stomach wall, about one-quarter of an inch to either side of the Lembert suture. The posterior wound edges were now brought together with another running suture from within; the same procedure

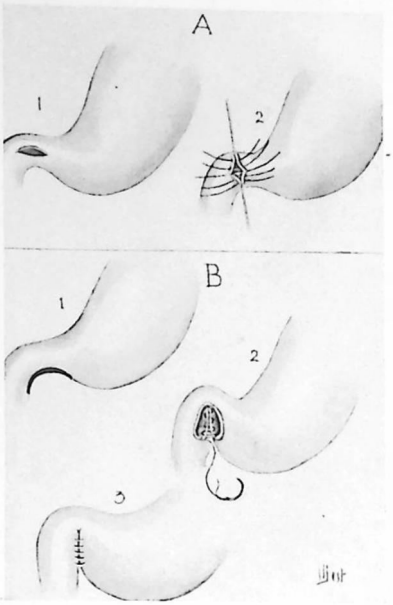


FIG. 1484. Heineke-Mikulicz operation for pyloric obstruction (pyloroplasty). A-1. Horizontal incision through the anterior wall of the pylorus. 2. Sharp tenacula pulling the walls of the stomach in opposite directions converting the horizontal incision into a vertical wound. Sutures placed. When these are tied the wound becomes vertical. This method has been abandoned in favor of the Mikulicz pyloroplasty. B-1. Mikulicz pyloroplasty incision along lower border of pylorus extending into the duodenum and stomach on either side of the pyloric ring. 2. Method of inserting the second row of sutures. The first row placed posteriorly is not shown in the drawing. 3. Operation completed. Posterior seromuscular suture continued anteriorly.

being then applied to the anterior edges from without. The final act of the operation consisted in reinforcing the anterior suture with a running Lembert stitch, and placing a few extra sutures at the lowest point of the stomach through the serous and muscular coats, where tension would naturally be greatest."

Gastrogastrostomy or Gastro-anastomosis (Fig. 1483)

Wolfler made vertical incisions 7 cm. long in the dependent pouches on each side of the central constriction and united these so as to form a free passage

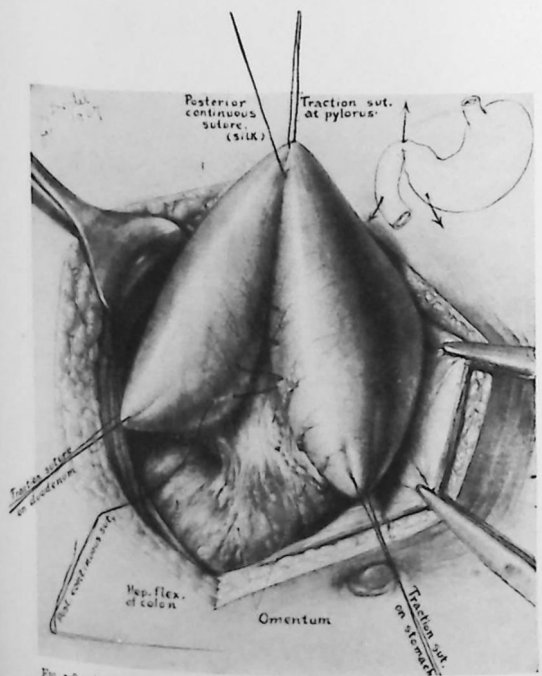


FIG. 1485. Finney's pyloroplasty showing traction stitches in pylorus, stomach, and duodenum. Posterior line of suture nearly completed. Courtesy of Dr. John M. T. Finney and W. B. Saunders Co.

beneath the isthmus. A clamp is applied on each side of the isthmus and the clamps surrounded by hot lap sponges. A seromuscular suture is applied below the isthmus down to the greater curvature of the stomach. Put the needle aside.

Incise both pouches in the grasp of the clamps. Introduce a second inner suture and complete the operation, precisely as in classical gastrojejunostomy (Fig. 1524, p. 1342).

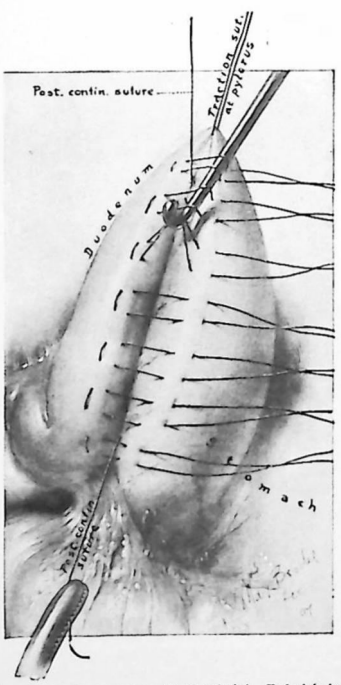


FIG. 1486. Posterior continuous suture placed and tied. Ends left long as retractors. Anterior row of mattress sutures placed but not tied. (Courtesy of Dr. John M. T. Finney and W. B. Saunders Co.)

PYLOROPLASTY (PYLOROTOMY)

Heineke-Mikulicz Operation

This operation was first performed by v. Heineke of Erlangen in 1886. Friedrich Fronmüller of Heineke's clinic described the procedure. In 1887

v. Mikulicz described the operation independently not being aware of v. Heineke's work—hence the operation is known as the von Heineke-Mikulicz operation. (Fig. 1484.)

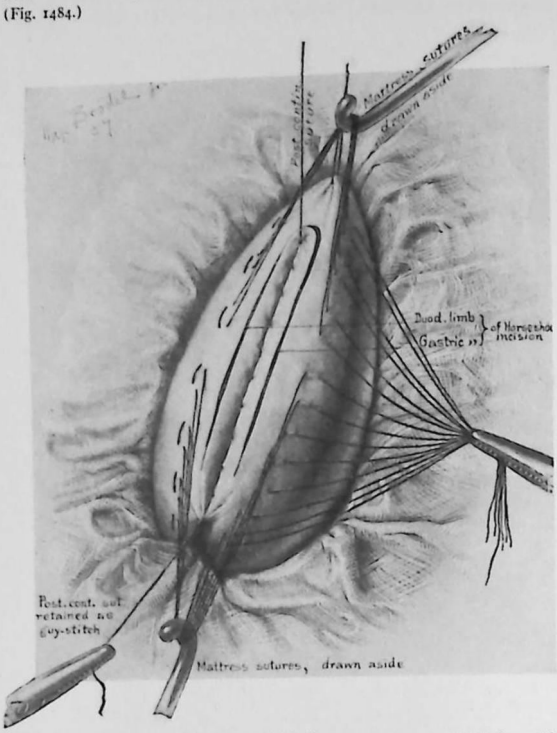


Fig. 1487. Anterior mattress sutures retracted. Incision completed through the anterior gastric and duodenal walls. (Courtesy of Dr. John M. T. Finney and W. B. Saunders Co.)

Step 1. Make a right rectus incision.

Step 2. Isolate the pylorus.

Step 3. Place lap-sponges and engage the affected segment between rubber-covered clamps on either side. Make a horizontal incision (Fig. 1484A[1]) 6 cm. to 7 cm. long across the anterior wall of the pylorus, dividing it. If the

incision is made shorter the stenosis is apt to return. Introduce a sharp hook at the midpoint of the upper and lower lips of the incision. Traction on these will convert the horizontal wound into a vertical one.

Step 4. Suture the wound vertically with two rows of sutures.

(a) Inner, through-and-through or Connell suture (catgut)

(b) Outer, Lembert suture. Pagenstecher linen or silk (Fig. 1484A[2].)

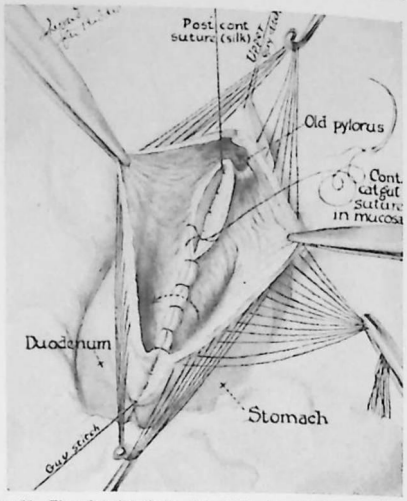


Fig. 1488. Finney's pyloroplasty. Introducing the posterior row of sutures.

Comment: This operation is simple of execution but contraindicated in the presence of dense adhesions. It is mentioned here for its historical interest. Most surgeons have abandoned it and resort to the Mikulicz pyloroplasty described below or, still better, to Finney's pyloroplasty operation.

Mikulicz Pyloroplasty

Step 1. Make an incision along the lower border of the stenosed pylorus extending into the duodenum and stomach on either side of the pyloric ring.

Step 2. Unite with a continuous Lembert suture the seromuscular coats of the posterior margins of the wound consisting of stomach and duodenum.

Step 3. With a through-and-through catgut suture, invert the posterior wall of the structures named and continue it in the same manner anteriorly.

Step 4. Continue the seromuscular suture over the last (inner) suture line anteriorly (Fig. 1484B).

Finney's Pyloroplasty

Step 1. Mobilize the pylorus and duodenum. The latter must be freely movable (detach it from its moorings) so that it can be brought into apposition with the pylorus without tension. Properly placed tension sutures aid in the proper apposition.

Step 2. Apply rubber covered clamps to the duodenum and stomach in a vertical direction. The tips of the clamps grasp those portions of the stomach

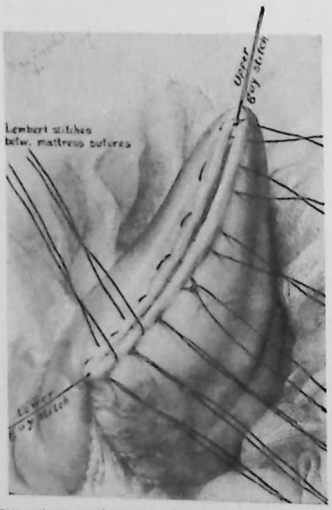


Fig. 1489. Mattress sutures previously placed now tied. Alternate Lemberts placed between the mattress sutures. (Courtesy of Dr. John M. T. Finney and W. B. Saunders Co.)

and duodenum in which the anastomosis is to be made but leave the upper portion of the duodenum to which the first traction suture is applied, free. Bring the clamps together. Protect the peritoneum thoroughly with gauze packs. The further technic resembles that described under gastrojejunostomy (p. 1388) except that into the respective viscus an inverted U-shaped incision is made (Fig. 1485).

Step 3. Unite the opposing surfaces of duodenum and stomach with a continuous suture (linen or silk) thus creating the outer (posterior) suture layer. Leave the lower end of the suture long with the needle attached to it (Fig. 1486).

Step 4. Make an inverted U-shaped incision on each side of the suture line connected by the horizontal part of the inverted U. This will give rise to an opening in each viscus of about 2½ inches (Fig. 1487).

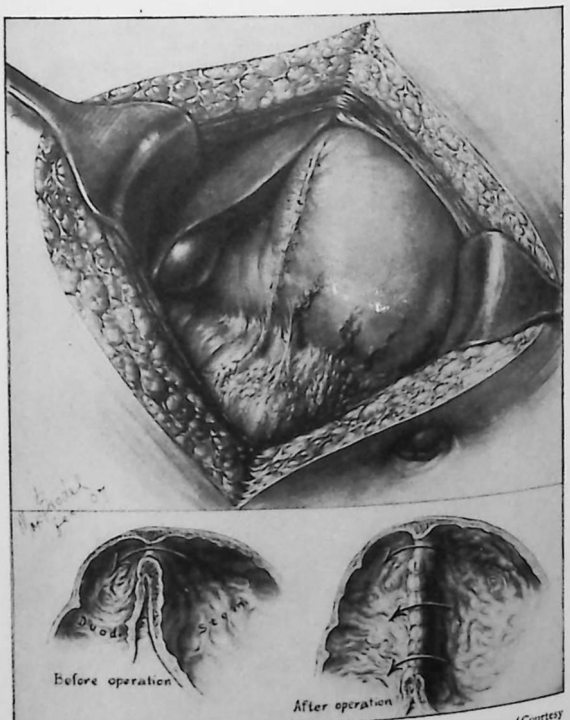


Fig. 1490. Operation completed. Showing relative sizes of old and new pylorus. (Courtesy of Dr. John M. T. Finney and W. B. Saunders Co.)

Step 5. Introduce, beginning from above, a through-and-through stitch of fine chromic catgut bringing the mucoso-muscular layers of the duodenum and stomach together. Continue the suture to the lowest point of the opening,

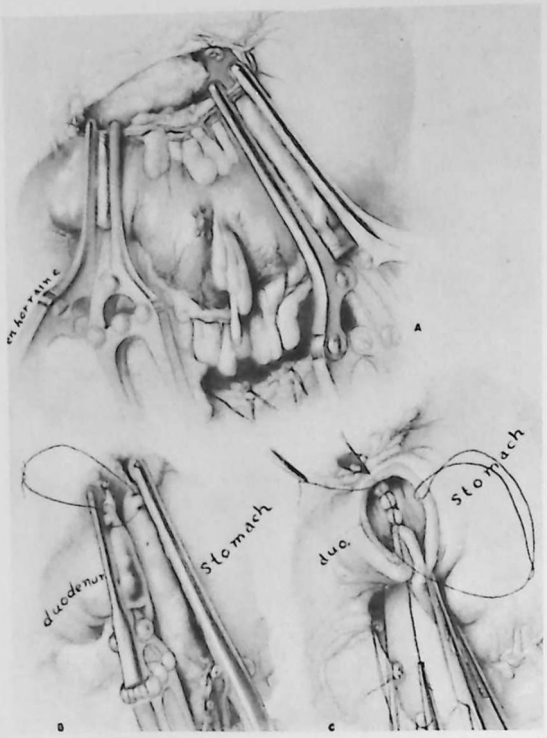


FIG. 1495. A. The gastrocolic and gastrohepatic omentum have been divided and tied in sections. Payr clamps are placed on the body of the stomach and on the duodenum just beyond the pylorus.

B. The segment of stomach has been removed, preferably with the electric cautery. The posterior margin of the stump of the stomach is being sutured to the posterior margin of the stump of the duodenum with interrupted mattress sutures of fine tanned or chromic catgut.

C. The internal row of sutures is being applied, uniting the posterior margin of the stump of the stomach to the posterior margin of the stump of the duodenum. The dotted line shows where the incision will be made in the duodenum to flare it open. (Courtesy of Dr. J. Shelton Horsley.)

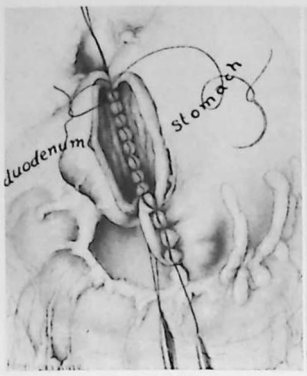


FIG. 1496

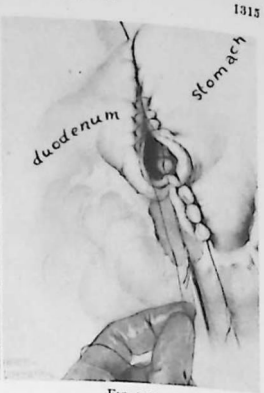


FIG. 1497

FIG. 1496. The duodenum has been flared open and the posterior line of sutures completed. The anterior row of sutures is begun and the short end is being tied to the short end of the posterior row of sutures.

FIG. 1497. The anterior row of sutures is continued in such a way as to invert the margins of the duodenum and stomach. The suture is drawn taut as it emerges from the duodenal mucosa, while slight pressure with the thumb or finger is made on the wound just beyond the stitch. (Courtesy Dr. J. Shelton Horsley.)

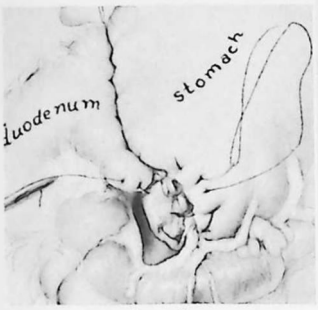


FIG. 1498

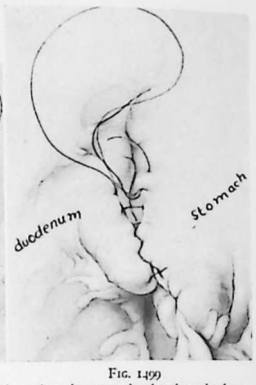


FIG. 1499

FIG. 1498. A purse-string suture of fine tanned or chromic catgut is placed at the lower portion of the stump of the stomach, inverting the redundancy.

FIG. 1499. This suture is continued anteriorly as a continuous right-angle suture with an occasional backstitch. An additional interrupted or purse-string suture is placed over the lower border of the stomach and the duodenum and brings over peritoneal-covered fat. This step is not shown in the illustration. (Courtesy Dr. J. Shelton Horsley.)

function of the stomach is restored as nearly as possible to normal. The physiologically active lesser curvature of the stomach is aligned with the upper border of the duodenum which is its normal relationship. The physiologically inactive greater curvature is easily folded in. The great objection to the original Billroth I operation is the so-called "deadly triangle" which occurred when the stump of the duodenum was aligned to the greater curvature where it is quite mobile. By bringing over peritoneal covered fat, this region is made secure. Flaring open the duodenum after it has been fixed by sutures does not displace its relationship to the upper border of the stomach and at the same time gives a wide opening which prevents contraction and will doubtless be a sufficient exit for food even if recurrence of the cancer makes some obstruction in this region.

The field of operation is limited to the vicinity of the lesion and does not involve the possibilities of spreading bacterial infection or cancer cells to the other organs or to tissues below the transverse mesocolon, which might be possible in the types of Billroth II.

Comment: There are many cases in which the stump of the stomach cannot satisfactorily be united with the duodenum. Under such conditions one must resort to a Billroth II operation or some of its modifications. Donati cautions to use the Billroth I only exceptionally, even if the duodenum has lent itself to free mobilization.

von Haberer's Technic for Radical Resection of the Stomach Following Previous Gastroenterostomy

is described by R. Russell Best[1] as follows:

In von Haberer's clinic the Billroth No. I is the operation of choice because it is the most physiologic-anatomic operation. The stomach is made to empty into the duodenum directly by means of an end-to-end anastomosis. The direction of flow of intestinal contents is maintained and mechanical complications are less to be feared.

Step 1. Make an median incision in the abdomen. Meticulously separate adhesions between the liver, stomach and duodenum. Examine the walls of the stomach and duodenum.

Step 2. If necessary, open the gastrohepatic and gastrocolic omenta. Lift up the tranverse colon and free any existing adhesions. Examine the line of anastomosis. Detach adhesions around the gastroenterostomy by blunt and sharp dissection.

Step 3. Insert a long spoon forceps transversely, to act as a guide. Separate the transverse mesocolon from the margin of the anastomosis by working from above and below.

Step 4. An exceedingly important step is to free the duodenum. Ligate the right gastric and right gastro-epiploic arteries first. Ligate meticulously the gastrohepatic and gastrocolic omenta. Carry this up on the lesser curvature of the stomach to the point where the left gastric artery enters the stomach wall.

[1] Annals of Surgery, August, 1931.

Step 5. Take down the gastroenterostomy. Resection of the jejunum is usually unnecessary. Place a curved Doyen clamp upon or just below the line of anastomosis. Place intestinal clamps upon the jejunum just before and behind the anastomosis. Divide the anastomosis below the Doyen clamp with an electric cautery. Suture the opening in the jejunum transversely. Place guide sutures at both ends and apply continuous locked catgut sutures to the mucosa. Leave the ends of the sutures long and replace the former guide sutures. Insert interrupted linen Lembert sutures to complete the closure.

Comment: If a great deal of the jejunal wall is to be removed, do a resection and follow it with an end-to-end anastomosis. In this procedure, ligate the mesentery of the jejunum just opposite the anastomosis. Place crushing clamps on the jejunum on either side of the anastomosis; place intestinal clamps about 1 inch from the crushing clamps. Perform an end-to-end anastomosis by first inserting a layer of interrupted linen (Lembert) sutures on the posterior wall and then a continuous locked catgut suture to the mucosa. Finally insert a layer of interrupted linen sutures on the anterior wall. Close the wound in the mesentery with interrupted catgut sutures.

The duodenum may be further mobilized by doubly ligating small strands of tissue and cutting. Place a Doyen clamp on the pyloric portion of the stomach. Grasp the pylorus between the thumb and fingers of the left hand and place guide sutures on the lower and upper margins of the duodenum at the desired level. Hold the pylorus and both guide sutures at slight tension; cut through the anterior wall of the duodenum below the ulcers with the electric cautery. Inspect the mucous membrane of the posterior wall. Insert a small sponge into the duodenum to prevent regurgitation. Cut through the posterior wall below the ulcers. If the posterior wall is in good condition and the peritoneum is not too scarce, do a Billroth No. I.

Place a clamp on the stomach at the desired level of resection. Bring it into approximation with the duodenum to decide whether or not an end-to-end anastomosis is possible. Place a linen Lembert suture through the lower angles of the stomach and duodenum and another through the upper angles of the stomach and duodenum. Between these two sutures insert another stitch through the stomach and duodenum—clamp the sutures; do not tie them. Remove the two guide sutures on the duodenum. Insert Lembert sutures between these three, then tie the two angle and middle sutures; tie the remaining sutures and cut all but one on each end which are used for guide sutures. von Haberer's hemostatic sutures are inserted as follows: Cut through the serosa and muscular layers of the stomach about one-half inch above the row of the interrupted Lembert sutures. Place a row of interrupted hemostatic catgut sutures along the lower cut margin. These sutures besides being hemostatic narrow the opening of the stomach. Displace the stump of the stomach to the right and cut through the serosa and musculature about one inch above the clamp; place a similar row of sutures on the surface of the stomach. Leave these two groups of hemostatic sutures long and clamp them so that one group

is to the right and the other group to the left; they serve as retracting and guiding sutures. Place a clamp on the stomach just above the row of su-

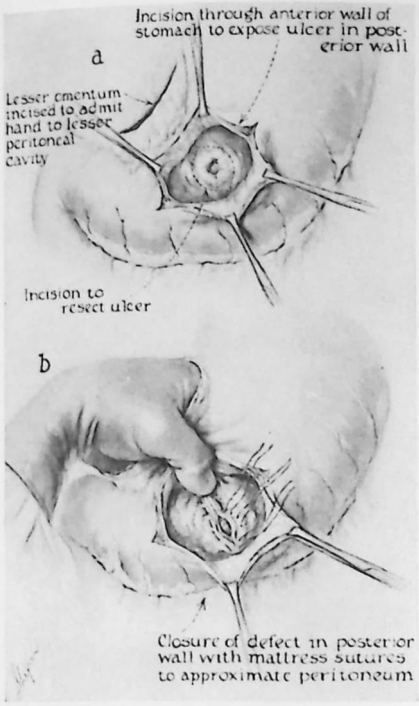


Fig. 1500. Transgastric resection of ulcer from posterior wall. a. The steps are indicated preliminary to resection of the ulcer. b. The closure of the posterior wall may be reinforced with suture of the mucosa. The incision through the anterior wall of the stomach is closed with two rows of sutures.

tures and amputate the stomach with the electric cautery. Cut the sutures to the right; suture the mucosa of the posterior wall of the stomach and duodenum with a continuous locked catgut suture penetrating all lay-

ers. Cut the sutures to the left. Continue the suturing on the anterior wall for a short distance; remove the gauze compress from the duodenum and suture the mucosa. Place interrupted linen Lembert sutures on the anterior wall at the angles and in the middle and tie them. Remove the clamp from the stomach and complete the row of interrupted linen Lembert sutures picking up more tissue than before.

If this procedure cannot be carried out, do a Billroth No. II with an enterostomy. Compared with the simple posterior Billroth No. II there is in this method less likelihood of stasis and back pressure ensuing in the stump of the duodenum, and later, if another operation is necessary, it is easier to take down an anterior Billroth No. II, than a posterior Billroth No. II.

TRANSGASTRIC RESECTION OF ULCER ON THE POSTERIOR WALL OF THE STOMACH

Approach the affected area either through an avascular space in the transverse mesocolon or, if difficult to perform, through the anterior wall of the stomach.

Excise the lesion. Close it from within the stomach by a through-and-through suture of chromic catgut. Reinforce it if possible with serous sutures from without. Fig. 1500 depicts and describes the steps of the operation.

EXCISION OF ULCER FROM THE LESSER CURVATURE (WEDGE RESECTION)

This operation may be extremely difficult because the ulcer may be very adherent to contiguous structures (pancreas, liver, etc.).

Open the abdomen in the usual manner. Ascertain the extent of the ulcer and the extent of complicating adhesions. Divide the gastrohepatic omentum above the ulcer. Ligate the vessels on either side of the ulcer bearing area. Divide the vessels. Enter the lesser peritoneal cavity with the exploring finger behind the stomach. Explore thoroughly.

Isolate the affected area with packs; apply clamps on either side of the area to be resected. Remove a triangular portion of the stomach bearing the ulcer. Do not carry the points of the clamps isolating the area to be resected too low down toward the greater curvature. As much healthy tissue of the stomach as is consistent with safety should be conserved. Bring the clamps together.

Suturing is now begun. A suture of Pagenstecher linen or chromic catgut is now introduced in the following manner: Make a "loop in the mucosa suture" as shown in Fig. 1501 A and B. This suture is begun toward the greater curvature and continued upward toward the lesser curvature. The suture then descends along the anterior surface of the stomach toward the greater curvature. Tie. Remove the clamps. Beginning at the posterior surface, reinforce the suture line by a continuous Pagenstecher suture and bring it down the front all along the anterior surface. Tie. Close the opening in the gastrohepatic omentum. Close the abdomen (Fig. 1501 C).

Comment: On excision alone, Balfour states:

"Excision alone for gastric ulcer is an operation which has been abandoned because other methods of surgical treatment have proved to be more effective. Experience has shown that recurrence of ulceration or of symptoms sufficient to classify the results as poor, occur in about 50 per cent of

cases. In many of these cases, secondary operation is required to bring about complete cure; therefore, surgeons have adopted the practice of combining either gastro-enterostomy or pyloroplasty with removal of the lesion. The fact that excision alone has proved so inadequate in its permanent result is the most conclusive proof that in any operation for peptic ulcer some permanent modification must be made in gastric function. This proof

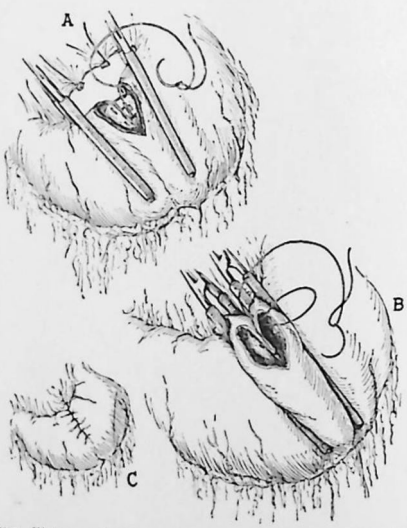


Fig. 1501. Wedge resection for ulcer of the stomach. A. The gastrohepatic omentum is divided and the blood vessel are ligated. The ulcer-bearing area resected. A "loop on the mucosa" suture is being applied. B. Continuation of the suture which is continued along the anterior wall of the stomach. C. The operation completed.

is particularly apparent in gastric ulcer, since the usual situation of the ulcer is at some distance from the pylorus, where it can be removed without producing marked deformity of the stomach. The fact that removal alone of a gastric ulcer gives such unsatisfactory results is further evidence that disturbance in gastric function is an important factor in the production of ulcer. We believe, however, that excision alone of gastric ulcer has been too nearly completely abandoned and that this has been because it has not been realized that excision of a lesion of the lesser curvature has resulted in motor dysfunction, which has been responsible for the disap-

pointing results of excision alone. If, therefore, excision alone can be done without interfering with normal peristalsis, the operation should have a distinct field of usefulness."

CAUTERY EXCISION OF GASTRIC ULCER

Balfour's Operation

Dissect carefully the gastro-hepatic omentum overlying the ulcer (Fig. 1502 A). Steady the area contiguous to the ulcer with Allis forceps; with a Paquelin cautery maintained at a dull heat burn the ulcer slowly until the stomach

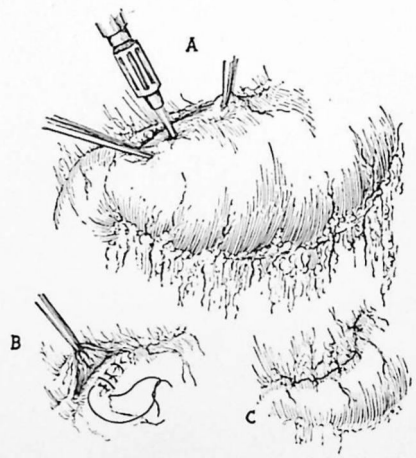


Fig. 1502. Balfour's cautery-excision operation for ulcer of the stomach. A. Lesser curvature steadied with tissue forceps; cautery destroying ulcer. B. Interrupted sutures reinforced by mattress sutures over the destroyed ulcer-bearing area. C. The suture lines are superimposed by a flap of lesser omentum held in place with interrupted sutures.

has been perforated. Destroy the ulcer margins with the cautery sufficiently but not excessively. Close the opening thus created by interrupted catgut sutures, reinforced by mattress sutures of Pagenstecher linen (Fig. 1502 B). Suture the reflected portion of the gastrohepatic omentum over the sutured area (Fig. 1502 C).

Balfour recommends cautery excision combined with gastro-enterostomy as an effective method in the treatment of certain types of ulcers of the stomach.[1] He summarized the advantages of this method in the following terms:

[1] D. C. Balfour, Surgical Clinics of North America 1:5-1921.

"1. The cautery efficiently destroys the focus of infection in gastric ulcer without the sacrifice of nature's protective induration surrounding the crater. 2. It may be applied in a large percentage of gastric ulcers. 3. It is simple, speedy and safe. 4. Clinical and roentgenologic evidence indicate that motility and function are better following excision by cautery and gastro-enterostomy than following knife excision and gastro-enterostomy. 5. The late results, if the lesion is completely removed, are at least the equal of any other method. 6. It can be used in cases in which no other means of direct attack on the ulcer is justifiable."

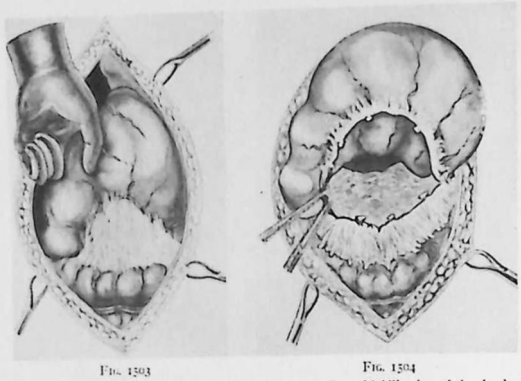


FIG. 1503 FIG. 1504

FIG. 1503. Donati's operation for gastroduodenal resection. Mobilization of the duodenum. Two fingers of the left hand have been introduced along the posterior surface of the pyloric region. The gastrocolic omentum has been made tense. It is incised in an avascular area.

FIG. 1504. Donati's operation for gastroduodenal resection. The gastrocolic ligament is divided and the blood vessels coursing in it are ligated in sections. Ligation of the pancreaticoduodenalis vessels.

It is essential that the center of the crater of the ulcer be completely perforated by the cautery. The method is most applicable to small ulcers or those involving the lesser curvature. If the crater is not more than 1 cm. in diameter, the cautery can be most satisfactorily used whatever the extent of inflammation about the crater may be (Balfour). In ulcers of the posterior wall of the stomach the transgastric route is employed.

Donati's Technic of Gastro-duodenal Resection[1]

Professor Mario Donati's technic differs from those commonly employed. This pertains principally to the treatment of the stump of the duodenum and in the gastro-intestinal suturing. Donati prefers gastrojejunal anastomosis to gastro-duodenal anastomosis. Considerable resection performed for carcinoma or for ulcer, makes the approximation of the gastric stump to the duodenum without tension, as practiced in the Billroth I procedure, particularly difficult even if the duodenum has lent itself to free mobilization. Donati admonishes that gastro-

[1] Technique Chirurgicale. No. 3. March-April, 1935.

duodenal anastomosis should, therefore, be performed only in exceptionally favorable cases

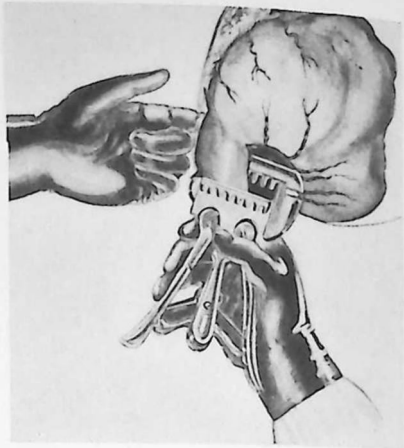


FIG. 1505. Donati's operation for gastroduodenal resection. After the duodenum is thoroughly mobilized and separated from the omental and pancreatic adhesions, Donati's instrument is introduced behind it as shown in the illustration.

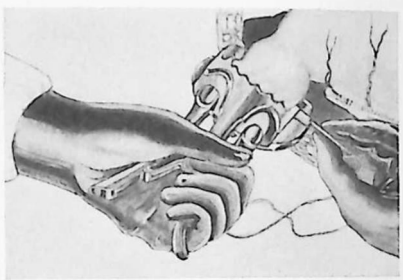


FIG. 1506. Donati's operation for gastroduodenal resection. The Donati instrument is closed tightly and the needle carrying a linen suture is passed through it as depicted.

In carcinoma, Donati excises the great omentum as a preliminary step to the subsequent operative procedure. In resections for ulcer, ablation of the omentum is not indicated, and the lesser curvature may be cut lower down; the incision

FIG. 1507. Donati's operation for gastroduodenal resection. The ends of the suture are passed behind the closed instrument.

FIG. 1508. Donati's operation for gastroduodenal resection. The duodenum is divided with a knife close to the instrument.

is usually made, under such circumstances, beyond the union of the vertical and horizontal portions of the lesser curvature. In gastric ulcer as well as in carcinoma of the stomach, one can usually divide and close the duodenum without difficulty. In duodenal ulcers, however, especially in those of the second portion, particularly if the ulcer is situated on its posterior wall and has invaded the pancreas, resection is an extremely difficult operation.

Regional anesthesia of the abdominal wall, by infiltration with one half per cent solution of novocaine to which has been added 2 cc. of vasopressin is resorted to at times; at others, ethylene and oxygen are used. The abdomen having been opened, ascertain the nature and the extent of the lesion; also its relations to neighboring organs. Determine the operative possibilities. As a supplementary anesthetic inject a few cubic centimeters of novocaine solution in the region of the pyloric and pancreaticoduodenalis vessels and in the region of the coronary gastric artery near the lesser curvature.

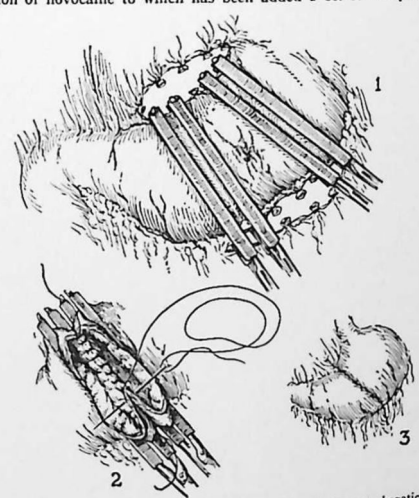


FIG. 1509. Sleeve resection on the stomach. 1. Separation of the gastrohepatic and gastrocolic omenta corresponding to the area to be removed. Application of rubber-covered stomach clamps on both sides of the ulcer-bearing area outlining the segment of the stomach to be removed. 2. Seroserous suture line placed; second suture line begun. 3. Operation completed. For technic of suturing see pages 1338-1345 incl., Figs. 1521-1524.

Donati performed 151 gastro-duodenal resections (1935). In resections for carcinoma, the mortality in his series of cases has been 8.3 per cent while in resections for ulcer, the mortality was 2.7 per cent. The illustrations (Figs. 1503-1504-1505-1506-1507-1508) depict, and the legends describe the further steps of his procedure.

For the anastomosis a jejunal loop is selected and pulled up through a vertical incision made in the transverse mesocolon. The left border of the divided meso-

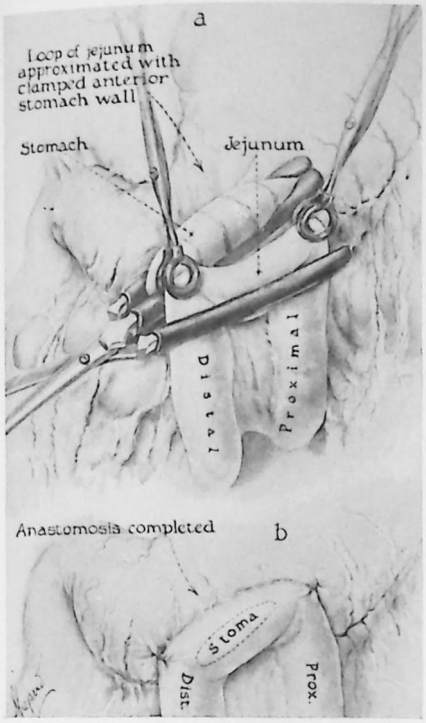


Fig. 1510. Anterior gastrojejunostomy. a. and b. A loop of about 15 inches of jejunum is brought anterior to the transverse colon and greater omentum and sutured to the anterior gastric surface in an isoperistaltic direction. The technic of anastomosis is the same as posterior gastrojejunostomy. See pages 1338-1345 incl., Figs. 1521-1524.

colon is sutured to the posterior wall of the stomach. Three-bladed anastomosis forceps are then placed in position. One of the clamps engages the stomach, the other clamp is closed on the jejunal loop. Perform the usual form of anastomosis

beginning with a continuous seromuscular linen suture. The suture is extra-mucosal.

Anastomosis and ablation of the stomach are done next. The anterior wall of the stomach is divided further from the compressing forceps than those on the anterior wall of the jejunum so as to have more tissue in front than behind. A continuous posterior suture (back-stitch) is introduced next. The last stitch of the posterior suture line is knotted. Remove the segment of stomach desired. The anterior continuous suture is introduced next. The needle traverses the submucosa and the muscularis and emerges on the serous surface of the intestine a few mm. from the wound edge. After the anastomosis is completed remove the anastomosis forceps and fix the right layer of the mesocolic breach to the anterior surface of the stomach.

MIDGASTRIC (SLEEVE OR SEGMENTAL) RESECTION

The omenta (gastro-hepatic and gastro-colic) overlying the area to be removed are detached and the vessels are ligated. Isolate the diseased portion of the

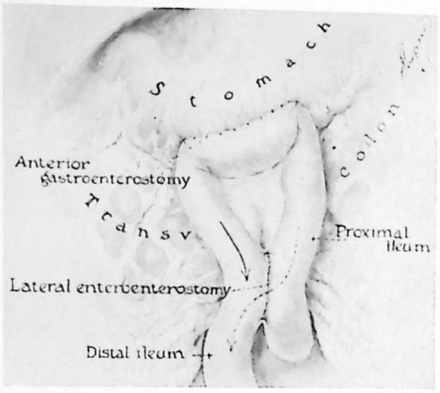


Fig. 1511. Anterior gastro-enterostomy; entero-enterostomy. For technic of suturing see pages 1338 to 1345 incl., Figs. 1521-1524.

stomach by crushing clamps, beyond which rubber covered clamps are placed (Fig. 1509). Excise the affected section of stomach. Proceed to unite both halves (end-to-end suture) as in classical gastro-enterostomy (pp. 1338-1345; Figs. 1521-1524).

ANTERIOR GASTROJEJUNOSTOMY

Wölfler's Operation

The suturing technic in the anterior operation is the same as that of the posterior procedure. In the performance of the former a loop of jejunum about

15 inches in length is brought from the duodenojejunal flexure anterior to the transverse colon and greater omentum and sutured to the anterior surface of the stomach in an isoperistaltic direction (Fig. 1510 a). For technic of suturing see pages 1338-1345 incl., Figs. 1521-1524.

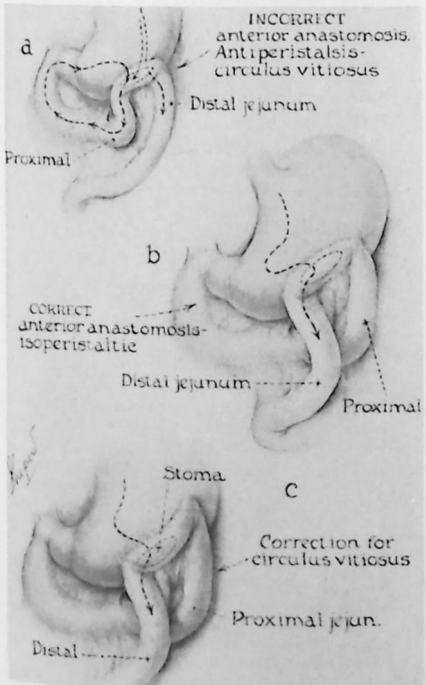


Fig. 1512. a. Antiperistaltic (incorrect) anterior gastrojejunostomy. b. Isoperistaltic (correct) anterior gastrojejunostomy. c. Anterior gastrojejunostomy to correct circulus vitiosus.

When the suturing is completed, the stoma should run obliquely from above downward and to the right (Fig. 1510 b). Somewhat distant from each angle of the anastomosis a suture is placed which adds security to the attachment of the jejunum to the stomach.

I often supplement the anterior gastrojejunostomy with a jejuno-jejunostomy (Braun-Jaboulay operation). This makes for better function. Such entero-anastomosis between the afferent and efferent jejunal loops is done by suture, or, if the patient's condition demands haste, by the Murphy button (Fig. 1511).

Figure 1512 depicts an incorrect, anti-peristaltic junction of the jejunum to the stomach, giving rise to vicious circle. The arrows indicate the abdominal course of the ingesta. Compare this with Fig. 1512 b, the correct (isoperistaltic) method of gastro-enterostomy, and the necessity to avoid this surgical pitfall will become apparent. If called upon to minister, surgically, to such a mishap the abdomen should promptly be opened and a degastroenterostomization (unhooking of the wrongly placed stomach) done and a correction of the condition accomplished by reoperating as shown in Fig. 1512 c.

GASTRO-ENTEROSTOMIA ANTERIOR OBLIQUA

Stanischeff's Operation

Professor Alex. Stanischeff[1] called attention to the fact that vicious circle following anterior gastro-enterostomy has been almost completely eliminated by supplementing such an anastomosis with a jejuno-jejunostomy (Braun's Operation).

In the six years preceding 1928, Stanischeff performed 190 gastroenterostomies with and without entero-anastomosis and has endeavored to improve the technic to eliminate the necessity of a supplementary jejunojejunostomy. He believes this is accomplished by assuming an oblique direction of the stoma. He points out that an oblique opening leading from the stomach to the jejunum in anterior gastro-enterostomy, as usually practiced, is not attained by the usual methods practiced which, after a time, results in the stoma becoming horizontal.

In operating on patients who have undergone anterior gastro-enterostomy and where a definite attempt had been made to secure an oblique direction of the stoma, I had many opportunities to verify Stanischeff's statement that in all such cases the stoma runs in a transverse, instead of the oblique direction aimed at. Stanischeff's conclusion, therefore, that it is impossible to get an oblique stoma by any method now in vogue, is justified.

To overcome the tendency for the stoma to become horizontal, Stanischeff devised an operation (Gastro-enterostomia anterior obliqua), the technic of which is as follows:

Step 1. Grasp the anterior wall of the stomach perpendicular to the transverse tangent of the greater curvature with rubber covered stomach clamps (Fig. 1513 a).

Step 2. Turn the handle of the stomach clamp toward the pylorus until it reaches a horizontal position (Fig. 1513 b).

Step 3. Bring up a loop of jejunum about 40-60 cm. from the duodenojejunal flexure. Grasp it in an isoperistaltic manner with the second clamp which is placed close to and parallel with the clamp holding the segment of the anterior stomach wall.

Step 4. Perform the usual gastrojejunal anastomosis (pp. 1338-1345 incl.; Figs. 1521-1524).

[1] Zentralblatt f. Chir. 1928. Nr. 52.

Comment: This operation constantly results in an oblique gastro-enterostomy stoma because of traction by the (1) stomach wall upward and (2) the distal loop of the jejunum downward. After removal of the clamps

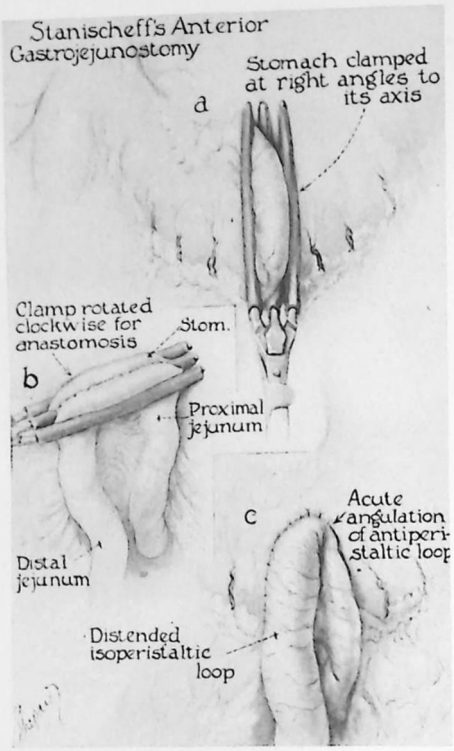


Fig. 1513. Stanischeff's oblique anterior gastro-enterostomy.

the appearance of the structures is shown in Fig. 1513 c. The anastomosed loop of jejunum angulates sharply at the upper pole of the anastomosis and thus considerable closure of the afferent loop of jejunum results. The opposite results at the lower pole of the anastomosis, the efferent

portion of the jejunal loop descends vertically and forms a wide communication with the interior of the stomach. Stanischeff (personal communication) assures me that

(a) the operation frustrates a vicious circle with certainty;

(b) it often eliminates the necessity of an additional anastomosis, hence considerable saving of time of operation;

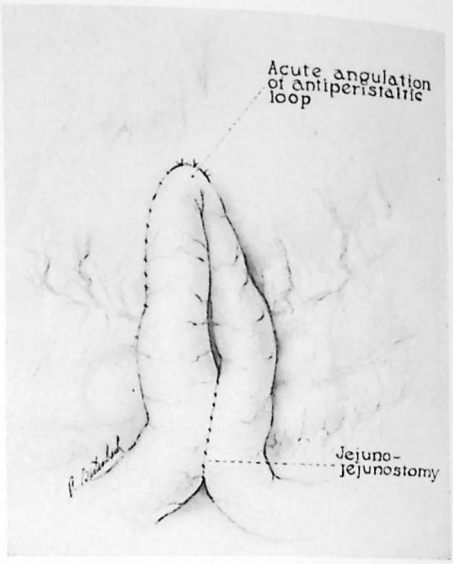


Fig. 1514. Author's modification of Stanischeff's operation which consists of combining a jejunojejunostomy with Stanischeff's procedure.

(c) it requires, therefore, less anesthesia, operative shock is minimized and is of benefit to a class of patients already debilitated.

(d) it avoids acute postoperative dilatation of the stomach.

I have used the Stanischeff procedure, following his technic meticulously, in 20 cases. The results were excellent. However, in three cases there was postoperative vomiting and epigastric distress. It occurred to me that in view of the fact that the addition of a jejunojejunostomy, in experienced hands, takes but a short time to perform and is simple of execution and also because of the long loop necessary in the Stanischeff procedure (40 to 60 cm. from the duodeno-jejunal junction) not being an

ideal state of affairs, that to combine Stanischeff's procedure with a jejunojejunostomy would form an ideal anterior gastro-enterostomy (Fig. 1514). This I have carried out in a series of nine cases. The results were perfect. Postoperative distress was completely eliminated.

Conclusions. Stanischeff's operation is a distinct advance over the usually practiced gastrojejunal anastomosis. It assures definitely an oblique stoma.

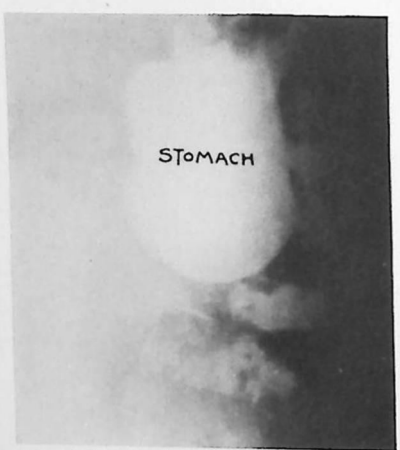


Fig. 1515. Radiogram six months after Stanischeff's anterior oblique gastrojejunostomy.

In combining Stanischeff's operation with jejunojejunostomy an ideal situation is created by eliminating stagnation in the afferent loop of the jejunum and contributes to the patient's comfort and further minimizes postoperative complications (Fig. 1515).

Roux' Gastrojejunostomy En "Y"

To avoid "vicious circle" following gastrojejunostomy the Roux' operation found many enthusiasts. The operation has lost adherents, however.

Step 1. Expose the stomach as described.
Step 2. Open the mesocolon.
Step 3. Isolate and clamp an area of stomach near the greater curvature.
Step 4. Isolate a loop of jejunum about 20 cm. long. Empty the loop of its contents and clamp it with a rubber covered intestinal clamp.
Step 5. Isolate the field of operation.

Step 6. Divide the jejunum straight across, two inches distal to the upper clamped extremity.
Step 7. Anastomose the distal end of the divided jejunum into the stomach area held in the clamp (pp. 1338-1345 incl. figs. 1521-1524).
Step 8. This anastomosis may be made either in the anterior or posterior part of the stomach. The line of incision in the stomach should equal the diameter of the intestine.
Step 9. Implant the proximal divided end into the side of the jejunum, about three inches below the site of anastomosis of the distal end of the stomach, where the anastomosis is made vertically and equal in length to the diameter of the intestine.
Step 10. Suture the mesocolon.
Step 11. Close the abdomen.

Comment: This type of operation is but seldom done. It is technically difficult. The limb of jejunum implanted in the stomach is exposed to the action of undiluted gastric juice down to the point of the lateral anastomosis with the other limb of the intestine. This greatly predisposes to gastrojejunal ulcerations.

PYLORIC EXCLUSION

This procedure was introduced to surgery by Doyen and v. Eiselsberg. Open the abdomen. Expose the portion of the stomach (usually the prepyloric) to be divided. Ligate and divide corresponding sections of the gastrohepatic and gastrocolic omenta. Place a lap sponge behind the stomach. Isolate the field of operation. Apply two crushing clamps. Divide the stomach between the two. Close the open ends of the divided stomach with continuous through-and-through sutures (catgut). Bring both sutured ends together and unite them with a seromuscular (linen) suture (Reinhard). In some cases volvulus resulted where this precaution was not taken. Close the divided omenta. Close the abdomen.

Kelling's Method

Apply a stout ligature at the point of proposed exclusion (silk or chromic catgut). A continuous seromuscular suture covers the first, constricted area. Before applying the ligature it is advisable to apply a crushing forceps and then ligate the crushed strip of stomach. Reestablishment of continuity often follows this procedure, after a time. To secure permanent occlusion Bogoljuboff used wide strips of fascia of the rectus abdominis muscle (3 cm. wide and 8-10 cm. long) while Wilms made use of strips of fascia lata. After applying these fascial bands to the ribbon resulting from the crushing of the stomach, a suture is passed through the fascial strip, tied and thus secured in place. The results seem to be more permanent, although not absolutely so.

Comment: E. L. Kellogg[1] states that the results of gastro-enterostomy are excellent in benign obstruction but much less satisfactory in non-obstructed ulcer because the greater part of the stomach contents may pass through the pylorus and prevent healing and that the gastro-enterostomy will then interfere with motility. Kellogg justly argues that under these

[1] The Duodenum—Paul V. Hoeber, 1933.

conditions a pyloroplasty or pylorectomy may be preferred; also that the former may appear inadequate and the latter too radical and under these

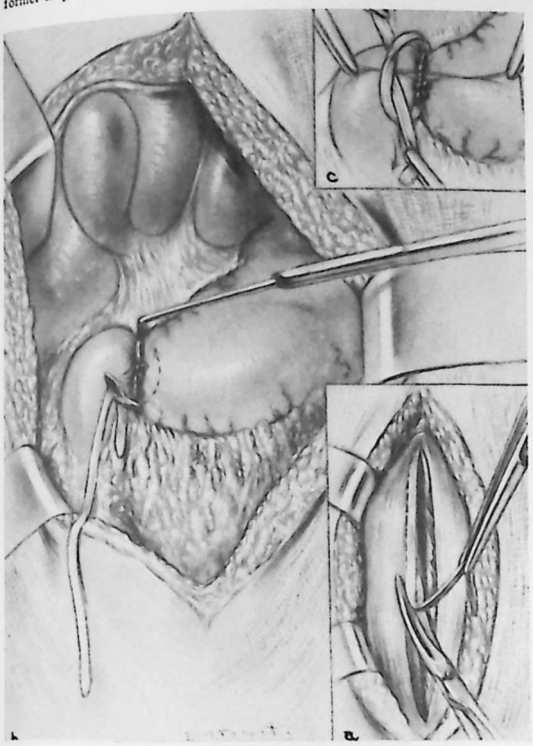


Fig. 1516. Pyloric exclusion. a. Strip of fascia excised from rectus sheath. b. Pylorus ligated with kangaroo tendon over which strip of fascia is passed. c. Fascia surrounding pylorus. Chromic gut suture in place to be tied across fascia band. (Courtesy Dr. E. L. Kellogg.)

conditions pyloric exclusion to supplement gastro-enterostomy should be considered.

Balfour observes that in his experience partial and temporary blockage of the pylorus in cases in which there are nonobstructing lesions of the anterior wall of the duodenum, has definite advantages, for the reason that

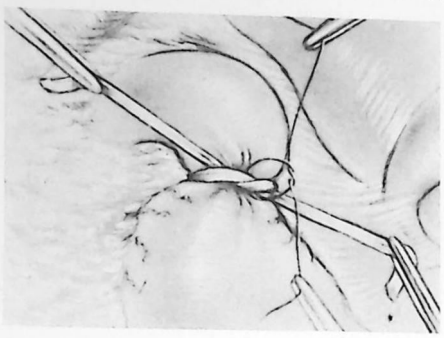


Fig. 1517. Pyloric exclusion. Fascia tied. (Courtesy Dr. E. L. Kellogg.)

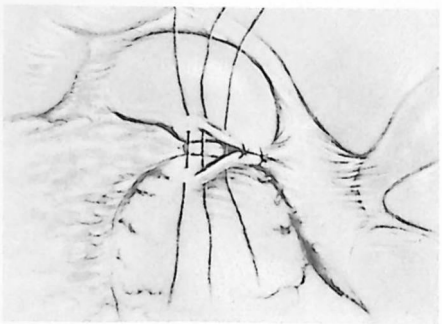


Fig. 1518. Pyloric exclusion. Chromic suture covering ligature of kangaroo tendon and fascia. (Courtesy Dr. E. L. Kellogg.)

in covering over the area of ulceration, particularly so if it is in a subacute stage especially where perforation threatens, adequate protection against perforation is thus afforded.

To exclude the pylorus, several methods have been recommended, some

of which are major surgical procedures while others, less radical, prove inadequate. Ligation of the pylorus with or without preliminary closure, as practiced by Biondi, is most frequently used. Berg formerly used a double ligature of Pagenstecher linen held in place by interrupted sutures at right angles. Brewer used metal clips; Parlaveccio a cotton band, Wilms a strip of fascia lata and Polya, the round ligament of the liver. While ligation may not cause permanent stenosis which will produce an exclusion that will last long enough to aid in bringing about healing of the ulcer, Kellogg stresses that ligation with kangaroo tendon produces a temporary closure of the pylorus and if this be reinforced by a band of fascia cut from the margins of the abdominal wound or by a strip of the ligamentum teres, the living tissues thus used become organized and cause permanent narrowing. And while such procedure usually fails to produce complete obstruction, it serves the purpose of diverting the greater part of the gastric contents through the stoma created by the gastrojejunostomy. (Figs. 1516-1517-1518.)

ANTRAL EXCLUSION

Devine's Operation[1]

Sir Hugh B. Devine of Melbourne has pointed out that the most certain and direct means of obtaining a cure for duodenal ulcer is by excluding it from all contact with food and gastric secretions. Antral exclusion was developed on the principles of von Eiselsberg's pyloric exclusion. The latter has been followed frequently by jejunal ulcers and has, therefore, for some years, been abandoned. The principles underlying the operation are to

(a) exclude the duodenum,
(b) divide the stomach well above the incisura,
(c) close the end of the lower segment and
(d) complete the operation with an end-to-side gastrojejunostomy.

This procedure tends to inhibit the acid-forming mechanism. The method is worthwhile and much less dangerous than gastric resection and is frequently followed by excellent results. Or, in the language of Devine who advocates this procedure, in certain cases of penetrating ulcer, chronic duodenal ulcer and bleeding ulcerations, the operative removal of which is beset with many technical difficulties, in the words of Devine, "gastric exclusion avoids the dangers of partial gastrectomy and the greater ones of partial duodenostomy and obtains the same uniform and consistent reduction of acid as does a partial gastrectomy, and by permanently excluding the diseased area the same certain and permanent healing of the ulcer."

Step 1. Ligate and divide the gastrohepatic and gastrocolic omenta; the gastrohepatic omentum about 2 inches above the incisura, the gastrocolic omentum high enough on the greater curvature so that an oblique line of division on the stomach will result.

Step 2. Bare the greater and lesser curvature of omentum for a distance of about two inches.

[1] Surgery, Gynecology & Obstetrics, Aug., 1928.

Step 3. Apply to the stomach two heavy Payr crushing clamps (Fig. 1522) in the proposed line of division. Divide the stomach between the clamps (Fig. 1519).

Step 4. Close the end of the lower segment with a continuous suture of chromic catgut.

Step 5. Bring down the upper segment of the divided stomach through an opening in the mesocolon and perform an end-to-side gastrojejunostomy (Fig. 1520).

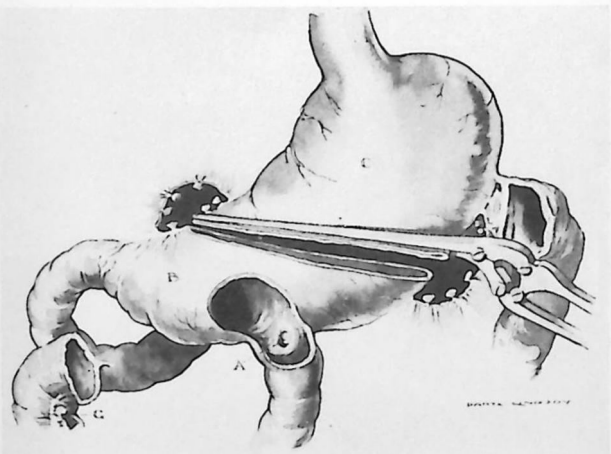


Fig. 1519. Devine's operation. First stage of oblique partial gastric exclusion for jejunal ulcer. Oblique division of stomach. Window cut to show jejunal ulcer A, and gastroenterostomy stoma; B, excluded segment; C, portion of stomach to which anastomosis is made; G, transverse colon. (After Devine in Surg., Gyn. & Obst., Vol. XLVII, p. 240, 1928.)

Comment: Balfour comments on Devine's procedure as follows:

"In the rare instance in which a duodenal ulcer becomes reactivated after this operation, particularly with recurrence of bleeding, removal of the lower segment presents no particular difficulties, since the inflammatory reaction about the lesion almost completely subsides as a result of the exclusion, and mobilization is relatively easy. This necessity occurred in one of our cases and we were able to bring about satisfactory and permanent cure by removal of the pyloric segment and of the first portion of the duodenum, as a secondary procedure. This is an important consideration to keep in mind about all exclusion operations; that is, if the

necessity of secondary operations arises in the future, such operation can be performed without difficulty."

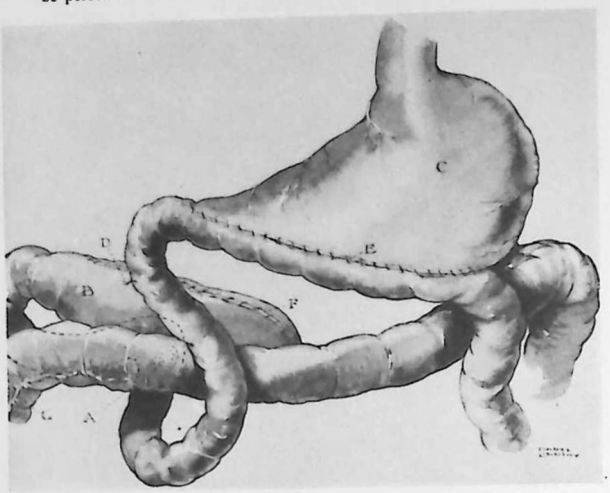


FIG. 1520. Devine's Operation. Second stage of oblique partial gastric exclusion for jejunal ulcer. A, Gastro-enterostomy stoma and jejunal ulcer; B, excluded segment; E, oblique anastomosis, anticolic, which avoids kinking and insures regurgitation where the afferent loop enters the stomach. Similarly the almost transverse position of the intestinal loop removes any tendency to angulation and facilitates emptying into the efferent loop; C, portion of stomach to which anastomosis is made; D, jejunum anchored to excluded segment to prevent angulation; F, suture line of excluded segment; G, transverse colon. (After Devine in Surg., Gyn. & Obst., Vol. XLVII, page 241, 1928.)

POSTERIOR GASTROJEJUNOSTOMY

von Hacker's Operation

The following factors are paramount in obtaining success with this operation:

(a) A properly placed stoma;
(b) Maintenance of the original direction of the first loop of the jejunum.
(c) Properly executed suturing technic and
(d) Closure of the opening in the mesocolon.

Step 1. Make an ample right paramedian incision.

Step 2. Examine the stomach, duodenum, gallbladder and appendix. Choose a point on the stomach best suited for the gastro-enterostomy. This is usually best in a most dependent portion of the stomach and close to the greater curvature.

Step 3. Lift up the greater omentum and bring to view the transverse colon.

Step 4. Expose the transverse mesocolon by pulling on the transverse colon. Locate the first loop of the jejunum. This is easily accomplished by gliding the hand along the mesocolon toward its base and to the left of the median line. The location of the ligament of Treitz denotes the position of the duodenojejunal flexure, opposite the second lumbar vertebra. If the ligament binds down the jejunum excessively, or is short, it may be carefully cut between ligatures. In so doing keep in mind the position of the inferior mesenteric vein.

Where it is difficult to deliver the stomach through an opening in the mesocolon, a second opening may be made as advised by Wilkie in the gastrocolic omentum, and the anastomosis completed in the lesser peritoneal cavity.

Step 5. Make an opening in an avascular area of the transverse mesocolon. Avoid injury to the middle colic vessels!

Step 6. Deliver a sufficiently large portion of the posterior wall of the stomach through this opening. If, as it sometimes happens, the division of the transverse mesocolon offers some difficulty, Moynihan advises the following maneuver: Hold up the transverse colon and stomach by the left hand, making the mesocolon taut. At a bloodless spot in the arch of the middle colic artery an artery forceps is applied to the under surface of the mesocolon. Having secured a firm hold, the mesocolon is lifted from the posterior surface of the stomach and the lesser peritoneal cavity is opened at once by a snip of the scissors by the side of the artery forceps. The opening is enlarged lengthwise by gentle separation of its edges until it easily admits three fingers. The whole posterior surface of the stomach may be explored through this opening. While in the illustration it seems that the incision in the transverse mesocolon is transverse, it is actually longitudinal. It assumes a transverse aspect when the stomach is delivered as depicted.

Step 7. Apply a stomach clamp diagonally (Mayo's no-loop method) in such a manner that the points of the blade are directed toward the patient's left side. A loop of jejunum is engaged in such a manner that, when replaced to a normal position, its distal portion is on a lower level than the proximal. Various clamps have been devised for gastrojejunostomy (Doyen's, Moynihan's modification of Roosevelt's, Hartman's, Harrington, etc., Fig. 1523). I use by preference a Roosevelt, or its Moynihan modification, three-blade instrument. The viscera are held steady with this instrument during manipulations. Properly used, a heavy instrument is more effective than a light one; yet the former is charged by some surgeons with being responsible for trauma.

Also, the lowest point in the proposed opening in the stomach should be at the greater curvature and run parallel to the normal direction of the first loop of the jejunum.

Allis forceps steady the stomach while a Roosevelt or single clamps are applied to the stomach, as indicated in the illustration. About three and a half inches of stomach should be in the grasp of the blade and project about an inch or more above the clamp. (Fig. 1521 a.)

Step 8. Suture now the proximal margin of the mesocolon to the stomach. The suturing of the mesocolon to the stomach should be done before the anastomosis is made, because if it is postponed until after the jejunum and stomach are united, the union of the mesocolon to the stomach becomes much more

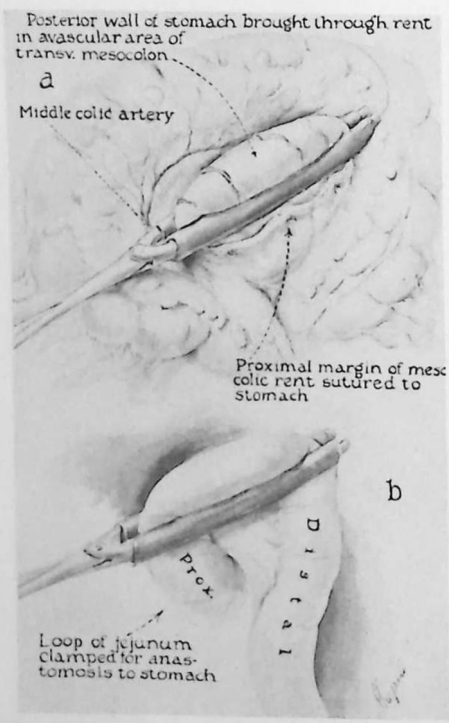


FIG. 1521. Posterior gastrojejunostomy. a. The transverse colon is mobilized upward through an adequate midline incision. The stomach is clamped diagonally upward toward the patient's left so that when stomach is replaced to a normal position the distal portion of the jejunum will be lower than the proximal. Avoid the middle colic vessels. b. The jejunum clamped close to the duodenojejunal junction. The operation is practically a no-loop anastomosis.

difficult and subjects the sutures already placed to undue strain. Another point emphasized by W. J. Mayo is that the margins of the rent in the meso-

colon be sutured to the stomach with interrupted sutures about half an inch above the site of the stoma. If sutured around the stoma there may result later a constriction from the contraction of the wound on the mesocolon which may give rise to trouble. On the other hand, Moynihan pre-

FIG. 1522. Payr's pylorus clamp.

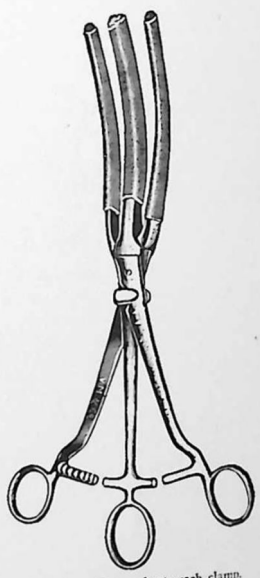


FIG. 1523. Roosevelt stomach clamp.

fers "to stitch the mesocolon to the jejunum rather than to the stomach, as is generally done."

Step 9. Clamp a loop of jejunum of the same size as the portion of stomach and approximate it to the side of the stomach in such a manner that its distal end is approximated to the greater curvature of the stomach (Fig. 1521 b). A short proximal loop (about two or three inches), or "no loop" is now generally used to avoid "vicious circle." The importance of this has been emphasized by Petersen. I prefer to leave the proximal loop sufficiently long (15-20 cm.) to perform a jejunojejunostomy should a contingency arise. Whether the jejunum is attached to the stomach, in an iso- (Moynihan) or anti-peristaltic direction (Mayo) seems, from a practical point of view, to

make no difference. Avoid inclusion of the mesentery in the clamp. "Strip" the jejunum of its contents before applying the clamp. Avoid too tight clamping, thus avoiding possible injury to the bowel wall, hematoma-formation or creating a predisposition to postoperative bleeding. Clamps, it must be remembered, are used for coaptation and not for strangulation. Moynihan's method of applying the blade of the clamps differs from that of Mayo.

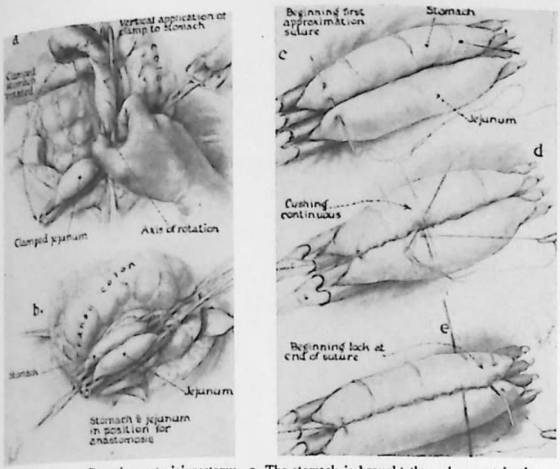


Fig. 1524. Posterior gastrojejunostomy. a. The stomach is brought through a rent in the transverse mesocolon and clamped vertically. The jejunum is clamped as close to the duodenal junction as possible. Now the stomach, grasped with the fingers to prevent slipping from the clamp, is rotated the reverse of clockwise to meet the jejunum. b. Surround the stomach and jejunum posteriorly and on the sides with gauze and the structures are ready to be united. c. The clamped stomach and jejunum are held together and gauze pads packed about. The first serous suture is begun. d. Continuing the first approximation suture. e. Beginning lock at end of suture.

The latter, as described, counsels the application of the clamps obliquely while the former engages the stomach in a vertical direction in line with the vertical portion of the lesser curvature and ends below at the lowest point of the greater curvature. The clamp is now turned transversely, the handle of the instrument pointing to the left of the abdomen and held there by an assistant. The jejunum is picked up, also vertically, by another clamp, the proximal end of which is made as taut as possible before closing the blades. This insures the inclusion of the jejunum as high as possible toward the duodeno-jejunal flexure. The clamps are now placed side by side (Fig. 1524).

Step 10. Isolate the operative field by lap sponges wrung out of warm salt

solution. A "lap-towel" with split center circumscribes the operative field. Place a towel over the handle of the clamps to prevent the sutures from catching.

Step 11. The first (approximation) suture line, is a continuous suture (seromuscular) which is non-penetrating and should include a portion of the submucous coat (recognized by a resistance to the point of the needle). I prefer for this suture Pagenstecher celloidin linen instead of catgut. It gives a greater sense of security. The suture is begun as a continuous Lem-

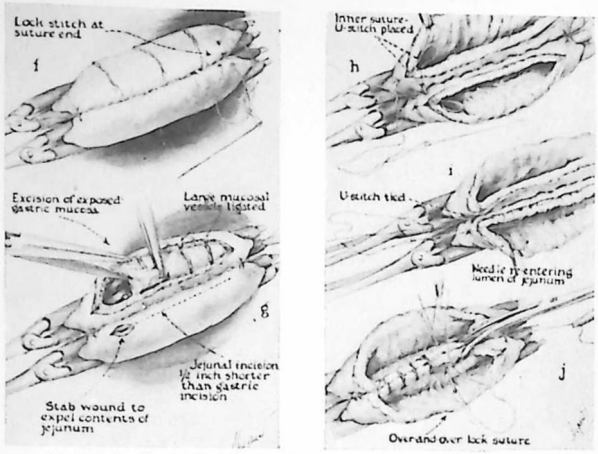


Fig. 1524 (continued). Posterior gastrojejunostomy. f. The Cushing suture is ended with a Lembert stitch and simple lock tie. g. The stomach is incised and prepared for anastomosis. h. Beginning the inner suture line. i. and j. Steps in placing the second (inner) suture.

bert stitch as shown in Fig. 1524 c. Knot it. Place a light forceps on the short end of the suture and continue it as a Cushing suture, sewing parallel to the clamps (Fig. 1524 d). It is locked at the opposite end (Fig. 1524 e). Another lock-stitch may be superimposed on the first one at the end of the suture line, for greater security (Fig. 1524 f). In placing this suture joining the jejunum and stomach, the suture is gently pulled upon at each passage of the needle, thus raising a ridge which indicates the next point of introduction of the needle.

Step 12. Opening into the stomach and jejunum is the next step. Outline the proposed openings to be made in the stomach and jejunum by lightly scarifying the surfaces of the respective viscera, with a scalpel. The incision in

the stomach is about one-quarter of an inch from the suture line, a little shorter than its extent and running parallel with it. A suction apparatus is a convenient means of evacuating the stomach and jejunal contents if no clamps are used (Horsley). Carry the incision through the serosa and muscularis down to the submucosa. Larger vessels here encountered may now be ligated (Fig. 1524 g). An elliptic portion of mucosa (not too wide) is excised. Moynihan lays great stress on this excision of the mucosa as a prophylactic measure against subsequent contraction. The opening in the stom-

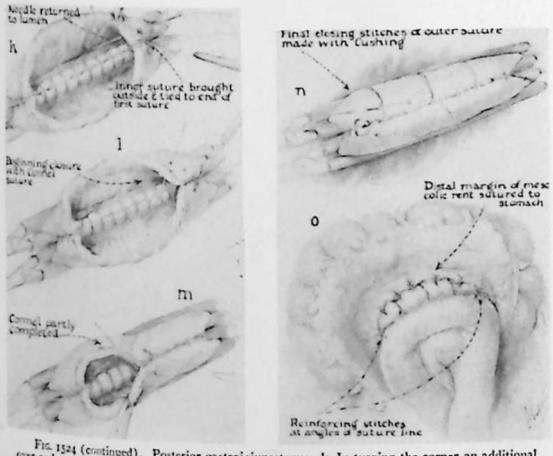


Fig. 1524 (continued). Posterior gastrojejunostomy. k. In turning the corner an additional over-and-over stitch or two without lock may be made. l. and m. The Connell suture begun and continued. n. Outer closing suture being completed. An additional serosal approximation suture is to be applied. o. The operation completed.

ach and jejunum should be about two inches in length. Make a stab wound to expel the contents of the jejunum. Open the bowel with knife or electrocautery. The latter effectually minimizes bleeding from the wound margins of the opened bowel. Swab the stoma in the stomach and jejunum with iodine on long applicators. Rinse the gloved hands. Replace soiled covers.

Step 13. Commence the second (inner), through-and-through suture (Fig. 1524 h) at the lower angle of the openings by a U-stitch as follows: Pass the needle from without into the stomach or jejunum midway between the knot of the first suture and the cut edge. Penetrate all coats, embracing both viscera. Let the needle emerge from the opposite side corresponding to its point of entrance. Tie. Apply a light forceps to the short end of the su-

ture as a guide. Reintroduce the needle into the jejunum (Fig. 1524 i) and suture the posterior edges of the stomach and jejunum with an over and over lock-stitch (Fig. 1524 j) until the opposite end is reached. Here the inner suture is brought outside and tied to the first suture. The needle is then again returned to the lumen (Fig. 1524 k) and the closure of the anterior walls is continued with a Connell or as I prefer an over-and-over suture (Figs. 1524 l and m) which embraces all the coats and is, if properly applied, hemostatic, preventing hemorrhage into the stomach. The suture should be firmly drawn by the surgeon himself and "so important a step should not be entrusted to an assistant" (Moynihan). When reaching the knot which marks the beginning of the second (inner) suture, insert one Lembert suture just beyond the knot and tie it. Cut the ends of the suture short. It is asserted by some that silk or linen used here as an inner suture may give rise to gastro-jejunal ulceration. I use chromic catgut for this suture. Instead of a Connell suture I routinely use an over-and-over stitch so successfully practiced by Moynihan. I do not make any special effort at inversion of the mucosa. In fact, Horsley points out that the inversion of the mucosa is a blind procedure while eversion is preferable, thus, permitting careful hemostasis under direct vision.

Step 14. After finishing the second (inner row) suture, release the viscera held in the clamps and discard soiled linen and instruments. Cleanse the field of operation. Wash or change gloves, inspect the suture line for bleeding points, pick up the long end of the outer suture and continue it with a right angle Cushing stitch to complete the operation (Fig. 1524 n). Tie it to the original short end. Place a reinforcing stitch at each angle of the suture line (Fig. 1524 o). Suture the distal margin of the mesocolon rent to the stomach at a distance from the line of anastomosis. This will prevent herniation into the lesser peritoneal sac.

Step 15. Inspect thoroughly.

Step 16. Replace the organs in proper position into the abdomen.

Step 17. Close the abdominal wall in layers.

ABLATION OF A GASTRO-ENTEROSTOMY—DEGASTRO-ENTEROSTOMIZATION

This procedure may be simple or become extremely difficult in the presence of extensive adhesions.

Operation

Expose the anastomosed area. Free it completely on all sides. Ligate the corresponding portions of the gastrocolic omentum and transverse mesocolon. Clamp the anastomosed portion of the stomach. Divide the line of anastomosis, preferably on the stomach side. Close the stomas in the stomach and jejunum in the long axis of the viscera by two layers of superimposed sutures. If the jejunum is found much narrowed, either a resection of the portion of jejunum with end-to-end anastomosis is done or a new short circuiting entero-anastomosis is performed. In the presence of gastro-jejunal ulcer the operative

technic becomes more difficult. The ulcer area may have to be resected, an end-to-end anastomosis done in the jejunum, the stomach resected to an extent indicated by the existing pathologic condition and the intestinal tube reconstructed by one of the Billroth II modification operations. If the transverse colon be involved, this also may have to be resected, followed by an end-to-end anastomosis and complimentary gastro-jejunal procedures.

BILLROTH II

This operation consists of resecting the pathologic segment of the stomach, supplemented by an anterior or posterior gastrojejunostomy with or without a Braun-Jaboulay anastomosis. These procedures have in recent years given place to the modified Billroth II which will presently be described.

PARTIAL RESECTION OF THE STOMACH (GASTRECTOMY) WITH TERMINO-LATERAL GASTRO-JEJUNOSTOMY

Billroth II, Modified by Reichl, Pólya, Moynihan, Balfour and Others

Step 1. Make a midline abdominal incision extending from the ensiform cartilage to the umbilical pit.

Step 2. Explore the abdomen. If done for carcinoma, avoid implantations of cancer cells by carefully packing off the abdominal viscera from the field of operation by lap sponges wrung out of warm salt solution.

Step 3. Ascertain the line of proposed resection; this should be at least one or two inches from the diseased area (to the left) and away from enlarged lymph nodes. The presence of such nodes, however, is no contraindication for operation.

Step 4. Separate the stomach from its attachments (Fig. 1525 a). This is commenced either through the lesser omentum or through the gastrocolic omentum. The latter mode of procedure will be described. Ligate doubly and divide the left gastro-epiploic vessels about the middle of the greater curvature of the stomach or more laterally to the left, if need be. Include a bit of the stomach-wall within the bite of the needle. Leave these ligatures attached to the forceps long, to be used as a tractor. Divide and ligate doubly the gastrocolic ligament. Carry this maneuver to the right, as far as the duodenum. Avoid injury to the middle colic vessels! These supply the transverse colon and if injured, gangrene of the bowel will result. In case of carcinoma, keep close to the upper border of the transverse colon to include all lymph nodes involved. Isolate and ligate the right gastro-epiploic artery (Fig. 1525 b), where it springs from the gastro-duodenalis artery. Free the pylorus from the pancreas posteriorly. Identify, doubly ligate and divide the right gastric (coronary) artery (Fig. 1525 c). If difficulties are encountered here by reason of adhesions, the left coronary (gastric) vessels are isolated, clamped, ligated and divided and the stomach divided at this juncture, between clamps, and reflected to the right. This will considerably facilitate further operative manipulations and permit the separation of the pylorus from the pancreas under direct vision. Occasionally firm adhesions are here encountered. It then becomes necessary to

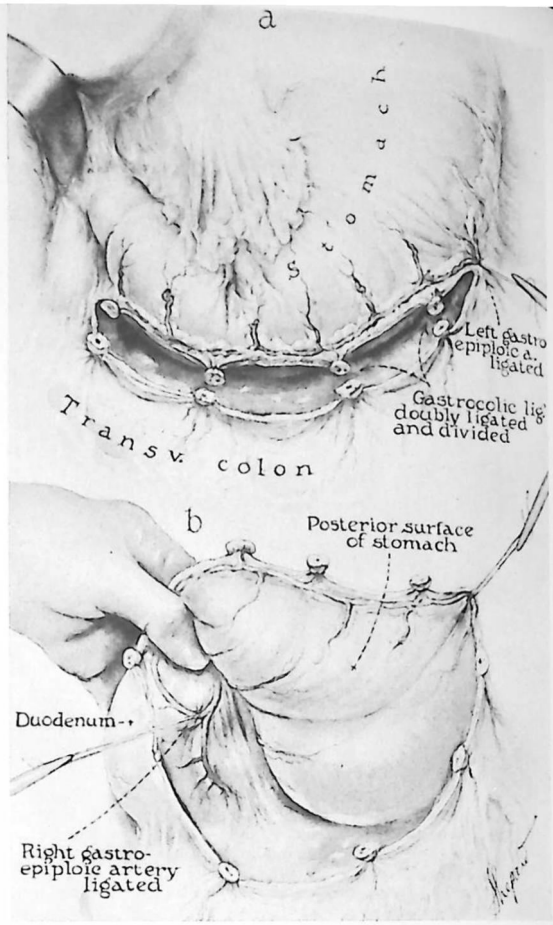


Fig. 1525. Partial resection of the stomach. a. The abdomen is opened by a midline incision from the ensiform to the umbilicus. The left gastroepiploic vessels are ligated with ligatures including the stomach wall. The omentum is gathered into the double ligatures of the vessels and cut between the ties. b. The stomach with its greater curvature mobilized is reflected upward and the right gastroepiploic vessels ligated near the branching of the duodenal artery.

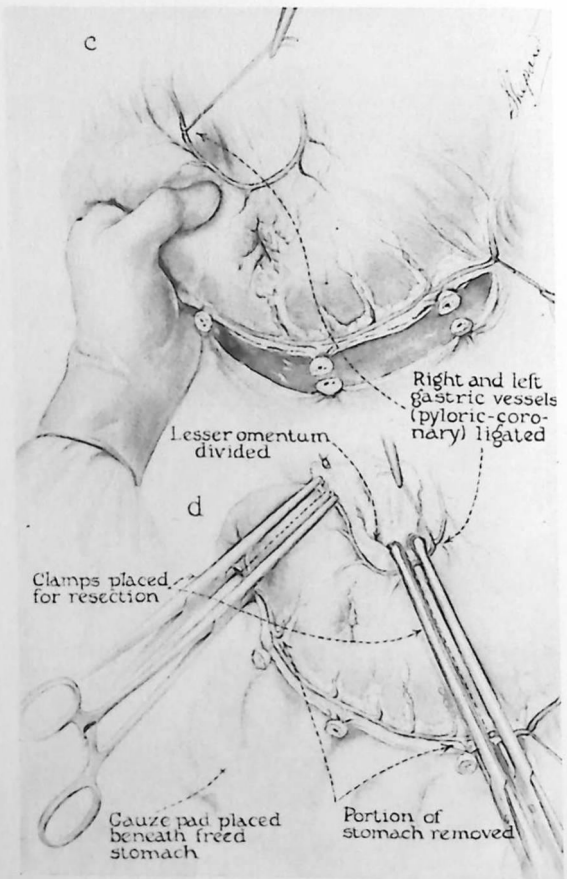


Fig. 1525 (continued). Partial resection of the stomach. c. and d. The vessels supplying the stomach from the lesser curvature are ligated, the lesser omentum divided and the mobilized portion of stomach clamped for resection.

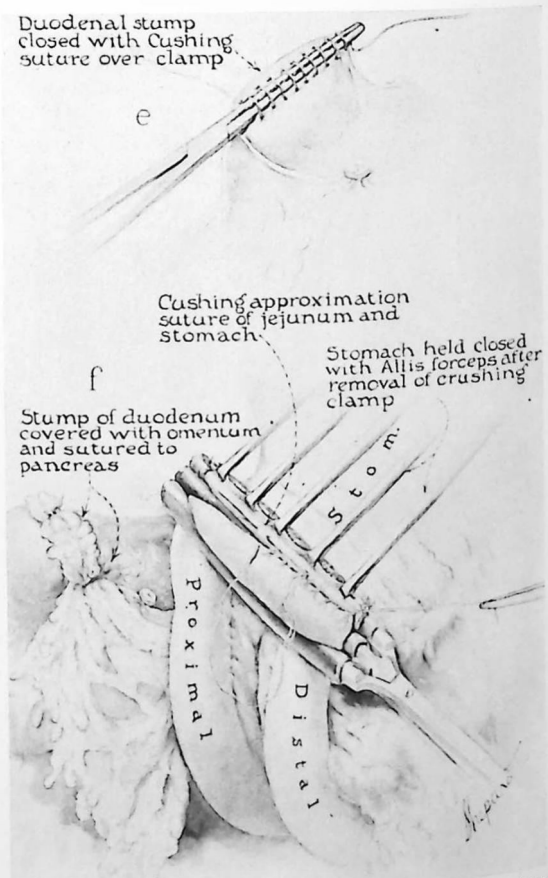


Fig. 1525 (continued). Partial resection of the stomach. e. The stump of the duodenum is invaginated with an infolding Cushing suture placed over the clamp. f. A long loop of jejunum is brought anterior to the colon and omentum for a side-to-end anastomosis with the gastric stump.

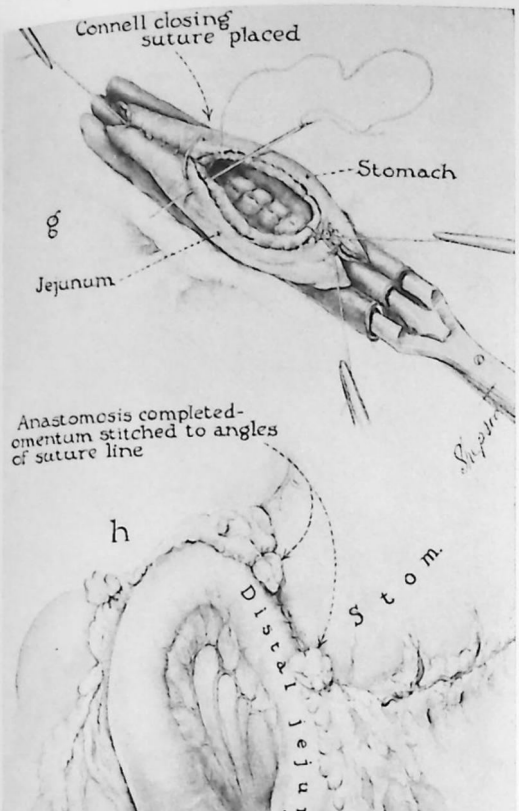


Fig. 1525 (continued). Partial resection of the stomach. g. The final suture of gastrojejunal anastomosis. The various steps are shown in posterior gastro-enterostomy (see pp. 1338-1345; figs. 1521-1524). h. The completed operation. The suture line is covered to a great extent with omentum.

(e) Avoidance of injury to the middle colic vessels and
(f) Security of the duodenal stump against leakage.

Step 10. We are now ready for the anastomosis (gastrojejunostomy).

Raise up and reflect upwards the omentum and the transverse colon. Identify the first loop of the jejunum.

Step 11. Pick up a loop of jejunum about fourteen to eighteen inches from the duodenojejunal juncture. Bring it up in front of the transverse colon and omentum (as advised by Balfour) and place it against the divided stomach stoma for anastomosis (Fig. 1525 f). It is important to remember that the distal end of the jejunum must always be at the greater curvature of the stomach. Allis forceps hold the stomach closed after the crushing clamps are removed.

Step 12. Drape as for the performance of gastrojejunostomy (see gastrojejunostomy pages 1338-1345). We are now ready for an end-to-side, terminolateral anastomosis.

Step 13. The first suture is introduced. This is a Cushing right angle stitch of Pagenstecher celloidin linen or silk carried on a straight or curved needle. On reaching the lesser curvature, the suture is tied (not locked).

Step 14. Make an opening in the jejunum. Remove the Allis forceps. Insert a U-angle suture and tie it.

Step 15. Unite the posterior wall of the stomach with that of the jejunum as in gastrojejunostomy by a continuous suture (see pp. 1343-1344) Figs. 1524 and 1525 g. After emerging on the opposite angle, continue the suture uniting the anterior walls of the divided viscera by a Connell or straight through-and-through suture (the latter is simpler to execute and just as effective).

Step 16. Superimpose over the last suture line a seromuscular (Cushing) stitch covering the anastomosis.

Step 17. Cleanse the operative field.

Step 18. Loosen the clamps. Discard the instruments used in the anastomosis.

Step 19. Don fresh gloves.

Step 20. Protect the angles of the anastomosis by stitching omentum over it (Fig. 1525 h).

Step 21. Inspect the operative field.

Step 22. Close the abdomen.

In debilitated individuals it will serve the interest of the patient best to operate in two stages.

Stage I. Gastrojejunostomy.

Stage II. Two or three weeks later, or when the condition of the patient warrants, resection of the affected segment of stomach is done (Billroth II).

Balfour's Technic for Two-Stage Resection of the Stomach

First Stage

Step 1. Infiltration anesthesia. Open the abdomen by an incision extending near the median line between the xiphoid and the umbilicus. Explore for palpable metastases. Ascertain whether the involvement is such that a surgical removal of the affected segment later, is out of question, or, whether it is still resectable.

shave off bits of pancreatic tissue. This, cautiously done, is a safe procedure, provided care is exercised not to injure the ducts of the pancreas. The lesser omentum (gastrohepatic) is divided in the same manner as the gastrocolic omentum.

Step 5. A large lap sponge (moist) is now placed behind the partially detached stomach.

Step 6. Two crushing clamps (Payr pattern) are now placed at the point of proposed section of the duodenum (usually about one inch from the pylorus). Divide the duodenum with the electrocautery knife keeping close to the distal clamp.

Step 7. Apply a clamp to the distal (left) segment of the stomach (Fig. 1525 d).

Step 8. Wrap the detached pyloric end of the stomach in a hot lap sponge and turn it over to the left of the patient and proceed with the closure of the duodenum by either of the methods depicted in Figs. 1525-1526.

In removing the segment of stomach for carcinoma it is essential that all involved lymph nodes, particularly the subpyloric group, should be taken away.

Closure of the duodenum. The crushed end of the duodenum is closed with a Cushing suture, applied over the clamp as shown in the illustration (Fig. 1525 e). It is not knotted at the start. While the clamp is gradually withdrawn, traction on the end of the suture (which is to be of stout chromic catgut) inverts the edges of the divided duodenum. The suture is now placed along the duodenum, returning to its starting point and securely tied. Superimposed sutures may be placed to reinforce the suture line, if deemed advisable. If the first and last bites of the suture are at right angles to the open end of the duodenum (Parker-Kerr stitch) inversion of the duodenum is facilitated.

Thorough closure of the duodenal stump is of utmost importance! Instead of the method described the following maneuver may be used. (Fig. 1526.)

Apply two clamps to the duodenum distal to the diseased portion and about one-half inch apart. The distal clamp should be a powerful crushing clamp. Divide the duodenum with the cautery knife. Release the crushing clamp and ligate the crushed ribbon of duodenum with strong chromic catgut. Superimpose a purse-string suture. Reinforce it with additional sutures, if deemed advisable, after inserting it.

In either method of duodenal closure described a tab of omentum is drawn over the duodenal stump and the latter fastened to the head of the pancreas in such fashion as to cover any denuded pancreatic surface and to further insure by mechanical stability against leakage from the duodenum (Fig. 1525 f).

The stump may also effectually be cared for by using Donati's duodenal stump clamp, an ingenious device which crushes the duodenum and permits exact closure of the stump by suture, in a surprisingly short time.

Step 9. Inspect the field of operation and make sure that the following has been effected.

(a) Thorough resection of all involved tissues beyond the limits of malignancy.
(b) Thorough removal of affected lymph nodes.
(c) Thorough cauterization of the divided duodenal and gastric ends.
(d) Thorough hemostasis.

Step 2. Ascertain the upper limits of the carcinoma. Introduce a finger into the lesser peritoneal cavity through the gastrohepatic omentum. Separate posterior adhesions.

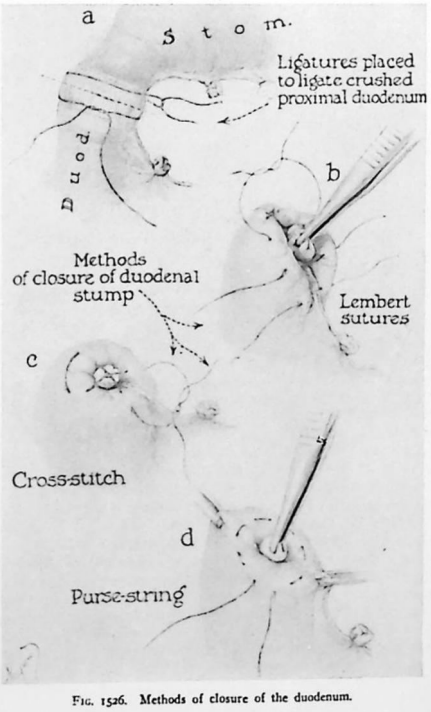


Fig. 1526. Methods of closure of the duodenum.

Step 3. Ligate and divide the gastrocolic and gastrohepatic omenta. Free both curvatures of the stomach for a distance of about 5 cm. and far enough above the growth so as to allow an easy closure of the lower end of the segment.

Step 4. Place two crushing clamps across the stomach and divide it.

Step 5. Close the pyloric segment below the clamp by a continuous mattress suture of heavy chromic catgut. Remove the clamp and continue the chromic catgut suture as a second row suture. Reinforce the suture line with interrupted silk sutures, as deemed advisable.

Step 6. Do an anterior or posterior gastrojejunostomy. If an anterior procedure is decided upon, add to it an entero-anastomosis. This completes the first step of the operation.

Proper postoperative care consists of giving the patient plenty of sodium chloride by rectolysis (at least 2,000 cc. per diem). Gastric lavage is resorted to on the evening of the day of the operation, the following day, and again after twelve hours, should there be a tendency to retention.

The second stage of the operation is performed, if no complications exist, in about a fortnight.

Second Stage

Step 1. Open the original incision.

Step 2. Mobilize the end of the pyloric stump. Ligate and divide the gastrohepatic and gastrocolic omenta and include all regional lymph nodes.

Step 3. Divide posterior attachments and if the pancreas appears involved in the malignant infiltration, carry out the dissection with a cautery knife.

Step 4. Continue the dissection. Remove as much of extra gastric and duodenal tissue as seems necessary.

Step 5. Place a small Payr clamp on the duodenum; remove the affected segment of stomach.

Step 6. Close the duodenal stump with chromic catgut. Reinforce the suture line. Protect the stump with adjacent omental tags.

Step 7. Cleanse the field of operation carefully with warm salt solution. Close the abdominal incision with through-and-through sutures of silkworm gut.

TOTAL GASTRECTOMY

This is indicated in certain forms of carcinoma of the stomach and in linitis plastica. The operation consists of removal of the whole stomach and union of the end of the esophagus with a loop of jejunum (esophagojejunostomy) or to the end or side of the duodenum (esophago-duodenostomy—Finney). In the latter instance, free mobilization of the duodenum will facilitate the approximation of the divided ends. Where the tension between the two ends seems marked, esophagojejunostomy should be performed. This may be done in antecolic or retrocolic fashion. It may be supplemented by entero-anastomosis (Fig. 1527).

The actual anastomosis is performed in the usual manner. The first line of suture (seromuscular) is introduced while the stomach is being removed, as the suture proceeds. A continuous inner suture follows as in other anastomoses (which see). After the suture is completed, fix the omentum to the suture line by two or three interrupted catgut stitches.

CARDIECTOMY

Access to the cardiac end of the stomach is rather difficult. If a vertical incision is used as a means of approach, it must be placed high. I prefer Mar-

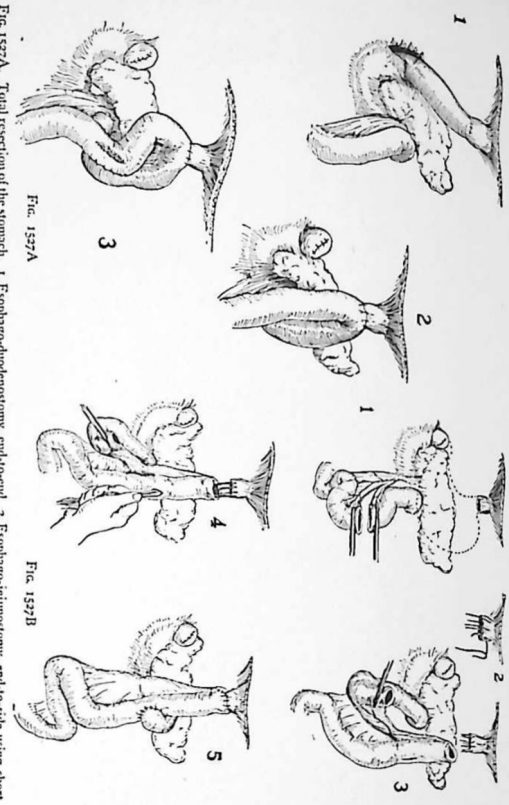


Fig. 1527A

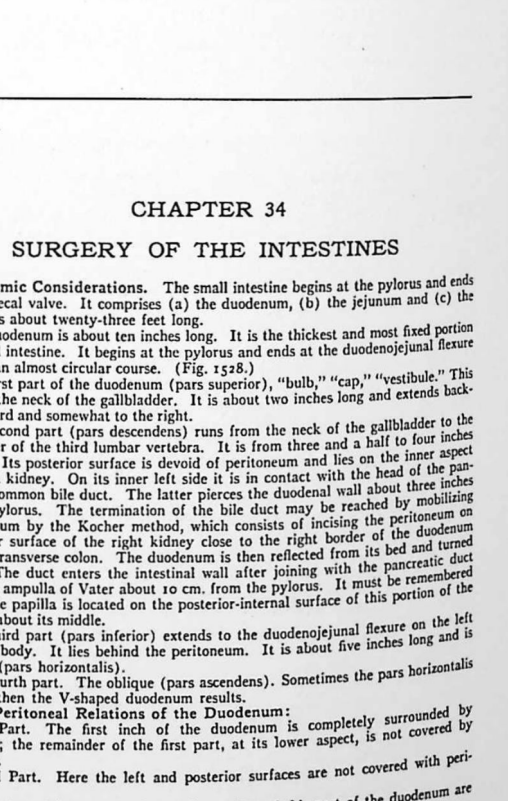


Fig. 1527B

Fig. 1527A. Total resection of the stomach. 1. Esophago-duodenostomy, end-to-end. 2. Esophago-jejunostomy, end-to-side using short upper loop of jejunum. 3. Esophago-jejunostomy, end-to-side together with Braun's anastomosis by using a loop of jejunum lower down.

Fig. 1527B. Esophago-jejunostomy (after Coenen). 1. The esophagus is divided and the stump of the duodenum closed with sutures. The dotted line shows that the stomach has been removed. The jejunum is divided transversely; the divided ends are held by stomach forceps. The nutrient arteries are protected from injury. 2. The first traction sutures are placed in the esophagus. 3. The duodenum is closed. The sutures seen in the esophagus above are ready to be pulled through the efferent loop of jejunum as seen in the next illustration. 4. Observe that the efferent loop of jejunum has been narrowed by sutures (see previous illustration); the other end of pulled through the incision as outlined in the previous illustration. 5. The illustration shows the open stump of the jejunum has been anastomosed with the efferent loop in the form of a Y-anastomosis at the opening where the esophageal sutures were pulled through.

wedel's incision. After the lower thorax and upper abdomen are elevated on the operating table by means of a body elevator, pneumatic pillow or sandbags, an incision, beginning at the ensiform cartilage and extending parallel with, and about two fingersbreadth below the left costal margin is made, which ends about the level of the costal cartilage of the tenth rib. The underlying soft tissues are completely divided in the same direction. Expose the cartilages of the seventh, eighth and ninth ribs by dividing and retracting the overlying muscles (external and internal obliques and rectus abdominis). Divide the exposed costal cartilages and reflect the thus formed flap of chest wall which permits easy access to the left hypochondrium.

In dividing the seventh costal cartilage, care should be taken not to open the pleura. The removal of the affected segment of the cardia is a difficult procedure and rests on the general principles of total gastrectomy with the difference that the esophageal end is implanted into the stomach after the tumor mass has been removed. Where the abdominal part of the esophagus cannot sufficiently be mobilized to effect a satisfactory anastomosis, the lower portion of the thoracic part will have to be utilized. To effect such mobilization, the cardiac end of the stomach and abdominal portion of the esophagus are separated from their ligamentous and vascular attachments. The vagi must be isolated and protected from injury, although in advanced cases of carcinoma their division cannot always be prevented. Just as the rectum comes down for a considerable distance after the superior hemorrhoidal vessels are ligated and divided, so does the esophagus come down considerably after separation or division of the vessels and nerves.

The serous covering of the esophagus at the esophageal opening of the diaphragm[1] is separated by incision and blunt separation and the esophagus mobilized by pulling it down by traction on the cardia. The pleura is frequently opened during this procedure—an unfortunate occurrence, particularly when no differential pressure chamber is available. Another danger is the effect on the heart and respiration through irritations of the vagi. Völcker divided both vagi and no ill results were noted. This operation is contraindicated, of course, when the operability of the tumor is questionable and when the patient's condition is poor. If deemed advisable to attempt the operation, a two-stage procedure is preferable (Kümmel). It is performed as follows: Mobilization of the esophagus; suture of its distal end over a rubber tube which is brought to the surface and there anchored by sutures. Close the stomach. Do a temporary gastrostomy. Bring the tube to the surface. Place tampons about the tubes (esophageal and gastrostomy). When healing and contraction have sufficiently progressed, a rubber T tube is made to connect the esophagus with the stomach. The patient is now fed per os. Later on, as the closure progresses, the fistula corresponding to the vertical part of the T tube is closed as a final step. When the tumor is inoperable gastrostomy should be done.

CHAPTER 34

SURGERY OF THE INTESTINES

Anatomic Considerations. The small intestine begins at the pylorus and ends at the ileocecal valve. It comprises (a) the duodenum, (b) the jejunum and (c) the ileum. It is about twenty-three feet long.

The duodenum is about ten inches long. It is the thickest and most fixed portion of the small intestine. It begins at the pylorus and ends at the duodenojejunal flexure describing an almost circular course. (Fig. 1528.)

The first part of the duodenum (pars superior), "bulb," "cap," "vestibule." This extends to the neck of the gallbladder. It is about two inches long and extends backward, upward and somewhat to the right.

The second part (pars descendens) runs from the neck of the gallbladder to the lower border of the third lumbar vertebra. It is from three and a half to four inches in length. Its posterior surface is devoid of peritoneum and lies on the inner aspect of the right kidney. On its inner left side it is in contact with the head of the pancreas and common bile duct. The latter pierces the duodenal wall about three inches from the pylorus. The termination of the bile duct may be reached by mobilizing the duodenum by the Kocher method, which consists of incising the peritoneum on the anterior surface of the right kidney close to the right border of the duodenum above the transverse colon. The duodenum is then reflected from its bed and turned forward. The duct enters the intestinal wall after joining with the pancreatic duct to form the ampulla of Vater about 10 cm. from the pylorus. It must be remembered that the bile papilla is located on the posterior-internal surface of this portion of the duodenum about its middle.

The third part (pars inferior) extends to the duodenojejunal flexure on the left side of the body. It lies behind the peritoneum. It is about five inches long and is horizontal (pars horizontalis).

The fourth part. The oblique (pars ascendens). Sometimes the pars horizontalis is absent; then the V-shaped duodenum results.

The Peritoneal Relations of the Duodenum:

First Part. The first inch of the duodenum is completely surrounded by peritoneum; the remainder of the first part, at its lower aspect, is not covered by peritoneum.

Second Part. Here the left and posterior surfaces are not covered with peritoneum.

Third Part. The upper and posterior surface of this part of the duodenum are not covered by peritoneum.

The blood supply of the duodenum consists of the superior and inferior pancreaticoduodenalis arteries. The part of the duodenum above the bile papilla arises from the foregut and is therefore supplied through the celiac axis, while the remainder arising from the midgut receives its blood supply from the superior mesenteric artery. The superior pancreaticoduodenalis is a branch of the superior mesenteric artery. These two arteries anastomose in a loop-like manner around the head of the pancreas. An artery supplying the anterior wall of the first part of the duodenum has been described by Wilkie—the supraduodenal artery; it springs from the hepatic or gastroduodenal artery. It is located in the anterior duodenal wall where the majority of duodenal ulcers occur.

The contents of a duodenal ulcer perforating into the general peritoneal cavity descend along the right paracolic gutter. Perforating ulcers on the posterior wall of the duodenum penetrate the head of the pancreas; they sometimes erode the gastroduodenal artery or one of its branches with fatal results. Ulcers below the biliary papilla are extremely rare. The lymphatics of the duodenum drain into the nodes around the head of the pancreas.

The Duodenojejunal flexure (Fig. 1529) lies on the left side of the second lumbar vertebra below the pancreas in front of the left renal vessels. The beginning of the jejunum passes downward, forward and usually to the left. If the transverse colon is displaced upward and the jejunum is pulled tensely to the right, a folded edge of peritoneum containing muscular fibers is seen passing from the flexure to the parietal peritoneum. This is called the suspensory ligament or muscle of Treitz, which is fixed to the left crux of the diaphragm. The fossa which is behind it is the

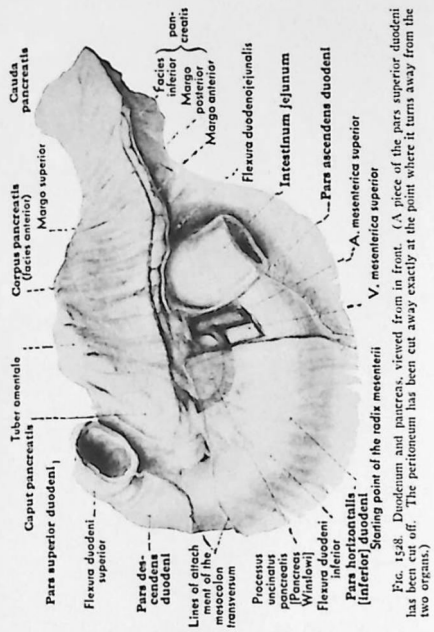


FIG. 1528. Duodenum and pancreas, viewed from in front. (A piece of the pars superior duodeni has been cut off. The peritoneum has been cut away exactly at the point where it turns away from the two organs.)

superior duodenojejunal fossa of Treitz while that below is the inferior duodenal fossa. Below this fossa runs the inferior mesenteric artery and near the left edge of the ligament, the inferior mesenteric vein (paraduodenal fossa). If these fossae be abnormally large, small intestines may enter them and a retroperitoneal hernia result. The constricting band is then the ligament of Treitz. If it be cut there is danger of injuring the inferior mesenteric vein.

To locate the ligament of Treitz and the first loop of the jejunum: (1) Displace the transverse colon and its mesentery upward; (2) follow the mesocolon downward and to the left. The beginning of the jejunum and Treitz' ligament will be found at the left of the second lumbar vertebra.

The jejuno-ileum extenus from the duodenojejunal flexure to the cecum. It is about 22 feet long. The jejunum forms the upper two-fifths of this structure and is situated for the most part on the left side of the upper abdomen; its coils are disposed in a transverse position. The ileum forms the lower three-fifths of this section of the intestinal tube and is situated mainly in the lower abdomen and pelvis. Its coils display a vertical disposition. The jejuno-ileum decreases in size from above downward. The jejunum is darker and imparts a thicker sensation.

Meckel's diverticulum. This diverticular outpouching arises from the antimesenteric border of the ileum, two or three feet from the cecum. It is due to the nonobliteration of a portion of the vitelline duct. Its patent part is usually 2 or 3 inches long. It usually causes no symptoms, but if it becomes adherent to one of the

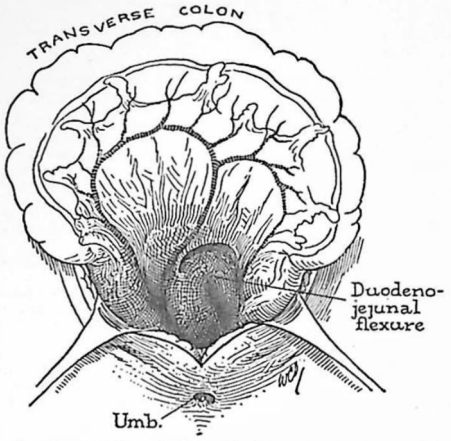


FIG. 1529. Proper manner to locate the duodenojejunal flexure in performing gastro-jejunostomy.

neighboring coils of the intestine an internal hernia may result. It may become acutely inflamed and give rise to clinical symptoms of acute appendicitis or the diverticulum may become invaginated giving rise to an intussusception.

The blood supply of the jejuno-ileum is derived from the vasa intestini brevis of the superior mesenteric artery (Fig. 1530). These anastomose within the mesentery and form a number of arterial arcades. These give rise to the vasa recta which pursue a straight course and enter the mesenteric border of the intestine without anastomosing with each other. Within the intestinal wall the anastomoses between the vessels are very meager. This is an important fact to keep in mind in enterostomy and entero-anastomosis. In such procedures it is essential to avoid injury of the vasa recta of the divided edge.

On the upper portion of the bowel the mesenteric vessels are distinctly larger than opposite any other part of the intestine; they grow smaller as they proceed downward until about the lower third of the intestine they remain about the same size as far as the ileocecal valve. The main branches of the superior mesenteric artery unite

to form primary loops; in some parts secondary and even tertiary loops are observed. From these the vasa recta run to the bowel. The mesenteric veins display a somewhat similar arrangement as do the arteries.

The loops of the mesenteric vessels. In the upper part of the bowel there are only primary loops; lower down the secondary loops become more numerous. At about the fourth foot of bowel the secondary loop becomes a permanent feature. Further downward the secondary and tertiary loops become still more numerous and the primary loops smaller, the loops constantly getting nearer and nearer the intestine. In the lower part of the bowel the loops generally lose their characteristic arrangement and are represented by a complicated network.

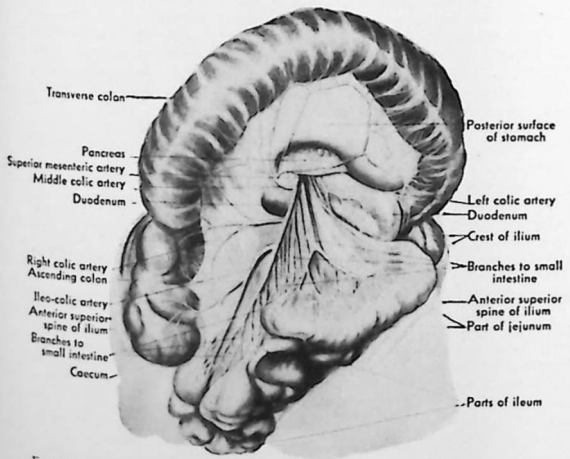


FIG. 1530. Superior mesenteric artery and its branches; transverse colon and stomach have been drawn upward. (Piersol.)

There also is a marked difference between the upper mesentery of the small intestine and that of the lower ileum. It is thinnest in the upper jejunum and progressively becomes thicker lower down. In thin persons the mesentery is more translucent than in the obese. Small transparent spaces are found between the vasa recta in the mesentery of the upper part of the intestine called Monk's "lunettes."

Identification of the Small Intestine. The jejunum is the thicker; it is usually empty. It is wider and more vascular than the ileum. The "lunettes" are more numerous and the vasa recta are longer than in the ileum. In determining the direction of a certain segment of the small bowel it must be remembered that the parietal attachment of the enteric mesentery runs obliquely downward from left to right. Withdraw a loop of gut. Hold it with its long axis parallel to the midline of the body. Put the mesentery on the stretch. Introduce the hand along the mesenteric surface and glide it along backward to the spine. If the hand remains on the same side of

the mesentery until its parietal attachment is reached, there is no torsion of that particular loop and that portion, in the upper end of the wound, is proximal. Also, to further ascertain which end of the bowel is proximal and which distal the method of Monk is of value. If the mesentery proceeds upward and to the left we have the proximal end; if the mesentery proceeds downward and toward the right, we are dealing with the distal end.

The lymphatics of the small intestine. There are two sets of lymph vessels: (a) in the mucosa and (b) in the muscular coat. The flow of lymph is in a circular direction toward the mesenteric attachment. The lymph is taken up by the first group of nodes along the mesenteric border, hence, through the second and third groups of nodes to the cardiac nodes around the origin of the superior mesenteric artery.

The Large Intestine. This is composed of (a) cecum and appendix; (b) transverse colon; (c) ascending colon; (d) descending colon; (e) sigmoid flexure (subdivided) into the iliac and pelvic colons; (f) rectum and anal canal. The length of the large intestine from the root of the appendix to the beginning of the rectum is about 4 feet, 8 inches (about 1.4 m.). Excluding the dilated part of the rectum the diameter of the large intestine gradually decreases toward the anus. Grossly, it differs from the small intestine in the following features: (a) greater caliber; (b) the longitudinal muscular fibers are arranged in three distinct bands (taeniae longitudinales) which produce puckerings (haustra intestinales) and (c) the presence of small peritoneal pouches containing fat (appendices epiploicae). These are found along the large intestine as far as the rectum. The cecum lying in the right iliac fossa is the widest part of the intestinal canal being about two and one-half inches in width and of about the same length. Normally it is entirely surrounded by peritoneum. There are no appendices epiploicae in the cecum. From an embryologic point of view, it is well to remember that the cecum first appears in the left iliac fossa, then is carried to the right hypochondrium (in close proximity to the gallbladder and right kidney). It descends just before birth into the right iliac fossa. The cecum may, therefore, be found in any of these positions if rotation fails, particularly in prematurely born infants.

The ileocecal valve is the point of emptying of the ileum into the large intestine and is situated on the posterointernal surface of the wall of the cecum. The valve is normally competent to prevent regurgitation of intestinal contents into the ileum. It will allow, however, the passage of gas from the large to the small bowel but no liquids or solids. (Nicholas Senn.)

The vermiform appendix varies much in length and diameter. The opening of the appendix in the cecum is about one inch below and a little behind the ileocecal opening. A fold of mucous membrane guards this opening and is spoken of as the valve of Gerlach. The point of origin of the appendix is represented on the surface of the body by the junction of the right and middle thirds of a line connecting the anterior superior spinous processes of the ilia (Lanz). The appendix is on an average about three and one-half inches long and has a mesenteriolum which does not extend to the tip of the organ. The mesenteriolum (meso-appendix) springs from the lower surface of the mesentery. It carries the appendicular branch of the ileocolic artery and the appendicular vein. While the appendix by reason of its tendencies to curl may occupy a variety of positions the following are the more common situations.

(a) Pointing toward the left in the direction of the spleen or high up to the right in front of the kidney or to the liver.

(b) Over the brim or into the pelvis (pelvic appendix) or to the external iliac artery.

(c) Retrocecal (intra- or extraperitoneal). The extraperitoneal situation is either congenital or (more frequently) acquired (inflammatory processes fusing the parietal and visceral peritoneal layers and serosa of the appendix, thus excluding the appendix from the peritoneal cavity). When excluded the appendix lies directly upon the posterior abdominal wall close to the quadratus lumborum, psoas, or iliacus muscle, the right kidney and ureter.

(d) Very long appendices may reach the rectum, ovary, tube or bladder close to Poupart's ligament.

Blood Supply of the Cecum and Appendix. The ileocolic artery springs from the superior mesenteric artery. It is retroperitoneal and after crossing the right ureter divides as it approaches the ileocecal angle into five branches: (1) anterior cecal; (2) posterior cecal; (3) colic; (d) ileac and (5) appendicular. Note: From the posterior cecal, a small vessel passes to the root of the appendix. Some hemorrhage may ensue from this source after ligating the appendicular artery during appendicectomy.

In removing the cecum and ascending colon the ileocolic artery is ligated as a preliminary step.

The Lymphatics of the Cecum and Appendix. The lymph vessels of the cecum and appendix drain into a group of nodes situated in the mesentery of the ileocecal angle. They accompany the ileocolic artery. There are three sets (Poirier) viz.: (1) Anterior cecal; (2) Posterior cecal and (3) Appendicular lymphatics. From the ileocecal nodes the lymphatics follow the arteries to the nodes at the root of the mesentery and empty into the receptaculum chyli. They do not follow the veins to the liver, therefore, infection of the liver is not caused through the lymph channels in appendicitis. In the appendix there are three sets of lymph capillaries, subperitoneal, submucous and the mucous set (Kelly and Hurdon).

Lane's Ileal "kink" also known as Lane's Ileal Membrane is situated in the last four inches of the ileum. It is either V- or U-shaped. From the point of angulation, a band known as the ileopelvic, extends downward and fuses with the parietal peritoneum from the right iliac fossa to the antimesenteric border of the ileum.

Jackson's Membrane. This thick diaphanous fold of peritoneum extends from the posterior abdominal wall to the right of the ascending colon. It is directed downward and inward. It is attached to the anterior longitudinal band of the cecum, or, ascending colon. At this attachment, thin, long, unbranching blood vessels are seen coursing in the membrane in the direction of its course.

The three lymph streams (anterior cecal, posterior cecal, appendicular) are separate and isolated from each other and drain their respective areas only.

The ascending colon is covered anteriorly and laterally by peritoneum. Its blood supply consists of (1) the right colic and (2) ileocolic arteries, both branches of the superior mesenteric artery. It is about six inches long.

The hepatic flexure lies upon the right kidney and is covered by the liver and gallbladder. The transverse colon is about eighteen or twenty inches long. It extends from the hepatic to the splenic flexure. It is invested by the transverse mesocolon which is attached to the anterior surface of the right kidney. As it crosses the second part of the duodenum continuing along the pancreas above the duodeno-jejunal flexure it reaches the anterior surface of the left kidney. The blood supply of the transverse colon is furnished by the middle colic or branch of the superior mesenteric artery.

The splenic flexure is located in the left hypochondrium. It is here in relation with the tail of the pancreas and the spleen. It is situated higher and deeper in the abdominal cavity than the hepatic flexure. The phrenicocolic ligament passes from its left border to the diaphragm opposite the tenth rib.

The descending colon is about five inches long. It extends from the splenic flexure to the iliac crest where it becomes continuous with the iliac colon. It is narrower than the ascending colon and is covered by coils of small intestines. It is covered by peritoneum except posteriorly. Blood supply: Left colic and sigmoid branches of the inferior mesenteric. Occasionally the ascending and descending colons have a mesentery. The sigmoid flexure is composed of two parts, the iliac and pelvic colon (Omega loop of Treves).

The iliac colon is 5 or 6 inches long and extends from the iliac crest to the brim of the pelvis. In the majority of cases this section of the large bowel has no mesentery. Its blood supply is the sigmoid artery.

The pelvic colon is about 17 to 19 inches long. It has a mesentery. Its terminal portion ends where the rectum begins opposite the third piece of the sacrum.

The Vessels of the Colon (Fig. 1530 and Fig. 1531). The superior and inferior mesenteric arteries are branches of the abdominal aorta. The superior mesenteric arises about half an inch below the celiac axis, the inferior mesenteric arises from the abdominal aorta about one and a half inches above its bifurcation.

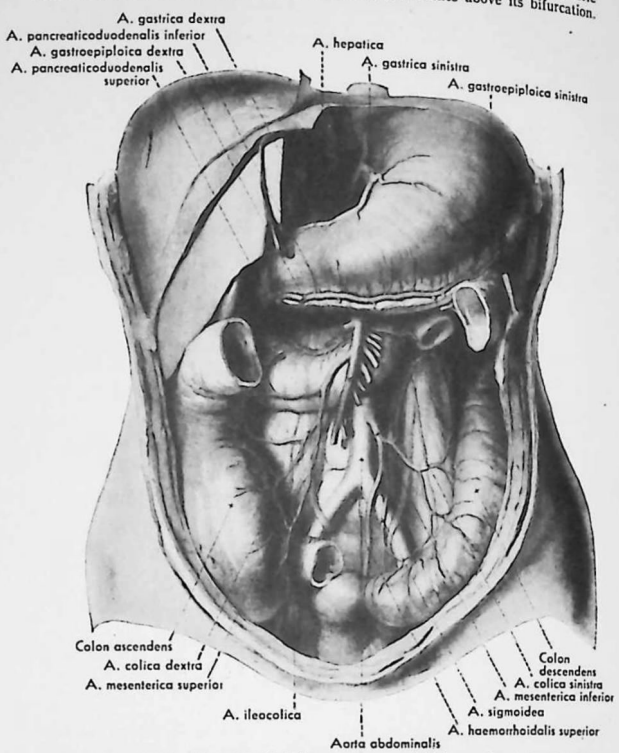


FIG. 1531. Arteries of the abdominal viscera, more superficial layer, viewed from in front. (The left lobe of the liver, the small intestines and the colon transversum have been removed; the mesenterium and mesocolon have been dissected off.) (Spaltcholz.)

The lymph drainage from the large bowel (Fig. 1532) to the right of the middle of the transverse colon passes into the nodes along the upper part of the superior mesenteric vessels. The rest drains to the nodes on the inferior mesenteric vessels. The efferents from the superior mesenteric nodes course to the intestinal trunk which

opens into the receptaculum chyli. The inferior mesenteric nodes drain into the left lumbar chain of nodes of the aorta.

SUTURES AND SUTURING

The best form of intestinal surgery is that which is accomplished by the simplest method. The oldest intestinal suture, or suture of the Four Masters (Venetian School in 1520) consisted essentially of a suture of the wound edges as in suture of the skin. To steady the intestine while the suture was being applied, a cylinder of cardboard or the trachea of a goose or calf was introduced into the lumen of the bowel. Duverger in 1846 made an improvement by cutting away the mucous membrane projecting from the edge of the bowel.

Lembert's principle of plane apposition (1826) and its amplification by Dupuytren (1839) in the form of a continuous suture has distinguished the French school as pioneers in this phase of intestinal surgery.

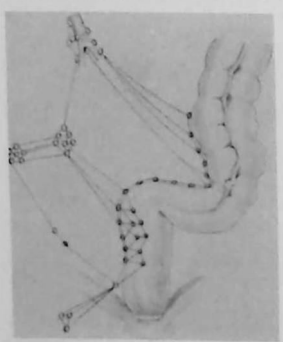


FIG. 1532. Lymph apparatus of rectum. (After Miles.)

REQUIREMENTS

An intestinal suture, to be successful, must fulfill the following requirements:

1. It must be secure without strangulating tissues.
2. The serous surfaces must be evenly coapted.
3. Not too much of the bowel edge should be inverted, thus predisposing to obstruction of the lumen of the bowel and
4. The junction must be watertight.

Continuous or Interrupted Sutures?

The continuous suture has the following advantages:

1. It affords greater rapidity in placement.
2. It coapts the surfaces more evenly.
3. It affords reliable hemostasis without the necessity to ligate individual vessels.
4. It forms a circular line of support to the suture itself, should the bowel become distended (Jacobson).

The disadvantages are:

1. Failure of the suture at one point jeopardizes the rest of the suture line.
2. Some believe that a continuous suture line seriously interferes with the retention of the segments united.

The following objections are raised to the interrupted suture.

1. It takes more time to introduce.
2. Coaptation is not as exact as with a continuous suture.
3. Hemostasis to be exact requires ligation of individual vessels.

4. The great number of knots necessary to accomplish proper union of certain segments of the intestinal tube.
5. The direction of the flow in the suture, by imbibition (the line of extension of infection), is toward the knot. (Chlumsky). There are, of course, some suture methods (Connell, Maunsell and others) where the knot when tied is within the lumen of the bowel, but often these are not easy to carry out.

Absorbable or Non-Absorbable Suture Material

Non-absorbable suture material in anastomosis often tends to become extruded into the lumen of the intestine. In gastrojejunostomy, it is accused of being the cause of gastrojejunal ulceration. As a general rule, I use two rows of suture in anastomosis, an inner, absorbable (catgut) and an outer nonabsorbable (silk or Pagenstecher linen). In intestinal suture particularly, this is a safe precaution because catgut may, for one reason or another, become absorbed too early and give rise to trouble.

Sutures uniting the stomach and intestine are early subjected to strains. The weakest point is at the mesenteric attachment; the strongest the submucous coat.

The solidarity of the suture line becomes progressively less during the first four days after insertion; it then gradually increases until about the eighth or tenth day, when its strength equals that of the intact viscus. The third to the fifth day is the critical period for disengagement of the united viscera. In view of these considerations, the importance of a properly selected diet in patients who have undergone an operation involving gastro-intestinal suture becomes apparent.

Most Important Forms of Sutures

Lembert's Suture. Originally Lembert included only the peritoneal coat and the sutures were interrupted. In time various modifications were made such as the inclusion of the muscular coat and also, later, the submucous coat.

Czerny's Suture. This method consists of first placing a row of interrupted sutures embracing all the coats of the bowel and securing the cut edges. Over this a Lembert suture is placed (Czerny-Lembert suture).

Dupuytren's Suture is a continuous Lembert suture.

Cushing's Suture (1899) is a Dupuytren suture but the needle, instead of entering the coat of the bowel transversely pierces it longitudinally in its long axis.

Halstead's mattress suture is also based on the Lembert principle. A small square of tissue is enclosed in each Halstead suture. The needle penetrates to the submucous coat. A series of short puckerings results with this suture.

A purse string suture is used mainly in inverting stumps (appendiceal, etc.), closing intestinal perforations, or closing the ends of a divided bowel before performing lateral anastomosis after enterectomy. It also is made to enter the submucous coat of the bowel.

Perforating Suture. Connell suture.

Samuel D. Gross (1843) and W. L. Halstead (1887) maintained that no

intestinal suture is safe unless all or a portion of the submucosa was included in its grasp. Since the submucosa of the small intestine is only one-sixth the thickness of the cambric needle ordinarily used in intestinal anastomosis, the impossibility of securing of the submucosa alone without piercing contiguous intestinal layers becomes apparent. It is, therefore, necessary, in order to make the anastomosis secure, to penetrate all the layers of the intestine. This can be done safely. The Connell suture evolved as follows: Perforating sutures date back to Heister (1724), Jobert (1826), Gely (1842), Vegren (1871), Nussbauer (1882), Bishop (1885), M. E. Connell and Maunsell (1892) advocated perforating sutures. The method did not receive popular recognition until F. G. Connell in 1903 published his method. Horsley in 1903 and in 1905 used the method of perforating sutures by applying a single row of overhand continuous sutures. Willard Bartlett (1910) simplified the application of the Connell suture and proved the safety of tying the final knot on the serosa of the bowel.

Application of the Connell Suture. Secure by intestinal forceps the bowel segments to be united. Approximate the serous surfaces to each other near the open ends of the bowel. A Lee stitch is introduced at the mesenteric border. Apply a row of interrupted mattress sutures from the interior of the intestine including all the coats. These sutures are interrupted and knotted on the inside of the bowel. For the second half of the sutures a fully curved needle should be used to close the anterior half of the anastomosis. A continuous Connell suture simplifies matters considerably.

There are many other more or less complicated methods of suturing the intestine but Moynihan admirably summed up this question in the following terms: "There are probably no pages in the history of surgery that are so grossly encumbered with the description of useless methods as those dealing with the subject of the suture of intestinal wounds. Of the procedures which have been advocated, volumes might be written, and willing and patient authors have not been found wanting. It is true that there has been a constant and laudable striving after perfection, but the steps upon the road to success have been infinite in number, and they have not all been steps in a forward direction. Even at the present time this subject is not free from the incursions of the eager inventor, enthusiastic as to the claims of his newest contrivance, despite the fact that all mechanical aids to suture are unnecessary—in that one word may be summarized all that need be said of them. I do not venture to suggest that even yet any method has been advocated that will win universal acceptance. But of this there can be no question, that such a method, when established, will of necessity combine in the highest degree two essential principles—simplicity and safety. A method that is simple, and therefore readily learned, applicable to all forms of anastomosis, speedy because of its simplicity, and safe because of all its attributes, is the only one that is destined to survive."

NEEDLES

Needles for intestinal work should be round without a cutting edge. The Mayo type straight cambric needle is excellent for intestinal work. When sutures are to be introduced into depths or into the interior of the bowel, curved needles are to be used. Needles to which the sutures are swedged are a worthwhile refinement in intestinal suturing.

In intestinal surgery, all unnecessary traumatisms must be avoided. Gentle handling of tissues is paramount. Avoid pulling on the mesentery, it produces shock, besides inflicting damage to the blood vessels, giving rise to petechiae, hematomas and troublesome bleeding. Hematomas, if of sufficient size, often interfere with local circulation, favoring suppurations and embolism. Avoid including large vessels while closing omental gaps. Keep the operative field constantly clean by frequent changes of soiled linens. Rinse the gloved hands

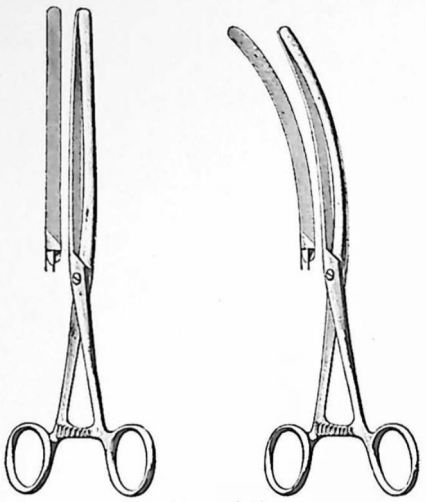


FIG. 1533. Doyen's Clamp.

often; gloves should be changed after completing the inner row of sutures in an intestinal anastomosis. Contaminated instruments should also be discarded. Cover all denuded surfaces with peritoneum, wherever possible.

INTESTINAL CLAMPS

Doyen's clamps are ideal and best suited for the purpose. They need not be covered with rubber; the elasticity of the blades is entirely sufficient to arrest the intestinal current (Fig. 1533).

The Roosevelt clamp or its modified pattern of Moynihan is very useful in lateral anastomosis, especially where the large intestine is included.

Other instruments used in intestinal work will be alluded to in their proper places.

Mirizzi's ligature carrier. *P. L. Mirizzi*[1] of Cordoba, Argentina, described a rather ingenious ligature carrier for placement of double ligatures. The instrument

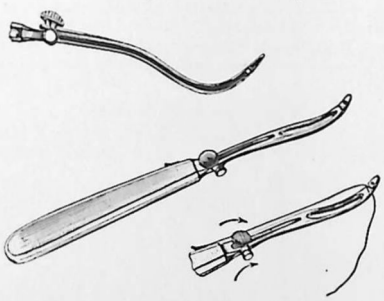


FIG. 1534. Mirizzi's cannula.

serves well to avoid mishaps while ligating friable tissues, particularly mesentery, ligaments and vascular adhesions. The object is obvious—two ligatures are promptly placed thus simplifying the procedure markedly.

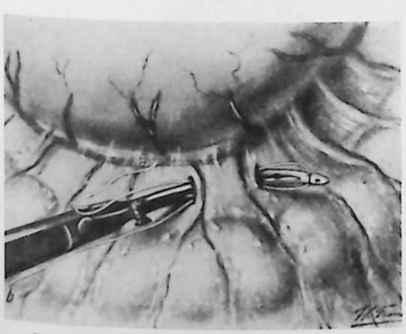


FIG. 1535. First step in use of Mirizzi's ligature carrier.

Mirizzi's instrument is depicted in Fig. 1534 and is made in the form of a ligature carrier of a number of sizes. It is composed of three parts. Fig. 1535 shows the first step in the use of the instrument. The instrument armed with the ligature penetrates the mesentery and delimits the vessels to be ligated. Figure 1536 shows the loop of the suture sectioned at the point shown in the illustration a and a'—thus two ligatures

[1] Revue Sud-Americaine T. IV. No. 9, Septembre, 1933.

are at the disposal of the surgeon. Figure 1537 shows the section of mesentery ligated; a scalpel divides the intervening tissues. The ligature carrier is so constituted that the structures in the back of the point to be sectioned are not endangered.

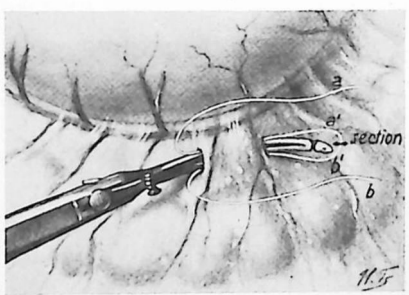


FIG. 1536. The loop of the suture is sectioned at the point indicated in the illustration at a and a'.

ENTEROTOMY AND ENTEROSTOMY

By these terms is understood the creating of an opening in any part of the intestinal tube. Special terms are used to designate the respective segment of

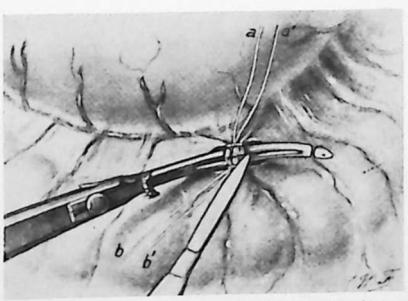


FIG. 1537. Section of mesentery doubly ligated and being divided with a scalpel.

bowel operated upon, viz.: (1) duodenostomy, (2) jejunostomy, (3) ileostomy, (4) appendicostomy, (5) cecostomy, (6) colostomy, (7) sigmoidostomy, etc. "Ostomies" are resorted to for the purpose of deflation, decompression and drainage.

The "otomy" procedures relate to making an opening followed by immediate closure of a given intestinal segment. "Ostomies" depending on indications may be either temporary or permanent.

Enterotomy may be done for immediate evacuation and prompt closure of a given segment of bowel, the distention of which interferes with contemplated operative procedures.

An enterostomy is often performed to great advantage in cases where the bowel wall has suffered by reason of distention or direct action of toxins or as a

Fig. 1538. Emptying of small bowel by "stripping" it with the finger.

stoma for the introduction of nourishment into the distal segment of the bowel. It finds its greatest usefulness in acute intestinal obstruction.

ENTEROTOMY

Step 1. Draw the desired segment of bowel out of the abdominal cavity. Thoroughly protect the abdominal cavity by moist, warm lap sponges.

Step 2. Empty the bowel by "stripping" its contents between two fingers (Fig. 1538). Introduce a heavy silk ligature around the bowel but do not tie it.

Step 3. Incise the bowel on its antimesenteric border longitudinally, for about an inch. Hold the edges of the incision thus made with fine vulsella forceps. Empty the lower portion of the distended bowel.

Step 4. A Moynihan tube (Fig. 1539 a) is now gently introduced into the bowel and gradually pushed upward for about three or four inches. Remove the vulsella forceps.

Step 5. Tie the ligature around the tube. With a dry gauze sponge draw the

bowel onto the glass tube within about an inch of the end to which the rubber tube is attached. An assistant now wraps a piece of gauze wrung out of hot salt solution around the tube and bowel together. This will prevent leakage

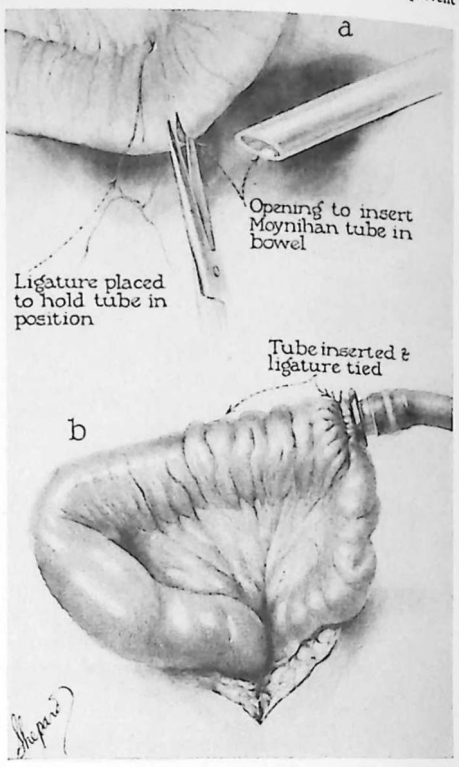


Fig. 1539. Enterotomy. a. Introducing Moynihan tube into bowel. b. Tube inserted and ligature tied.

of intestinal contents along the side of the tube. More and more of the intestine is now drawn, continuously, slowly and with utmost gentleness onto the tube by the surgeon, and while so doing, the offensive bowel contents escape through the tube into a nearby receptacle. In this way as much as 8 or 10

feet of bowel may be brought into the field of operation and thoroughly emptied (Fig. 1539 b). Moynihan admonishes that the tube must not be pushed into the bowel, the intestine must be drawn over and along it. Plenty of time must be allowed for the complete emptying of the bowel and any damage to it scrupulously avoided.

Step 6. The intestine may be washed out with saline solution in the manner advised by Moynihan, as follows: Puncture the bowel at the highest accessible point with a medium-sized needle to which a long India rubber tube and a funnel are attached. As the salt solution runs into the bowel it grad-

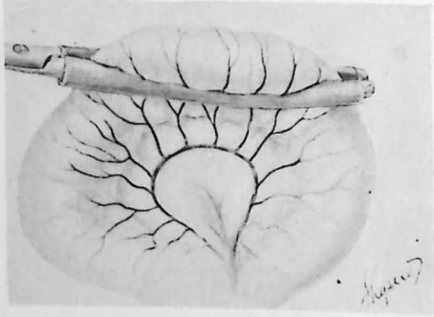


Fig. 1540. Enterotomy for the removal of a foreign body.

ually trickles downward and escapes by the rubber tube. Close the point of puncture by a few Lembert sutures or a purse string suture infolding the intestinal wall.

Step 7. Replace the bowel with the exception of the segment which carries the incision which is closed by introducing an inner row of through-and-through sutures including the whole thickness of the bowel. Superimpose Lembert seromuscular sutures.

Step 8. Wash the exposed loop of bowel thoroughly with warm normal salt solution. Replace the cleansed intestine into the abdominal cavity.

Enterotomy for Removal of Foreign Bodies

Step 1. Engage the segment of bowel affected. Strip it of its contents with the fingers, as above. Apply a Doyen clamp as shown in Fig. 1540. Do not traumatize the bowel by too vigorous or too prolonged clamping.

Step 2. Open the bowel on its antimesenteric border, with the electrosurgical knife. This minimizes bleeding; or, the scalpel may be used; remove the foreign body.

Step 3. If the incision is made in a longitudinal direction and if constriction is feared, suture it transversely with two rows of sutures, as above.

Step 4. Replace the bowel. Close the abdomen.

ENTEROSTOMY

This term designates the establishment of either a temporary or permanent fistula in some portion of the intestinal tube.

Indications: (a) Relief of obstruction; (b) A means of introducing nourishment; (c) Preliminary or following certain extensive operations on the gastrointestinal tract.

Hendon's Enterostomy Technic

G. A. Hendon[1] has since 1936 used an operation for diverting temporarily the alimentary current situated anywhere along the intestinal tube including the

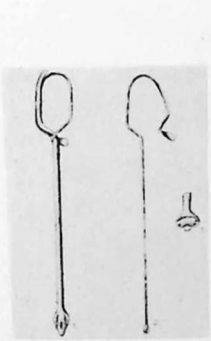


Fig. 1541

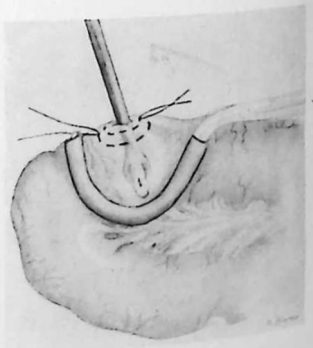


Fig. 1542

Fig. 1541. Hendon's method of enterostomy. 1. de Pezzer catheter impaled on stylet ready for insertion. 2. Specially modified stylet. 3. Segment of catheter that had been cut and passed through the intestinal canal.

Fig. 1542. de Pezzer catheter inserted in segment of small bowel, showing appearance before stylet is removed and purse-string sutures tied.

stomach by a procedure which he devised, the essential steps of which are as follows:

Step 1. With a U-shaped forceps covered with rubber, grasp the part of the intestine chosen for the site of entry. Make a small incision into the lumen of the bowel at right angles to its long axis.

Step 2. Introduce a de Pezzer catheter upon a stylet. Insert one or two rows of purse-string sutures around the opening while the stylet is in situ. Draw the sutures tight, release the spring and withdraw the stylet.

Step 3. Bring the stem of the catheter out at the lower angle of the wound or through a separate opening (Figs. 1541-1542-1543).

Comment: This operation may be used as a means of egress or escape

[1] Southern Surgeon, February, 1936.

of gas and intestinal contents or as the portal of entrance for fluid and nutrition as well as medication. The function varies with the situation of the tube.

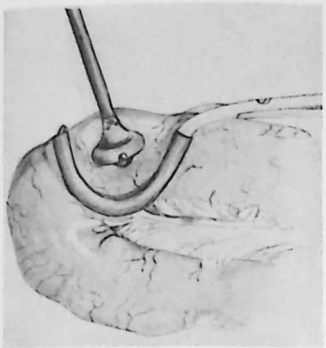


Fig. 1543. de Pezzer catheter after the stylet is removed and the purse-string sutures tied. The bulbous end of the catheter has expanded to its normal shape within the lumen of the intestine.

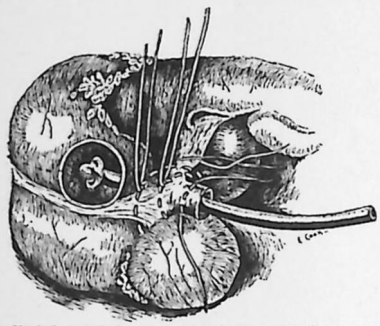


Fig. 1544. Hendon's method of enterostomy in the treatment of ruptured appendix. The de Pezzer catheter has been passed through the stump of the appendix into the cecum, and sutures are in place ready to be tied. A window has been cut in the wall of the cecum to show the position of the head of the catheter.

For an internal "hot water bag," establish the enterostomy in the cecum or insert a catheter into the cecum through the appendix and secure it with two sutures passed through the appendix and catheter; cut and ligate the

meso-appendix. The colon may be filled with water at 120 degrees, and the catheter clamped to retain the fluid. In case of a long tedious abdominal operation this will serve to supply heat and moisture as desired. If the meso-appendix is excised, the appendix will slough off in about a week.

In the case of a ruptured appendix (Figs. 1544-1545) sever the appendix between the rupture and the cecum; cut and tie the meso-appendix. Dilate the stump with hemostatic forceps and insert a de Pezzer catheter, threaded on the stylet, through into the cecum and secure it there by three rows of purse string su-

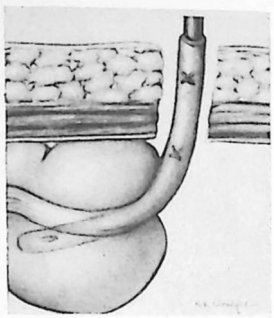


Fig. 1545

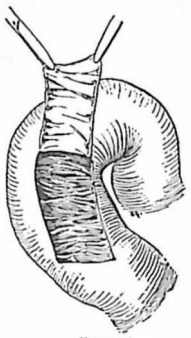


Fig. 1546

Fig. 1545. Hendon's method of enterostomy. Catheter passed through the lumen of the appendix to serve as a means of filling the large bowel with hot water to act as an internal hot water bag, supplying heat and moisture to combat shock. The meso-appendix has been cut, and tied, causing the appendix to drop off at the end of six days.
Fig. 1546. Duodenostomy (Rhéaume). Outlining and dissecting up quadrangular flap from the anterior duodenal wall.

tures. Establish proper drainage and close the wound. The catheter may be used for the drainage of waste products and, if necessary, employed for the introduction of fluids, food and drugs, especially purgatives. No attempt is made to remove the catheter; cut it off flush with the wall of the abdomen and push the distal end into the intestine whence it will escape in about three days.

The degree of success of this operation depends upon the time of its performance. It should be kept in mind during every laparotomy and performed when peritonitis threatens or is already present. The above procedure is so simple and free from danger that Hendon counsels performing it at all times when in doubt. It is highly commended in cases of intestinal obstruction.

To increase the efficiency of an enterostomy, attach a suction apparatus of the Wangensteen type to an enterostomy tube.

Duodenostomy

The advantages of duodenostomy lie in the fact that nourishment can be introduced here above the point of entrance of biliary and pancreatic secretions,

thus approaching the normal digestive process as nearly as possible. While theoretically advantageous, its practical application is vitiated by the difficulty encountered in fixing the duodenum to the anterior abdominal wall. The management of the resulting fistula is extremely difficult. Pierre Rhéaume's tubular duodenostomy based on the principle of the Depage-Janeway gastrostomy effectually overcomes these drawbacks; it has been referred to in the chapter on gastrostomy, pp. 1287-1295 incl.

PIERRE RHÉAUME'S TECHNIC

In cases of linitis plastica where the involvement of the stomach is so great that it is impossible to do a gastroenterotomy or a simple gastrostomy, many surgeons

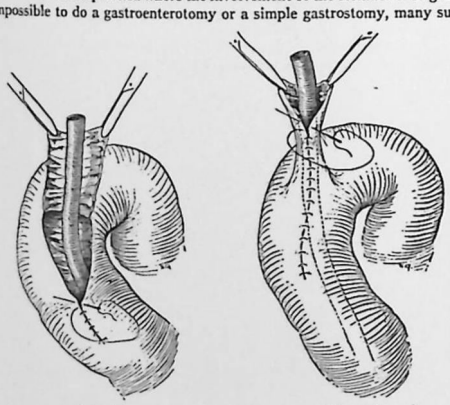


Fig. 1547 Fig. 1548

Fig. 1547. Duodenostomy. Flap steadied by two forceps. Introduction of rubber tube. Edges of flap united around catheter forming a tube lined with mucous membrane.
Fig. 1548. Duodenostomy suture of the tube nearly completed (Rhéaume).

have recourse to a jejunostomy or a duodenostomy. The deep position of the duodenum in the abdomen and the traction resulting from its attachment to the anterior abdominal wall renders such a procedure a rather risky proposition. On the other hand a duodenostomy is preferable from a physiologic point of view to a jejunostomy.

This being the case, Pierre Rhéaume conceived the idea of employing the Depage-Janeway principle of gastrostomy forming a tube from the duodenum, with which it has basically much in common.

Rhéaume has called this operation "Continent Duodenostomy with Tube Formation."

Laparotomy is done in the usual manner. Exploration to ascertain the extent of healthy duodenal tissue needed for the operative procedure. One may do a duodenostomy as near the stomach as possible or at various points of the duodenum down to the lower limit of its second portion.

Step 1. Outlining of flap: Four forceps outline the flap to be formed from the anterior surface of the duodenum. This, a rectangular flap, should measure about 2 cm. in width by about 4 cm. in length as related to the long axis of the duodenum (Fig. 1546).

Step 2. Formation of Flap: It is of utmost importance that the surgeon should begin the formation of the flap from below upward; that the superior part of the rectangle should act as a base around which the flap may form a semicircle directed upward. It should be of sufficient length, of course, to be brought to the external surface and possess the necessary degree of mobilization.

Step 3. Formation of the Tube: (Fig. 1547) shows that the flap is steadied by two forceps; a rubber catheter of about No. 12 French size is introduced into the duodenum just to a point of the level of the jejunum. The edges of the flap are approximated around the catheter, thus forming the tube with the mucous membrane pointing inward.

Step 4. Suture (Figs. 1548-1549). The suture is begun at the base of the duodenal opening. It is continued upward to the upper extremity of the flap where it is attached temporarily to the rubber tube.

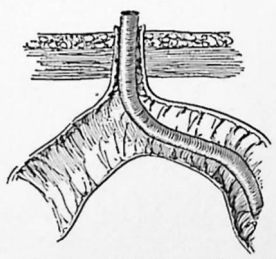


Fig. 1549. Duodenostomy (Rhéaume) operation completed. Note rubber tube extending to jejunum.

A canal about 4 cm. in length is thus formed which is readily attachable to the external surface of the abdominal wall through a stab wound which traverses the entire thickness of the musculature on the right side. The catheter is permitted to remain until healing is complete. At about the end of ten days the patient is fed through a continent tubular opening as often as is considered necessary.

Comment: Rhéaume has practiced this operation on the cadaver and once upon a patient who was suffering from generalized linitis plastica. He states the performance of the operation is simple and can be done in about 15 minutes.

A point of great importance to remember is that the base of the tube must have sufficient blood supply to nourish the flap from which the tube is formed. Rhéaume believes that this technic offers all the advantages of the Depage-Janeway gastrostomy (continence; continuity of the mucosa; etc).

Jejunostomy or Ileostomy

This operation was first performed by Surmay of Havre, in 1879, to give some relief to a patient afflicted with carcinoma of the stomach.

Indications: To afford rest to the stomach (inflammatory conditions; caustic poisons, gastric hemorrhage (Mikulicz) and in certain functional disorders (von

Eiselsberg). When gastrostomy cannot be performed in cases of extensive involvement of the stomach and esophagus.

Operations: Consist of either a jejunostomy or an ileostomy. Where the large bowel is concerned colostomy is spoken of.

Witzel's jejunostomy was modified by von Eiselsberg in 1895 and later by Moynihan.

If the technic of the Witzel gastrostomy on page 1286 (Fig. 1464) is followed, the same procedure may successfully be performed on the jejunum, ileum, or for that matter on any part of the intestinal tube, with excellent results. In brief, the operation is as follows:

Step 1. Open the abdomen on the left side.
Step 2. Deliver a loop of jejunum about 20 or 30 cm. from the duodeno-jejunal flexure. "Strip" its contents as previously described (Fig. 1538, p. 1370).
Step 3. Apply lateral clamps.
Step 4. Isolate the field of operation by moist, warm lap sponges.
Step 5. Imbed a Nélaton catheter in the antimesenteric side of the bowel with Lembert sutures in such a manner as to form a serosa-lined canal hugging the catheter rather snugly. The opening of the catheter should point analward. It is held upward by a pair of forceps (Fig. 1550 a).
Step 6. Place a retention suture or two a short distance from the point of the proposed opening into the jejunum which is made either with a scalpel or thermocautery through which the distal end of the catheter is introduced.
Step 7. Bury the end of the catheter with a few interrupted Lembert seromuscular sutures.
Step 8. Fasten the end of the catheter to the margin of the incision in the bowel by a catgut suture. (This step, however, is not essential.) Ascertain that no constriction in the catheter exists (introduction of some fluid).
Step 9. Suture the parietal peritoneum to the site of operation of the jejunum, using interrupted catgut sutures (Fig. 1550 b).
Step 10. Close the abdomen.
Step 11. Slip a portion of a rubber tube over the catheter and transfix both with a safety pin.

COFFEY'S METHOD

This is a modification of the Witzel operation and consists of incising the jejunum down to the mucosa. A purse string suture is placed at the lower end of the incision, to be tied after the tube is projected into the bowel. A seromuscular suture covers the tube.

The same principle may be used in performing a cecostomy (Fig. 1551). A much larger tube, which is placed on the taenia longitudinalis, is used here.

Mayo-Robson believes jejunostomy to be of great value in jejunal ulcer, following gastro-enterostomy when the patient is too feeble to undergo degastro-enterostomization and also lauds its value in "ulcer near the cardiac end of the stomach" along the lesser curvature and also in some ulcers of the duodenum.

The great objection to jejunostomy is the escape of bile and pancreatic juice through the fistula. This is obviated by the Maydl operation (1892) which consists of dividing the jejunum transversely about 8 inches below its origin. The open end of the upper segment is implanted into the side of the lower segment and the open end of the lower segment is sutured to the skin. The principle of Maydl's procedure is identical with that of Roux' gastro-enterostomy en "Y." A just criticism of Maydl's operation is that it takes considerable time

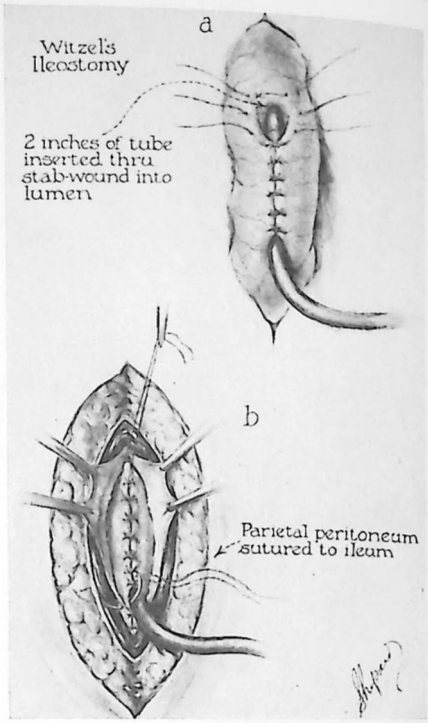


FIG. 1550. Witzel's ileostomy.

to perform and the procedure is done on patients already much exhausted by disease, who are "poor operative risks," at best.

ALBERT'S METHOD

This consists of delivering a sufficiently long loop of jejunum and establishing an entero-anastomosis at its base. The loop of bowel is now drawn through

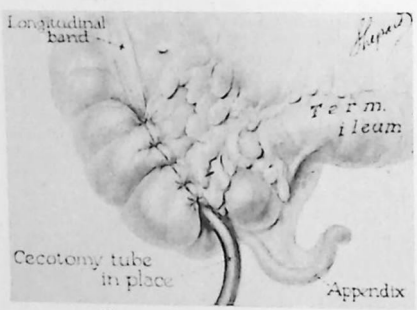


FIG. 1551. Witzel type of cecostomy.

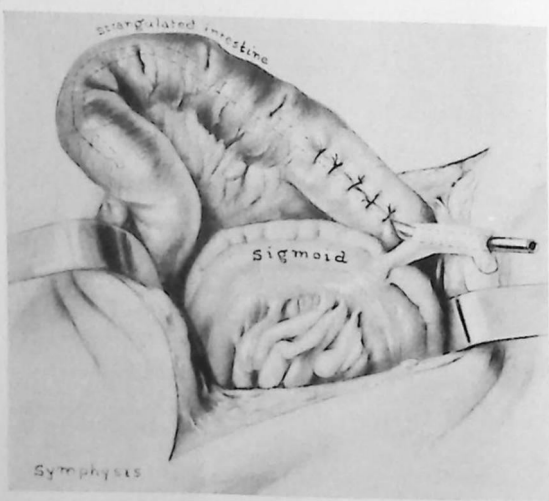


FIG. 1552. The protection of an enterostomy opening by the use of appendices epiploicae from the sigmoid. (Cannaday.)

the fibers of the rectus abdominis muscle and then attached to the parietal peritoneum. An opening is made at the apex of the loop of bowel and a tube introduced into it and there fastened by one or two purse string sutures. Cannaday protects the suture line in enterostomy with appendices epiploical (Fig. 1552).

Mayo-Robson's method consists of a jejunostomy similar to that of Albert's.

Appendicostomy

Indications: Appendicostomy is used (a) as a means of relieving gaseous distention and for purposes of (b) lavage, medication and the introduction of nourishment into the large bowel.

Step 1. Make a right pararectus incision.
Step 2. Expose the ileocecal region. Isolate the appendix. Deliver it through another smaller incision placed lateral to the first (Fig. 1553).

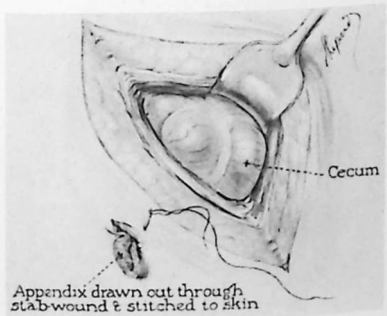


FIG. 1553. Appendicostomy.

Step 3. Unite the serosa of the appendix to the skin wound with interrupted sutures of Pagenstecher linen permitting about 1 cm. of the distal extremity of the appendix to protrude above the margins of the smaller opening.
Step 4. Close the abdominal wound in layers. After two or three days adhesions will have united the appendix to its surroundings.
Step 5. Amputate the protruding tip of the appendix. Introduce a Nélaton catheter into the bowel through the opening thus made. No fecal matter will escape.

Comment: Where adhesions prevent the appendix being delivered, they must be divided. Do not divide too much of the mesenteriolum which carries nourishment to the appendix—gangrene may result followed by peritonitis.

The appendicostomy opening usually closes spontaneously when no longer used. If not, a curettement or destruction of the mucous membrane by the thermocautery will cause the opening to close.

COLOSTOMY (ANUS PRAETERNATURALIS)

Historical Notes. This operation was first suggested by Littré in 1710 in a case of imperforate anus. A stoma was created in the sigmoid flexure. Pillore performed the operation as a typhlotomy in 1849. The approach to the ascending colon through a lumbar incision was suggested by Callisen in 1798. Fine, first performed a colostomy on the transverse colon in 1797, while in 1839, Amussat did an extraperitoneal right colostomy.

Colotomy was the term used for a couple of centuries for the operation of creating either a temporary or permanent opening in the colon. Petit, in 1886 proposed the term colostomy as more appropriate, and justly so, for colotomy like gastrotomy or cholecystotomy means the opening and immediate closing of a viscus while "ostomy" designates the creation of a stoma.

Temporary sidetracking of the fecal current was first suggested by Pollosen in 1884 and put to practice by Schede in 1887.

Colostomy consists of making an opening in the colon after it has been attached to the abdominal wall. Two types of colostomy are practiced: (a) temporary; (b) permanent colostomy. Either are performed above the seat of the lesion.

Indications:

1. In cases of obstruction of the bowel, as a means of temporary relief (temporary colostomy);
2. To create an artificial anus in cases of malignancy of the rectum or pelvic colon (permanent colostomy).
3. In cases of volvulus accompanied by marked distention above the point of trouble (temporary colostomy).
4. In certain forms of ulcerative lesions of the large bowel (tuberculosis, dysentery), for diverting the fecal current and as an avenue for the introduction of medication.
5. In fistulous connections between the bladder and rectum.
6. In obstruction of the large bowel from extrinsic tumors and in
7. Congenital malformations of the lower intestinal tract.

Sites of Intestinal Obstruction in Order of Frequency (Fig. 1554).

1. Pelvic Colon
2. Cecum
3. Splenic Flexure
4. Hepatic Flexure

Cecostomy, Ascending Colostomy

C. L. Gibson of New York suggested this operation as a means of irrigating the colon. It is now much used for decompression in various forms of intestinal obstruction.

Step 1. Make a Battle-Kammerer incision (which see, p. 1236).

Step 2. Deliver the ileocecal segment of bowel from the abdomen. The site for cecostomy is usually made opposite the ileocecal valve.

Step 3. If the condition calling for the operation is acute, open the bowel at once; otherwise, defer this step for 2 or 3 days and then open the bowel with scalpel or thermocautery.

Step 4. Introduce a tube into the opening thus created.

Step 5. Fasten the tube to the cecum with a catgut suture.

Step 6. Place 2 or 3 purse string sutures around the tube and proceed on the principle of the Kader-Stamm or Senn gastrostomy (p. 1283, Figs. 1462-1463). Tie the sutures. This will cause a portion of the bowel to be telescoped about the catheter into the cecum. In tying the sutures be careful not to constrict the tube.

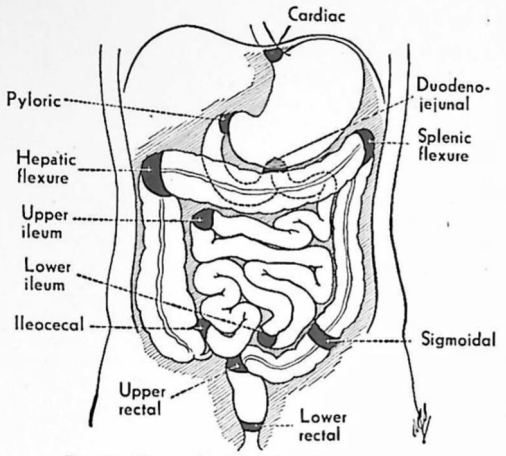


FIG. 1554. Diagram of typical positions of intestinal obstruction.

Step 7. Fix the bowel to the parietal peritoneum and fascia.

Step 8. Close the abdominal wall in layers above and below the cecostomy opening.

Comment: The same technic is employed if the ascending colon is the segment of bowel to be operated upon.

Where it is imperative to relieve the obstruction immediately, deliver as much of the bowel into the wound as is needed for thorough work. Clamp the segment of bowel with a Doyen intestinal clamp. Exteriorize the intestine by isolating it from the general peritoneal cavity with moist hot lap sponges. Place a purse string suture around an area of the bowel in the center of which an opening is made. A Paul tube is inserted, the purse string suture tied and the abdomen closed (Fig. 1555).

ADVANTAGES AND DISADVANTAGES

The advantages of a cecostomy carried out two to four days before a resection of the colon or rectum are stressed by A. O. Whipple.[1]

1. It makes possible a proper cleansing of the colon before the major procedure.
2. It permits the part anastomosed to be at rest until the period of fibroplasia is complete.
3. It increases the comfort of the patient by reducing distention and pains of ineffectual peristalsis.

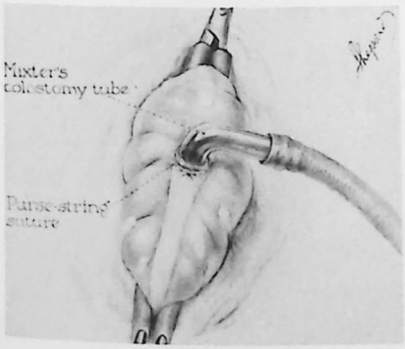


FIG. 1555. Colostomy.

4. It obviates the temptation and the necessity in some cases of giving enemas or irrigations in the critical period of repair.
5. In cases of partial or complete obstruction of the colon or rectum it has long been recognized as essential. If it works so well in the patients who are desperately sick, it is even more efficacious in the nonobstructed case.

Whipple advocates cecostomy rather than appendicostomy for the following reasons:

1. The appendix either is missing or is so atrophic in adults as to be of little use as a sheath for a rubber tube.
2. A cecostomy properly done by the Kader or the Witzel method closes more promptly than an appendicostomy.
3. A tube sufficiently large to act as a real safety valve can be placed in the cecum more easily than in the appendix.

[1] JAMA, Dec., 1931.

There are certain dangers to be avoided in the use of preliminary cecostomy:

1. The overenthusiastic use of the cecostomy tube as a means of administering fluids or enemas or irrigations before and after major procedures on the colon and rectum should be discouraged. This carries risk of leakage around the cecostomy opening and, after resections, of distending the intestine proximal to the suture line.
2. The tube should be kept in one position. If it comes out, it should be left out.
3. Only the most gentle syringing of the tube to dislodge fecal particles in the several terminal perforations should be used.
4. Whipple found that a No. 24-28 French colon tube of good rubber, with from four to six openings in the terminal 8 cm., gives the best results as a safety valve. The Witzel method is the one of choice in introducing the tube into the cecum. The cecostomy is usually done under local anesthesia from two to three days before the major procedure.

Transverse Colostomy

There are certain operative and other advantages in performing a transverse colostomy in preference to the ones already described. The well developed mesentery of the transverse colon offers less technical difficulties. When, in performing an inguinal colostomy, the mesosigmoid is too short to allow satisfactory delivery of the sigmoid flexure, transverse colostomy will solve the problem. As a matter of fact, many surgeons have, in late years, abandoned iliac colostomy in favor of this procedure claiming the following advantages:

1. A constant ease of delivery of the transverse colon and facility of operation.
2. The anus praeternaturalis in this position is cared for easier by the patient than at the classical site.
3. In some instances separated fibers of the rectus abdominis muscle may be so arranged as to form a sort of sphincter about it.
4. A retentive apparatus (colostomy bag) may be more advantageously supported by the costal arch and the upper abdominal wall.
5. Prolapse of the bowel is minimized by the direction of the pull of gravity.
6. The feces, while of sufficient consistency, are less odoriferous than in the lower sections of the bowel.
7. If the operation is for a temporary colostomy, its opening may be closed with greater facility than elsewhere. McGavin (1906).

Nevertheless, in order to evaluate fully both sides of the question, it must be pointed out that many surgeons prefer the sigmoid flexure for colostomy, for the following reasons:

1. The sigmoid flexure has an unusually long mesentery.
2. It is easily accessible.
3. It is considered a convenient site for the anus praeternaturalis.
4. It is more physiologic.

Iliac Colostomy

In case of doubt as to the site of obstruction the following methods are at the disposal of the surgeon to clarify the situation.

METHOD A

1. Abdominal exploration.
2. Location of the obstruction.
3. Colostomy made proximal to the obstruction.

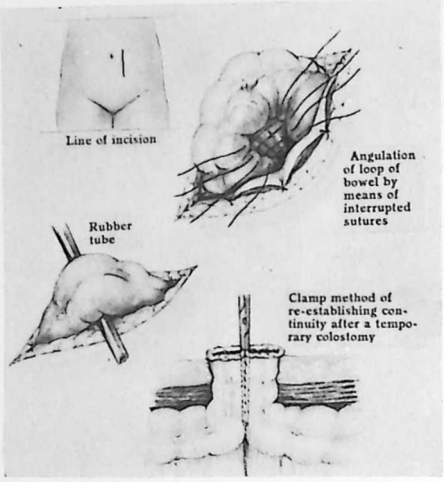


Fig. 1556. Steps in temporary colostomy.

METHOD B

1. Enter the abdomen over the region of the sigmoid.
2. If the obstruction lies higher up, perform an ileosigmoidostomy.

Temporary Colostomy

Step 1. Make a vertical incision about 3 inches in length the center of which passes on a line between the anterior superior spine of the ilium and the umbilicus. Divide the rectus abdominis muscle, its fasciae and peritoneum, longitudinally. Enter the abdominal cavity and explore (Fig. 1556[1]).

Step 2. Deliver the left colon which is identified by its taenia longitudinalis and appendices epiploicae. Exteriorize only that portion of the bowel directly concerned in the operation; return the rest of the bowel to the abdomen.

Step 3. Angulate the selected section of bowel by passing interrupted sutures of chromic catgut through the edge of the bowel about half an inch apart (Fig. 1556[2]). In placing these sutures avoid the mesentery. Tie each suture after its introduction, thus creating an angulated loop four to five inches in length.

Step 4. Fix the segment of bowel thus treated to the peritoneum and fascia above and below, by interrupted sutures of Pagenstecher linen which are passed through the taenia longitudinalis. An eversion of the peritoneum results which is in direct contact with the peritoneum of the bowel.

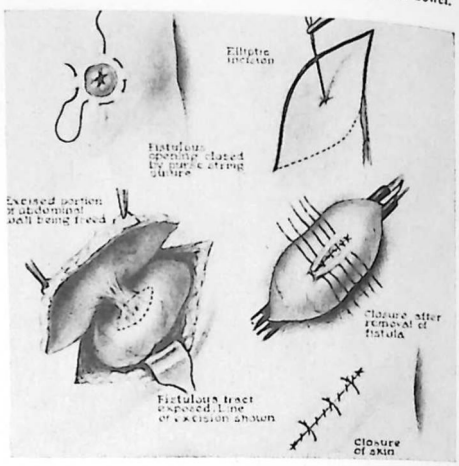


Fig. 1557. Steps of closure of fecal fistula and artificial anus. Study in conjunction with text p. 1388.

Step 5. Pass a glass rod or rubber tube of appropriate size beneath the loop of bowel and fix it in place (Fig. 1556[3]).

After four or five days when the bowel and peritoneum have become thoroughly adherent to one another, the sigmoid is opened transversely with the thermocautery. In urgent cases the bowel may have to be opened sooner or even at once in order to afford relief. In emergency cases the following methods may be resorted to:

1. Suture the loop of bowel along its circumference with interrupted sutures to the skin, securely, to avoid contamination and then open it.
2. Divide the bowel transversely. Suture a Paul tube into each segment.
3. Insert a Nélaton catheter of appropriate size into the knuckle of bowel and secure it with one or more purse string sutures.

CLOSURE OF ARTIFICIAL ANUS OR FECAL FISTULA

If a temporary colostomy has served its purpose, it becomes necessary to close the artificial anus. If there be no "spur" preventing the onward passage of the feces, all that may be necessary is to dissect the mucous membrane from the skin margins, invert the former toward the lumen of the bowel, uniting it with interrupted catgut sutures and suturing the skin, the edges of which have been freshened, with interrupted, nonabsorbable sutures (silk, Pagenstecher linen or fine silkworm-gut). This, as will be seen, is an extraperitoneal closure of the fistula which can only be done when the fistula is not very large.

If the fistula is large, an intraperitoneal procedure is called for and may be done as follows:

Step 1. Surround the fistulous opening with a purse-string suture of silk. Make two elliptical incisions (Fig. 1557) which encircle the opening lined with mucous membrane.

Step 2. Deepen these incisions to the peritoneum.

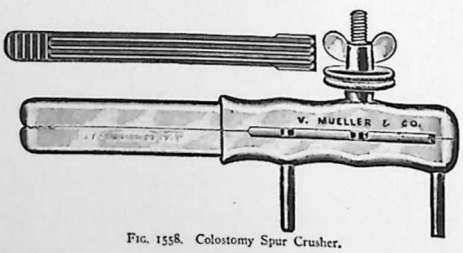


Fig. 1558. Colostomy Spur Crusher.

Step 3. Separate the bowel carefully from the abdominal wall and mobilize it sufficiently for thorough work. Protect the peritoneal cavity with lap sponges.

Step 4. Trim away the margins of the opening in the bowel.

Step 5. If the loss of substance in the bowel is not too great, close the opening transversely by two rows of sutures of catgut. (Fig. 1557).

Step 6. Superimpose a row of interrupted sutures, of Pagenstecher linen (Fig. 1557). If the loss of intestinal substance is great, do an enterectomy with an end-to-end anastomosis.

Step 7. Close the skin.

Where a Spur Exists (Dupuytren's Method)

Apply a clamp to the spur. (Figs. 1556-1558.) Leave it in position until by pressure it causes the spur to slough away. After this, the barrier for the onward progress of the fecal current is removed. Follow this with a closure of the fistula by the extraperitoneal method, described above.

A special enterotome to destroy the spur is not necessary. One blade of a stout four-inch clamp is placed in each opening of the colon and the clamp is

closed to the first notch. (Fig. 1556.) Rankin advises the use of two such clamps. Each day these are tightened one notch until the partition is cut through. The clamp usually drops out between the fifth and eighth day. Frequently such intestinal stomas close spontaneously.

R. Russell Best and N. Frederick Hicken[1] describe a new method of

Plastic Repair of a Stenosed or Retracted Colostomy Stoma

as follows:

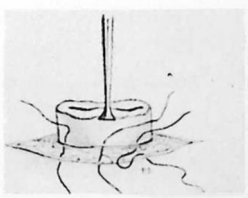


Fig. 1559

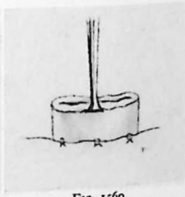


Fig. 1560

Fig. 1559. Plastic operation for the repair of retracted and stenosed colostomy. The stump of the colon is seen free from surrounding tissues.

Fig. 1560. Interrupted sutures fix the skin margins to the tissues in the sulcus at the depth of the wound. (Best and Hicken.)

Step 1. Irrigate the colon the night before the operation and thoroughly cleanse the skin around the stoma before the operation; a strip of gauze soaked in antiseptic solution is left within the stoma. Anesthetize the area by local infiltration.

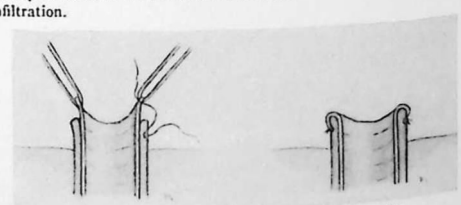


Fig. 1561

Fig. 1562

Figs. 1561-1562. Mucosal layer is separated from muscular layer, everted and secured by interrupted sutures. (Courtesy of R. R. Best.)

Step 2. Make an elliptical incision around the opening, leaving about 1 cm. of skin margin. Grasp the gauze wick and margin of the stoma with forceps. Free and lift off the abdominal wall by traction and sharp and blunt dissection an inch or more of large bowel (Figs. 1559-1560).

Step 3. Fix the freshened skin margin to the tissues in the sulcus at the depth of the incision by interrupted No. 1 chromic catgut sutures quite snug to the bowel wall but not penetrating it.

Step 4. Excise the skin attached to the colostomy stump; separate the mucosal

[1] Amer. Jour. of Surg., Vol. XXX, No. 2. Nov., 1935.

layer from the muscular layer by sharp dissection for a distance of ¼ inch or more in the entire circumference of the bowel. (Fig. 1561.) Evert the mucosal layer and secure it to the serosal surface of the bowel with interrupted No. 0 chromic catgut sutures (Fig. 1562).

Step 5. Lift the colon margin up from the surface of the abdominal wall for a period of four days by utilizing a "rubber doughnut" made by tying silkworm-gut threaded through a piece of ¾ inch rubber tubing, long enough to surround the colostomy. Place this "doughnut" around the colostomy and secure it to the bowel at the upper and lower angles by dermal sutures which pass through the bowel wall below the margin of the mucosal flap and out upon the upper surface of the rubber doughnut (Fig. 1563).

PERMANENT COLOSTOMY

Mixter's Anterior Colostomy

Step 1. Make an incision as shown in Fig. 1564 a. The outer portion of the incision must be a short distance inside of the outer edge of the rectus abdominis muscle. The incision divides the skin, subcutaneous fascia, and fascia of the rectus abdominis muscle.

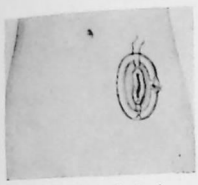


Fig. 1563. Stump of colon is retained in an elevated position by placing two sutures through bowel wall and over to upper surface of rubber doughnut. (Courtesy of R. R. Best.)

Step 2. Split the rectus abdominis near its outer margin. Open the abdomen.

Step 3. Deliver the sigmoid flexure from the abdomen. Replace all excess of sigmoid upward into the abdominal cavity leaving as little bowel as possible below the eviscerated loop. In other words, the portion of bowel to be united to the abdominal wall is selected as low down as possible. In so doing, a reservoir for the feces is provided.

Step 4. Split the mesosigmoid for about two inches at a right angle to the long axis of the bowel. Suture the peritoneum, posterior fascia and the two edges of the middle portion of the separated rectus muscle together through the opening in the mesosigmoid (Fig. 1564 b).

Step 5. Push the reflected quadrangular segment of skin and rectus fascia flap through the aperture in the mesosigmoid and suture it into its original position (Fig. 1564 c).

Transsection of the Intestine. After four or five days the exposed coil of the sigmoid may be resected by the thermocautery. Bleeding is controlled with catgut sutures. Often the heat generated by the thermocautery apparatus is sufficient to stop bleeding. The mucosa is stitched to the skin edge. The appearance of the divided ends of the bowel is as depicted in Fig. 1564 d. The distal opening is used for irrigations—an important step in the treatment of malignancies of the rectum.

If this method is used in acute intestinal obstruction the bowel may be opened as described in the preceding paragraph and a Paul or Mixter tube inserted.

Difficulties and Complications

While generally speaking the average surgeon finds the performance of a colostomy comparatively easy, there are, nevertheless, certain difficulties and complications encountered in this operation that often tax the resourcefulness of even experienced surgeons. Among the most troublesome conditions met with, the following need mention:

1. Short mesosigmoid. This may be a congenital condition or acquired by reason of inflammatory processes (mesenteritis). If such be the case the delivery of the colon or sigmoid flexure becomes difficult. A lymphangitis or lymphadenitis due to infiltration with malignant cellular elements may give rise to the same difficulty.
2. Adhesions between the colon and small intestines. Makins had to deal on one occasion with adhesions between the sigmoid and the stomach and he was compelled to remove a part of the stomach wall.
3. Excessive distention or contraction of the sigmoid flexure may create great technical difficulties in performing a colostomy.

Shortness of the mesentery may be remedied by

1. Incising the parietal peritoneum at its junction with the mesentery which is then stretched.
2. Suturing the sigmoid to the parietal peritoneum and opening the bowel in the depth of the wound. This is imperative in urgent cases. The opening thus produced usually closes promptly unless supplemented, in a week or two, by a secondary operation.
3. By using the transverse colon for the anus praeternaturalis. Frequently the transverse colon may be delivered through the lateral colostomy wound. If this is not possible, another incision should be made.

Complications Following Colostomy

1. Peritonitis. This is rare.
2. Cellulitis of the abdominal wall.
3. Retraction of the colostomy spur. When this occurs the objects of the operation are defeated. (See Best and Hicken's operation to remedy this, p. 1389.)
4. Prolapse of the bowel.

In severe instances, ablation of the redundant mucous membrane may suffice for amelioration, or, amputation of the prolapsed segment with reattachment to the skin and subcutaneous tissues may be resorted to.

In an article on "Abdominal Incision in Lesions of the Rectum and the Rectosigmoid as Related to the Colostomy," R. Russell Best[1] describes a

Modification of Hirschman's Technic for Opening a Colostomy

which eliminates the necessity of "the patient experiencing the odor of his own burning flesh as well as the distress which so often accompanies the grasping of bleeding points along the mesenteric border." The procedure is further simplified by combining the exteriorization of a loop of bowel with the cauterization of an opening, in one operation.

[1] Surg. Gynec., and Obst., Aug., 1934.

Step 1. Exteriorize the loop of bowel; suture in layers the peritoneum, fascia and muscle securely.

Step 2. Grasp a longitudinal band of the exteriorized bowel with two forceps about 2 inches apart.

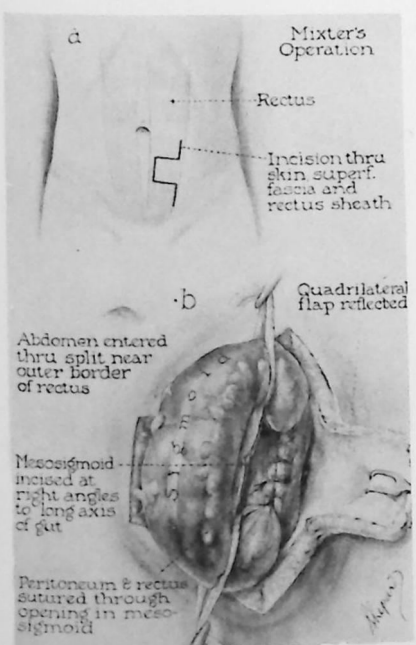


Fig. 1564. Mixter's anterior colostomy. a. Skin incision just median to outer border of rectus. b. Middle portion of rectus sutured between afferent and efferent loops of sigmoid.

Step 3. Raise the bowel upward; place a long curved clamp just below the ends of the traction forceps; a cautery then removes the bowel tissue beyond the margin of the clamp (Fig. 1565).

If it is necessary to open the bowel after a few hours for decompression, the

opening is already present; or, if immediate drainage is necessary a catheter may be pursestringed into the loop of bowel and immediate drainage established (Fig. 1566).

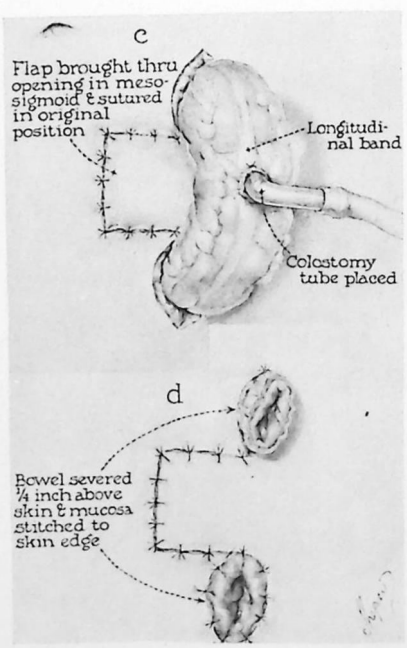


Fig. 1564 (continued). Mixter's anterior colostomy. c. First stage of operation completed. A colostomy tube is inserted in case of acute obstruction. d. After about five days the exposed bowel is resected. If necessary, the cut ends may be whipped over with a continuous suture to stop bleeding before stitching to the skin.

Postoperative Colostomy Apparatus

There are a multitude of devices on the market to be used for the reception of intestinal evacuations. These consist of belts carrying pads to occlude the

stoma in the colon or cups or bags to receive the discharges. There are also obturators for introduction into the bowel after which they are inflated with air. It takes some little time until the patient becomes accustomed to any particular mechanical contrivance (Fig. 1567).

Many patients learn by careful regulation of the diet so to control the consistency of the bowel movements and their timed evacuation as to make for a comfortable existence and for normal activities.

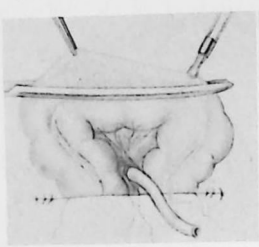


Fig. 1565

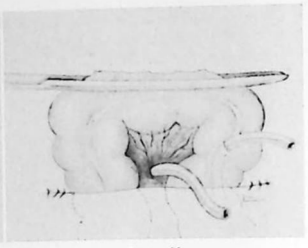


Fig. 1566

Fig. 1565. R. Russell Best's method of temporary colostomy through left rectus. Application of crushing clamps in a longitudinal direction and excision of the tissue with the cautery. Bowel drainage is permitted by release of the clamps, thus requiring no further use of the cautery.

Fig. 1566. The tissue beyond the clamp has been excised with the cautery. Release of the clamps establishes the temporary colostomy through the left rectus. If immediate drainage of the proximal loop is imperative, a small catheter is purse-stringed into this loop.

When the colostomy opening is on the right side and the feces of fluid consistency, a receptacle usually supplements the cup.

ENTERECTOMY

RESECTION OF THE SMALL INTESTINE

End-to-End (Axial) or Lateral Anastomosis

Indications:

1. Localized benign or malignant growths.
2. Tuberculous lesions.
3. Gangrene of the bowel (external and internal herniae).
4. Trauma, sufficiently extensive to exclude the possibility or probability of successful enterorrhaphy, etc.
5. Irremediable strictures of the bowel.
6. Fecal fistulae not yielding to conservatism and less radical operative measures.
7. Embolism or thrombosis of the mesenteric vessels.
8. Intussusceptions under certain conditions.
9. Volvuli under certain conditions.
10. Certain chronic inflammatory conditions.

Step 1. Incision—Paramedian, high or low, right or left, depending on the portion of bowel to be resected. Exposure must be ample.

Step 2. Thoroughly isolate the segment of intestine to be removed and bring it out of the abdominal cavity.

Step 3. Empty the segment of bowel of its contents by stripping it with the fingers (Fig. 1538). Protect the general peritoneal cavity by warm lap sponges. Determine the limits of the segment of bowel to be resected. Resection must take place in healthy portions of the bowel, at a safe distance from the affected area. In other words, suturing in order to be effectual, must take place in tissues entirely free from inflammatory, gangrenous or otherwise diseased processes. Apply intestinal clamps (Fig. 1568 a).

Step 4. Scrutinize the blood supply as it courses through the mesentery. This may be enhanced by holding the mesentery up to the light. Doubly ligate the blood vessels supplying the portion of intestine to be removed. Two sets of clamps are placed on the bowel as shown in the illustration. The mesentery is usually divided in a V-shaped manner, except where a short segment of bowel is to be ablated, in which case the mesentery may be divided parallel with, and close to the intestine. A ligature is placed and tied in the mesentery at the point of the V and the rest of the vessels, as already stated, ligated. Avoid the large arterial arches toward the base of the mesentery.

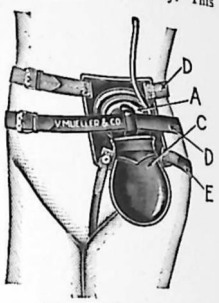


Fig. 1567. Colostomy bag.

Place two ligatures close to and including a small bite of the intestinal wall, just beyond each line of section. The purpose of these is:

1. To close the gap in the mesentery.
2. To prevent the mesentery from stripping away from the bowel and
3. Hemostasis.

Step 5. Divide the intestine on each side of the diseased segment in an area well supplied with blood, between the clamps placed in an oblique direction (see illustration). This will permit more of the free border of the bowel to be removed than that of the mesenteric attachment. Such ablation offers the following advantages:

1. Obliquely divided ends have a greater circumference than when cut transversely, thus compensating the loss of diameter occasioned by the suturing and
2. Because the antimesenteric portion of the bowel is more liable to be well nourished.

Step 6. Union of the divided ends. It is essential that the intestinal ends are not traumatized by clamps, etc. Figure 1568 b shows the method of introducing the mattress suture for closing the mesenteric gap. This is a very important step in axial anastomosis for at this point a "locus minoris resistentiae" for leakage is found, and unless properly guarded against, may

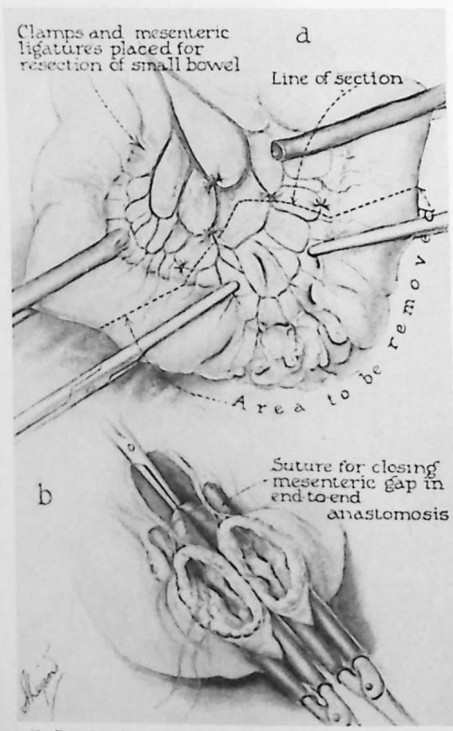


Fig. 1568. Resection of ileum and end-to-end anastomosis. a. The mesenteric vessels have been ligated proximal to the line of section. The rubber-covered clamps should be placed a full inch from the point where the bowel is severed. Resection of ileum and end-to-end anastomosis. b. Resection has been made, the holding clamps brought together, and a mattress suture placed to approximate the distal edges of the mesentery.

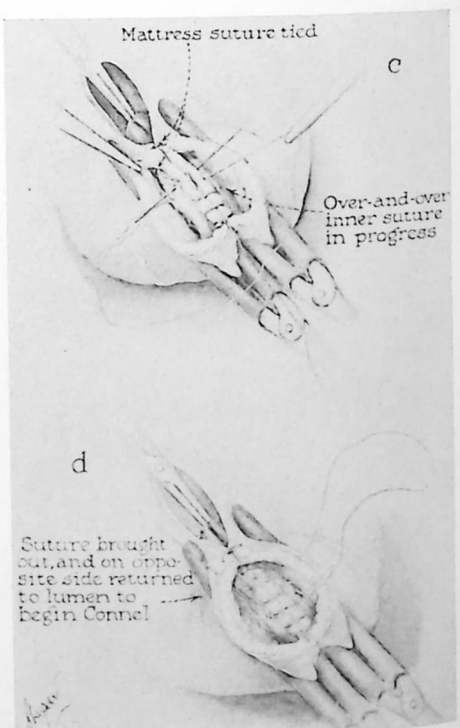


Fig. 1568 (continued). Resection of ileum and end-to-end anastomosis. c. The inner suture being placed. A lock stitch may be employed here if desired. Resection of ileum and end-to-end anastomosis. d. Beginning the outer suture.

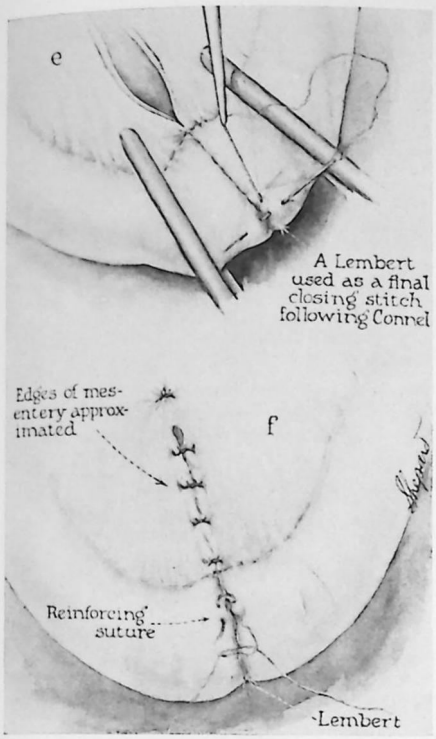


Fig. 1568 (continued). Resection of ileum and end-to-end anastomosis e. The final closing stitch is being made. f. The entire bowel suture line is reinforced if thought necessary. A type of reinforcing suture is shown which infolds very little tissue—a point to be considered.

lead to disastrous results. The open ends of the intestine should be cleansed (with gauze, mild iodine solution or ether). An artery forceps holds the rubber tip of the clamps in apposition, thus steadying the structures to be united.

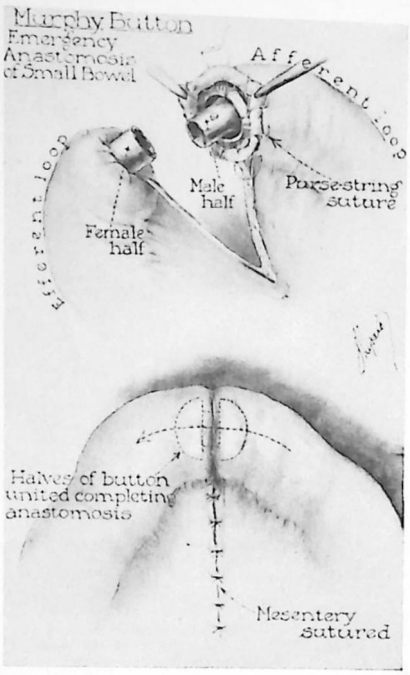


Fig. 1569. Emergency Murphy-button anastomosis.

Tie the mattress suture (Fig. 1568 c) and cut its ends. Now begin the over-and-over (inner) suture at the end opposite to that at which the mattress suture has been placed and continue it as simple over-and-over or, if preferred, as a lock-stitch. Draw it taut after each passage of the needle. Do not allow the suture to slacken at any time.

The sutures include all the coats of the divided bowel ends and are placed between $\frac{1}{8}$ or $\frac{1}{4}$ of an inch apart and about the same distance from the divided edge of the bowel. When reaching the mesenteric side, the suture is brought out and then returned to the lumen of the bowel (Fig. 1568 d) and a Connell or over-and-over suture is begun and continued all along the anterior segments of the bowel to its point of beginning where it is tied, after taking a final Lembert bite (Fig. 1568 e), and the ends cut short.

Step 7. Reinforcing: Lembert-Cushing sutures (Fig. 1568 f) at various points on the entire circumference of the anastomosed bowel may be introduced to good advantage.

Step 8. The opening in the mesentery is now closed as shown in the illustration. If no V-shaped resection of the mesentery has been done, the redundancy is folded upon itself and secured with a few interrupted sutures, taking pains not to jeopardize the nutrition of the bowel by inadvertently compromising its blood supply. When several feet of intestine have been removed, particularly where the mesentery is surcharged with fat, it is often difficult to suture the mesentery neatly, and a raw surface results which will invite adhesion-formation and thus predispose to intestinal obstruction. If such be the case, ligate and remove an appropriate piece of omentum and fix it over the raw surface with a few interrupted sutures. Omental (free) grafts may also be used to cover denuded surfaces of bowel.

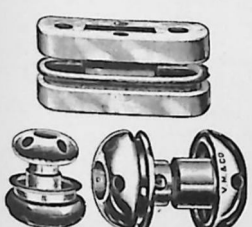


Fig. 1570. Murphy buttons.

Step 9. Inspect the operative field. Cleanse it. Remove lap sponges. Return the anastomosed portion of the bowel carefully into the abdominal cavity. Close the abdominal wall. Dress the wound.

End-to-end enterostomy may also be performed by the two-suture method on the same principle as described under gastrojejunostomy (p. 1338). The steps of the operation are essentially those described in the preceding methods, except that the union of the bowel ends is accomplished by

1. A first outer seromuscular suture of silk or Pagenstecher linen and
2. An inner, second, through-and-through suture (catgut).

A study of Fig. 1568 in conjunction with the illustrations depicting gastrojejunostomy explains the procedure fully. Very often I give preference to the two-suture method in axial anastomosis. The results are gratifying.

Intestinal Anastomosis by Means of the Murphy Button

Although suturing methods have been adopted as the ideal method for joining hollow viscera, the deft use of a Murphy button and the appreciation of its invaluable use in emergencies will often save life. Where speed is paramount,

or where sutures are difficult to introduce, the Murphy button has no equal. (Fig. 1569.) It is now marketed principally in two forms (Fig. 1570):

1. Circular for end-to-end and
2. Oblong for end-to-side anastomosis. They consist of two halves (male and female); the former has a spring-flange which exercises pressure on the ends of the included intestine, while two spiral springs, which project through openings in the hollow stem, act as a thread of a screw when the male half of the button is telescoped into the female segment.

Murphy admonished that neither the button, its modifications nor suture should ever be used in end-to-end anastomosis of the large intestine (except in the rectum and sigmoid) where an end-to-side or side-to-side anastomosis is possible, because anatomically too large an area of bowel-circumference, in these situations, is not covered by peritoneum.

Lateral Anastomosis by Means of the Murphy Button

Step 1. Open the abdomen. Engage the two loops of bowel to be united and bring them out of the abdominal wound. Strip the segments of intestine of

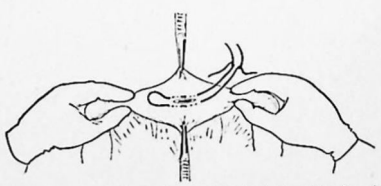


Fig. 1571. Berg's method of introducing the Murphy button when there is no open end of the bowel. A double-armed Pagenstecher thread is passed in a parallel fashion a little more than a quarter of an inch apart. The passage of the suture is facilitated by the bowel being held taut by an assistant and the convexity of the bowel flattened by lateral traction with forceps. An incision is made between the two parallel sutures just large enough to allow the insertion of the Murphy button.

their contents. Keep them empty by Doyen clamps. Pack off the field of operation with hot, moist, lap packs.

Step 2. Introduce a purse string suture of substantial silk or chromic catgut, preferably the former on the antimesenteric border of the intestine. The suture penetrates all the coats of the bowel. A longitudinal incision is made in the area mapped out by the purse string suture. The longitudinal opening thus made should be sufficiently large to admit the Murphy button (Fig. 1571-1572).

Step 3. One-half of the oblong Murphy button is now seized with hemostats or special forceps and its head is introduced into the opened bowel. Careless use of an artery forceps may so injure the button as to render it unsafe (Weir). Pull the purse string snugly together and tie it in such a manner that the opening in the intestine is firmly fastened about the neck of the button. Any excess tissue distal to the suture is removed with knife or scissors. If this precaution be not taken the proper approximation of the two halves of the button may be interfered with.

Steps 2 and 3 are repeated on the other loop of bowel.

Step 4. Remove the forceps holding the halves of the button. Insert the neck of the male half of the button into that of the female half and press them together snugly. A few interrupted Lembert sutures placed here and there fortify the anastomosis.

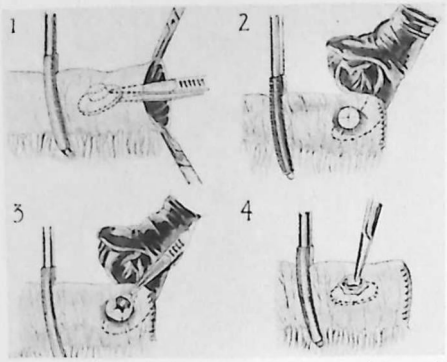


FIG. 1572. Method of inserting Murphy button through open end of resected bowel. 1. Half of the button is placed in the lumen of the bowel, intestinal clamp prevents spilling. 2. The open end of the bowel has been closed and the cylinder of the Murphy button is being pressed against the lateral wall of the bowel at the projected site of anastomosis. Crucial incisions slightly less in diameter than the cylinder of the button are made. 3. The flaps of the incised bowel are being drawn over the cylinder of the button insuring a tight fit. 4. The button has been drawn through the bowel, and the flange of the button is being held lightly against the intestinal wall with a clamp. The same process is repeated on the opposite end following which the two halves of the button are clamped together. The intestinal clamps are not removed until after the halves of the button have been brought together. (After A. A. Berg.)

End-to-End (Axial Union) by Murphy Button

This operation is practically the same as that described in the preceding paragraph.

The steps are as follows (Fig. 1569):

Step 1. Free a coil of bowel from its contents.

Step 2. Apply clamps laterally to the portion to be excised.

Step 3. Introduce a suture through the mesentery of the portion of bowel to be excised about an inch and a half from the intestinal border.

Step 4. Split the mesentery centrifugally from the intestine to the point of the ligature.

Step 5. A silk suture about ten inches long, armed with two needles, is passed making a pleat, one on either side of the intestine from the mesenteric to the free margin of the bowel. Do not draw the threads, but keep the needles in position to act as splints during the division of the bowel.

Step 6. Divide the bowel. Draw the puckering thread tight. Introduce the

button, as previously described, into the bowel. Draw the suture tight. Knot it. Cut it short.

Step 7. Repeat the procedure in the other end of the bowel. Introduce the other half of the button into the opposite opening in the bowel. Excise and treat the mesentery as indicated. Bring the two ends of the button into apposition and press them together.

Step 8. Cleanse the field. Remove the lap sponges. Close the abdomen. A great variety of contrivances have been put to use for intestinal anastomosis (decalcified bone plates (Senn); bobbins (Mayo-Robson); elastic ligature (McGraw) etc.).

Comment: Moynihan dismisses the subject of such appliances in the following terms, "The weightiest argument against all mechanical aids to anastomosis is this—they are unnecessary. By their aid we do not accomplish anything that cannot be accomplished with equal rapidity and with greater safety by the simple suture. We have nothing to gain from their use and we risk much by leaving something, which may be, and often has been, the direct cause of danger and of death. The day of mechanical aids is over. The buttons and the bobbins, the elastic ligatures and the forceps of many forms have now no more than an historical interest."

While these statements are essentially correct, yet, I believe, that as stated at the outset, in an emergency, and in hands not highly skilled, the Murphy button still has its place.

Lateral Entero-Enterostomy

(Isoperistaltic)

The advantages ascribed to lateral (side to side) over axial (end to end) anastomosis are as follows:

1. Comparative ease of performance.
2. Less danger of primary and secondary stricture.
3. The line of anastomosis is completely surrounded by broad peritoneal surfaces, which promptly agglutinate, thus minimizing leakage and avoiding the "weak points" at the mesenteric attachment, resulting in axial anastomosis.
4. In connecting two segments of unequal caliber it offers distinct advantages.

Treat the intestinal loops to be united as in axial anastomosis (p. 139). The bowel is divided with the thermo- or electrocautery and closure of the ends of the sectioned bowel is performed as follows: The ends are turned in by basting (Kerr-Parker) stitch. This stitch is used as a gathering suture, the bowel is puckered and the two ends of the stitch are tied together. Superimpose a purse string suture which will bury the knot of the original basting stitch.

Technic of Closure of Ends of Divided Bowel

Method A (Fig. 1573 a). This is done, simply, by placing two rows of continuous suture, an inner through-and-through (catgut) suture and an outer seromuscular Lembert suture (Pagenstecher linen).

Method B (Doyen's). The bowel is crushed with an écraseur or crushing

clamp, a catgut ligature is tied around the crushed ribbon of intestinal tissue. A purse string suture is superimposed and the ligated stump is inverted toward the lumen of the intestine and the purse string suture tied. As many interrupted Lembert seromuscular stitches as seem necessary are used to reinforce the closed end. (See Fig. 1526, p. 1353.)

In the large bowel two or three rows of sutures are necessary to obtain security of closure.

Method C (Moschkowitz's) (Fig. 1573 b). Clamp the bowel segment to be divided with crushing forceps. Divide the bowel with the thermo- or electro-

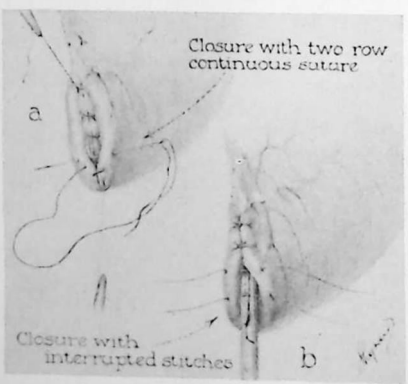


FIG. 1573. Closure of divided end of bowel.

cautery knife. The cauterized end is invaginated with the clamp remaining in situ while interrupted or a continuous Lembert suture is introduced as shown in the illustration. The clamp is removed immediately before the last stitch is introduced.

Technic of the Anastomosis

Step 1. The stripped segments of bowel to be anastomosed are engaged in Doyen intestinal clamps and placed side by side in an isoperistaltic manner, e.g., the closed ends of the loop point in opposite directions; or, a three-bladed anastomosing clamp may be used, which grasps the bowel just above the attachment of the mesentery. Three to four inches of intestine are held in each clamp. The anastomosis should not be made too far from the closed ends, thus avoiding the formation of retentive pockets.

Step 2. Introduce an outer seromuscular continuous suture (Lembert) of Pagenstecher linen or fine silk following the same technic as described in gastrojejunostomy. Lock the end of the suture.

Step 3. Open the bowel with the electrocautery or a sharp scalpel. The open-

ings should be about ½ inch shorter than the seromuscular suture and placed about ¼ inch away from it. Moist gauze sponges surround the bowel segments. When soiled they are replaced with fresh ones.

Step 4. An inner, hemostatic, through-and-through suture is begun as a U-stitch and unites in a continuous manner the whole thickness of the posterior wall of the bowel segments to be joined (see above Gastrojejunostomy, p. 1343, Fig. 1524 l-m). The knot of the U-stitch is tied on the outer surface of the bowel effectually closing the corner and serving as a landmark for the return stitch which embraces the whole thickness of the anterior wall of both bowel segments and is tied to the short end of the inner suture. The angle is reinforced by a superimposed Lembert stitch made with the same suture.

Step 5. Loosen the clamps. Wash off the anastomosed bowel with warm salt solution. Inspect the suture line. Change gloves. Discard soiled instruments.

Step 6. Pick up the long end of the seromuscular suture and continue it as a right angle Cushing stitch (Fig. 1524 n, p. 1344) to its starting point. Ligate it with the short end.

Step 7. Place reinforcement sutures wherever needed. Fortify the angles by lifting and anchoring the ends with interrupted sutures.

Step 8. Repair the mesentery with interrupted catgut sutures

Step 9. Inspect. Make sure that the blood supply has not been interfered with, particularly at the ends, and that there are no torsions or kinks of the bowel or mesentery. Replace the anastomosed bowel gently. If a drain is used (seldom necessary) particularly if it be of gauze, it should be kept at a safe distance from the anastomosed zone.

Resection of the Proximal Duodenum and Pyloric Sphincter for Multiple Duodenal Ulcers

While the scope of this operation, Dr. T. M. Joyce* points out, is limited, yet it provides a "graceful exit" from the embarrassing situation one faces when unsuspected contact ulcers are encountered in the course of the performance of a pyloroplasty. The operation has, therefore, a very definite place in surgery of the duodenum. In 1927 and again in January, 1929 Balfour reported practically an identical operation except that he removed more of the stomach than does Joyce. In the Balfour method, 7 to 8 cm. of the stomach is removed. It is essentially a Billroth I including the ulcer bearing duodenum. Joyce believes it unnecessary to resect the stomach except to remove the pyloric ring. It is only in this that the Joyce method differs from that of Balfour. The latter recommends simple duodenectomy for multiple ulcers calling attention to the fact that in this operation, the entire circumference of the duodenum is removed and stresses the desirability of this operation in which the chief reason for surgery is hematemesis. The accompanying illustrations depict the technic of the procedure. (Figs. 1574-1575-1576.)

Nissen's Method of Resecting Deep-Seated Duodenal Ulcers[1]

Nissen pointed out that "Resection for Exclusion" in cases of duodenal ulcer which are deeply situated, while lauded by many, has been followed by rather unpleasant experiences in other hands. Nissen did eighteen palliative re-

* Thomas Martin Joyce, Annals of Surgery, 1929.
[1] Zentrbl. f. Chir., 1933, No. 9.

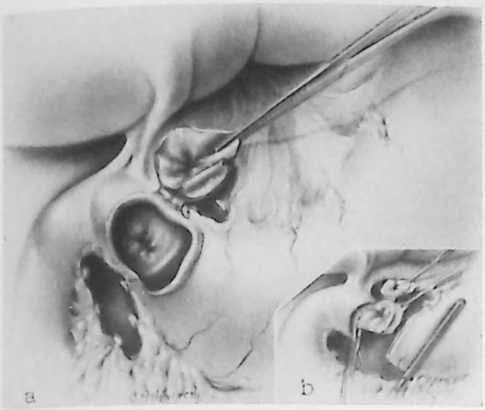


FIG. 1574. a. Jund pyloroplasty partially completed showing anterior and posterior ulcers. b. Method of resecting posterior ulcer—first step of partial duodenectomy, excision of posterior ulcer and pyloric ring. (Courtesy Dr. Thos. Martin Joyce, Ann. Surg., 1929.)

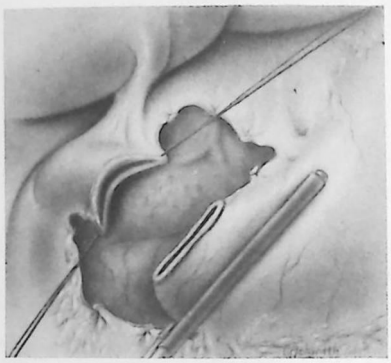


FIG. 1575. Second step of partial duodenectomy. Note that the semicircular incision widens the duodenum sufficiently to permit direct anastomosis to the stomach. (Courtesy Dr. Thos. Martin Joyce, Ann. Surg., 1929.)

sections. In this series, one patient died from perforation of the remaining ulcer, another on the eleventh day after the operation following a serious hemorrhage from the ulcer; four patients had to be reoperated on for jejunal ulcer (three on his service and another one elsewhere as already reported in the Festschrift for Prof. Papayoannou). It was thought that peptic ulcer may be the result of the recurrent pylorus left behind.

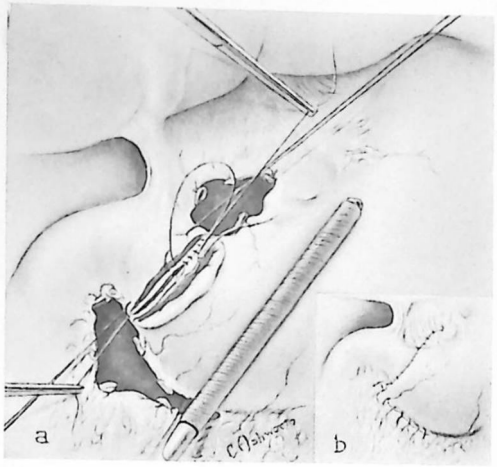


FIG. 1576. a. Method of anastomosis. Three layers of sutures are used. b. Operation completed. (Courtesy of Dr. Thos. Martin Joyce, Ann. Surg., 1929.)

In order to avoid such occurrences, Flörcken, Eck and Melchior have suggested certain procedures. Ordinarily these cases concern ulcers which penetrate into the hepatoduodenal ligament or the posterior wall of the duodenum into the head of the pancreas. The crater of the ulcer extends to the vicinity of the papilla. To close the duodenum in a typical manner under such circumstances is a difficult proposition, to say the least.

Nissen's Technic

Step 1. Mobilize the duodenum from its mesentery on both sides. Separate adhesions particularly on the anterior wall.

Step 2. Open the affected area and incise the duodenal wall in such a manner as to expose the entire ulcerated region and its crater (Fig. 1577).

Step 3. Divide the anterior wall of the duodenum completely (Fig. 1578).

Step 4. The first row of sutures embraces the anterior wall of the duodenum and the opposite aboral margin of the crater of the ulcer (Fig. 1579).

FIG. 1577. Nissen's method of resecting deep seated duodenal ulcer. The ulcerated area in the head of the pancreas is opened. (Courtesy Prof. R. Nissen.)

FIG. 1578. Nissen's method of resecting deep seated duodenal ulcer. Division of the anterior wall of the duodenum. (Courtesy Prof. R. Nissen.)

Step 5. The second suture effects the closure of the opening of the duodenum and embraces the anterior wall of the duodenum and its oral circumference as shown in Fig. 1580.

FIG. 1579. Nissen's method of resecting deep seated duodenal ulcer. Placement of first row of sutures which embraces the anterior wall of the duodenum and the aboral margin of the ulcer. (Courtesy of Prof. R. Nissen.)

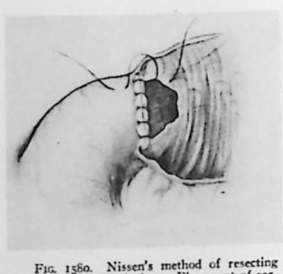


FIG. 1580. Nissen's method of resecting deep seated duodenal ulcer. Placement of second row of sutures which embraces the anterior wall of the duodenum and the oval margin of the ulcer. (Courtesy of Prof. R. Nissen.)

Step 6. Since the peritoneal covering of the pancreas is usually thickened by reason of chronic inflammation, it affords opportunity to use this membrane as a third suture-line in covering the anterior wall of the duodenum (Fig. 1581).

Step 7. Tags of omentum may be used as a final covering over all.

Step 8. The final step consists of a two-thirds resection of the stomach (Pólya-Reichel).

Comment: In a period of two and one-half years, Nissen performed twenty-two duodenal resections in cases of deep-seated duodenal ulcers. Of these cases, one patient died on the second day following the operation from hemorrhage. In this instance a cholecystectomy was also done for cholelithiasis. The post-mortem examination did not disclose the point from which the bleeding took place. In all other cases healing was perfect. There were no duodenal fistulae and up to the present time not a single peptic ulcer has been observed in this series of cases.

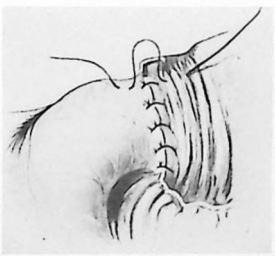


FIG. 1581. Nissen's method of resecting deep seated duodenal ulcers. Third line of sutures consists of covering the anterior wall of the duodenum with peritoneum derived from the thickened capsule of the pancreas. (Courtesy Prof. R. Nissen.)

RESECTIONS OF THE LARGE BOWEL

The modern methods of bowel resection are as follows:

1. One-stage resection with immediate axial union of the bowel ends.
2. Primary resection of the involved segment of bowel and creation of a permanent colostomy (abdominal; fascial; perineal).
3. Bloch (1891), Paul (1895)-Mikulicz (1900), two-stage operation consisting of
   (a) Exteriorization and ablation of the tumor.
   (b) Removal of the resulting artificial anus.
4. Schloffer's three-stage operation consisting of
   (a) Cecostomy.
   (b) Resection of the tumor with axial anastomosis.
   (c) Closure of the artificial anus.
   (d) Hochenegg and Langemark's two-stage operation consisting of:
      (1) Exclusion of the diseased segment.
      (2) Resection of the affected area.

The location of a tumor and its relation to contiguous structures may render the removal of the affected segment very hazardous, unless mobilization of a rather large segment of the bowel carrying the tumor may be effected.

A thorough knowledge of the blood supply nourishing a given segment of bowel and the arrangement of the lymph vessels and nodes draining a certain territory is of utmost importance in successfully performing the removal of different sections of the large bowel (Figs. 1530-1531).

Jamison and Dobson have accurately described the lymph territories of respective sections of the colon, a knowledge of which enables the surgeon to plan

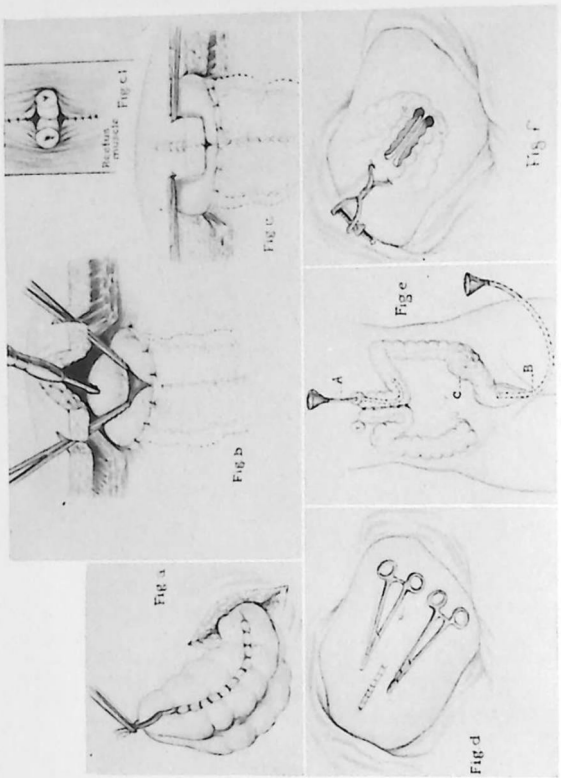


FIG. 1581A.

his mode of attack and surgical strategy. Lord Moynihan aptly states that "the surgery of carcinoma is the surgical anatomy of the lymphatic system." Jamison and Dobson's conclusions may be summarized as follows:

The lymphatics connected with any given segment of the colon correspond in their course and arrangement with the main arterial branches of supply to such segment. The course and distribution of these will, therefore, afford an all important index as to the extent of intestine, parietal peritoneum, retroperitoneal tissue, or mesentery which demands removal in order completely to extirpate the lymphatic area corresponding to a given tumor in a particular locality. Four lymphatic areas are described.

1. Ileo-colic.
2. Middle colic.
3. Left colic, and
4. Inferior mesenteric.

The lymph nodes connected with each area are divided in four distinct intercommunicating groups, viz.:

1. Epicolic nodes situated in the appendices epiploicae on the wall of the bowel.
2. Paracolic, arranged parallel to the mesenteric margin of the bowel between the intestine and the arterial arcades and on the arcades.
3. Intermediate nodes arranged around the trunk of the arteries about midway between their origin and the bowel.
4. Main nodes, arranged around the main trunk of the artery near its origin.

The intermediate groups receive lymph vessels from the epicolic and paracolic groups, and some vessels may pass to these directly from the bowel itself.

The main groups receive lymph vessels from the three peripheral groups and in certain regions, notably the lower part of the inferior mesenteric system, directly from the intestine itself. These are also centrally connected with the lumbar and mesenteric nodes.

The mode of attack in malignancies of the large bowel depends upon

1. The extent of local involvement,
2. The position of the neoplasm in relation to its blood supply,

FIG. 1581A. Devine's operation of defunctioning the distal colon. a. Proximal part of the transverse colon has been delivered into the wound. A rubber tube has been passed through its apex, the limbs of the loop have been connected by a running suture for the purpose of making as long a spur as possible (about four or five inches). b. The parietal peritoneum is sutured around the neck of the exteriorized loop of sigmoid. Button-hole openings are made through the abdominal wall one inch on each side of the incision. Through these openings Kocher clamps are passed and applied to the bowel. The button-hole openings do not include the muscle of the abdominal wall. The bowel between the clamps is divided with a diatherm knife. c. The cut bowel ends after being coagulated with the diatherm current have been drawn up by the forceps into the button-hole openings. Fig. c-1 shows position of the abdominal muscle in relation to the ends of the bowel. d. The skin edges around the bowel ends are now sutured so as to leave a pair of tiny fistulas. The abdominal incision is closed. The two clamps on the ends of the divided bowel are shown in position on the abdomen. e. Diagram showing how the bowel is prepared by being washed out from the colostomy opening in the distal colon. "A" shows a tube connected with a funnel introduced into the colon. "B" where there is complete obstruction, the rectum is also washed out from below by means of tube and funnel. "C" tumor causing obstruction. f. Diagram illustrating the application of the enterotome. One blade of the enterotome is first introduced into one opening followed by the second blade in the opposite stomece of the bowel. After being placed properly, the large winged nut brings the two blades tightly together crushing the spur.

3. The extent of involvement of the lymph apparatus and
4. The physical condition of the patient in relation to the magnitude of the surgical procedure.

Removal of the Cecum and Ascending Colon—Ileocolic Resection

Anesthesia. Wherever possible spinal anesthesia should be used.

Position of the patient. The right side of the body should be raised.

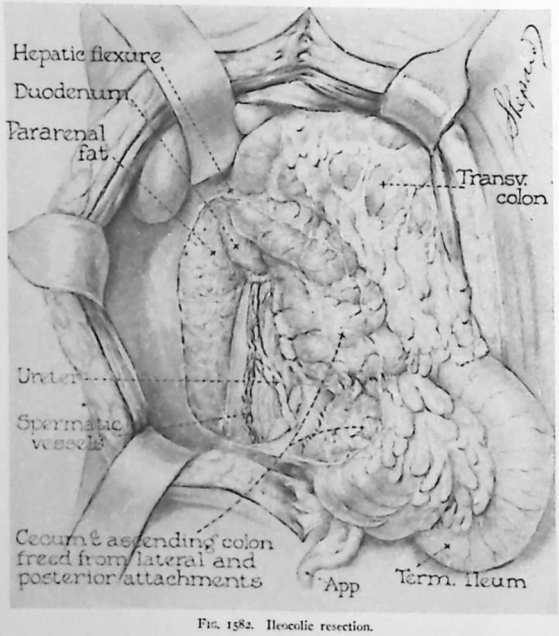


FIG. 1582. Ileocolic resection.

Step 1. The incision should be ample for thorough exploration and operative manipulations. It should be about eight inches long, paramedian in type with displacement of the rectus abdominis muscle outward. Explore the abdomen. Orientation is essential. (Fig. 1582.)

Step 2. Pack all viscera not concerned in the operation out of the way, except about 8 inches of ileum. Incise the posterior parietal peritoneum about an inch to the outer side of the cecum and ascending colon. Free the cecum

from its bed by blunt (digital) dissection. The "white line" represents the margin where the physiologic process ceased. Gauze-protected fingers dissect and mobilize the colon. Hemorrhage need not be feared here because the main vessels reach the bowel from the inner aspect.

Avoid the ureter during this step of the operation as well as the ovarian or spermatic vessels.

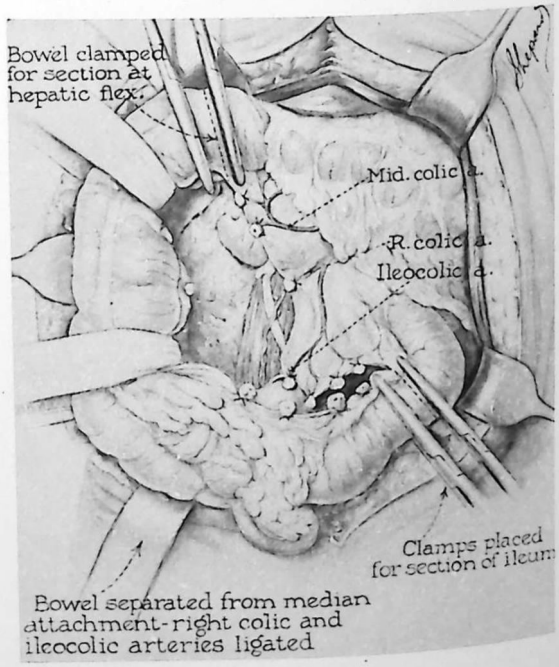


FIG. 1583. Ileocolic resection.

As one proceeds upward, the duodenum is exposed. Mobilization is considered adequate when the hepatic flexure and the cecum are found free.

Place a hot lap pack behind the mobilized large bowel.

Step 3. Ascertain the position of the ileocolic and right colic arteries. Instead

of attacking the ileocolic vessels from in front it is better to deal with them and the lymph structures from behind. The mobilized bowel being attached to the peritoneum only, will permit, when transilluminated, to ascertain the location of the vessels concerned. Ligate the ileocolic doubly, and divide it. The right colic, if it does not originate from the ileocolic, which it usually does, is ligatured separately, well up at its origin.

The anastomotic branch to the transverse colon as well as the recurrent branch to the ileum is also ligated. Avoid injury to the superior mesenteric artery. The parts to be removed are ablated between two clamps after dividing the mesentery or as follows (Fig. 1583):

The distal end of the colon may first be divided with the electrocautery and the part to be removed freed in a downward direction. While so doing the vessels are clamped at some distance from the margin of the colon before dividing them. All retroperitoneal tissues appearing involved should be carefully dissected from the posterior abdominal wall, care being taken not to injure the ureter.

Step 4. With two crushing forceps applied about an inch apart clamp the ileum about eight inches from the cecum. Divide the bowel with the electrocautery knife about an inch distal to the crushing clamps. Ordinary intestinal clamps (rubber covered) are placed distal to the crushing clamps.

Step 5. Two courses are now open:

1. To close both ends of the divided bowel and make a lateral anastomosis, or
2. To close the colic end and join the ileum with the colon (lateral implantation).

The former method is the usually accepted procedure.

Lateral anastomosis is usually made in the transverse colon, in preference to the more fixed part of the remaining ascending colon, if that part be preserved.

Close the ileum with a running suture of catgut. Invert the stump and superimpose another running suture of Pagenstecher linen. Treat the end of the divided colon, which has up to this point been kept wrapped up in a moist warm lap sponge, similarly (Fig. 1584).

Step 6. Change soiled lap sponges and gloves. Release the clamps. Engage the portion of ileum and transverse colon to be anastomosed in Doyen intestinal or anastomosing clamps. These are to be grasped in such a manner that no pockets will remain at the ends, in other words the clamps should reach as near to the end as is consistent with safety. The closed end of the ileum is made to point to the patient's left. A stoma of about two and one-half inches is made between the ileum and transverse colon and the anastomosis accomplished by the two-row suture method (outer linen, and anastomotic catgut) as described in performing gastro-enterostomy or side-to-side intestinal anastomosis (pp. 1338-1345; Fig. 1524).

Step 7. Close the defect in the posterior parietal peritoneum with meticulous care for infection engrafted here may prove disastrous.

Peritonization of the denuded surface here is not always possible. Unite the mesentery running from the ileum and the edge of the transverse mesocolon. If a raw surface remains it is best to introduce a gutta-percha drain for a day or two.

Some surgeons prefer end-to-side anastomosis. If so, the end of the colon is closed and the end of the ileum is anastomosed to the side of the colon at the anterior taenia longitudinalis. End-to-side anastomosis may also be accomplished by the Murphy button in emergencies.

Resection of the Hepatic Flexure

Position of the patient. Raise the lower thorax and upper abdomen by means of operating table elevator, air cushion, or sandbag.

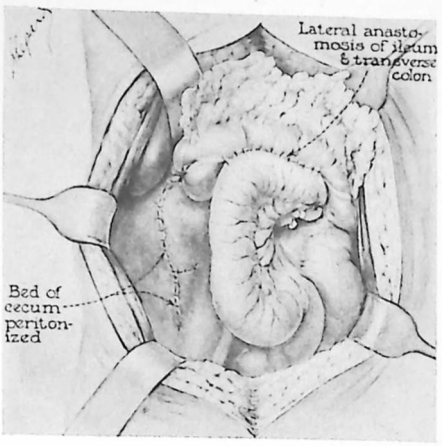


Fig. 1584. Ileocolic resection.

Step 1. Make a right rectus incision. Deliver the segment of bowel to be resected.

Step 2. Isolate the middle colic artery and ligate it at its origin. Incise the mesentery. The upper segment of the ascending colon and about half or more of the transverse colon are removed.

Step 3. Close the ends of the bowel in a manner already described (p. 1402).

Step 4. Perform an ileosigmoidostomy.

Resection of the Transverse Colon

The technical difficulties here are not great because of good mobility by reason of a well developed mesocolon; this is especially marked on the left side. This facile mobility allows of axial anastomosis after the tumor is removed. End-to-end union is enhanced through the security offered by the peritoneum

which completely surrounds the bowel here. If preferred, a side-to-side union may be done.

The extent of the resection will necessarily depend upon the degree of the involvement of the bowel, invasion of the regional lymphatics and contiguous structures.

Step 1. Divide the gastrocolic omentum.

Step 2. Ascertain the extent of the bowel to be resected. Ligate off the great omentum, and remove as much of it as is necessary. Deliver the section of bowel to be resected.

Step 3. Ligate the middle colic artery.

Step 4. Divide the transverse mesocolon.

Step 5. Apply two sets of clamps at each end of the transverse colon and sever the bowel (electrocautery) between the two.

Step 6. Do an end-to-end or side-to-side anastomosis.

Step 7. Reinforce the suture line with omentum.

Step 8. Close the mesocolon to shut off the lesser peritoneal cavity. To gain better approximation, mobilize the hepatic and splenic flexures, if need be.

Resection of the Splenic Flexure

Here the operation is more difficult to perform because of the deep position of the flexure which is fixed in position by the costocolic band. A mesocolon is present in about five per cent of cases. Usually about one-half of the transverse colon and a considerable portion of the descending colon are removed. According to Moynihan, after such resection, the free mobility or facility for mobilization of the transverse colon and sigmoid flexure affords an opportunity of anastomosis between the divided proximal and distal ends in almost every case.

Step 1. Make a vertical incision. According to Makins an oblique incision about six inches long running along the left costal margin affords greater exposure. Whichever incision is used, the important desideratum is—it should be ample. Moynihan condemns transverse incisions.

Step 2. Pack off the general peritoneal cavity from the field of operation.

Step 3. Detach the omentum from the left end of the transverse colon.

Step 4. Divide the peritoneum on the outer side of the descending colon carrying the incision around the splenic flexure.

Step 5. Divide the costocolic ligament and the outer portion of the gastrocolic omentum.

Step 6. Mobilize the flexure. This is often a difficult task to perform. To accomplish it and to facilitate delivery and mobilization of the tumor, the descending colon and sigmoid flexure may have to be thoroughly detached.

Step 7. Turn the detached bowel over to the right. Isolate the left colic artery; divide its ascending branch between two ligatures; if the lower portion of the descending colon is also to be removed the main trunk of the left colic artery is also ligated.

Step 8. Divide the ends of the portion of bowel to be removed between two clamps placed at either end of the segment.

Step 9. Perform an axial (end-to-end) anastomosis, or a side-to-side union, after closing the ends of the severed bowel; the latter method is preferable.

Excision of the Descending Colon

Tumors in this situation are rare. Here also, exposure, mobilization and delivery of the bowel segment are rather difficult to accomplish. The steps of the operation are much the same as in the removal of the splenic flexure. Here a mesentery is more frequently encountered than in the ascending colon.

Isolate the left colic artery and ligate it. The lymphatic area here consists of the epicolic and paracolic nodes and the intermediate nodes on the branches of the left colic and first sigmoid arteries (Jamison and Dobson). The further steps are the same as described in the preceding procedure, except that the lower division consists of the upper part of the sigmoid flexure instead of the descending colon. The first sigmoid artery is ligated close to its origin. Here again, either an axial or side-to-side anastomosis is made, preferably the latter. The sigmoid flexure is mobilized and displaced upward to facilitate the anastomosis.

Resection of the Sigmoid Flexure

Malignancies in this division of the bowel are frequent. Fortunately, a rather well developed mesentery facilitates operative manipulations here, unless inflammatory changes or congenital cicatricial bands or a short, crippled mesentery render operation difficult.

Step 1. Place the patient in high Trendelenburg position. Spinal anesthesia is of much value.

Step 2. Make a rather long pararectus incision on the left side of the abdomen which will permit thorough exploration and operative manipulations.

Step 3. Deliver the tumor. Pack the rest of the abdominal cavity off with lap sponges. Where a long mesentery exists and the tumor is situated in the central portion of the sigmoid, delivery is easy, otherwise difficulties will present themselves. The difficulties are particularly great where the tumor is situated in the lower section of the sigmoid.

Step 4. Mobilize the bowel by incising its outer mesenteric border. This is essential. If necessary, the lower portion of the sigmoid and as much of the descending colon as needed should be mobilized. Avoid injury to the ureter and the ovarian or spermatic vessels during mobilization.

Step 5. Preserve the main trunk of the inferior mesenteric artery, the sigmoid and the superior hemorrhoidal arteries, for proper nutrition of the lower sigmoid and rectosigmoid junction.

Step 6. Apply clamps as previously described and the segment of bowel is removed together with a portion of its mesentery and such lymph nodes as are found in the involved area.

Step 7. Ligate the sigmoid arteries when encountered or preliminary to the removal of the bowel.

Step 8. Here again an axial or side-to-side anastomosis may be made. If, as frequently happens, the removal of a segment of bowel in this situation does not permit of a satisfactory anastomosis, the following procedures may be resorted to:

Rutherford Morison's Method

The lower end of the bowel is closed and its stump invaginated and a colostomy is performed. The operation consists of the following essential steps:

Step 1. Excise the diseased bowel segment.

Step 2. Tie a glass bobbin to which is attached a rubber tube, into the upper end of the sigmoid flexure.

Step 3. Pass the rubber tube down, from above, through the lower divided end into the rectum where its passage through the anus is aided by the finger of an assistant. If difficulty is encountered during this step of the operation, the assistant passes a stomach tube up from the anus into the abdomen. A piece of string is tied to the stomach tube as well as to the rubber tube and all are drawn back through the anus.

Step 4. Traction is now applied to the tube until the ligature of the upper divided end of bowel is inside of the lower cut end of bowel.

Step 5. A ligature is passed around, immediately below the lower cut end and securely tied. This renders the junction watertight.

Step 6. Further traction is now resorted to, to produce a short intussusception; this is maintained by a few Lembert sutures.

In from eight to ten days the ligated, sloughing bowel separates. The tube is then released. Some modifications of this procedure have been made by Lockhart-Mummery and Donald Balfour.

A temporary cecostomy to afford decompression and protection of the suture line is of much value in these operations.

Bloch-Paul-Mikulicz Two-Stage Resection of the Large Bowel

(also spoken of incorrectly as Mikulicz operation)

Historical Note. While this operation is generally credited to Mikulicz, Moynihan points out that priority belongs "beyond doubt" to F. T. Paul of Liverpool who in an article[1] gives the following description:

"Explore first in the middle line unless the stricture has been located.

"Make a sufficiently free incision over the site of the tumor.

"Having cleared away any adhesions, ligate the mesentery with the help of an aneurysm needle and divide it sufficiently to free the bowel well beyond the growth on each side.

"Let the loop of bowel containing the growth or stricture hang out of the abdomen and sew together the mesentery and the adjacent sides of the two ends. See that the stumps of the mesentery lie beneath the bowel where, if deemed advisable, it can be drained by packing cyanide gauze down into it.

"Ligate tightly a glass intestinal drainage tube into the bowel above and below the tumor and then cut away the affected part. Do not cut off first, or blood will be lost unnecessarily. Only the proximal tube is really necessary. The distal end may be closed or included in the proximal ligature.

"Close the ends of the wound with a few silkworm-gut sutures, passing through all the layers of the abdominal wall; no others are necessary.

"Where the operation is performed in this way all the vessels except those in the primary incision are tied before they are cut and the intraperitoneal work is rendered quite bloodlessly.

[1] British Medical Journal, 1895, i, 1139.

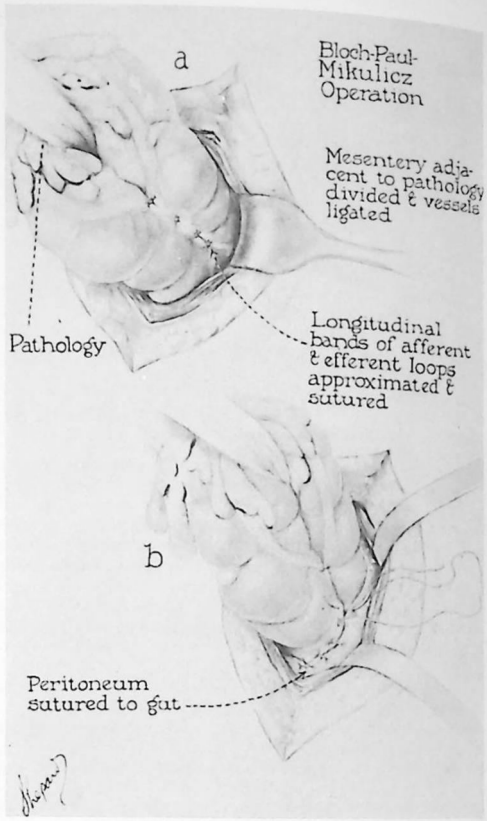


Fig. 1585. Bloch-Paul-Mikulicz operation.

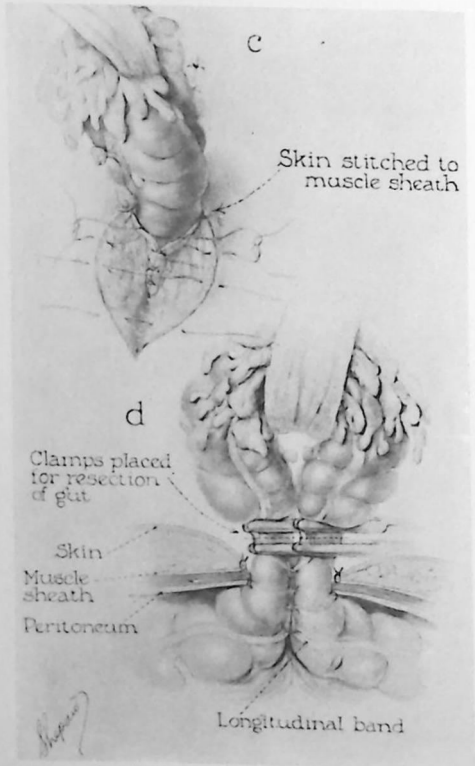


Fig. 1585 (continued). Bloch-Paul-Mikulicz operation.

"The second stage of the operation—that of breaking down the spur with an enterotome, should generally be undertaken about three weeks later. As soon as this has been satisfactorily accomplished, the artificial anus is closed by separating the rosette of mucous membrane from the skin, turning it in and bringing the freshened edges of the latter together over it."

Priority for this operation according to Moynihan belongs as stated to Paul whose procedure was described in the preceding paragraphs. In his subtle but convincing way Moynihan says, "The name of many surgeons has been attached to it (the operation). It has been claimed by Mikulicz whose brow wore many noble laurels; for Hartmann, by those afflicted with the quaint gallic frugality of recognition for the work of others; and for surgeons in other countries."

Oscar Bloch, on October 20, 1891, read a paper before the Surgical Society of Copenhagen on "Extra-abdominal Treatment of Intestinal Cancer (with the exception of the rectum)." This lecture appeared in two sections in the Nord Medical Arkiv, 1892, No. 1, og. 8. An abstract of it was also printed in the Zentralblatt f. Chir., 1892, p. 628.

Late in 1892, Réclus published, in collaboration with E. Forgue, in Traité de Therapeutique, two cases of exteriorization of the bowel which he has described. He does not mention Bloch's name. In view of the fact that Bloch's very exhaustive contribution to this subject appeared a year before Réclus' paper, priority for this operation unquestionably should be accorded to Bloch, although in justice to Réclus it must be stated he may have thought of an exteriorization operation without knowing of Bloch's work.

Paul published his paper about nine years after the publication of Bloch's lecture; i.e., in the British Medical Journal, February 3, 1900. Paul advised division of the mesocolon, abutment of the proximal and distal loops of the bowel carrying the tumor, with immediate extraperitoneal resection of the tumor mass and the introduction into each end of the bowel of a glass tube to carry off the intestinal contents, without soiling the dressings.

Despite all this, surgeons throughout the world in performing an exteriorization operation refer to it as the "Mikulicz operation." An examination of the facts discloses that Mikulicz published a description of the exteriorization of the bowel in 1902. He also says he had performed this operation since 1898. His operation consists of exteriorizing the bowel, dividing the mesocolon, followed by immediate resection of the tumor. Mikulicz spoke of the procedure in the Transactions of the Thirty-second Congress of German Surgeons, in 1902. Thus, even though Mikulicz's statement would be found to be correct, viz., that he had performed this operation since 1898, although he reported it in 1902, Bloch would still antedate him by seven years, because Bloch reported his findings to his Surgical Society in 1891.

Yet, from a careful study of the literature, Oscar Bloch* of Copenhagen should be accorded the credit for the procedure. The following throws an interesting side light on the question at issue. Theodor Kocher in his "Operationslehre"[1] states: "In a memorial volume dedicated to Mikulicz, Anschütz credits Oscar Bloch with having been first to propose resection of the large bowel in two stages." Bloch read his paper October 20, 1891 before the Surgical Society of Copenhagen over seven years before Mikulicz reported his procedure.

* See Mikulicz, "Exteriorization Operation." Max Thorek, Annals of Surgery, July, 1937.

[1] 5th Edit. Gustav Fischer, Inc., 1907, p. 947.

While Mikulicz insists that the mesentery be divided and mobilization be thorough, these are not insisted upon by other surgeons (von Schmieden):

Fig. 1586. Exteriorization for carcinoma of the bowel. Note clamps left in situ for a number of days. The tumor prior to its removal by thermocautery.

FIRST STAGE

Step 1. Open the abdomen. Explore thoroughly. Make sure that the tumor is operable.

Step 2. Thoroughly mobilize the intestinal segment, its mesentery and the lymph nodes to be resected. Exteriorize the involved bowel segment in such a manner that not only the projecting limbs remain free from tension but that the limbs of bowel in the abdominal cavity rest against one another without pull or interference with their blood supply. The mesentery is incised and after ligating the blood vessels concerned, it is removed together with the affected lymph nodes. The afferent and efferent limbs of the intestine are now united through their taeniae with interrupted Pagenstecher linen sutures for about 2 or 3 inches (Fig. 1585). The mesentery should not be included in the united limbs of the bowel.

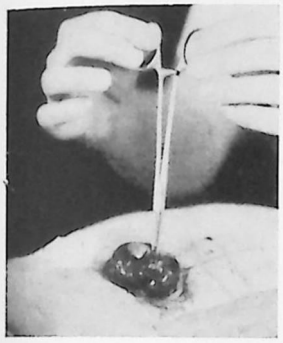


Fig. 1587. Appearance of proximal and distal segments of bowel after Bloch-Paul-Mikulicz exteriorization operation. Note spur to be removed with enterotome to re-establish continuity of the bowel.

Step 3. Mobilization of the bowel must be thorough. This is often difficult particularly when tumors affect the ascending or descending colon. Here the advice of Anschütz to mobilize the bowel even as far as the transverse colon is of distinct benefit.

Unite both limbs of the sutured bowel to the parietal peritoneum, in a circular manner. (Fig. 1585 b, c.)

Step 4. Close the abdominal wall in layers. Apply crushing clamps to the limbs of the bowel (von Schmieden) and remove the affected segment with the thermocautery a day or two later. The crushing clamps remain in situ until peritoneal agglutination has taken place (Figs. 1585 c-d; 1586).

A voluminous dressing supporting the bowel carrying the tumor is applied. Zinc salve or aluminum paste covers the area.

SECOND STAGE

This consists of removal of the spur (see page 1388 under temporary colostomy) (Fig. 1587).

Schloffer's Three-Stage Resection

FIRST STAGE

Do a cecostomy (p. 1382).

SECOND STAGE

Same as Bloch-Paul-Mikulicz operation.

THIRD STAGE

Closure of anus preternaturalis in the cecum.

This method is very advantageous in safeguarding the operative area by decompression, permitting irrigations to be carried out and bringing the patient into the best possible condition for the radical procedure.

RECAPITULATION

The following illustrations depict the surgical procedures in the treatment of tumors of the large intestine.

Tumor of Cecum

Area to be Resected. From about 3 inches distal to the ileocecal valve to about the middle of the ascending colon; or to about the left half of the transverse colon (Fig. 1588).

Vessels to be Ligated. Ileocolic and right colic.

Form of Anastomosis. Side-to-side ileotransversostomy.

Tumor of the Hepatic Flexure

Area to be Resected. From about 3 inches of the ileocecal valve to about the middle of the transverse colon (Fig. 1589).

Vessels to be Ligated. The ileocolic, right colic and middle colic arteries.

Form of Anastomosis. Side-to-side ileotransversostomy.

Tumor of the Transverse Colon

Area to be Resected. Tumor-bearing segment and liberal portions (about 3 inches on either side) of healthy transverse colon (Fig. 1590).

Vessels to be Ligated. Branches of middle colic and left colic arteries.

Method of Anastomosis. After free mobilization, axial (end-to-end) anastomosis of the hepatic and splenic segments.

Fig. 1588

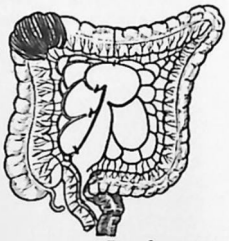


Fig. 1589

Fig. 1588. Diagram for resection of a tumor of the cecum. Lines indicating extent of resection of the ascending colon and ileum. Points of ligation of the blood vessels are shown.
Fig. 1589. Diagram showing area of small and large bowel to be removed in case of a tumor of the hepatic flexure of the colon.

Tumor of the Splenic Flexure

Area to be Resected. Liberal normal segment on either side of, and the tumor-bearing area (Fig. 1591).

Fig. 1590

Fig. 1591

Fig. 1590. Diagram indicating area of transverse colon to be removed in case of tumor.
Fig. 1591. Diagram showing tumor of the splenic flexure of the colon and area of bowel to be removed at operation.

Vessels to be Ligated. Branches of the left colic artery.

Method of Anastomosis. Side-to-side union of the remaining mobilized segments of the transverse and descending colon.

Tumor of the Descending Colon

Area to be Resected. From the outer third of the transverse colon to the beginning of the sigmoid flexure (Fig. 1592).

Fig. 1592

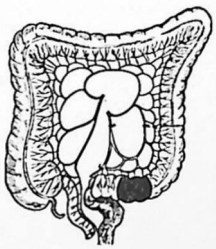


Fig. 1593

Fig. 1592. Tumor of the descending colon. Lines indicate extent of colon to be removed.
Fig. 1593. Tumor of the sigmoid flexure. Diagram showing extent of bowel to be resected.

Vessels to be Ligated. Left colic artery.

Method of Anastomosis. Either axial or lateral union of the transverse colon and sigmoid flexure.

Tumor of the Sigmoid Flexure

Area to be Resected. The tumor-bearing area and about 3 or 4 inches on either side of it (Fig. 1593).

Vessels to be Ligated. Branches of the left colic, sigmoid and superior hemorrhoidal arteries.

Method of Anastomosis. Axial (end-to-end) or lateral anastomosis after thorough mobilization of the splenic flexure and descending colon (Fig. 1594). It is well to recall that in one-stage resections a preliminary cecostomy is of great value for reasons given above.

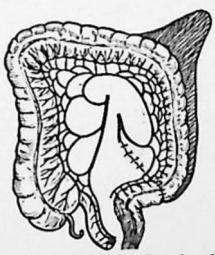


Fig. 1594. Outline of reunion of the cut ends of a tumor of the left colon after mobilization of the splenic flexure. (After Mayo.)

It must also be emphatically stated that one-stage operations unquestionably result in higher mortality than graded procedures.

One-stage operations should be done if the tumor is situated on the right side and graded operations when on the left (Victor Pauchet). The condition of the patient, the type and seat of the tumor must, of course, play an important rôle in arriving at a decision. I am in favor of graded operations.

RESECTION OF THE RECTOSIGMOID AND RECTUM

Rankin's Combined Abdominoperineal Operation in Two Stages

Fred W. Rankin[1] divides the surgical procedure into three phases: (1) preoperative preparation; (2) operative technic; and (3) postoperative treatment.

PREOPERATIVE PREPARATION

Decompression is just as essential a consideration as is the choice of operative procedure (advanced age; debilitating diseases; cachectic states). Decompression, Rankin points out, is essential because of the fact that a high percentage of all cases of sigmoidal growths produce, at some time during their presence, obstruction, subacute, chronic or acute.

When medical measures (repeated irrigations, mild purgatives) fail, surgical decompression (cecostomy, colostomy) is indicated. Rankin prefers cecostomy to colostomy.

By the use of a de Pezzer catheter for cecostomy, as Hendon does, satisfactory decompression of the bowel is obtained. In acute obstruction, blind cecostomy without exploration is counseled by Rankin. At the second stage the cecostomy is admirable as a decompressive measure if an anastomosis is attempted; if this is not done the vent is still desirable if a combined abdominoperineal resection in one stage, following the decompression is planned. "I believe," says Rankin, "that as an alternative procedure where one explores the abdomen and finds the colon too thickened and obstructed despite the medical decompressive measures to undertake a resection or manufacture of a single-barreled colostomy, the cecostomy is most advantageous. A second stage resection, beginning from behind and going forward as in the operation I have outlined, is carried out subsequently and the cecostomy is a grateful adjunct."

During the period of decompression, besides the rehabilitory measures, routine blood transfusions are given.

Anesthetic. The choice of anesthetic for combined abdominoperineal resections of the rectum is an important problem. Rankin's advocacy of spinal anesthesia as the method of choice continued unabated over a period of years until he suffered an operating room casualty which was rapidly followed by another one. In consequence his faith in its routine was shaken. Rankin's own choice of anesthetic for the first stage of the operation (exploration of the peritoneal cavity, colostomy) is gas-oxygen-ether, or ethylene. The second stage of the operation which is begun from behind and carried forward, is done first under transsacral anesthesia and when the patient is turned over and the abdomen is opened for a second time, then again ethylene or gas-oxygen-ether is used.

FIRST STAGE

Low midline incision. Explore for palpable metastases (liver); explore from above downward (nodes about the pancreas, aorta, bifurcation of the common iliac arteries). Explore the pelvis for deposits on the pelvic peritoneum. Lastly, the growth is gently palpated for mobility and resectability. It must be remembered that ulcerative and obstructive processes greatly enhance the permeability of the bowel. Havoc becomes rampant when rude manipulations are resorted to during manual palpation of the tumor and its environs. Let me quote in

[1] Am. Jour. Surg., 1934.

Rankin's own terms: "It is my considered opinion that peritonitis, which is the lethal factor in the majority of unsuccessful resections of the colon and rectum, more often follows spread of infective organisms by manipulation at exploration, or in the course of mobilization of the growth, than from failure of the suture line to hold."

Here the judgment of the surgeon and his experiences are of paramount importance. It must be remembered that neoplasms which appear nonresectable at this exploration may become vulnerable to successful surgical attack after

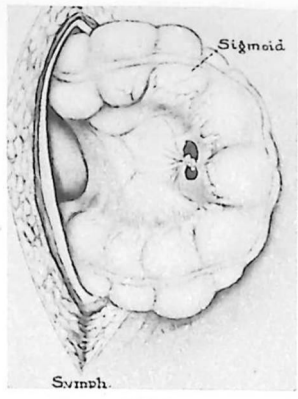


FIG. 1595

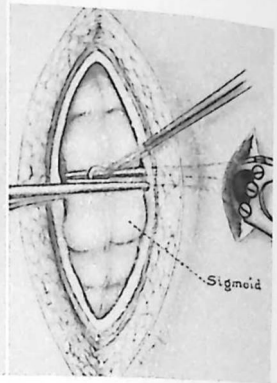


FIG. 1596

FIG. 1595. Abdominoperineal resection of rectosigmoid and rectum. First stage. Abdomen is opened through a low mid-line incision and sigmoid flexure brought out. Ligation of a single vessel in the mesentery of the sigmoid close to the bowel wall. This allows inspection under eye of the blood supply to both distal and proximal ends of bowel.

FIG. 1596. The sigmoid is divided between Payr clamps. Proximal clamp is thrust through a stab wound in left flank, and clamp on distal segment is applied in opposite direction to it. Bowel is divided with a cautery. (Courtesy Dr. Fred W. Rankin.)

decompression at the hands of the experienced surgeon. I have seen this happen. In one instance the first exploration forbode a rather hopeless aspect of the situation. At the second séance Rankin successfully resected the neoplasm in masterly fashion. If the surgeon feels that the neoplasm is resectable he should proceed to do a colostomy. The highest point of the most convenient portion of the sigmoid is chosen. Divide the mesentery close to the bowel (Fig. 1595). The division of the mesentery should be only sufficiently wide to permit the proximal end of the bowel to be brought out through a stab wound in the left groin. The distal end of the bowel is inverted, sutured and returned to the peritoneal cavity. Inspect the blood supply of the bowel. Figure 1596 shows the manner of division of the bowel between two Payr clamps, the upper one of which has been introduced through a stab opening in the flank and is placed at a

convenient point to properly take care of a colostomy bag and only of sufficient size to permit the bowel to pass through the muscles and teguments. The second clamp is shown approximating the first but in an opposite direction. Divide the bowel with thermo- or electrocautery between the two clamps. Draw the proximal end through as shown in Fig. 1597, and remove the clamp at the end of forty-eight to seventy-two hours. The bowel is not sutured to the peritoneum.

All aims should be directed toward the prevention of prolapse of the mucous membrane of the bowel, and herniation around the colostomy.

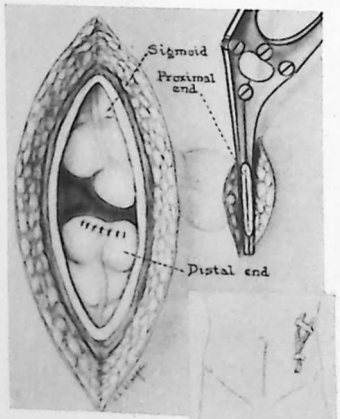


FIG. 1597. Abdominoperineal resection of rectosigmoid and rectum. First stage. Proximal end of divided bowel is drawn out through stab wound, and distal end is turned in and dropped back. Insert shows abdominal wound closed, and clamp holding proximal portion of sigmoid. Clamp is to be removed at end of forty-eight to seventy-two hours. (Courtesy Dr. Fred W. Rankin.)

SECOND STAGE

A month to six weeks should elapse between the two stages of operative procedure. Between stages efforts are directed toward rehabilitation of the patient and as far as possible reduction of the infection around the local growth.

About the tenth day after the operation, rectal irrigations are instituted and are continued daily up to the time of the second stage. In order to avoid undue pressure on the inverted stump, Rankin advises the use of a two-way rectal tube.

After inducing a transsacral anesthesia, begin the resection posteriorly, ending up with an abdominal approach incision. Posterior partial mobilization permits extensive dissection of the pelvis up to the peritoneum. Without opening the peritoneal cavity, it is possible to clean out the hollow of the sacrum and ischiorectal fossae. The levator ani muscle is sacrificed and the node-bearing

tissues around the prostate gland and seminal vesicles in the male and from the posterior vaginal wall, cervix, and broad ligaments in the female are cleared away.

The technic is as follows: the patient is placed on the operating table, face downward as is done in posterior resections of the rectum. The hips are elevated and the anus closed with a purse string suture. Encircle the anus with two incisions which are carried upward and joined a little above the sacrococcygeal articulation (Fig. 1598). By undercutting these incisions, it is possible to clear

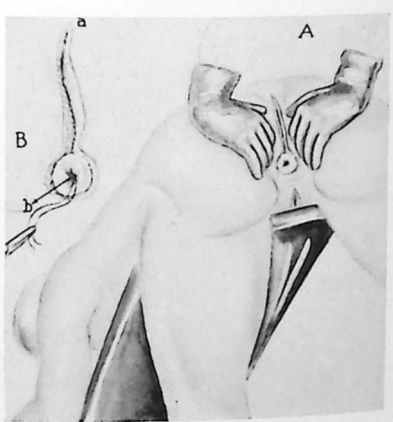


FIG. 1598. Abdominoperineal resection. (Rankin's technic.) Posterior incision for the removal of the segment of bowel left after first stage of operation. A. Position of the patient on the operating table. B. Detail of incision: a. sacrum, b. anus closed with pursestring suture.

the ischiorectal fossae from fat and node-bearing tissues as much as is necessary. The coccyx is disarticulated from the sacrum. The fascia propria opposite the sacrococcygeal articulation is divided; blunt dissection of the hollow of the sacrum follows. Lateral dissection is carried completely up to the peritoneum, which is not opened (Fig. 1599).

Encase the rectum in a rubber glove (Fig. 1600); tie it snugly around the cuff, and push it back into the hollow of the sacrum; close the posterior wound. The peritoneum has thus far not been opened.

Turn the patient and proceed to carry out the anterior part of the dissection. Reopen the low midline incision which was used originally for exploration. Enlarge it to extend from the symphysis to an inch above and to the left of the umbilicus. Do not explore. Pack the pelvis off carefully with lap sponges wrung out of salt solution; look for the turned-in end of the bowel. Incise the peritoneum over the inferior mesenteric vessels; identify both ureters. The left

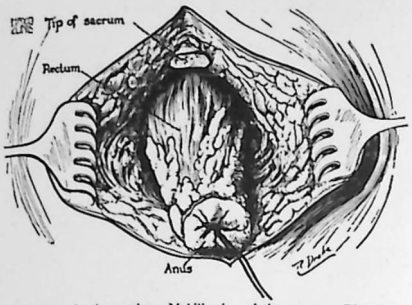


FIG. 1599. Abdominoperineal resection. Mobilization of the rectum. The tip of the sacrum has been amputated. (Rankin.)

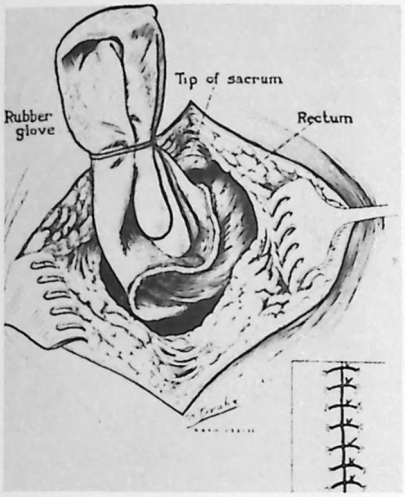


FIG. 1600. Abdominoperineal resection. Completely mobilized rectum encased in rubber glove. Insert shows wound closed after segment is dropped back into hollow of sacrum. (Rankin.)

ureter runs close to the vessels; the right one is well away from them (Fig. 1601). Doubly ligate the inferior mesenteric vessels close to their origin (Fig. 1602).

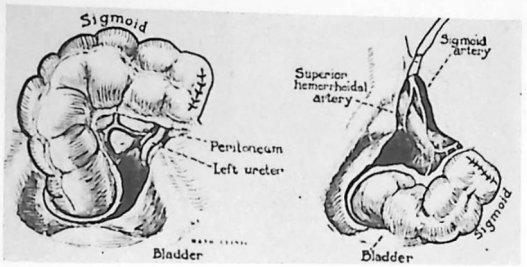


FIG. 1601 FIG. 1602

FIG. 1601. Abdominoperineal resection. Division of peritoneum for mobilization of sigmoid and exposure of left ureter. (Rankin.)

FIG. 1602. Anterior approach following posterior mobilization of rectum. Ligation of blood vessels to sigmoid and rectum. (Rankin.)

This accomplished, practically all of the blood supply is thus tied except the sacra media (a terminal branch of the aorta). Incisions in the peritoneum toward the base of the bladder on both sides separate the bladder from the rectum. By means of gauze dissection, the node-bearing tissues on both sides of the bowel are wiped mesially and the entire segment of bowel is lifted out through the abdomen. Effect peritonealization of the pelvis; this is usually accomplished with ease (Fig. 1603). The female pelvis is readily peritonealized because the broad ligaments and the uterus may be mustered into service for the closure of the defects left. Rankin points out that "In the male, with a little care in making the peritoneal flaps, one may also manufacture a new pelvic diaphragm with little effort."

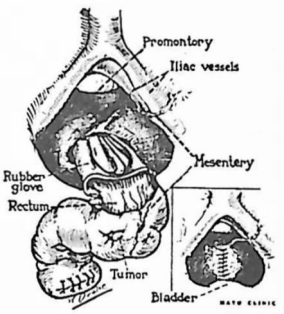


FIG. 1603. Abdominoperineal resection. Entire rectum being lifted out of hollow of sacrum. Peritonization of pelvis completed. (Rankin.)

Close the abdominal wound. Drain the pelvis with a tube which is made to enter through an opening in the posterior wound. If deemed necessary (oozing) a small gauze pack may be used in addition. I am giving Rankin's postoperative treatment verbatim.

POSTOPERATIVE TREATMENT

"Postoperatively I have made it a rule to insist upon abstinence from fluids of any kind for forty-eight to sixty hours. During this time adequate amounts of narcotics are supplied not only to keep the patient comfortable, but also to quiet any peristaltic movements. I believe that a good test of the time to begin administration of food and fluid by mouth is the passage of gas from the colostomy. Adequate hydration is accomplished by the administration of at least 3000 to 4000 cc. of fluids by hypodermoclysis or venoclysis during each twenty-four hours. We have recently routinely instituted postoperative blood transfusions in all cases of bowel or rectal resections. It apparently has a most beneficial effect upon these cases, not only in reducing immediate postoperative reaction, but in promoting a smoother and less complicated convalescence. Complications are treated in a routine manner as they arise, with the exception of one, namely parotitis, which seems to be much more likely to develop after an operation upon the large bowel and rectum than it does in the course of operation for other chronic lesions.

"In a series of cases which I studied in 1930, there was one case in each 135 operations on the colon and rectum which developed parotitis. This is nearly 17 times as many as the number encountered in general surgical cases. The use of radium applied as early as possible after the beginning of swelling appeared to be the treatment of choice, and not only did it avoid incision of the parotid gland in the majority of instances, but at the same time influenced most favorably the prognosis. The most important point in using radium is to apply it early and in doses which consist of four applications, eight hours in duration, at intervals of eight hours, of four 50 mg. tubes.

"The care of the postoperative wound following the second stage of the procedure is of importance and is best carried out by attendants who are accustomed to handling such cases. For the first 72 hours the wound is untouched except for changing the outside dressings. There will be a small amount of seroSanguineous drainage, but not a great deal. At the end of 72 hours it is desirable to remove the gauze pack and begin hot irrigations. The gauze pack is then removed after carefully soaking it with peroxide of hydrogen, and pain may be done away with by the administration of some of the barbiturates. Two irrigations a day are generally employed after removal of the pack, of either a physiologic solution of sodium chloride or a solution of potassium permanganate 1:5000. Irrigations are also supplemented by heat from an arc of carbon filament lamp which is employed twice daily. It is astounding how few of these wounds develop severe infections, and how readily most of them heal up. Usually, it is a matter of two or three months before they are entirely healed, but I have seen one instance in which the posterior wound had healed, except a small superficial granulating surface, by the end of the twenty-seventh day.

"The care of the colostomy is an important consideration and is handicapped rather than advantaged by the use of any complicated or cumbersome bag or attachment to receive the fecal material from the stoma. Since abandoning all such apparatus and relying upon a simple elastic belt which is much like an ordinary abdominal supporter, and in which is placed a removable rubber mat

about 8 inches square, I have found that these patients are much more comfortable. They cleanse and irrigate the bowel once a day, place a small amount of cotton or tissue paper over the stoma, and over this apply the simple belt. So long as the stools are formed there is scant likelihood of unpleasant accidents except for the escape of gases. When the bowels are loose, any colostomy is intolerable and no type of apparatus is satisfactory. The mental attitude of the patient toward the care of his colostomy, and attention to his diet, are important factors in his comfort.

"The ultimate end-results following successful extirpation of malignancies of the rectum by radical means have been proved by statistical studies of a long series of cases by many surgeons. Whether the operative type of procedure can be accomplished in one stage or two, I think, depends upon a great many factors, but the problem of greatest importance is to adjust operative technic to the whole group of cases in such a manner that each individual will receive the best chance of longevity by utilizing the maneuver most suitable for the individual case. I believe that procedures which are compatible with mortality rate of around 10 per cent should be instituted in every case as judgment indicates. That there should now be a marked lowering in the operability curve seems most essential. The very fact that 46 per cent of the removed specimens show glandular involvement seems adequate reason for applying a maneuver to cancers of the rectum and rectosigmoid which will extend the operative field beyond the local growth and the first group of glands in immediate juxtaposition to it."

Rankin's Obstructive Resection Operation of the Colon

Resection and obstruction, or "obstructive resection" as a type of technical maneuver for resection of the colon was first performed by Fred W. Rankin in 1925, and subsequently reported with a review of 31 cases done by this method with one death, in 1929.

Rankin's operation combines the essential features of exteriorization with a radical removal of the node-bearing tissues in the immediate vicinity of the growth. It also avoids the direct transplantation of malignant cells into the cut surfaces of the wound itself, which occurs in about 12 per cent of cases operated upon by the old exteriorization method. It avoids the necrosis which follows the exteriorization of bowel loops, in which the mesenteric blood supply was ligated and which necessitated removal of the loop of bowel containing the tumor within 48 hours of the primary stage of the operation, with the frequent result of contamination.

The obstructive operation is indicated in the presence of a growth in a mobile segment of bowel beyond the hepatic flexure. Rankin deprecates its use in the right colon and does not employ it in that segment at all. One important factor which must never be overlooked in employing the obstructive resection is the presence of obstruction. All obstruction should be vigorously gotten rid of by preliminary preoperative measures, but if there is a small amount of obstruction present as evidenced by slight dilatation and particularly edema and infiltration in the region of the growth, Rankin vigorously urges the use of a complementary enterostomy if the operation is undertaken.

The contra-indications to the operation are: first, its employment in the presence of great infection which frequently occurs around adherent growths;

second, obstruction even of a low grade; and third, its application to segments of the colon with a short mesentery, in obese patients with thick abdominal walls.

FIG. 1604

FIG. 1605

FIG. 1604. Rankin's obstructive-resection operation (in two stages). First stage—abdominal incision exposing carcinoma of the sigmoid. (Rankin.)

FIG. 1605. Beginning mobilization of neoplasm. Incision in the lateral parietal peritoneum which frees the growth and allows its rotation mesially. There are no blood vessels in this parietal layer. (Rankin.)

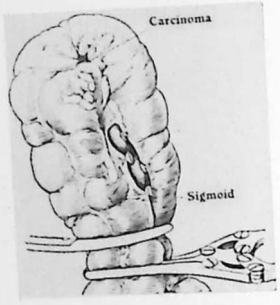


FIG. 1606

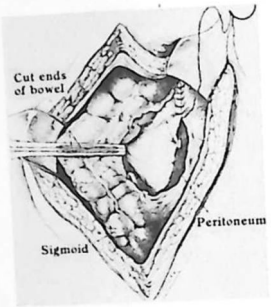


FIG. 1607

FIG. 1606. Mobilization completed. The mesenteric blood vessels are ligated and a wide expanse of mesentery is sacrificed. The growth is caught between clamps to be removed with cautery. (Rankin.)

FIG. 1607. The clamp is in situ. The growth has been removed and peritonealization of the lateral surfaces is begun. (Rankin.)

FIRST STAGE

Step 1. Incision over the tumor and abdominal exploration (Fig. 1604).

Step 2. Mobilization of the tumor (Fig. 1605).

Step 3. Ligation of the blood supply and dissection of the lymph nodes.

Step 4. Resection of the tumor with the cautery, between clamps (Fig. 1606).

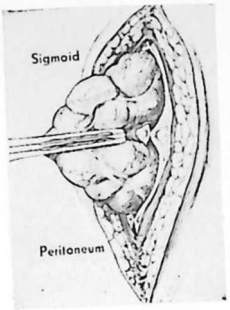


FIG. 1608

FIG. 1609

FIG. 1608. The peritoneum is brought under the loop and is sutured snugly around on all sides. This step holds serous surface to serous surface, permits early healing and does away with the necessity of sutures in the wall of the bowel.

FIG. 1609. Second stage. After the clamp has been removed and the wound is healed, the spur is cut out of the two "gun barrels" by the application of clamps which necrose through it slowly. This step is similar to that of the Bloch-Paul-Mikulicz operation. Courtesy of Dr. Fred W. Rankin.

Step 5. Peritonealization and closure of the rent in the mesentery (Figs. 1607-1608).

Step 6. Closure of the abdominal wound around the tumor.

SECOND STAGE

Step 1. Cutting of the spur (Fig. 1609).

Step 2. Closure of the colostomy (Fig. 1610).

Rankin uses a 3-bladed clamp for anastomosing the segments of bowel. The blood supply to the loop is ascertained under direct vision. After the first clamps are on place another clamp anterior to them and divide the segments of bowel between these clamps with the thermocautery. The opening in the mesentery is closed. The raw surfaces on the sides of the resected bowel can be peritonealized with facility. Bring the clamp out of the wound in a position where least tension results on the structures. Close the wound snugly close to the clamp and pull a tongue of peritoneum in between the two limbs of the bowel under the clamp; this procedure brings the peritoneum snugly about

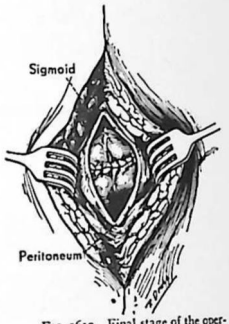


FIG. 1610. Final stage of the operation showing closure of the colostomy opening. In more than half of the cases this step is unnecessary and spontaneous healing takes place. (Rankin.)

the bowel and renders the introduction of sutures unnecessary except where the loop has been short and could not readily be delivered from the abdomen. Rankin wraps a piece of iodoform gauze around the clamp in the peritoneal cavity and then closes the peritoneum snugly around it in order to avoid contamination, in case of leakage.

After completing the operation, the wound having been closed tightly around the clamp, the bowel is left completely obstructed for from 60 to 72 hours. Rankin has never experienced any untoward results from this one step and neither was he ever compelled to remove the clamp sooner than 60 hours following the operation. No food is given by mouth and nausea or vomiting does not occur. Hypodermoclysis and intravenous administration of glucose and salt solution are resorted to.

At the time thought proper, the proximal blade of the clamp is opened, the distal clamp is left closed and the clamp is not removed. This is desirable for agglutination has already taken place, the bowel has become united to the wound and if gaseous distention is sufficiently pronounced it will "blow out" the proximal end of the loop subjected to the pressure of the closed clamp and the bowel will relieve itself spontaneously. Rankin prefers this to opening the colon. The clamp is permitted to remain on the distal loop until it drops off (usually about the seventh day).

The further steps of the operation are those of the Bloch-Paul-Mikulicz procedure (p. 1416; removal of the spur with the enterotome or clamps). At least a month should elapse before the final step (closure of the colostomy opening) is undertaken. If the spur is removed properly, the opening will close spontaneously and the third stage of the operation will not be necessary.

In all nonobstructing mobilizable tumors of the bowel this procedure is the method of choice. With this operation, removal of the affected node-bearing area is made possible, a condition not obtainable in the classical Bloch-Paul-Mikulicz procedure which permits only a local removal of the growth.

While in selected cases it would seem desirable to do an end-to-end anastomosis, with an enterostomy for decompression, at once, experience has shown that the mortality would be increased by so doing; or as Rankin puts it: "It is hoped that in the future, with adequate co-operative management and proper selection of cases, aseptic anastomosis in one stage, with or without proximal decompression, will become the operation of choice in a high percentage of cases of malignancy of the colon." For the present it appears certain that the graded procedure gives satisfactory results with lower mortality.

In a recent communication Rankin writes me: "I have frequently put a de Pezzer catheter into the cecum at the same time as I was doing an obstructive resection in spite of the fact that the large bowel was effectually decompressed. This is a very useful thing, especially in debilitated people and permits feeding the patient sooner. It is a good step, but I do not believe in using it routinely."

Rankin's Technic of Total Colectomy

According to Fred W. Rankin[1] two procedures are available in colectomy, viz.:

(A) Three-stage operation consisting of

[1] Annals of Surgery, 1931.

1. Ileostomy.
2. Colectomy including the colon down to the rectosigmoid junction and
3. Combined abdominoperineal resection of the rectum.

(B) Ileosigmoidostomy followed by colectomy. If this method be adopted, the rectum and sigmoid left behind carry polyps which require electrosurgical or other means for their destruction. To counterbalance this, it has the advantage of (1) retaining the sphincteric apparatus and (2) avoiding the necessity of forming an artificial anus.

Nevertheless, the removal of the rectum at a subsequent stage may become a necessity to get rid of the polyps in the terminal segment of the bowel. And while one vacillates between the choice of the two operations Rankin reminds us that "after ileostomy and colectomy, if it is possible to get rid of the rectal polyps, a feasible step is to implant the ileum into the top of the rectum as a subsequent maneuver."

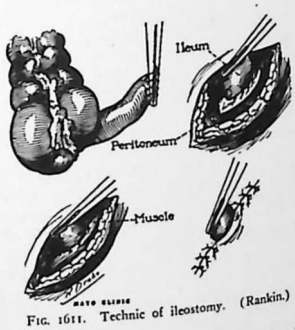


FIG. 1611. Technic of ileostomy. (Rankin.)

From a physiologic point of view we must remember that ileostomy of itself is a serious undertaking—disturbed water balance follows it. As is known, the right portion of the colon absorbs most of the fluids taken. Ileostomy deprives the colon of its accustomed physiologic function and the loss of fluid is so precipitate that the patient loses weight and suffers from dehydration until the physiologic equilibrium is reestablished. When the patient begins to travel upgrade again the ileum gradually compensates for the right colon and assumes its function. Finally the stools become semisolid or formed. A colleague operated on by Rankin in the manner outlined observed the phenomenal physiologic readjustment described. He looks after a rather strenuous practice despite the loss of his colon and his ulcerations which made life a burden to him.

FIRST STAGE

Ileostomy (Fig. 1611). This is of the single-barreled type. No double-barreled (loop) ileostomy is used. Rankin divides the ileum close to the ileocecal valve, turns the cecal end in and brings the proximal end out through a McBurney incision, leaving a clamp on it. The ileum is sutured very closely to the peritoneum. Close the wound snugly around it. Leave the bowel obstructed for about forty-eight hours; then remove the clamp. "As one of the steps," Rankin says, "I have shut off the space between the mesentery of the terminal portion of the ileum and the lateral parietal peritoneum, just as one would do in performing colostomy involving the sigmoid. This prevents obstruction by loops of small bowel slipping around the structures formed at the ileostomy and becoming adherent since the ileostomy is formed through a small McBurney

incision, in short, exploration, and the wound heals tight; a single-barreled stoma results, which is not difficult to care for" (Fig. 1612).

SECOND STAGE

Three months are permitted to elapse before the second stage in the operation is undertaken. Physiologic readjustment takes place during that period. The patient is brought to the optimum condition for the strenuous ordeal of colectomy. The colon is removed through a left rectus incision. The dissection begins at the cecum on the right side of the colon. Mobilize the bowel by dividing the outer leaf of the peritoneum (Fig. 1613). Ligate and divide the blood vessels close to the bowel. Leave sufficient peritoneum to cover the resulting raw surfaces. Avoid injury to the ureter and retroperitoneal portion of the duodenum. Having mobilized the right section of the colon and ligated the vessels securely, the raw surfaces of the remaining omentum (Fig. 1614) are

Fig. 1612. Ileostomy. (Courtesy of Dr. Fred W. Rankin.)

Fig. 1613

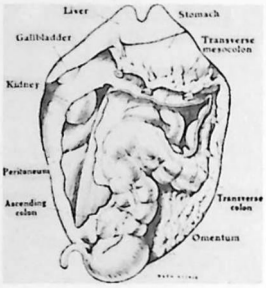


Fig. 1614

Fig. 1613. Total colectomy. Beginning mobilization of cecum and right half of colon. Incision is made through the parietal peritoneal attachment of the bowel and the dissection is made from without inward. (Rankin.)
Fig. 1614. Further mobilization of the right portion of the colon and of the transverse colon. The omentum has been divided. (Rankin.)

carefully sutured. Mobilize the transverse colon up to the splenic flexure; mobilization of the latter is the most difficult step of the operation. Its position

is usually higher and fixed; these drawbacks are overcome by dividing the splenocolic ligament; clamp, ligate and divide the blood vessels. Proceed with the mobilization of the descending colon and sigmoid flexure (Fig. 1615).

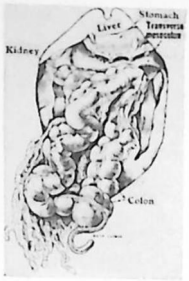


Fig. 1615

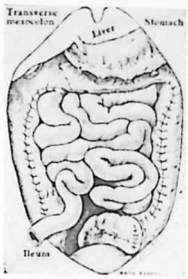


Fig. 1616

Fig. 1615. Mobilization of the colon has been carried down to the junction of the descending colon with the sigmoid. (Rankin.)
Fig. 1616. Total colectomy completed. The raw surfaces left by dissection are closed with a running suture. A new pelvic floor has been made out of peritoneum. (Rankin.)

As on the right side, the left parietal leaf of peritoneum is divided, the colon and sigmoid loosened, the blood vessels clamped, ligated and divided and the raw surfaces peritonealized. Rankin thinks it wiser to divide the bowel at about the middle of the sigmoid or at the juncture of the lower and middle thirds of the sigmoid in order to insure adequate vascularization of the portion of the bowel left behind (Fig. 1616).

In operating for polypoidosis, a point with good blood supply is selected. The bowel is divided with the electrocautery between two clamps and the lower end is turned in. In ulcerative colitis it is impossible to turn in the lower end with a suture. Rankin divides the bowel holding the lower end very lightly and then sutures over and over, without attempting to turn it in, wrapping it in iodoform gauze and bringing it out through the lower end of the wound. Drainage is thus instituted. Peritonitis is rare except in the congenital type of polypoidosis. Total colectomy is completed as shown in Fig. 1616.

THIRD STAGE

Usually two or three months are permitted to elapse before this stage of the operation is undertaken. In complicated cases this stage is the most difficult one to perform and is performed according to Rankin's abdominoperineal resection of the rectum (which see).

Aseptic End-to-Side Ileocolostomy: Clamp Method

RANKIN'S TECHNIC

According to Rankin, end-to-side anastomosis between the terminal ileum and the transverse colon is decidedly the most satisfactory method in cases where it is desired to resect the right half of the colon either immediately or subsequently. The greatest advantage of end-to-side anastomosis is the ability thereby to sidetrack the fecal current from passing over an ulcerating surface. Rankin and A. Stephens Graham[1] believe that "the necessity of a graded operation is largely dependent upon the amount of infection around the primary growth which not only renders immediate resection hazardous but gravely undermines the individual's powers of resistance. Reduction of this infection and rehabilitation are two steps which are not to be gainsaid in a successful attack on right colonic lesions. Moreover, the end-to-side anastomosis more clearly approaches the natural anatomic relationship of ileum to cecum." Rankin and Graham describe the operation as follows:

"If one can determine in advance that the contemplated resection will not be attempted at the initial operation, there is an advantage in making a left rectus incision which centers on the umbilicus. This permits subsequent entrance into the abdominal cavity through a right rectus incision, unhampered by possible infection of the primary wound. Otherwise a right rectus incision is made in the first instance. The liver and aortic glands are first palpated to determine the presence or absence of gross metastatic implants, and finally the growth and the lymphatics adjacent to the containing portion of the bowel are visualized when possible, then palpated. The latter maneuver should be conducted with considerable circumspection and great gentleness. Timidity here is far more a virtue than is boldness since one may very easily and unsuspectingly insert a finger into an abscess should it be present. Moreover, the spread of infection from the primary growth throughout the peritoneal cavity by the examining hand because of the number and virulence of the organisms in and about the growth is an easily demonstrated danger.

"The terminal portion of the ileum about ten to fifteen centimeters from the ileocecal valve is brought into the wound. Ordinarily it will be found necessary to tie but a few of the terminal branches of the mesenteric vessels just before they enter the intestinal wall. By avoiding the larger vascular branches and, therefore, disturbance to the circulation of the bowel, the technic is simplified and time is saved in that the necessity for removing a segment of bowel is eliminated. In order to secure as large an opening in the intestine as is possible the special clamp is applied to the ileum at about an angle of 45° (Fig. 1617). A Payr, or any other suitable clamp, is applied distal to the first and as close to it as is possible and the bowel between them is divided with a cautery; the end toward the cecum is invaginated and dropped back into the abdomen, to be removed with the colon at subsequent resection. A point is now selected on the anterior surface of the transverse colon, ordinarily at about the juncture of the proximal and middle thirds unless the growth is at the hepatic flexure, in which case a

[1] Annals of Surgery, 1934.

more distal point is chosen (Fig. 1618). Allis forceps then are applied to the colon sufficiently far apart to assure an opening comparable in size to the diameter of the ileum and with these forceps elevated the selected segment of colon is fixed by the free blade of the special clamp, one blade of which already contains

Fig. 1617

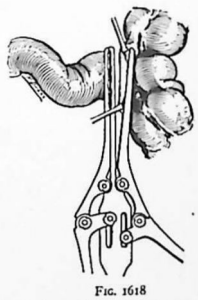


Fig. 1618

Fig. 1617. Application of clamp to ileum. The blood supply in the mesentery has been tied off and the special clamp is applied at an angle so as to obtain a wider lumen for the anastomosis. The bowel is divided with cautery. (Rankin.)
Fig. 1618. The clamp is shown being applied to a point selected on the transverse colon for the colonic end of the anastomosis. (Rankin.)

the proximal portion of ileum. The elliptical piece of colon which protrudes above the closed blade of the clamp is removed with the cautery, leaving the cauterized edges of the two pieces of bowel occupying positions exactly opposite each other (Fig. 1619).

"The clamp and the mobility of the bowel permit easy manipulation in establishing the anastomosis. The clamp is now turned completely over making the handle point away from the operator so as to bring the posterior side of the bowel into view (Fig. 1620). This permits accurate approximation of the peritoneal coats of the bowel on the undersurface of the anastomosis, because here the two arms of the bowel are in juxtaposition. A continuous suture (our preference is chromic catgut to which a curved needle is welded) is employed and it is tied at one end and locked at the other; the two ends are left long in order that the ends of the anterior suture may be tied to them after removal of the clamp. The clamp is now turned back to its original position and starting with a new suture (this should be an invariable rule) the anterior line of suture is applied by means of a continuous Cushing stitch which passes over the upper surface of the clamp; ties are not made at either end at this stage since to do so would defeat the purpose of this inverting type of suture (Fig. 1621). Preparations are now made for removing the clamp. An assistant grasps one of the long ends of the posterior suture in order to steady the bowel, and as the operator withdraws the clamp, the blades of which have been opened slightly, the assistant

draws his end of the anterior suture taut, thus commencing the process of inversion. When the clamp has been completely withdrawn, the operator draws his end of the anterior suture taut and in this manner completes the inversion.

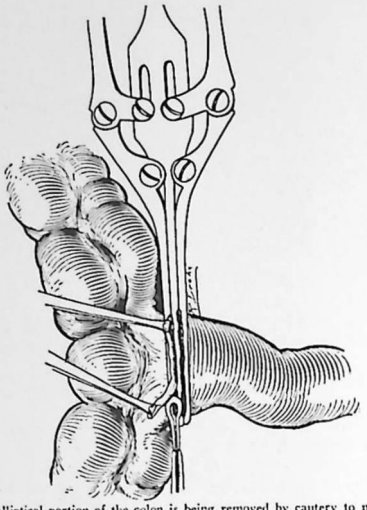


FIG. 1619. An elliptical portion of the colon is being removed by cautery to make an opening in its lumen; the small bowel is shown approximated at this point. (Rankin.)

The agglutination of the two ends of the bowel under the steady pressure keeps it intact as this maneuver is carried out. Leakage at this stage has not occurred in any of our cases. The two ends of the anterior suture are now tied with the corresponding end of the posterior suture. Another layer of sutures, either continuous or interrupted, is inserted around the entire anastomosis and tags of fat and omentum are attached at both ends as a precaution against leakage. At this stage it is well to force the wall of the colon ahead of the fingers until the fingers are felt to have passed through the anastomosis, thus to break out the agglutination which forms a diaphragm (Fig. 1622).

"Although we did not establish an enterostomy proximal to the anastomosis in any of our 60 cases, we are cognizant of its potential value under certain circumstances and believe that thorough consideration should be given to its employment in every case. Pringle believes that death in acute septic peritonitis is due to intestinal toxemia secondary to paresis of the inflamed intestine rather

than to absorption of the products of the suppurative inflammation of the peritoneum. Handley and others concur in this opinion. If this is true, then en-

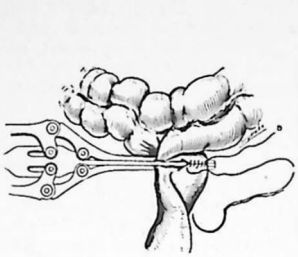


FIG. 1620

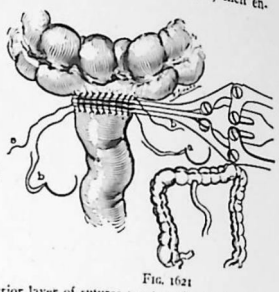


FIG. 1621

FIG. 1620. Ileocolostomy over a clamp. Posterior layer of sutures anastomosing the ileum and transverse colon. Clamp is turned over. (Rankin.)

FIG. 1621. Ileocolostomy over a clamp. Anterior layer of sutures applied. a. Posterior suture; b. anterior suture. Insert shows the operation completed. (Rankin.)

terostomy established at the time of operation should prove a sound precautionary measure as regards the probable development of peritonitis. Moreover, enterostomy possesses the very desirable feature of lessening intra-intestinal pressure which might produce undue tension on the line of suture.

"The abdominal wound is closed in the usual manner and without drainage. We consider it important in these cases always to insert a rectal spool or rectal tube, which is left in place, except for cleansing, during the first seventy-two hours in order to prevent an increase in the intracolonic pressure.

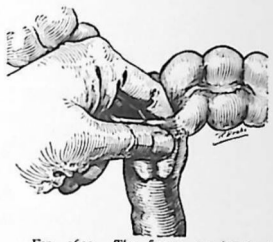


FIG. 1622. The fingers are introduced through the anastomosis to break up the agglutination which forms a diaphragm. (Rankin)

"The details of the preoperative and postoperative care of such cases have recently been outlined by Rankin, Bargen and Buie and unquestionably are highly important to comfortable convalescence.

"Summary. (1) In cases of carcinoma of the right half of the colon, it is our feeling that aseptic ileocolostomy between the terminal ileum and the transverse colon followed by resection of the right segment at the same stage or a subsequent one is the procedure of choice.

"(2) The employment of end-to-side anastomosis rather than lateral anastomosis is urged in this particular instance because of the very desirable feature

which the end-to-side method has over the lateral in sidetracking the fecal current and allowing as much reduction of local inflammatory reaction around the growth as is possible. Moreover, the end-to-side anastomosis more nearly approaches the natural anatomical relationship of ileum to cecum."

Colectomy

The removal of segments of the large bowel presents difficulties not encountered in dealing with resections of the small intestine. Anatomic peculiarities with reference to fixation, location, and blood- and lymph-vessel distribution of the particular segment of bowel coming under consideration are all factors playing an important rôle in resections of this part of the intestinal tract.

Fixation, rendering the operation difficult, may be overcome by dividing the parietal peritoneum at the outer border of the bowel thus rendering a fixed part of the intestine mobile.

Devine's Methods in Surgery of the Colon

Sir Hugh B. Devine points out* that the operative mortality rate for carcinoma of the colon is 15 to 30 per cent according to the figures.

	OPERATIVE MORTALITY PER CENT
Wilkie	15
Statistics taken from some hospital records (Australia):	
Distal colon carcinoma	31
Proximal colon carcinoma	41
Rankin (Mayo Clinic):	
Resections for growths in left side of colon, with clamp and enterotome	9.6
Watson	17.7
Cheever	17.6
Saltzstein and Sandweiss:	
Distal colon carcinoma	57
Proximal colon carcinoma	39

Recent advances in the treatment of carcinoma of the colon with the aim of lowering this rate are:

1. Early diagnosis.
2. Increasing patient's general resistance.
3. Preoperative drainage of colonic contents.
4. Removal of distal colon carcinoma by modification by Bloch-Paul's method.
5. Devine's method of "defunctioning" of the colon.
6. Devine's "Enterotome method" for bad cases of proximal colon carcinoma.

The choice of anesthesia contributes greatly to the safety of operative procedures on the colon. Ether anesthesia is contra-indicated in many of these cases. Spinal anesthesia cramps the freedom of the surgeon to operate quickly and the healing of wounds is not so satisfactory. The most satisfactory routine of anesthetic for these cases is nitrous oxide and oxygen, with addition of a little ether, where relaxation is needed.

Preoperative drainage of the colon in treatment of carcinoma of the distal colon is done with a view of removing the evil effects of intestinal obstruction and

* Med. Press and Circ., Aug. 7, 1935, Vol. CXC, No. 5022.

of bringing the contents of the colon and the condition of its walls back to normal.

The method of colonic drainage is important. A fistulous opening at a distance from the obstruction will not drain the colon completely; and an opening close to the growth makes the resection difficult and fecal discharge soils the operative area.

An anus with a spur drains the bowel satisfactorily—but in a malignant sigmoid, there is not sufficient bowel available for its construction.

The difficulties and dangers of using a sutured anastomosis in the distal colon are:

1. Soiling of the peritoneum—with occurrence of peritonitis.
2. Poor vascularity for proper repair.
3. Peritoneal union of colon—may leak.
4. High mortality rate.

Modification of Bloch-Paul's method is to convert a three-stage operation into a one-stage operation.

Modification:

Step 1. After the resection of the segment of the bowel containing the growth, the cut ends of the proximal and distal segments of the colon are allowed to project a short distance above the abdominal surface.

Step 2. An enterotome shaped to encourage peritoneal adhesion along the line of the anastomotic opening about to be produced, is at once applied, and the divided ends, after a cuff of the peritoneum and muscular coat of the bowel is turned back, are closed down over the enterotome, except for the necessary drainage.

Note. This type of operation requires sufficient mobile bowel. It is applicable only to growths in the middle section of the sigmoid or transverse colon.

Devine's Method of Colonic Resection

(Study Fig. 1581 A (p. 1410) in conjunction with text)

Indications: Operations in the distal colon where Bloch-Paul's principle is inapplicable, such as the upper or lower parts of the sigmoid, the rectosigmoid junction, the splenic flexure, or the descending colon.

Rationale: This method is based on the principle that if a segment of bowel be isolated and thus deprived of its function, its bacterial count will slowly disappear. Fecal content is absent. The walls become thicker and more vascular, and the segment is free from peristaltic movements.

Stage I

"Defunctioning" the Distal Colon: Disconnect the proximal from the distal colon by an artificial anus either at the middle of the transverse colon or the hepatic flexure.

Step 1. Make an incision two and a half inches long in the upper right rectus muscle. Explore thoroughly.

Step 2. Bring out the proximal part of the transverse colon. Pass a rubber tube through the apex of the loop; connect the limbs with a running suture making a spur four or five inches long. If the transverse colon is too short, suture its proximal part to the ascending colon (Fig. 1623 a).

Step 3. Suture the parietal peritoneum around the neck of the loop (Fig. 1623 b).

Step 4. Make button-hole openings, through skin and fat only, on each side of the incision. Through these grasp with Kocher clamps the loop of bowel and divide it with a diatherm knife (Fig. 1623 b).

Step 5. Pull the bowel ends through the small incisions and suture them to the skin edges. Close the exploratory incision (Fig. 1623 c, d).

Step 6. Remove the proximal Kocher clamp in twelve hours; the distal clamp is left on several days.

Preparation of the excluded distal colon: Lavage the distal colon either by rectum or the abdominal fistula with antiseptic solution, or instill cod liver oil (Fig. 1623 e). A period of about three weeks is necessary for the colon to be reasonably clean, before resection can be carried out.

Stage II

A month later, perform an anastomosis in the "defunctioned" distal colon (rectosigmoid tumors) by resecting the tumor and suturing the divided end of the sigmoid to the rectum, or, do a telescopic anastomosis.

Resect the tumor. Suture the severed rectum. Close the peritoneum over it. Implant the divided end of sigmoid in the wound.

Six months later.

Step 1. Reopen the abdomen by a median subumbilical incision.

Step 2. Make an incision around the artificial anus so that a substantial ring of skin is left attached to the mucous membrane. The sigmoid anus is disconnected from the abdominal wall, and the descending colon is mobilized.

Step 3. Suture a rubber tube to the ring of skin which has been left attached to the detached end of the colon.

Step 4. Introduce a sponge holder with a swab on the end through the anus into the rectum and have an assistant press it against the upper blind end. Make an incision from above of appropriate size through the rectal wall on to the swab. The forceps is now made to grip the end of the tube and is drawn, with the attached bowel, through into the rectum.

Step 5. The sphincter is divided and the tube so fixed as to keep the parts in a fixed position. By the time the rectosigmoid junction is complete the sphincter has healed. In order to insure the patient continence resort to

Stage III

Closure of the Disconnecting Anus

Step 1. Crush the spur for 48 hours with the Devine enterotome. Five or six days later inject some novocaine solution around the bowel openings. (Fig. 1623 f).

Step 2. Divide the segment of skin between the two openings of the bowel, which should be mobilized, and close by a few sutures.

Closure is usually prompt.

Operation for Proximal Colon Carcinoma

Ileocolectomy by the Devine Enterotome Method

Step 1. Make a midline incision. Mobilize the terminal ileum, the cecum, the ascending colon and the hepatic flexure, and bring these to the midline.

Step 2. Divide the vascular connections of the mesenteric leaf.

Step 3. Make a long spur, by suturing for four inches, a segment of the ileum to the transverse colon.

Step 4. Marsupialize the terminal ileum, the proximal colon and the amputated mesenteric leaf.

Step 5. Close the peritoneum and suture it carefully around the limbs of the ileum and colon as they emerge from the abdominal wall.

Step 6. Close the layers of the abdominal wall.

Step 7. Now remove the carcinoma leaving the ends of the ileum and of the colon protruding for about an inch beyond the abdominal wall.

Step 8. Apply a Devine enterotome to the spur between the ileum and the transverse colon. Close the cut end of the colon by interrupted sutures around the enterotome.

Step 9. Remove the enterotome in forty-eight hours—leaving a small colonic opening, as well as a small ileal opening which acts as a safety valve to drain the obstructed bowel.

SHORT-CIRCUITING OPERATIONS

INTESTINAL EXCLUSION

Von Hacker set down clinical indications for the performance of intestinal exclusion in 1888 while Salzer popularized the method in 1891 and 1892. The distinction of performing the first short-circuiting operation on man belongs to Trendelenburg. This intestinal exclusion was done in 1885.

Indications for Exclusion

1. Intestinal ulcerations causing fistulae.
2. Intestinovaginal fistula following hysterectomy.
3. Chronic intussusception.
4. Certain forms of colitis (ileosigmoidostomy).
5. Carcinoma of the cecum and ascending colon when resection is contra-indicated.

Forms of Intestinal Exclusion

Partial exclusion.

Entero-anastomosis (Maisonneuve's operation).

Entero-anastomosis with constriction by suture of the part distal to the upper opening.

Complete exclusion.

Unilateral Exclusion (Nicholas Senn's Operation). The bowel is divided and the proximal end is anastomosed with the side of the distal end; or the distal end may be closed or left open. Only healthy sections of bowel should be anastomosed. Never suture distended or dilated intestine.

Unilateral exclusion with terminolateral (ileotransversostomy) anastomosis with or without cecostomy may be resorted to.

An ileosigmoidostomy may be done with implantation of the distal end of the ileum into the abdominal wall.

In unilateral exclusion, there remains more or less tendency for intestinal contents or gas to enter the excluded segment via the established anastomosis.

Bilateral exclusion with closure of both ends of the excluded segment of

bowel is of historical interest only. It was advocated by Obalinsky and justly condemned by Moynihan.

Perforation of the segment of bowel occluded at both ends and remaining in the abdomen may take place as late as 12½ years after operation, as in the case of Wiesinger. Besides, the collection of intestinal secretions and of products of ulceration of the wall of the excluded segment in a sac, which the excluded bowel represents, may give rise to severe auto-intoxications.

A number of methods have been devised to obviate these drawbacks, viz.:

1. **Monprofit's Method.** This consists of
   a. performing a unilateral exclusion with
   b. implantation of the proximal end of the excluded segment into the colon beyond the point of the established anastomosis.
2. Bringing up the distal end of the excluded segment into the abdominal wall.
3. As in 2, with the addition of a cecostomy.
4. **Hochenegg's Method.** In this operation the two open ends of the excluded segment are brought to the surface of the abdominal wall and sutured there.
5. **Salzer's Operation.** The bowel is divided in two places. Do an entero-anastomosis. A segment of bowel is left detached. One opening is closed, the other is brought to the surface to form a fistula, or, both ends are attached to the skin.

INOPERABLE TUMORS

In this class of cases an exclusion operation (entero-anastomosis) or an anus praeternaturalis is at the surgeon's command to afford the patient, if not lasting, at least, temporary relief for a greater or lesser period of time. The former is preferable, more comfortable to the patient and should be practiced when no contra-indications exist.

OPERATIVE PROCEDURES IN ACUTE INTESTINAL OBSTRUCTION

The first important factor to remember is: as soon as obstruction is diagnosed the patient should be operated on without delay (Figs. 1624-1625-1626). Procrastination often spells death.

Second: Whenever possible spinal anesthesia is the ideal form of anesthesia. I do not use subarachnoid block in cases where the systolic pressure is below 100. Spinal anesthesia will often permit a diagnosis between spastic and mechanical ileus.

The incision. If a definite diagnosis is made the incision is placed over the seat of the trouble; if in doubt, an ample median or paramedian exposure is counseled. The seat of the obstruction is ascertained by either of the following procedures:

1. Palpation and inspection.
2. Finding the junction of the collapsed and distended segments of bowel.
3. Eventration.

If the large bowel is distended the seat of the obstruction is in the large intestine, if collapsed, in the small bowel.

Fluoroscopy is of inestimable value in making a diagnosis. If the small

bowel is markedly distended and interferes with the operative manipulations, an enterostomy should be promptly performed (see above).

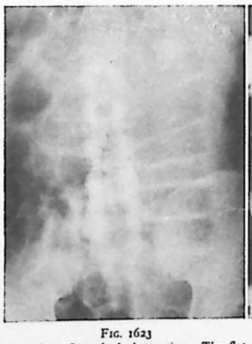


FIG. 1623

FIG. 1624

FIG. 1623. Intestinal obstruction. The flat plate of the abdomen showing gas filled bowel with "paralleling" or "step-ladder" appearance especially well seen on the left side. No barium was given. (Roentgenologic Service, Cook County Hospital.)

FIG. 1624. Intestinal obstruction. In cases where barium has been given the paralleling is better outlined. Note "herring bone" appearance of the ileum. (Roentgenologic Service, Cook County Hospital.)

FIG. 1625. Intestinal obstruction. Depicting "herring bone" appearance of the jejunum.

FIG. 1626. Large bowel pattern in carcinoma of the rectosigmoid.

In order to avoid intestinal contents entering the stomach during exploration von Schmieden recommends to apply a Doyen intestinal clamp to a loop of

jejunum high up. This effectually prevents regurgitation of intestinal contents into the stomach. This accomplished, systematic exploration of the large bowel may proceed.

If the trouble be in the small intestine the sites of predilection (hernial apertures, navel) are at once sought. A collapsed segment of bowel is sought and

Fig. 1627

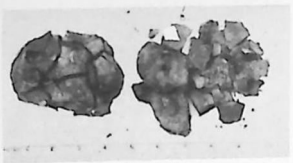


Fig. 1628

Fig. 1627. Intestinal obstruction the result of impaction of large gallstone. Female patient, aged 76 years. Stone removed by enterotomy. (Dr. Phil Thorek.)
Fig. 1628. Gallstone causing intestinal obstruction.

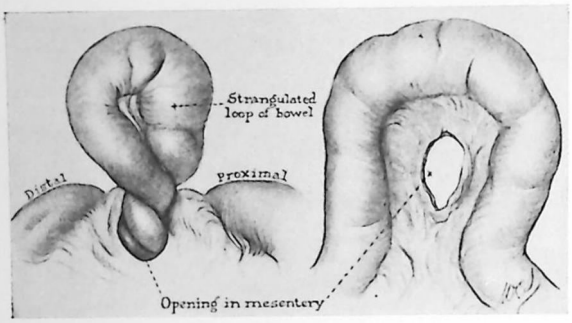


Fig. 1629 Fig. 1630

Fig. 1629. Openings in the mesentery may permit a loop of bowel to slip through and become strangulated and twisted. The mechanism is shown in this illustration.
Fig. 1630. The loop shown in Fig. 1629 has been reduced, detorsion has been done and the opening in the mesentery is ready to be closed.

followed to the point of obstruction. If this fails, eventration will have to be resorted to.

Obstructions may also be occasioned by:

1. Foreign bodies (gallstones [Figs. 1627-1628], fecal impactions, worms, etc.)
2. Mesenteric thrombosis.

3. Volvulus.
4. Intussusception.
5. Strangulation by bands of adhesions or Meckel's diverticulum.
6. Internal hernia.
7. Holes in the mesentery, etc. (Figs. 1629-1630).
8. Compression from without.
9. Torsion of the omentum.
10. Benign tumors of the intestinal wall.

Foreign bodies are removed by enterotomy (see p. 1446).
Early operation is imperative.

MESENTERIC THROMBOSIS AND EMBOLISM

This entity was first described by Virchow in 1847. Only in exceptional instances does collateral circulation take place in these cases, Chiene (1878). The prognosis is grave. Prompt interference is essential.

When the transverse colon is involved by reason of blockage of the middle colic artery the treatment is obvious: Resection of the affected segment with axial anastomosis should at once be done, supplemented by a cecostomy.

If the Right Half of the Colon is Occluded: Resect the cecum and ascending colon. Ileocolostomy. If the left half of colon, resection or Bloch-Paul's operation should be done. If the small intestine is affected, it, and the mesentery carrying the blocked and affected segment of bowel should be removed. Often it is imperative after resection has been performed to bring both limbs of the divided bowel out of the abdomen; they are placed side by side and their peritoneal surfaces sutured to the abdominal wound. It often is advantageous to insert a Paul's tube into each opening. Thorough drainage is essential. After some time, depending on the factors pertaining to a given case, the second stage of the operation is performed, which consists of the closure of the intestinal fistula by either an end-to-end or side-to-side anastomosis.

Only a few cases of this type on record have recovered. Resection, if done, must be very thorough.

VOLVULUS

This is a torsion of the bowel and its mesentery. There are three sites of predilection for volvulus:

1. The lower segment of the small bowel;
2. The cecum with a long ileocolic mesentery and
3. The sigmoid flexure.

Volvulus of the Small Bowel

1. Gain prompt access to the twisted bowel (eventration, if need be).
2. Divide adhesions about the twisted bowel.
3. Detorsion of the affected segment (Fig. 1631) supplemented by plication of the mesentery in the same manner as shown in Fig. 1633, p. 1451.
4. After detorsion, ascertain the viability of the bowel (hot lap-packs). If viable, replace the affected segment of intestine into the abdomen; if not, do an enterectomy with anastomosis.

5. If the patient's condition is precarious it is better to do an enterostomy following detorsion.

Fig. 1631. Proper method of untwisting a volvulus. Note direction of rotation (arrows) to accomplish reestablishment of the normal direction of the bowel.

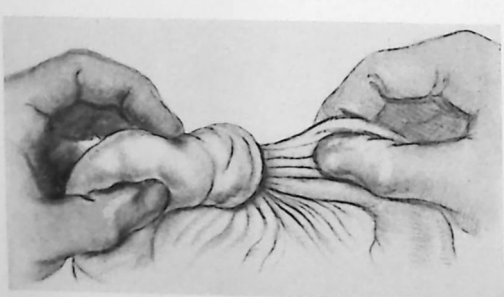


Fig. 1632. Reducing an intussusception. The left hand expresses the invaginated portion, while the right exerts gentle traction on the other extremity of the invaginated bowel. Never traumatize. Gentle manipulations only are permissible. Rough handling may do a great deal of damage. Push; abstain from pulling; coax gently with the right hand.

Volvulus of the cecum is treated by detorsion and fixation or plication of the ileocolic mesentery (Fig. 1633).

Volvulus of the Sigmoid Flexure

Sigmoidoscopy. Endeavor to pass a rectal tube; if this fails:

1. Open the abdomen through a left lower paramedian incision.
2. Deliver the volvulus.
3. Attempt detorsion. While so doing have an assistant manipulate a tube in the rectum with the object of passing the obstruction, as soon as detorsion is effected.
4. If the distention is so marked that attempts at detorsion become threatening evacuate the gas by puncturing (small trocar) the bowel through a taenia

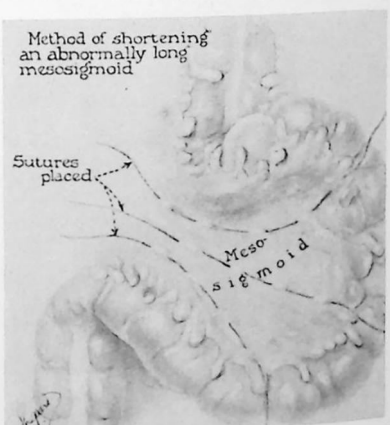


Fig. 1633. Method of shortening an abnormally long mesentery of the sigmoid.

and permit the gas to escape. Close the puncture opening with a purse string suture. Do a cecostomy.

5. If it is impossible to effect detorsion,

Sew a tube into the apex of the distended sigmoid loop until conditions are propitious for a resection.

6. In gangrene of the loop with the patient in good condition,

Do a resection, and introduce a Paul tube into each limb of the bowel. If the condition of the patient is bad, perform Bloch-Paul's operation with a tube introduced and do a resection later.

Volvulus of the sigmoid tends to recur. To avoid this, shortening and fixation of the mesentery has been advised by Nicholas Senn (1889). If this fails resection should be done.* (Fig. 1633.)

* A case of volvulus and obstruction of the sigmoid caused by the splenic pedicle was recently operated on (resection, splenectomy) by Dr. Phil Thorek. Recovery. Cook County Hospital.

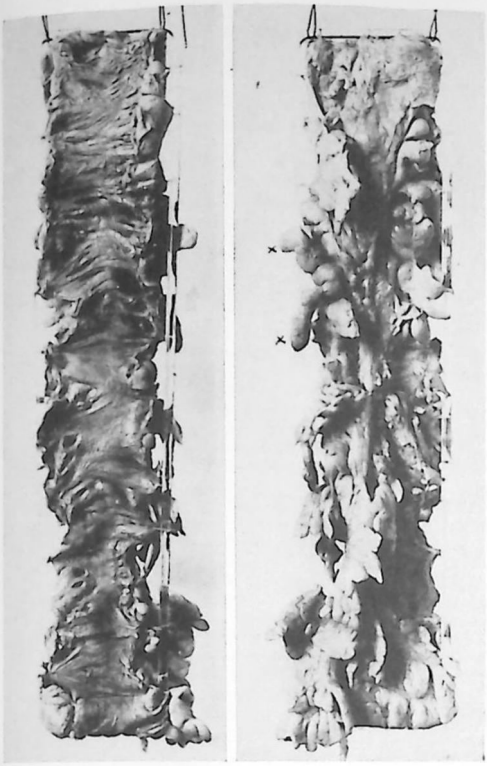


Fig. 1634 Fig. 1635

Figs. 1634 and 1635. Diverticulosis of the large bowel. xx shows appendix-like diverticulae having undergone inflammatory changes. (Courtesy of Prof. deQuervain.)

DIVERTICULOSIS AND DIVERTICULITIS

About 5 per cent of people over forty years of age have diverticulosis which consists of the formation of sacs along the line of entry of the blood vessels at the sides of the attachment of the mesentery; in some instances they affect the appendices epiploicae. However, the sigmoid colon is the usual site of occurrence (Figs. 1634-1635). This condition does not produce symptoms unless the sacs become inflamed from irritation caused by the stagnation of their contents (diverticulitis). The condition often calls for surgical treatment. It may appear as a so-called:

1. Left-sided appendicitis—acute diverticulitis.
2. Chronic diverticulitis with intestinal obstruction.
3. Diverticulitis with pericolic abscess formation and external fistula.
4. Diverticulitis with internal fistula.

According to Wakely, there is no causal relationship between diverticulitis and malignancy. Lockhart-Mummery also favors this view.

Treatment

1. Acute diverticulitis: Laparotomy; excise the affected diverticulum and suture the colon. A decompression colostomy may be advisable in complicated cases.

2. Chronic diverticulitis with obstruction: Do a laparotomy; explore; do a cecostomy or transverse colostomy; 1 to 3 months later resect the affected sigmoid carrying the diverticulae.

3. Abscess from perforation: drain the abscess; later proceed as outlined above.

4. Internal fistulae: perform a temporary colostomy; later excise the fistula and repair the affected bowel.

INTUSSUSCEPTION

This condition usually occurs in children, the ratio being 95 children to every 5 adults; and is usually caused by benign tumors (lipomas, polyps, ulcerations, etc.). (Fig. 1636.)

ACUTE INTUSSUSCEPTION IN INFANTS

General Anesthesia

Hamilton Bailey states: "For some time I have used spinal anesthesia in these cases as a routine, reserving general anesthesia for special cases, such as older children in good condition, or when the services of a specially skilled anesthetist are available. The advantages of spinal anesthesia outweigh its disadvantages when operating upon the average case under ordinary emergency conditions."

Bailey uses stovaine 0.2 cc. in saline solution as a standard dose up to the age of two years, after which the dose may be increased. He advises against barbotage and administers ½ cc. of pituitrin to counteract the fall of blood pressure.

OPERATION

Step 1. Open the abdomen through a right paramedian incision extending above and below the umbilicus.

Step 2. Explore gently and identify the involved segment of bowel. Bring it out of the abdomen. Pack the rest of the abdominal cavity off with lap packs of proper temperature. Use every means to retain the body temperature of the infant.

If the mass of bowel involved in the process cannot be delivered, endeavor to disengage the intussusception with the bowel in situ.

Step 3. Disengagement should be done by gentle manipulations only. Do not use force. Squeezing at one end (**Hutchinson's maneuver**) will often suffice.

While Hamilton Bailey justly says, "push but never pull," nevertheless, gentle guidance of the intussuscepted limb, while pressure is exerted on the tumor mass, has caused me no regrets.

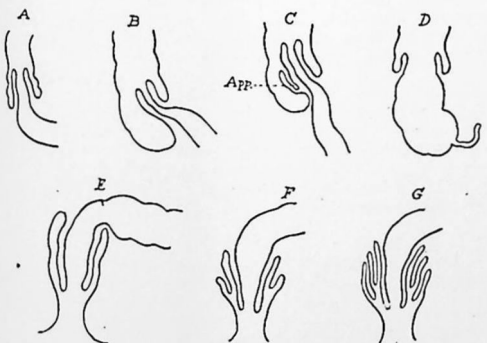


Fig. 1636. Diagrammatic sketch showing types of intussusception. A. Ileo-ileal, B. Ileo-colic, C. Cecocolic, D. Colic, E. Rectocolic, F. Double, G. Triple, invagination.

Step 4. After disengagement, make sure that the bowel is viable. If so, replace the disengaged intestine into the abdomen.

Step 5. Close the abdominal wound in layers.

Step 6. The removal of sutures should not be hurried. Follow the advice of Baldwin who admonishes to leave sutures in for 12 to 14 days or even longer, if eventrations are to be avoided. Do not attempt to avoid recurrences by some form of plication or suspension. Any such devices to shorten the mesentery or anchor the cecum, Clubbe justly remarks, are examples of misdirected surgical zeal. Yet, Suermondt, Fourniér and Chifolian recorded successes after performing cecopexy supplemented by appendicostomy in intussusception cases.

What To Do if the Intussusception Is Irreducible

The following methods are at our disposal:

Cope's Method (Fig. 1637 a). This consists of insinuating the little finger

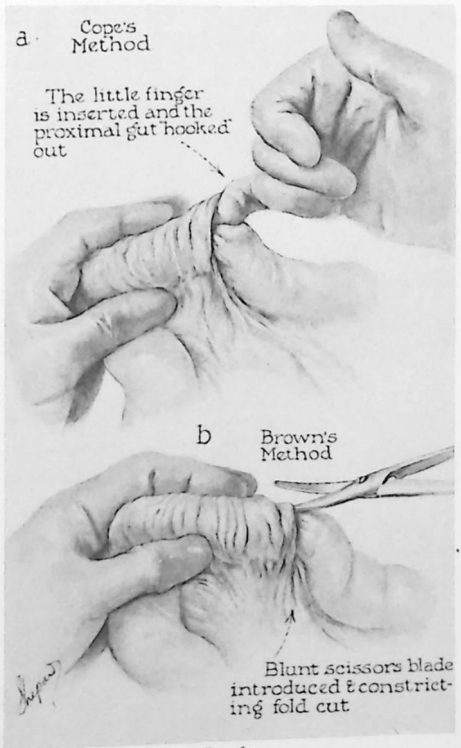


Fig. 1637

between the intussusceptum and intussuscipiens and separating the one from the other, followed by disinvagination.

Daws' Method. Here, instead of the little finger, a stick sponge, or some blunt-nosed forceps is used for separating (gently) the involved portions of bowel.

Brown's Method (Fig. 1637 b). One blade of a pair of Mayo scissors is insinuated through the constricting ring of bowel which is divided. After reduction, the incision is sutured.

Hipsley's Preliminary Injection Treatment of Intussusception

P. L. Hipsley* points out the value of preliminary injections of salt solution into the rectum, stating that about 60 per cent of all cases will be completely reduced, that doubtful cases show at least 18 per cent reduction and that there are still others that would in all likelihood be reduced by a more prolonged effort. Since pressure at the apex of the intussusception effects reduction, it does not matter whether such pressure is digital or hydrostatic. Rupture of the bowel from hydrostatic pressure may be ignored. A column of water 3 feet 6 inches in height which equals a column of mercury 65 mm. is quite safe. Palpation of the abdomen during hydrostatic reduction is dangerous. Hipsley states that he used this method as a routine for over twenty years and he has not made a single mistake as to the completeness of the reduction.

The quantity of the salt solution varies with the age of the child. It is not the quantity but the pressure of the solution which is the important factor. General anesthesia is used and the surgeon must be in readiness to operate should occasion arise. No higher pressure than indicated above should be resorted to. Use an ordinary glass douche container so that the level of the water may be seen. Suspend the vessel so that the height of the column of solution is 3 feet 6 inches above the table on which the child lies. Insert a No. 15 soft rubber catheter for a few inches into the rectum. Push the buttocks together. No lubricant is used. After 3 minutes disconnect the catheter; allow the saline solution to escape into the bedpan. Repeat this twice at three minute intervals. On occasion Hipsley permitted the solution to remain 8 to 10 minutes.

Signs of complete reduction: (1) Obvious distension of small bowel following injection; (2) Alteration in the circumference of the abdomen (increase of about 2 inches around the umbilicus when reduction has been effected); (3) Yellow fecal matter is often seen in the third return of saline; (4) Passage of flatus; (5) X-ray appearance after opaque injection; (6) Charcoal through stomach tube will be recovered 5 hours later in large bowel washings.

Operation should be undertaken when evidence points that reduction is incomplete. Results depend upon early diagnosis and adequate treatment. Combat shock; restore loss of fluids and chlorides. When forced to operate Hipsley favors lateral anastomosis leaving the unreduced portion of bowel in situ.

When All of these Methods Fail

Resect the affected segment of intestine, followed by an anastomosis (side-to-side). Resection is to be a last resort because the mortality is tremendously high in young infants (80 per cent).

Intussusception in Adults

After disinvagination, a tumor is usually found to be responsible for the intussusception. Such tumor must unreservedly be removed. If left behind, a recurrence of the invagination is sure to follow soon.

* Surgery, Vol. 1, No. 6; June, 1937; p. 825.

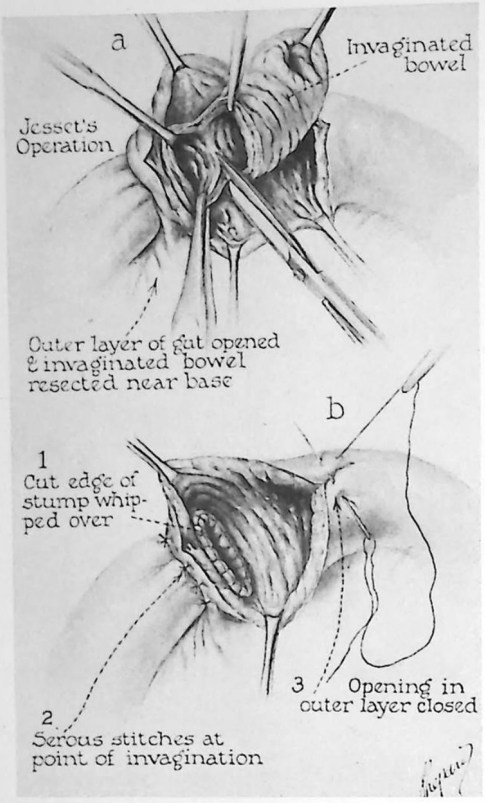


FIG. 1638

In adults, resection is the method of choice. If the small intestine is the seat of the intussusception and if the patient's condition is good, a one-stage operation is performed. In the large intestine graded operations are preferable.

In some cases of irreducible intussusception without gangrene a short-circuiting operation may be performed with success (p. 1443).

If the bowel is irreducible and gangrenous, the following methods are at our command.

1. Resection with end-to-end or side-to-side anastomosis.
2. Jessett's operation (Fig. 1638). This consists of removing the invaginated portion of bowel alone, through the ensheathing portion of the intestine.

After the incision in the bowel is made, the invaginated part is pulled as far downward as possible and is cut away. A circular suture unites the divided edges of the amputated, gangrenous bowel. The ensheathing portion of the bowel is now closed by a continuous suture (through-and-through) superimposed by a Lembert stitch. A few interrupted sutures are placed at the neck of the intussusception.

OBSTRUCTION OWING TO BANDS AND ADHESIONS

Prompt division of the constricting band is followed by immediate relief. The earlier, therefore, the diagnosis is made and the earlier the treatment, the better is the prognosis.

Intraperitoneal adhesions may produce acute and chronic obstructions.

Guides

1. If the history and symptoms point to a certain region, explore that section.
2. If in doubt as to where the obstruction rests, explore the pelvis first. Search for a collapsed portion of bowel. When this is found follow it to the point of obstruction.
3. If the cecum and colon are distended explore the rest of the large bowel notably the sigmoid flexure.

How to Deal with Adhesions

If cordlike, divide them between two artery forceps, ligate the ends and remove the redundant part. Flat, recent adhesions may be separated by gentle pressure with gauze wrapped about the index finger.

Old adhesions: Be moderate in the extent of separation. Divide only those adhesions that are directly concerned in the obstruction. Gentle separation with scalpel and scissors with particular attention to avoid injury to the bowel should be the guiding rule. Cover raw surfaces (suture, free omental graft, etc.) wherever possible.

When the bowel is greatly distended, we may be compelled to do an enterotomy to enable thorough work to progress. Multiple adhesions may present too formidable a task for successful separation (tuberculous peritonitis, etc.). Lateral entero-anastomosis or more than one of such intercommunications may be necessary to accomplish the desired end.

In order to avoid recurrence, the constricting band should, wherever possible,

be excised. These bands are often vascular. Proper hemostasis should be looked after.

Where the strangulation has lasted a long time and gangrene of the affected segment of bowel is encountered, resection with proper anastomosis is the treatment.

Exteriorization (Bloch-Paul-Mikulicz Operation) does not serve as well in the case of the small intestine as in affections of the large bowel where it constitutes the procedure of choice.

A history of previous operation often aids in the diagnosis of intestinal obstruction.

INTESTINAL OBSTRUCTION FOLLOWING APPENDICECTOMY

While the patient is still under treatment. In these cases symptoms of obstruction usually become manifest within the first fortnight after appendicectomy. Hamilton Bailey recognizes three different types of this category of affection, each of which requires different therapeutic measures.

Type I

This occurs within the first ten days following appendicectomy. Here, procrastination spells death. Upon the very first symptoms of obstruction, the abdomen should be opened and the obstruction, usually fresh adhesions from coils of intestines to some raw surfaces, should be promptly relieved. In these cases, mild symptoms are often misleading and should put the surgeon on guard. Prompt action is imperative.

Type II

In this group the patient is ill from the very beginning. The surgeon has to decide whether he is dealing with a paralytic ileus or definite obstruction; a most difficult task. For the first three days conservative treatment with careful vigilance and evaluation of every symptom presenting itself may be permissible. Bailey warmly recommends antigas-gangrene serum.

If the condition, instead of improving is getting worse, do a jejunostomy or ileostomy. This should be done without further delay supplemented by gastric lavage and Rehfuss-tube.

Type III

In this class of cases pools of pus accumulate in the pelvis, extensive loops of small bowel become adherent in an effort to wall off or limit the extension of the process and intestinal obstruction results.

If the condition of the patient is still good, Bailey counsels the following:

"Through a supra-umbilical midline incision, a coil of small intestine is found. If neighboring gut is free from peritonitis and not enormously ballooned, we run the small intestine through our fingers until the commencement of the diseased area is reached. If the great omentum is well developed, a hole is made in it under its attachment to the transverse colon and the selected coil is brought through. If the great omentum is poorly developed, this step is omitted. Then, using clamps, lateral anastomosis between the ileum and transverse colon is performed.

"Ileotransverse colostomy in the type of case described would save many lives. The operation is performed through an unscarred area; the gut is free; the operation is a 'set' one and should occupy a definite period of time which can be judged beforehand."

In desperate cases I have frequently resorted to simple enterostomy. In some instances, the results were gratifying.

OBSTRUCTION OWING TO MECKEL'S DIVERTICULUM

The diverticulum and its omphalomesenteric duct act here as a constricting band. Its distal extremity, normally usually free, may become attached to any point within the abdomen.

Guy Van Alstyne reported[1] two interesting cases of intestinal obstruction resulting from strangulation from persistent obliterated omphalo-mesenteric ducts (Fig. 1639).

The obstruction may supervene in a variety of ways, each of which requires special treatment. Generally, however, the steps of procedure are as follows:

Step 1. Free the extremity of the diverticulum.

Step 2. Crush its enteric extremity a short distance from the intestine. Place a catgut ligature around the compressed ribbon of tissue remaining. Remove the diverticulum.

Step 3. Superimpose a sero-muscular suture burying the catgut ligature. Reinforce the suture line with a free omental graft.

In a surgical experience of over thirty years, I have encountered only two cases where Meckel's diverticulum was the cause of intestinal obstruction.

Obstruction from an adherent appendix vermiformis may play a rôle similar to the type just described. Appendicectomy is the treatment.

OBSTRUCTION DUE TO INTERNAL HERNIA

Segments of bowel may slip through apertures in the mesentery giving rise to strangulation. The treatment is obvious: Reduction of the incarcerated segment and closure of the opening in the mesentery. (Figs. 1629-1630.)

Apertures in the omentum and broad ligaments may also occasion strangulation.

INTRA-ABDOMINAL HERNIA

Hernia into the Retroperitoneal Fossae

1. Hernia of the foramen of Winslow.
2. Hernia of the duodeno-jejunal recess.
3. Hernia of the retrocecal and ileocecal fossa.
4. Hernia of the intersigmoid recess.
5. Retrovesical hernia.

HERNIA OF THE FORAMEN OF WINSLOW

The hernia here finds its way into the lesser peritoneal cavity (Fig. 1640). The situation may be regarded as a pre-existing hernial sac. Such hernias are rare because the opening is usually narrow. The portion of the

[1] Annals of Surgery, 1930.

bowel becoming constricted is usually the colon but small intestine may also become strangulated.

A paramedian right upper incision is used. Endeavor to withdraw the intestine from the foramen. In case the herniated portion consists of large bowel, the cause is ascribed by Moynihan to an abnormal mobility of the cecum or ascending colon by reason of the presence of a common mesentery.

After disengagement of the herniated bowel, plication of the mesentery or cecopexy should be done. An effectual closure of the opening cannot be accomplished.

If there is difficulty of delivery of the incarcerated bowel, do an enterotomy first, to evacuate the intestinal contents. If further difficulty is encountered Moynihan and Wilms advise division of the constricting neck by incising the peritoneum as it passes from the duodenum to the posterior abdominal wall. This mobilizes the duodenum which can now be displaced downward and the ring enlarged.

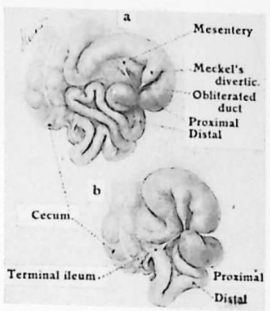


Fig. 1639. Guy Van Alstyne's cases of intestinal obstruction due to persistent omphalo-mesenteric ducts.

HERNIA THROUGH THE DUODENOJEJUNAL FOSSA

The orifice of this fossa looks upward. It is formed by a peritoneal fold and is usually to the left of the spine at the duodenojejunal junction (Fig. 1641). In many instances it may contain all of the small intestine projecting behind the posterior parietal peritoneum. The duodenum can be observed to enter the sac and the beginning of the ileum to leave it. The renal artery is behind the sac and the inferior mesenteric in front of it (Treves). The inferior mesenteric vein and occasionally the left colic artery run at the upper border of the aperture.

Make a paramedian incision through the left rectus abdominis muscle. The neck lies to the right of the sac, to the left of the third lumbar vertebra. Attempt reduction, which at times may be easy. If difficult, divide the neck of the constriction, cautiously. Avoid injury to the inferior mesenteric vein and left colic artery. After reduction attempt closure of the neck. Removal of the sac is impracticable.

THE RIGHT DUODENOJEJUNAL FOSSA

is situated in the mesentery at the very beginning of the jejunum below the duodenum. Its opening faces to the right. The superior mesenteric artery runs in its free edge. In dealing with hernia of the paraduodenal fossae one must remember the presence of important vessels in their free border. When reduction fails, the neck of the hernia should be divided in an avascular area.

HERNIA INTO THE FOSSAE ABOUT THE CECUM

The disposition of these fossae is shown in Fig. 1642. They consist of the

1. ileocecal fossa.
2. ileo-appendicular fossa.
3. retrocecal fossa.

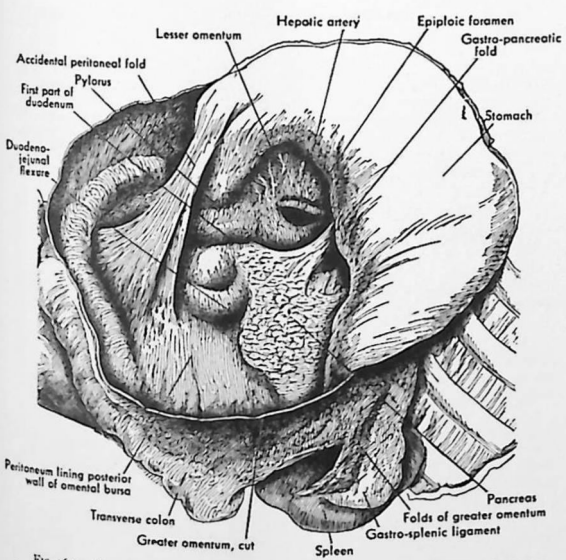


Fig. 1640. The subject, lying on its back, is seen from the left side; the stomach, except fundus, is turned over. The greater omentum has been cut below the greater curvature of the stomach so as to open the lesser sac to show the foramen of Winslow from the left side. (Piersol.)

Hernias here are very rare. Usually, when occurring, they are found in the retrocecal fossa extending upward behind the cecum and ascending colon. Coils of the lower ileum may find their way here.

The paracecal fossae are comparatively avascular. If reduction fails, the neck of the hernia may be divided with comparative impunity. After reduction the fossa should be obliterated with catgut sutures.

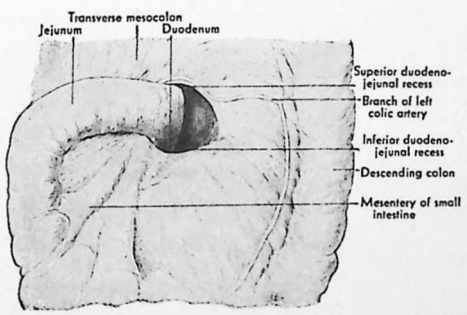


Fig. 1641. Duodeno-jejunal junction, showing duodenal fossæ; jejunum turned to the right.

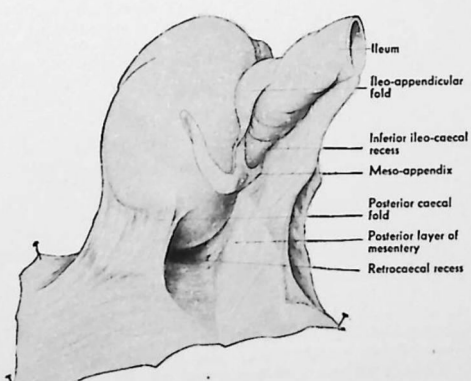


Fig. 1642. Peritoneal fossæ of ileo-cæcal region, cæcum being drawn forward and upward. (Jonnesco.)

HERNIA INTO THE INTERSIGMOID FOSSA

This space is exposed by raising the sigmoid flexure and retracting it to the left. It will be found opening toward the left between the root of the sigmoid mesocolon and the parietal peritoneum. Coils of small intestines may find their way into this fossa.

The relation of the sigmoid artery must be kept in mind in endeavoring to reduce a hernia in this locality.

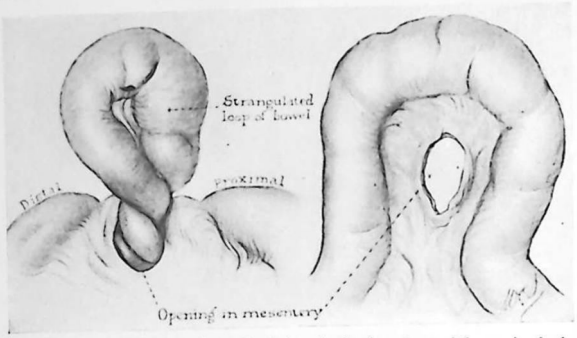


FIG. 1643. The loop shown has been reduced, detorsion has been done and the opening in the mesentery is ready to be closed.

The plica hypogastrica may form a deep peritoneal pocket forming a retrovesical hernial pouch.

Strangulation may also be occasioned through

1. A hole in the falciform ligament of the liver.
2. By a Fallopian tube or long pedicle of an ovarian cyst.
3. Holes in the mesentery (Fig. 1643) or omentum may occasionally result in intestinal obstruction.

IMPACTION OF FECES

If accumulation of fecal matter obstructs the onward passage of the current, occasioning symptoms, disimpaction should be done (softening oil enemas, breaking up of impacted mass with gloved fingers or spoon).

TORSION OF THE OMENTUM

When this causes intestinal obstruction it is treated by (a) detorsion and (b) resection of omentum.[1]

OPERATIONS FOR INJURIES AND PERFORATIONS OF THE BOWEL

Either injury or disease may cause solution of continuity in some part of the intestinal tube. One can never be sure that there exists no intestinal perforation

[1] Thorek, Max. Med. Jour. and Record, June 3, 1931.

because of absence of external evidences on the abdominal surface. It is far better to err on the side of safety and adopt unreservedly the dictum "When in doubt explore." I have met many surprises by adhering to this dictum, and was often painfully reminded of the fallibility of human judgment. Of course, where penetration of the abdomen has taken place, the indications for operation are clear.

Make a median incision between the umbilicus and the symphysis pubis. Observe the condition of the peritoneum. If gas escapes endeavor to ascertain by the sense of smell whether large or small bowel has been perforated.

Search for the point of injury. If not readily ascertained explore the small intestine from below upward and the large intestine from the cecum downward. While so doing, mop up, or use the suction apparatus for the removal of, escaped intestinal contents.

When the Point of Perforation Is Found

Avoid further escape of intestinal contents. To accomplish this, wrap the affected segment of bowel in a hot lap pack, pull the injured bowel forward and have an assistant hold it; or, engage the affected loop of bowel in a Doyen intestinal clamp. Isolate the rest of the abdominal cavity with warm lap sponges. Always keep the possibility of multiple intestinal perforations in mind.

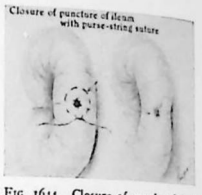


FIG. 1644. Closure of gunshot injury to the intestine.

PUNCTURED WOUNDS

These should be closed with a purse string suture (Fig. 1644). Superimpose a Lembert seromuscular stitch placed transversely to the long axis of the bowel.

Incised wounds are repaired by two rows of sutures: (a) an inner through-and-through catgut suture and (b) an outer inverting seromuscular Lembert line of sutures.

LACERATED WOUNDS

Devitalized borders must be excised before union is attempted. Repair should be accomplished by two-layer sutures placed tranversely to avoid constriction of the bowel. Where much of the intestinal wall is injured enterectomy may be the preferable operative procedure.

Wherever free blood or actual bleeding is encountered, the latter must at once be stopped and all free blood clots removed; they form excellent pabulum for escaped microorganisms. These clots must be cleared away before suturing of the bowel is done.

Before closing the abdomen make sure that no perforation has been overlooked. If in doubt, eventrate and explore, and be sure!

Small bowel perforations are usually easily found. Perforations in the large bowel are often discovered with difficulty.

Enderlen advises, in suspected large bowel perforations, or lacerations, to systematically explore the large intestine in the following order: pelvic colon,

colon descendens, transversum, the beginning of the small bowel to the cecum and finally the ascending colon.

In multiple perforations of a given segment of bowel, it is better to resect that portion instead of attempting to close each perforation separately.

Areas of crushed bowel without actual perforation must be excised and the bowel reconstructed in healthy tissues.

Portions of bowel detached from the mesentery should be resected.

Large bowel defects are difficult to handle for the following reasons:

1. Difficulty in delivering the affected portion of bowel (short mesentery).
2. Difficulties in suturing.
3. Facility of infections.

Defects must be securely repaired. A number of layers of sutures, reinforced by omental grafts should be the rule. Never omit to drain after repair of defects of the large bowel.

In extensive lacerated injuries of the intestines, resection should be done (for technic see page 1365). If the condition of the patient is precarious do a Bloch-Paul-Mikulicz two-stage operation.

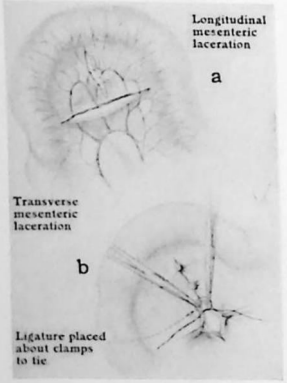


FIG. 1645. Laceration of the mesentery (schematic). a. A longitudinal laceration of the mesentery at right angles to the bowel is usually safely closed. A long transverse laceration compromising the blood supply to the bowel necessitates resection. b. Method of coaptating the edges of the mesentery. The edges are held in approximation and a ligature placed.

INJURY TO PORTIONS OF BOWEL WITHOUT MESENTERY

Duodenum, Colon Ascendens and Descendens

Injuries of these bowel segments may be retroperitoneal and then even more dangerous than intraperitoneal injuries.

Local emphysema beginning in the flank and spreading to the front is a comparatively early symptom. Colostomy here is often life saving. It should be performed early. In injuries to the duodenum the reflection of the peritoneum is bile stained. Hematomas speak for retroperitoneal large bowel injuries.

Treatment

Explore thoroughly. Leave nothing to chance. Mobilize the affected segment of bowel. Close the perforation thoroughly. A lumbar drain should never be omitted. Protect the peritoneal cavity during the operative manipulations. Reunite the parietal peritoneum. Remember the drain should never be brought into direct contact with the suture line.

Never operate during shock. Use all possible measures to counteract the primary circulatory depression, then proceed to operate.

LACERATIONS OF THE MESENTERY

In lacerations that run parallel to the axis of the intestine (Fig. 1645 a) the nutrition of the intestine is jeopardized. If such laceration be over two inches in length, resection with anastomosis should be done. Even smaller injuries which show only a slight discoloration of the intestine indicating interference of circulation call for resection.

Longitudinal lacerations should be closed by interrupted ligatures (Fig. 1645 b). The results are good.

Hematoma of the Mesentery

A hematoma may strangulate the intestine and cause its death. Where a hematoma is present it should be subjected to the following treatment.

1. See if the hematoma is present on both sides of the mesentery. If so, aspirate its contents. If aspiration causes a reformation of the hematoma a vessel is surely bleeding. Open the hematoma. Find the bleeding vessel and ligate it.
2. Scrutinize the nutrition of the bowel. If impaired, consider resection.

INJURY TO THE BOWEL WITH PERFORATION OF THE ABDOMINAL WALL

In these cases matters are complicated by the introduction of septic material from without.

Treatment

Step 1. General anesthesia.
Step 2. Excise the ragged borders of the wound.
Step 3. Explore.

Treat as indicated above.

Keep in mind the possibility of injury to the structures in the retroperitoneal space. Make sure that the pancreas has not been injured by a bullet. If so, attempt to remove the bullet; if that does not seem feasible drain the retroperitoneal space and region of the pancreas.

When omentum and bowel are prolapsed, do not replace these without first repairing the damage done and supplement this by thorough disinfection and drainage, if need be.

SURGERY OF THE APPENDIX

Some aphorisms of pioneers in the surgical treatment of appendicitis may not be amiss here:

"The physician treats appendicitis, the surgeon cures it." (Kümmel.)

"There is no medical treatment for appendicitis." (Poiriér.)

Concerning the so-called conservative treatment of appendicitis, Gussenbauer pointedly asked, "Whom do you wish to conserve, the patient or the appendix?"

Von Eiselsberg concludes: "Early operation is the ideal method of treating appendicitis."

Pothecat admonished: "Operate, do not wait for the appendix to suppurate."

Dieulafoy stressed: "On ne doit pas mourir d'appendicite" (one should not die from appendicitis) and

Kocher said, in substance, that he would suffer from no scruples because he had removed a hundred apparently normal appendices but would suffer remorse when losing a patient from appendicitis because of procrastination.

Every experienced surgeon will concur in the conclusions drawn by D. P. D. Wilkie.[1]

1. The mortality from appendicitis remains as high as it was twenty years ago, because, while facilities for treatment have improved, diagnosis in the fatal type of case has not.

2. There is now very strong evidence that the fatal cases of acute appendicular disease are primarily cases of obstruction of the appendix and not inflammation. It is necessary to distinguish between these two types of acute disease, the clinical symptoms and essential pathology of which differ widely. The obstructive cases must be regarded and treated as belonging to the same category of urgency as internal strangulation of the intestine.

3. Free exposure at operation is essential.

4. While immediate operation is expedient in the early stages of appendicitis, delay is advisable in the resolving case, the danger of operation being greater than that of expectancy.

5. Where a large localized abscess is present, simple drainage with minimal disturbance is the safest line of treatment.

6. In cases with perforation and peritonitis, infection of the abdominal wound may be an important factor in determining a fatal issue. Open treatment of the wound is therefore advisable.

7. Postoperative obstruction accounts for a number of deaths. A timely enterostomy or ileocolostomy may prove a life saving measure.

APPENDECTOMY (APPENDICECTOMY)

Removal of the Appendix in the Quiescent Period

Anesthesia. General, local or spinal.

In the early nineties when McBurney described the muscle-splitting operation commonly spoken of as the gridiron incision (or as Roux referred to it as "l'incision anatomique") he recommended that this incision should be used in interval cases only and stressed the point that it should not be used in acute cases. For reasons I cannot fathom the incision gained in popularity when it should have been discarded.

I am convinced it is a dangerous incision except on rare occasions as it often places the surgeon in an embarrassing position, particularly where complications exist such as abnormal locations of the appendix, wrong diagnosis, adiposity, etc.

It is surprising that recent literature shows reports by competent writers who claim that the use of the McBurney incision lowers mortality; but they do not offer satisfactory explanation as to the reason for the alleged lowered mortality.

While the pendulum has been swinging back and forth as to the merits and demerits of this incision, many experienced surgeons maintain that it is a com-

[1] Brit. Med. Jour., Feb., 1931.

plicated procedure and should be resorted to only in exceptional cases, viz., in interval operations for the removal of the appendix where the diagnosis is incontrovertible. Apropos of the surgical approach to the appendix, we read in Romanis and Mitchiner's "Science and Practice of Surgery":

"The oldest incision, which is now quite out of date, is the muscle-splitting incision of McBurney, where a skin incision 3 inches long parallel to and 1 inch from the outer half of Poupart's ligament was made. The abdominal muscles were then split in the direction of their fibers and the peritoneum opened. This had the advantage of lying directly over the appendix and cutting no muscles; it had no other merits whatsoever and many disadvantages. It was quite impossible to enlarge it satisfactorily without damaging muscles and no examination of other abdominal organs could be made through it. Moreover, it is much more painful than the other incisions. As soon as it was realized that there were very few cases in which a mere appendectomy sufficed, and that in practically every case an examination of other abdominal organs should be made, this incision fell out of use except for opening appendicular abscesses. The practice of removing appendixes through small 1-inch McBurney incisions of which some surgeons boast, is quite undesirable and a mark of total lack of surgical balance."

Roger T. Vaughan states:

"The surgeon who operates on female patients for appendicitis routinely through a McBurney incision is bound to overlook considerable pelvic pathology besides ruptured Graafian follicles and corpora lutea. Both the Battle and the right paramedian incisions are preferable when the clinical picture of appendicitis is not typical."

A. S. Vosburgh[1] states: "In the early '90's McBurney described the muscle-splitting operation which is known as the 'McBurney Method.' It is of interest to note that McBurney used this only in interval cases and laid stress on the point that it should not be employed in acute cases. At present it is used by most surgeons in acute cases, and some other incision is used where any exploration is contemplated or the diagnosis is at all doubtful."

This is not entirely in accord with the author's observations to which I would like to add that the beginner particularly will do well to look upon the McBurney incision as one which invites him to pitfalls which he can ill afford, particularly on the threshold of his surgical career. Inguinal hernias are invited when the McBurney incision is used because of injury to the nerve supply of the region under discussion.

Step 1. Incision (Fig. 1646). The simpler the incision the better. Exposure should be ample. Two or three decades ago surgeons were proud of the small incisions through which they were able to remove an appendix. Such foolhardy display, to which the writer also was no stranger, cost many lives.

I have completely discarded the use of the McBurney incision. It should be of historical interest only. It has no merits and many disadvantages to its credit. True, when the appendix is in its classical position the McBurney incision permits exposure without dividing the abdominal muscles. The story is different when the appendix is retrocecal, in or near Morison's pouch, displaced to the left or in any other unusual position (Fig. 1647). Under such conditions

[1] Johnson, Op. Ther., 1915, Vol. II.

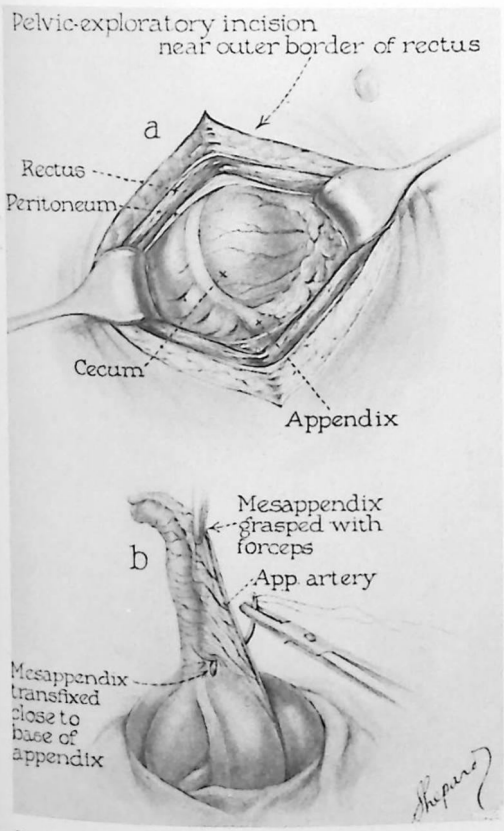


Fig. 1646. Appendicectomy. a. A right rectus or pararectus incision is made sufficiently large to permit thorough exploration of the pelvis and to investigate the biliary passages and duodenum. b. Rupture of the appendix may result from clamping with traction. The appendix is more safely retracted by grasping its mesentery which also facilitates ligating the supplying vessels. A curved, non-cutting needle is used.

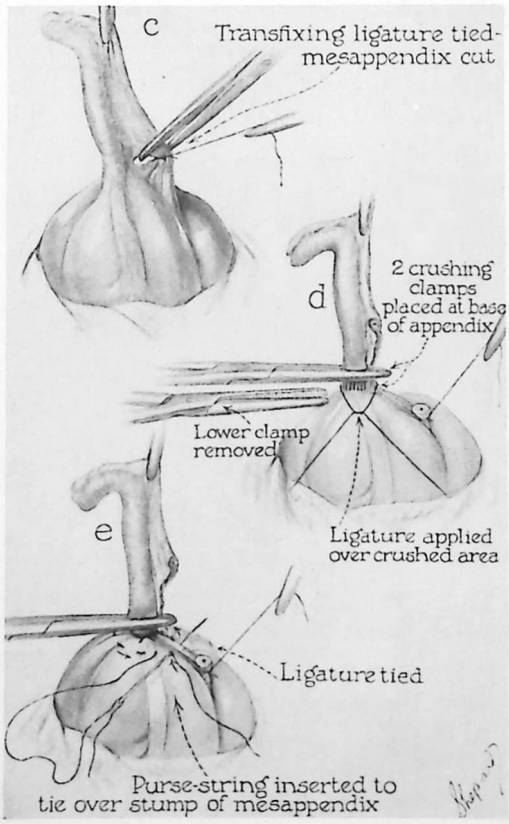


Fig. 1646 (continued). Appendicectomy. c, d, and e. Steps showing division of the appendiceal mesentery; clamping and ligation of appendix and insertion of pursestring suture for invagination of appendiceal stump.

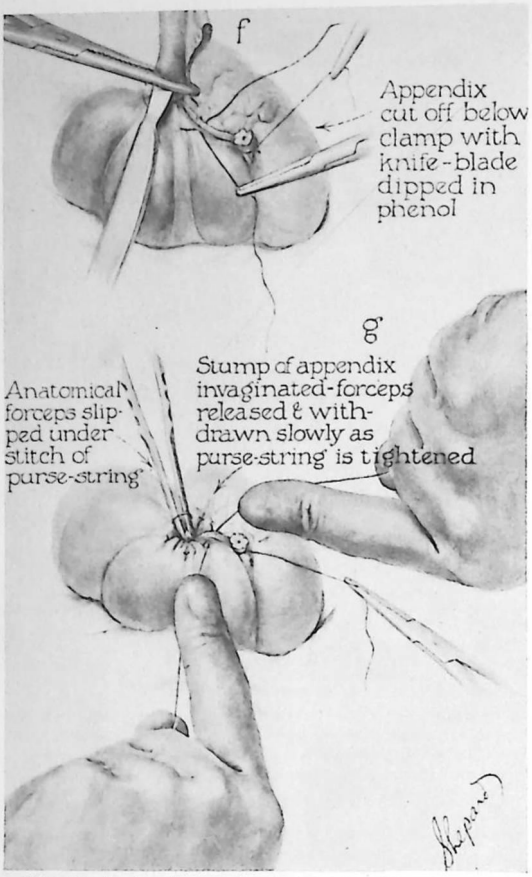


FIG. 1646 (continued). Appendicectomy. f, and g. Amputation of appendix; invagination of stump.

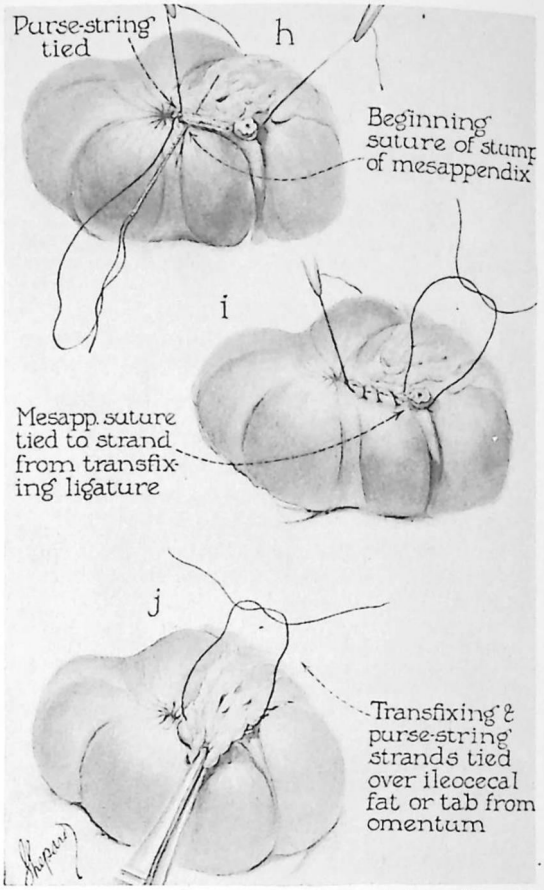


FIG. 1646 (continued). Appendicectomy. h, i, and j. Stump of mesoappendix sutured and covered with fat.

it is quite impossible to enlarge the opening satisfactorily without damaging the abdominal muscles. Besides, McBurney himself advised not to resort to this incision in acute cases. Thorough abdominal exploration is impossible through the McBurney incision. No experienced surgeon is nowadays satisfied with a simple removal of the appendix when, knowing as he does, or should know, that many other pathologic conditions may be present besides a diseased appendix, the latter often playing a subsidiary rôle in the actual picture.

The Paramedian and transrectus incisions are simple. They may be enlarged when need be (upward or downward) for exploration of other viscera or to deal with complications where proper exposure is essential. They have

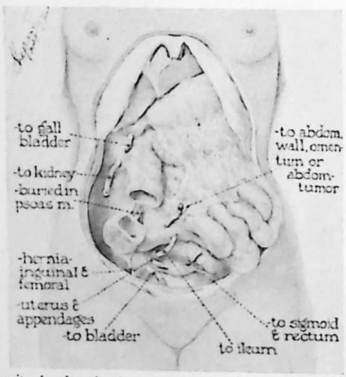


FIG. 1647. Composite drawing showing appendix at various points of abdominal and pelvic attachment. (Modified from Kelly Hudson.)

much to recommend them. The paramedian incision is made over the rectus abdominis muscle. In this incision the rectus sheath is opened and the rectus abdominis muscle retracted laterally.

In America we often speak of paramedian incisions as "trap-door" incisions. Here also, numerous writers lay claim to priority (Lenander; Kammerer, 1897; Jalaguier—1897, etc.).

Trap-door incisions make bad partners where suppurations are encountered and drainage becomes a necessity.

The transrectus incision should always be used in females (possibility of adnexal pathology). This is placed 1-2 cm. lateral to the linea alba and after incising the anterior sheath of the rectus abdominis muscle, its fibers are split longitudinally. The posterior sheath of the rectus and peritoneum are next divided longitudinally.

Step 2. Locating the Appendix. The ileocecal segment of bowel is identified and delivered.

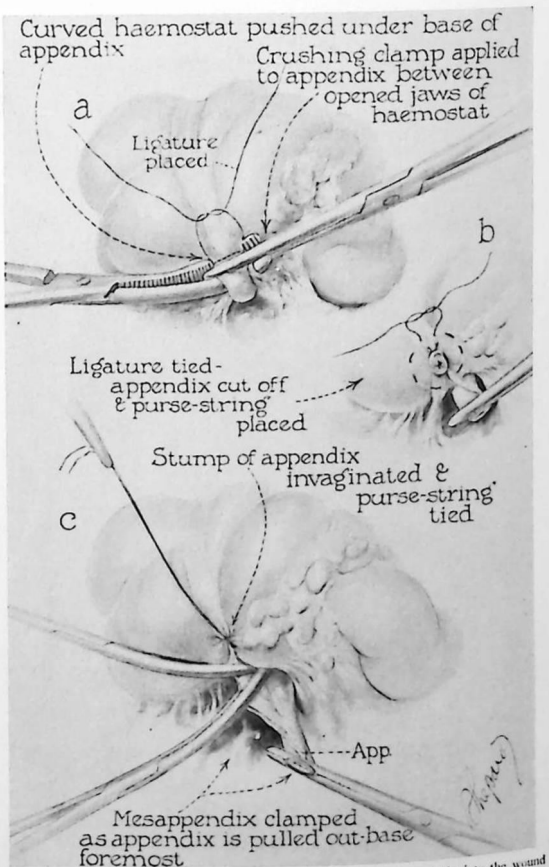


FIG. 1648. Appendicectomy. Where it is difficult to deliver the appendix into the wound resort to the retrocecal "robin" operation. a, and b. The procedure is reversed somewhat from the usual appendicectomy (see text). The base of the appendix is freed first and therefrom traction is applied. Crile likens the operation to the pulling of a worm from the ground by a robin. Push a hemostat under the base of the appendix. Open its jaws. Apply a crushing clamp between the opened jaws of the artery forceps. (a). Ligate the crushed ribbon of tissue with a catgut ligature. Place a pursestring suture of linen around the ligated stump. Invert the stump and tie the pursestring suture. (b). Clamp the mesoappendix as the appendix is delivered by pulling.

Finding the appendix may be simple or most difficult. There are numerous aids for its identification. Follow a longitudinal band of the intestine downward and it will lead to the position of the appendix. If the appendix is not obscured by adhesions, it may be found in any position about

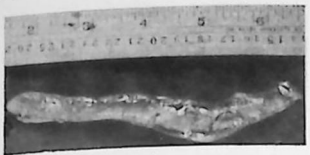


Fig. 1649. Appendix. Preoperative diagnosis: ruptured gastric ulcer or gallbladder. Operative findings: retrocecal appendix of enormous dimensions; tip of appendix attached to under surface of liver.

the cecum, curled up on itself or extended. Adhesions, if present, are gently separated and the appendix is delivered into the wound.

In cases where the appendix is difficult to deliver resort to retrograde dissection, viz., separating the appendix from its base first and inverting the stump with a purse string suture. Detachment of the appendix proceeds toward the tip instead of the reverse, as is usually done (Fig. 1648).

If the taenia longitudinalis does not lead to identification of the appendix, sweep the finger across the iliac fossa until the iliac vessels are recognized; continue with the finger upward until it is stopped by the mesentery of the terminal ileum. Follow this outward and invariably the ileocecal junction will be found which is brought out of the abdomen. Do not work blindly. If these methods of delivery fail, remember the possibilities of nondescent or nonrotation. Explore the subhepatic or left lower abdominal quadrant (Figs. 1649-1650).

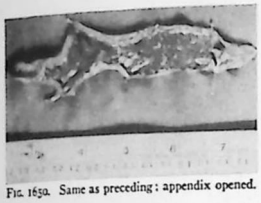


Fig. 1650. Same as preceding: appendix opened.

As soon as the appendix is delivered only the parts concerned in the operation are permitted to remain exposed, the rest of the abdominal cavity is packed off with moist lap packs of proper temperature.

The Cecum Is Delivered and No Appendix Is Visible. Explore the posterior portions of the terminal ileum or cecum. Mobilize the cecum by dividing the line of its peritoneal reflection along its lower and outer margin. Roll the cecum inward and pull it upward and search carefully. Diligent search will often be rewarded by finding the appendix lying in the loose, retroperitoneal tissue or intimately united by adhesions to the posterior wall of the cecum—the retrocecal appendix.

Under such conditions, locate, ligate and divide the stump of the appendix at its base. Then sever it between the ligature and an artery forceps at its

distal part. Superimpose a purse string suture around the ligated stump. Ligate the blood vessels in the mesenteriolum which is often absent in these cases, working from the base to the tip. The important point to remember in removing a retrocecal appendix is that the appendicular blood vessels are situated mesially to the appendix and dorsal to the cecum, colon and to their vessels. (Fig. 1648 a, b, c.)

If there is suspicion of abscess, protect the abdominal cavity with gauze pads, one placed mesially to the cecum and one below it.

If the cecum is not visible when the peritoneum is opened, insert the index finger, direct it outward and glide it along the ventral and then the lateral wall of the abdomen. Lift the cecum into the wound. The base of the appendix may be located by following down the ventral taenia longitudinalis.

If the cecum is not found, glide the finger across the iliac fossa to the iliac vessels, thence upward to the mesentery of the terminal ileum. Follow this outward and locate the ileocecal junction. Wherever possible, roll the cecum out of the wound; it will facilitate the maneuvers necessary for the removal of the appendix. The nonvascular fold which runs from the terminal ileum to the cecum frequently serves as a landmark.

If the ileocecal junction has not been identified after following the above suggestions, make search in the subhepatic or left lower quadrant.

If the cecum is discovered but no appendix found, search for it behind the cecum or terminal ileum. If not found, mobilize the cecum by incising the line of the peritoneal reflection along its external border. Roll the cecum inward and upward and the appendix will usually be found in the retroperitoneal areolar tissue or in the posterior wall of the cecum.

If the appendix is retrocecal, divide it at its base between two ligatures or clamps. Cauterize both ends and take care of the stump. Ligate the vessels from the base to the tip and remove the appendix. In removing a retrocolic or retrocecal appendix remember the position of the vessels (lying mesial to the appendix and dorsal to the cecum and colon and their vessels).

Robert L. Payne[3] pointed out that there were straight vessels situated on the terminal ileum hitherto undescribed which are definite anatomic features of this particular portion of the intestinal tube (Figs. 1651-1652). This enables the surgeon to recognize at a glance the last 1½ inches of the terminal portion of the small bowel by the straight course of the vessels alluded to. It is interesting that beginning at the pylorus and extending down the entire small bowel to a point 1½ inches from the ileocecal valve, the visible blood vessels run at right angles to the long axis of the bowel—passing up from the mesentery on the convex surface of the bowel to meet at a point opposite the mesentery. In the terminal portion of the ileum, however, one to three small straight vessels spring from the anastomosis formed by the ileocolic and right colic arteries; these branches extend upward from the ileocecal valve just under the peritoneum and parallel to the long axis of the bowel for a distance of one-half to one and one-half inches or thereabout. Also, these vessels are end-arteries and run immediately underneath the peritoneal coat in contradistinction to the other blood vessels supplying the small bowel which run between the mucosa

[3] Surg., Gyn., Obst., 1934.

and submucous coat. Payne has observed the frequency of this finding in 1000 consecutive celiotomies. This factor affords the surgeon an easy method of locating the appendix using the last 1½ inches of the terminal ileum as a guide to the base of the appendix; it is more practical than locating the appendix by following the taenia longitudinalis downward.

Step 3. Ligation of the Mesenteriolum. (Fig. 1646, see p. 1468.) Be sure that the mesenteriolum and the appendicular artery with it are securely ligated. Divide the mesentery at a little distance from the point of application of the ligature to prevent the latter from slipping. Often the mesenteriolum will have to be ligated in small sections. This is particularly true in the retrocecal or retrocolic type of appendix.

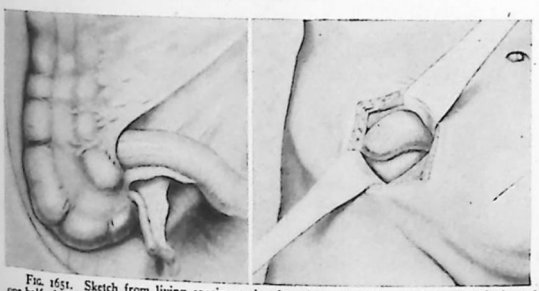


Fig. 1651. Sketch from living specimen showing three straight vessels in last inch and one-half of ileum, running parallel with the long axis of small bowel. Sometimes only one or two vessels are found present.

Fig. 1652. A right-rectus incision. A quick location of ileocaecal valve or appendix is made easy by picking up the terminal ileum which is recognized by the longitudinal vessels as seen on the lowermost knuckle of bowel presenting in the incision. (Courtesy of Dr. R. L. Payne.)

Step 4. Treatment of the Stump. (Fig. 1646 d, e, f, g.) Wrap the appendix in a gauze dressing. Place two clamps at its base. The artery forceps next to the cecum crushes the appendix. Ligate the crushed ribbon thus produced with a catgut ligature. Prior to the division of the appendix a Pagenstecher linen purse string suture is applied around the prospective stump. Dip a scalpel in carbolic acid and section the appendix about a quarter of an inch from the ligated base. The remaining mucosa in the stump should be thoroughly cauterized. Wipe off the excess of carbolic acid.

After the appendix is cut away an anatomic forceps steadies and depresses the stump which is buried while the purse string suture is being tied. In the region of the mesentery, the needle carrying the purse string suture must pass under the blood vessels so that when the ligature is tied the vessels are included. It is a good precaution to superimpose a Lembert seromuscular suture or another purse string suture (Giordano) over the first one. The mesenteriolum may be sutured over the point of the invaginated appendix. Fig. 1646 h, i, j, page 1471.

Other Methods

A number of other methods are practiced for the care of the stump, each having its advocates.

SIMPLE LIGATION OF THE APPENDIX

Baldwin of Columbus, claims for this simplicity and rapidity besides avoiding contamination incident to the penetration of the mucosa by the needle carrying the purse string suture, a penetration which cannot always be avoided. Hortolomei[1] is also an advocate of the Baldwin method of procedure. Torek[2] reports two cases of intestinal obstruction following this method.

Comment: J. Shelton Horsley, in commenting on the inversion of the stump of the appendix, has the following to say[3]:

"There was formerly much discussion about the best method of treating the stump of the appendix. Dr. John A. Wyeth merely tied the stump of the appendix with silk and cauterized it with carbolic. After doing this for a few years, I became convinced that the technic of burying the stump was unnecessarily complicated and was really more dangerous than the simple treatment of the stump; so about twenty-five years ago I went back to the original procedure of merely ligating the stump and treating it with carbolic acid. Lately, I have often drawn a small amount of peritoneal covered fat over the stump with the end of the ligature around the base of the appendix, but at no time for twenty-five years have I attempted to invert the stump with any purse string suture or any suture in the cecum itself.

While this simpler technic has been unpopular, it seems to be gaining in favor. Until recently the practice at the Mayo Clinic was to bury the stump of the appendix. The following is a quotation from Dr. Charles W. Mayo, of Rochester, which appears on page 103 of the February number of Southern Medicine and Surgery. In view of the great number of appendices that are removed at the Mayo Clinic and the careful observation of the pathologists who have charge of the postmortem examinations, this statement should attract much attention:

"There are four reasons why I do not invert the carbolized stump of the appendix: (1) Dr. Robertson of the Section on Pathologic Anatomy at the Clinic, has found that invariably, in cases in which appendectomy with inversion of the stump has been done in combination with some other surgical procedure and death has resulted, there is a pus pocket in the inverted stump up to twenty-one days postoperatively; (2) the cultured suture material used to invert the stump, once having run through the intestinal wall, invariably is infected with pathogenic bacteria; (3) noninversion shortens the surgical procedure, and (4) I have not had occasion to regret not having inverted the stump."

Where the wall of the cecum is indurated about the base of the appendix it may be impossible or imprudent to use a purse string suture.

[1] Zbl. f. Chir., 1931, No. 38.
[2] Zbl. f. Chir., No. 38.
[3] Va. Med. Monthly, Vol. 61, March, 1935.

Simple ligation, the consensus of opinion has it, is not as safe as invagination. Should the ligature slip or give way, danger is not far away.

Step 5. Inspection. I recall one instance where I lost a patient from insecure hemostasis at the stump of the mesenteriolum. Since then I refer to this point as the "death angle" and impress my assistants with the importance of never replacing the ileocecal segment without making sure that hemostasis is secure and that a poorly inverted stump has not, perhaps, escaped inversion.

Step 6. Cover all raw surfaces with peritoneum.

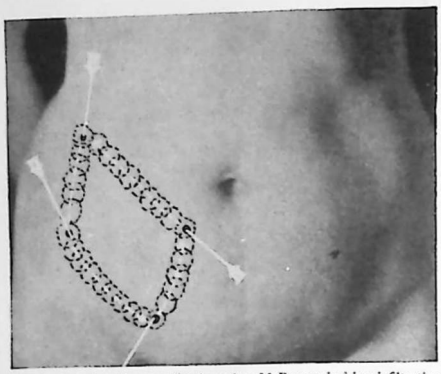


Fig. 1653. In removing the appendix through a McBurney incision infiltration anesthesia, as illustrated, is occasionally resorted to. Deep infiltrations supplement the superficial block after the incision is made.

Step 7. Replace the bowel into the abdominal cavity.

Step 8. Close the abdominal wound in layers. Dress the wound.

Acute Appendicitis

The rule I adopted, based on the statistics of careful observers and experienced surgeons and my own studies, is as follows: As soon as the diagnosis of acute appendicitis is made, regardless of its type, the appendix should be removed, the sooner the better. This rule, however, applies to the first 72 hours. After that, the delayed (Ochsner-Sherron) treatment of conservatism should be practised.

Step 1. Anesthesia and incision as before; occasionally block anesthesia is used. (Fig. 1653.)

Step 2. Remove accumulated fluid with the suction apparatus. Pack off the general peritoneal cavity with gauze lap sponges, leaving the field of operation well isolated. Excessive sponging does more harm than good. During the early hours of peritoneal inflammation the accumulated fluid is made up largely of serum rich in antibodies and leukocytes. Later the fluid becomes

turbid owing to dead tissue elements and bacteria. This should be removed by suction. The important thing is to have the general peritoneal cavity well walled-off.

Step 3. Delivery of the appendix. (See p. 1472. Step 2.)

Step 4. Ligate the meso-appendix as described above. If the mesenteriolum is gangrenous, the suture will cut out. Careful hemostasis with sutures (not ligatures) is essential.

When the appendix has sloughed off, thrombosis of the vessels in the mesenteriolum is so marked that no bleeding will be encountered. Retracted bleeders should be sought out and ligated.

Step 5. Removal of the appendix from point to base or in a retrograde manner should now be done as described above. Should these cases be drained? I have adopted the following practice: If the amount of fluid is inconsiderable and the visceral peritoneum only slightly altered (congestion, luster) I close the abdomen. In the majority of cases, however, when the fluid is turbid and the peritoneum has lost its luster, or when the appendix has ruptured during its removal and its contents soiled the peritoneum, I drain.

When conditions in the next day or two are promising and drainage is slight I remove the drain with no appreciable delay in the convalescence.

At the Cook County Hospital, in Chicago, some surgeons of the staff (Karl Meyer, Raymond McNealy and others) often omit drainage and obtain excellent results. Meyer

1. removes the appendix.
2. mops up the accumulated fluid and
3. closes the peritoneum.

Raymond McNealy proceeds as outlined but does not close muscle, fascia or skin. He sutures the peritoneum only and permits the rest of the abdominal wall components to fall evenly together. The results leave nothing to be desired.

Despite these excellent results, however, when confronted with similar conditions, a subconscious dictum always seems to admonish me: "If you are in doubt; drain!"

ACUTE APPENDICITIS WITH ABSCESS·

Ubi pus ibi evacuo, holds as good today as on the day when it was first uttered. Yet, small collections of pus without marked physical manifestations may be permitted to be resorbed without surgical interference, under watchful expectant care. But such expectant treatment must be, as Bailey aptly puts it, "carried out by the surgeon himself on the threshold of the operating theater."

Indications for drainage.

1. The abscess does not decrease after a week but remains stationary.
2. There is a sustained hectic temperature with marked systemic manifestations.
3. Fluctuation is present. (Do not wait for fluctuation to appear.) Be guided by the size of the accumulation and general symptomatology.
4. Pelvic abscess develops.

Do not omit rectal examination! Valuable information is thus gained.

Appendicular abscesses vary in position depending upon the position of the appendix. Moynihan has operated for appendicular abscess on the left side.

Fixed, hard masses, akin to those encountered in a "frozen pelvis" are better left alone and should be treated by what Bailey aptly terms "masterly expectancy."

Anesthesia. Infiltration or nitrous oxide-oxygen will usually suffice.

Incision. This should be made over the most prominent part of the accumulation of pus, no matter where located (retrocecal, retrocolic, subphrenic, etc.). This rule should be strictly adhered to. A finger should be introduced into the opening made and the abscess cavity explored. Pelvic and laterocolic extensions are thus discovered and properly treated. If the general peritoneal cavity has inadvertently been opened, close it at once and pack the area away, insuring freedom from contamination during the evacuation of the pus. A lateral approach is desirable, for if the omentum be overlying the mass, severe hemorrhage may result from injury to the omental vessels. In exploring an abscess cavity it must be remembered that the greatest care is to be taken to avoid breaking down protecting adhesions. Evacuation of the pus should be accomplished by the use of a good suction apparatus. Should the appendix be removed? If encountered and easily brought to the surface, it should be removed. If its isolation and delivery are beset with difficulties, leave it alone (Fig. 1655b).

After evacuation of the pus, drainage is to be instituted which must be thorough. Properly placed drainage tubes are ideal for the purpose, for upon thorough drainage depends the success of the operation. If the abscess extends laterally and upward, counter-drainage through the loin for laterocolic or retrocolic accumulations should be done: rectal or vaginal drainage may be indicated.

Do not be in a hurry to remove drainage tubes. Disregard of this rule may lead to a premature closure of the wound with reformation of the abscess.

Retrocecal abscesses often assume large proportions. They may be approached as follows:

Extraperitoneally (Figs. 1654 a, b; 1655 a). To reach the extraperitoneal cellular tissue the incision is made a finger's breadth above Poupart's ligament and gradually deepened until the abscess cavity is reached without endangering the peritoneum.

Where a Pelvic Abscess Has Developed

It may be approached in the male

Through the rectum (Fig. 1656);

In the female, through the vagina (see posterior colpotomy). The suprapubic approach to a collection of pus in the pelvis is always preferable to evacuation of the purulent collection through the rectum. The latter is a blind procedure, the former more exact. To utilize the rectal approach the surgeon must be thoroughly convinced that the diagnosis is correct and that he is not dealing with conditions that simulate collections of pus in the pelvis (distended bowel in the male, adnexal collections in the female). If the diagnosis is doubtful, approach through the abdomen and ascertain whether the mass is thoroughly walled-off and whether it communicates with the general peritoneal cavity.

Lithotomy position. Dilate the anus, fully. Outline by palpation the projecting mass and ascertain its point of fluctuation. Incise the rectal mucous membrane; through the incision thus made, perforate the intervening tissues with a blunt dissector or artery forceps (Fig. 1656). As soon as the abscess is reached

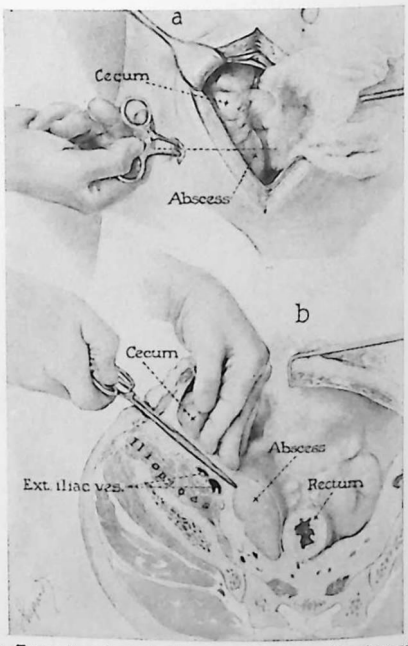


Fig. 1654. Transperitoneal approach with extraperitoneal evacuation of appendiceal abscess. If the abscess is found accessible by an extraperitoneal route, a small incision is made in the right loin lateral to the first. Through this secondary incision a hemostat is inserted until the abscess is reached. The hemostat is guided visually and manually through the abdominal incision. Contamination of the general peritoneal cavity may thus be avoided. b. Shows in cross section the anatomic relations of a.

pus will issue. Dilate the opening. Do not introduce a drainage tube. It opens an avenue for the entrance of fecal matter. Careful dilatation with the finger, as often as needed, is preferable to a tube.

When the Vaginal Route is Chosen. The same technic is employed as in posterior colpotomy (which see).

Acute Appendicitis with Progressive Fibrinopurulent Peritonitis

This form of the disease is grave from the very beginning. I have but seldom seen a recovery in this type of disease.

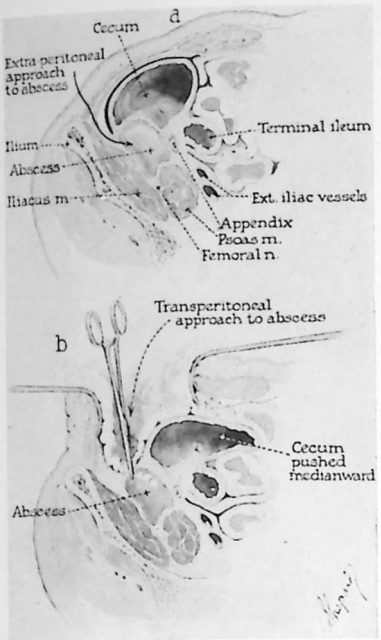


Fig. 1655. Evacuation of appendiceal abscess. a. Extraperitoneal route; b. transperitoneal route.

Explore gently.

If no difficulties present, remove the appendix. Evacuate the pus by suction. Drain.

CHRONIC APPENDICITIS

Comment: Warren H. Cole[1] points out that: "The term chronic appendicitis is inaccurate from the literal standpoint since chronic inflammation of the appendix produced by the same organisms which cause acute appendicitis is extremely rare. However, because of common usage and the lack of a better term it may be applied to such conditions as fecaliths, strictures and kinks due to adhesions, all of which lesions may produce mild chronic pain in the right lower quadrant. The actual number of cases of chronic appendicitis is considerably smaller than generally appreciated. An enormous amount of difficulty may be experienced in arriving at a correct diagnosis because of the paucity of manifestations and the similarity of the symptoms to those caused by many other diseases. For this reason, a thorough examination of the patient is necessary. When operation is performed, the incision must be made near the midline and large enough to allow a thorough exploration of the abdominal cavity."

[1] Jour. Miss. State Med. Ass'n, Sept., 1935.

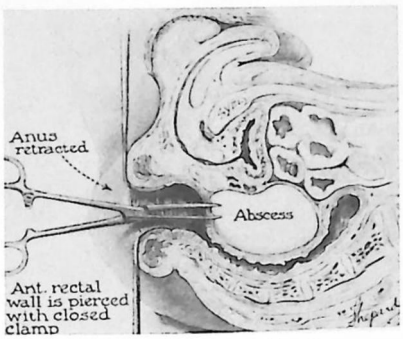


Fig. 1656. Pelvic abscess in male opened into the rectum.

SURGERY OF THE RECTUM AND ANUS

Anatomic Considerations. Cancer of the rectum may involve any portion of the terminal bowel. It is most frequent at the rectosigmoid junction; it is found next in frequency in the ampulla and least in the anal portion. It is essential to thoroughly understand the blood and lymph supply, as well as the anatomic peculiarities of the region in question.

Blood Supply of the Rectum (Figs. 1657-1658). Arteries. The inferior mesenteric artery gives rise to the superior hemorrhoidal which runs in the pelvic mesocolon and divides opposite the junction of the pelvic colon with the rectum into two branches which pass downward along the walls of the rectum. The middle hemorrhoidal (2) derived from the internal iliac, and the inferior hemorrhoidal (2) which are derived from the external pudic. Occasionally an additional supply is derived from the sacra media.

Veins. The veins of the rectum show a marked disposition to the development of varices (hemorrhoids) near the anus. The veins lie in the loose submucous tissue between the muscular layer and the mucocutaneous surface. From here they ascend

in the columns of Morgagni to form a dense plexus in the lower part of the ampulla, in the so-called "pile-bearing area." The vessels issuing from the plexus penetrate the muscular wall to unite and form the superior hemorrhoidal veins.

Nerve Supply. This is derived from the hypogastric and sympathetic plexuses and the second, third and fourth sacral nerves.

Lymphatics. These are: (a) Intramural and (b) extramural. The intramural lymph vessels communicate with a lymph sinus which lies between the wall of the rectum and the surrounding fat. The extramural vessels pass (1) across the ischiorectal fossa to the internal iliac lymph nodes; (2) across the upper surface of the

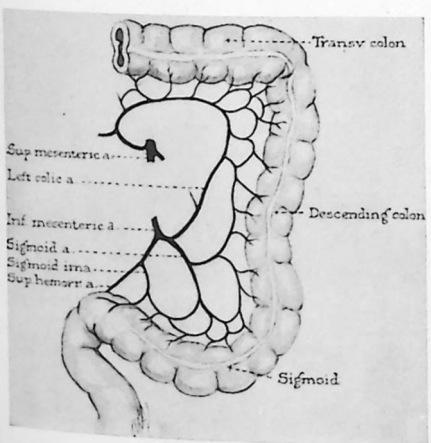


Fig. 1657. Blood supply of the lower segments of the large bowel.

levator ani to the internal iliac glands; (3) posteriorly to the nodes behind the rectum (sacral lymph nodes); (4) upward along the superior hemorrhoidal vessels to the pelvic mesocolon and onward to nodes at the bifurcation of the left common iliac artery, and thence to the lymph nodes along the big vessels up to the nodes at the origin of the superior mesenteric artery.

Extension of carcinoma of the rectum is by the lymphatics. W. E. Miles describes three zones of spread: (a) Zone of downward spread involving the perianal skin, the ischiorectal fat and the external sphincter ani; (b) Zone of lateral spread involving the levator ani muscles, the sacral and internal iliac lymph nodes, the base of the bladder and the seminal vesicles. In women the posterior vaginal wall, the cervix, and base of the broad ligament also are involved. Miles mentions especially a lymph node situated on the uterine artery where it crosses the ureter, the so-called Poirier's gland. This is often involved in carcinoma of the rectum. (c) The zone of upward spread involves the pelvic peritoneum, the whole of the pelvic mesocolon and the nodes at the bifurcation of the left common iliac artery.

PROCTOSCOPY AND SIGMOIDOSCOPY

The proctoscope or sigmoidoscope is very useful in examining the sigmoid flexure and rectum in cases of affection of the lower bowel (colitis, polyposis, malignancy, etc.); it may also be useful in revealing the source of hemorrhage which cannot otherwise be determined. The instrument is made up of a rather long metal tube with a bulbous end into which a rounded metal obturator is fitted which facilitates the entrance of the instrument into the bowel (Figs. 1659-1660-1661).

After the sigmoidoscope has been inserted into the bowel, the obturator is withdrawn and the eyepiece, which is equipped with a light bulb and a nozzle for connection with bellows, is placed in position. The lumen of the bowel is thus effectually illuminated, making possible satisfactory examination. The bellows is used to inflate the bowel in cases where it is desirous to efface the intestinal folds.

If the patient is excessively nervous, a general anesthetic may be administered for this examination. Under usual conditions no anesthetic is necessary.

Much experience is necessary in order to correctly interpret the findings revealed during such examination and the information gained is most helpful.

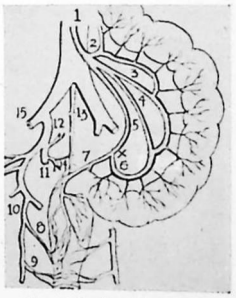


Fig. 1658. The blood supply of the sigmoid flexure and rectum. (After Fischer). 1. Origin of the inferior mesenteric artery from the aorta; 2. left colic artery; 3. sigmoid artery; 4. sigmoid artery; 5. superior hemorrhoidal artery; 6. represents the last arcade-sigmoidea ima artery; 7. point of division of the superior hemorrhoidal artery; 8. middle hemorrhoidal artery; 9. inferior hemorrhoidal artery; 10. pudic artery; 11. gluteal artery; 12. hypogastric artery; 13. sacra media artery; 14. lateral sacral artery; 15. external iliac artery; x. the critical point of Sudeck.

LOCAL ANESTHESIA IN OPERATIONS ON THE RECTUM AND ANUS

Direct infiltration anesthesia has many advantages over sacral block (such as change of position of the patient, frequent failure of entering the sacral canal, toxic symptoms, broken needles, etc.).

Begin to inject the anesthetic fluid by marking a wheal near the anal margin and proceed to infiltrate the tissues as shown in Figs. 1662-1663-1664-1665. Make sure that no vein is entered during the infiltration (subdermal or deeper). A diamond-shaped, anesthetized zone results. Through this area introduce the needle at right angles to the skin surface and parallel to the wall of the rectum depositing a wall of infiltration fluid about the lower end of the rectum. With the finger above the internal sphincter muscle as a guide and with the aid of long needles (7-10 cm. long, 22 gauge) excellent anesthesia is usually obtained all around the rectum. Keep the needle constantly moving while the anesthetic

fluid is injected. While the anesthetic should be deposited all around, in the anterior quadrant little solution is required.

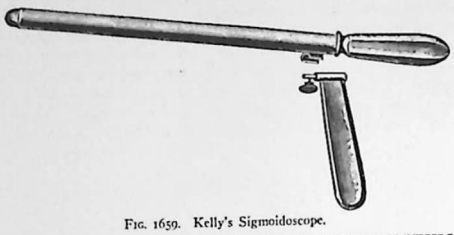


Fig. 1659. Kelly's Sigmoidoscope.

AMPUTATION AND RESECTION OF THE RECTUM

Terminology. When the rectum, including its anal portion as well as the rectoperineal musculature is removed, we speak of an amputation of the rectum.

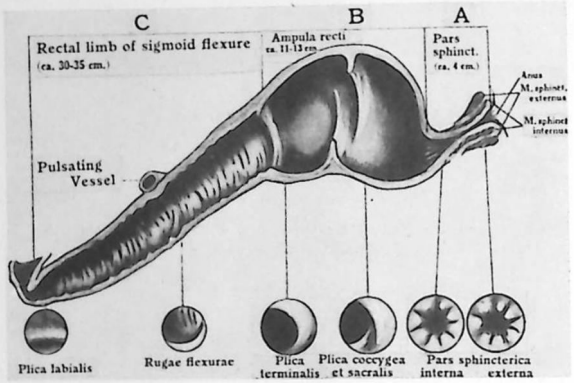


Fig. 1660. Diagrammatic representation of proctoscopic examination. (After Hermann Strausz). A, B and C, the divisions of the rectum. Below, the proctosigmoidoscopic appearance at various levels of the terminal of the intestinal tube.

When the sphincters are retained and the continuity of the bowel is restored, resection is spoken of. The methods of procedure in these operations are:

1. Perineal Method.
2. Dorsal Method.
3. Combined Methods.

PERINEAL METHOD

(Lisfranc, Dieffenbach, Lockhart-Mummery)

Step 1. Place the patient in the lithotomy position. General or spinal anesthesia, preferably the latter.

Fig. 1661

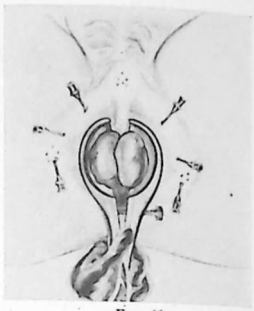


Fig. 1662

Fig. 1661. Indirect inspection of the rectum. Note that the thighs are perpendicular to the table.
Fig. 1662. Infiltration anesthesia in hemorrhoidectomy.

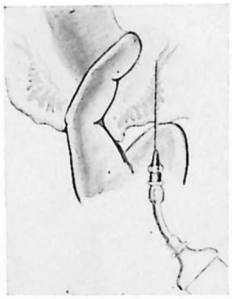


Fig. 1663

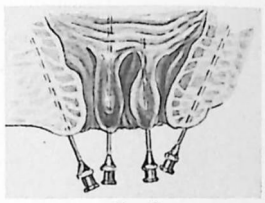


Fig. 1664

Fig. 1663. Diagrammatic drawing showing penetration of needle in infiltrating deeper tissues in hemorrhoid operations. Note that the index finger is above the internal sphincter. The infiltrations are made clear around. Note points of entry in the previous illustration.
Fig. 1664. Infiltration anesthesia in hemorrhoidectomy. Note position of needles. Longitudinal section.

Step 2. Introduce a catheter into the bladder. Pack the ampulla of the rectum and pass a purse string suture around the anus.

Step 3. Make an incision (Fig. 1666 a. 1, 2, 3, 4) encircling the anus and extending in front along the median raphé of the perineum about the bulb of the

urethra and in the back to the coccyx. Resect the coccyx if more space is needed. Divide the central tendon, the sphincters and fasciae on both sides of the rectum. Expose and divide the levator ani muscles.

Step 4. Doubly ligate and divide the inferior hemorrhoidal arteries. Divide (through the central tendon transversely) the connections between the sphincter ani, the transversus perinei and bulbo-urethralis muscle. Separate the internal sphincter from the levator ani. Pull the anus toward the left side of the patient. Expose the fascia pelvis parietalis by splitting the posterior fibers of the levator ani muscle. Separate the muscular attachments from the coccyx and divide the anococcygeal ligament. Split the pelvic fascia (fascia pelvis parietalis) in the direction of the division of the levator ani. Repeat the procedure on the opposite side. The anal portion of the lower bowel is now considerably freed. Displace it upward.

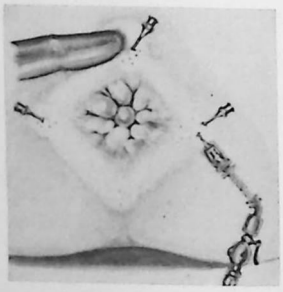


Fig. 1665. Local anesthesia in hemorrhoid operation. Note position of needles and point of entry for subdermal circumferential infiltration.

Step 5. Divide the anterior fibers of the levator ani muscle and the fibrous structures which extend from the rectum toward the bulb and membranous portion of the urethra. Pull the rectum downward. Dissect the bowel sharply, under guidance of the catheter and the finger which palpates the prostate, membranous urethra, seminal vesicles and the urethral bulb.

Step 6. Dissect (bluntly), with the finger, the pelvic portion of bowel (anteriorly). Keep dissecting upward, until the rectovesical reflection of the peritoneum is recognized. Open the rectovesical space. Displace the rectum upward. Dissect (bluntly) between the posterior wall of the rectum and the hollow of sacrum. Ligate and divide the lateral attachments to the rectum carrying the middle hemorrhoidal vessels (not shown in the illustration). Avoid entering the rectum (Fig. 1666 b, 5).

Step 7. Ligate the superior hemorrhoidal vessels running close on the posterior wall of the rectum. Open Douglas' space. Pack the protruding small intestines out of the way. Remove accessible fat and enlarged lymph nodes. The rectum must be mobilized sufficiently to permit it being attached finally to the skin margins without tension.

Step 8. Attend to hemostasis. Remove the packs. Unite the peritoneum to the anterior wall of the rectum with interrupted sutures. (Fig. 1667 a, b.) Clamp and remove the rectum at a distance from the tumor. Ligate all bleeding vessels thoroughly. Obliterate dead spaces. Attach the end of the bowel to the skin edge with interrupted sutures. An alternative method (Fig. 1667 c) consists of suturing the rectum to the fascia at the left of the

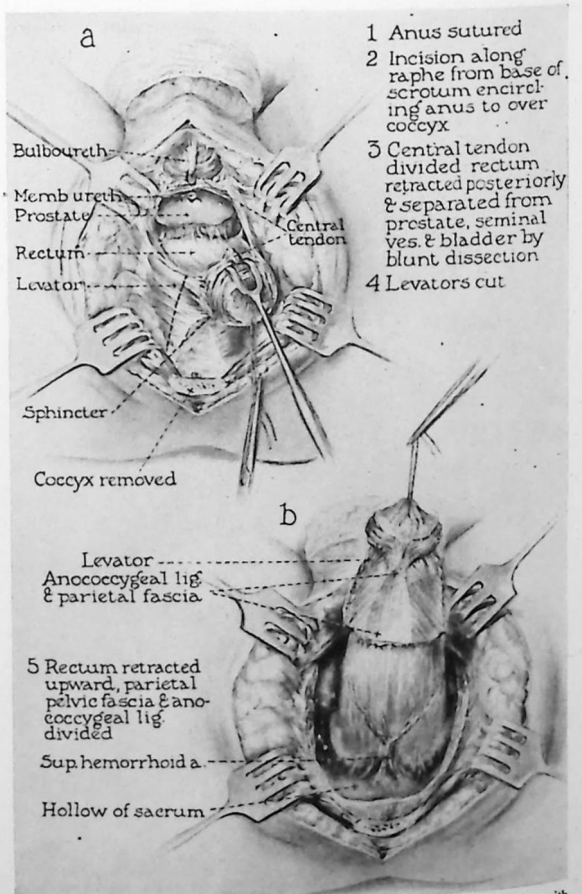


Fig. 1666. Perineal method of amputation of the rectum. Study legends on illustration with steps of operation described in text.

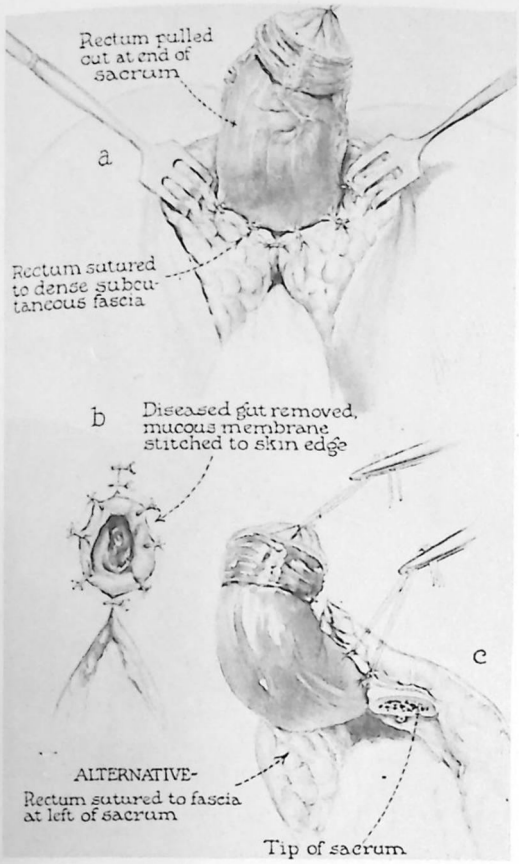


FIG. 1667. Final steps in the perineal method of amputating the rectum. Compare legends with text.

sacrum. In women, the operation is much facilitated for anatomic reasons (short urethra, roomy pelvis).

Difficulties and Dangers. Always mobilize the bowel thoroughly. If the peritoneum is not opened mobilization is difficult, while opening the peritoneum permits effective mobilization. Hemostasis in the depths of the wound is often a difficult matter. Careful dissection and identification of the structures is of paramount importance. In separating the bowel, be gentle and keep close to the sacrum. Avoid injury to the blood vessels supplying the segment of bowel remaining by abstaining from rough handling of the tissues. Injury to the blood supply will cause sloughing. Do not permit hemostats to remain attached to blood vessels while proceeding

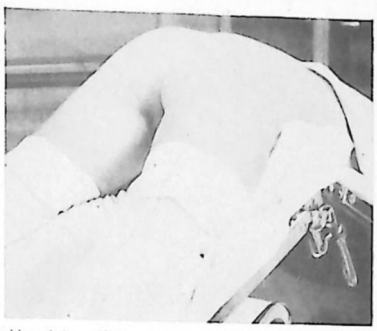


FIG. 1668. Position of the patient on the operating table for removal of the rectum by the sacral route (Depage-Völcker position).

with the operation. Ligate as you go along. Careful dissection will avoid injury to the bladder, prostate, seminal vesicles, ureters and urethra.

Dorsal Method

(Kraske)

This operation may be performed as a one-stage operation in the form of a resection or an amputation (usually an amputation) with the formation of a sacral anus. Many surgeons, including the author, perform a combination two-stage operation. The latter will be described. Occasionally a third-stage operation may become necessary. This is the case when a double-barreled artificial anus is established and the distal short blind segment of bowel remains in the body permanently since it is not possible to remove the sigmoid up to the colostomy by the dorsal route. Usually this section of bowel causes no trouble. However, if it becomes desirable to eliminate it, this may be accomplished at a later date with facility.

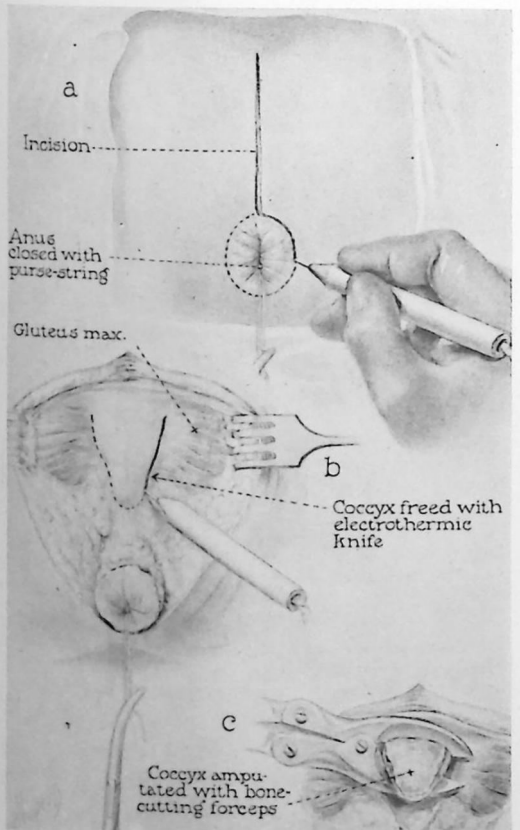


FIG. 1669. Removal of carcinoma of rectum by the dorsal (Kraske) method. a. The anus is closed with a purse-string suture of braided silk or silkworm gut. The incision is made with the scalpel or diatherm knife. It circumscribes the anus and is made to extend over the coccyx and lower sacrum. b. The soft tissues are dissected laterally until the sacrosciatic ligaments are exposed. Free the coccyx from its attachments. c. Amputate the coccyx with bone-cutting forceps.

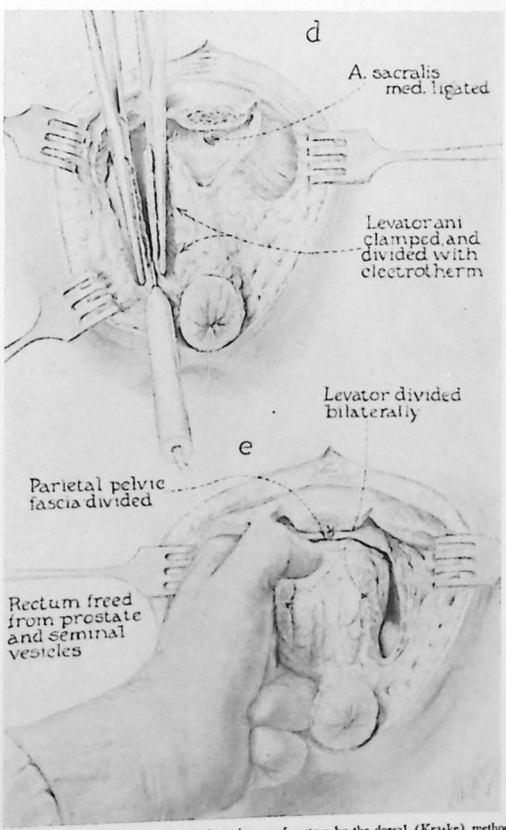


FIG. 1669 (continued). Removal of carcinoma of rectum by the dorsal (Kraske) method. d. Ligate sacra media artery. If that is not easily accomplished a hot compress pressed against it will cause hemostasis from this source. The fascia pelvis parietalis and levatores ani muscles are clamped and divided as far from the median line as possible and to the top of the internal sphincter muscle. e. Both levatores have been divided, the transverse incision made in the fascia pelvis visceralis (fascia propria) is shown joining the two lateral incisions. Through a line of cleavage (*zone décollable*) the anterior surface of the rectum is freed from the prostate and seminal vesicles and urethra in the male and cervix and vagina in the female.

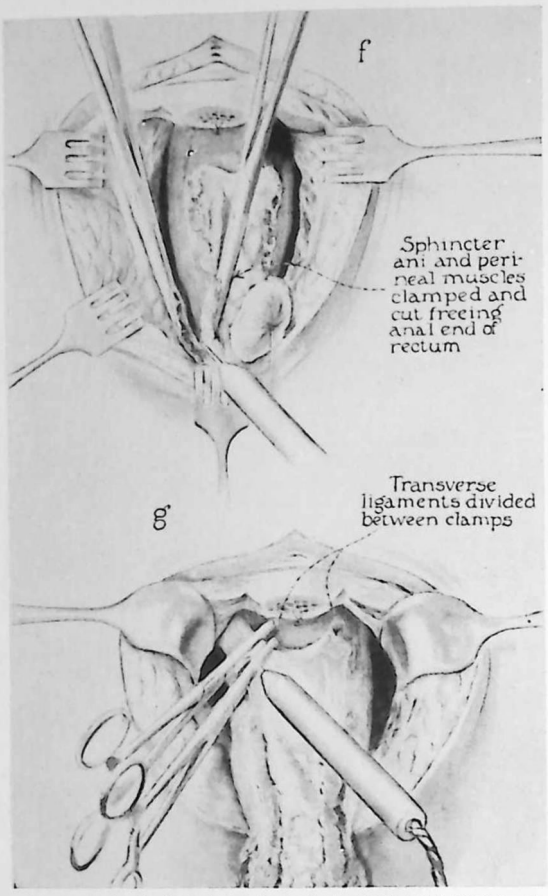


Fig. 1669 (continued). Removal of carcinoma of rectum by the dorsal (Kraske) method. f. The sphincters and perineal muscles are being clamped and divided. The anal end of the rectum is thus liberated from its attachments. g. Transverse fascial bands carrying the middle hemorrhoidal vessels are clamped and divided.

FIRST STAGE

This consists of an abdominal exploration and making a permanent colostomy (see page 1382).

SECOND STAGE

The second stage of the operation may be performed by sharp dissection or by electrosurgical means. In the latter event the diatherm knife is substituted for the scalpel and most of the blood vessels (with the exception of the superior and middle hemorrhoidal vessels) are electrocoagulated instead of ligated (consult illustrations and legends for details).

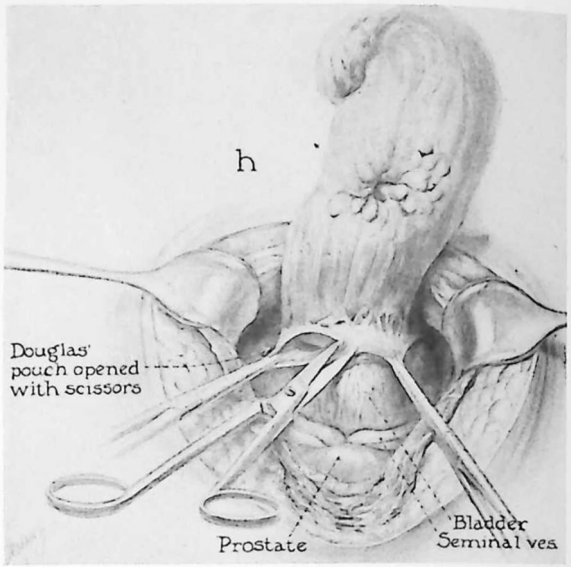


Fig. 1669 (continued). Removal of carcinoma of rectum by the dorsal (Kraske) method. h. The freed bowel is wrapped in a compress (not shown in the illustration) and displaced over the sacrum. The reflected peritoneum on its anterior surface is opened with scissors (Pouch of Douglas). Avoid the ureters.

Step 1. Introduce a catheter into the bladder. Leave it there throughout the operation and as long postoperatively as deemed necessary.

Depage-Völcker Position. This consists of placing the patient on the abdomen with the head lowered, the pelvis elevated and the thighs lowered and separated (Fig. 1668).

Step 2. Anesthesia. Spinal.

Step 3. Close the anus with purse string suture (Fig. 1669 a).

Step 4. The incision surrounds the anus and extends along the coccyx and over the lower part of the sacrum. Separate the soft tissues laterally.

Step 5. Dissect the coccyx and (Fig. 1669 b) the glutei maximi muscles from their attachments until the sacrosciatic ligaments appear.

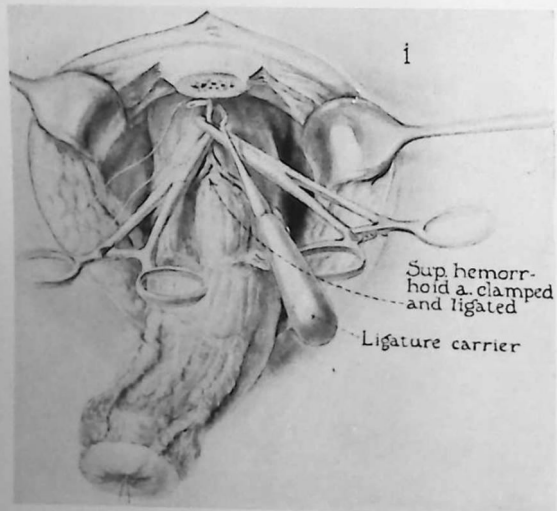


Fig. 1669 (continued). Removal of carcinoma of rectum by the dorsal (Kraske) method. i. Separate the rectum further from the anterior wall of the sacrum. *Ligate the superior hemorrhoidal vessels.* Remove all accessible lymph nodes and fat along the vessel.

Step 6. The coccyx is freed from its attachment with rongeur forceps (Fig. 1669 c) and removed. If necessary, one or two lower sacral vertebrae are taken away by means of a sharp chisel and hammer.

Step 7. Ligate the sacra media artery. If that be difficult a hot pack will usually suffice to arrest the bleeding from this source. If the growth is extensive or the operation threatens to be a difficult one, unilateral division of the sacrosciatic ligament will afford additional space.

Step 8. Clamp and divide the levator ani, and the fascia pelvis propria from above downward (Fig. 1669 d) as far from the median line as possible. Extend this incision to the top of the internal sphincter muscle.

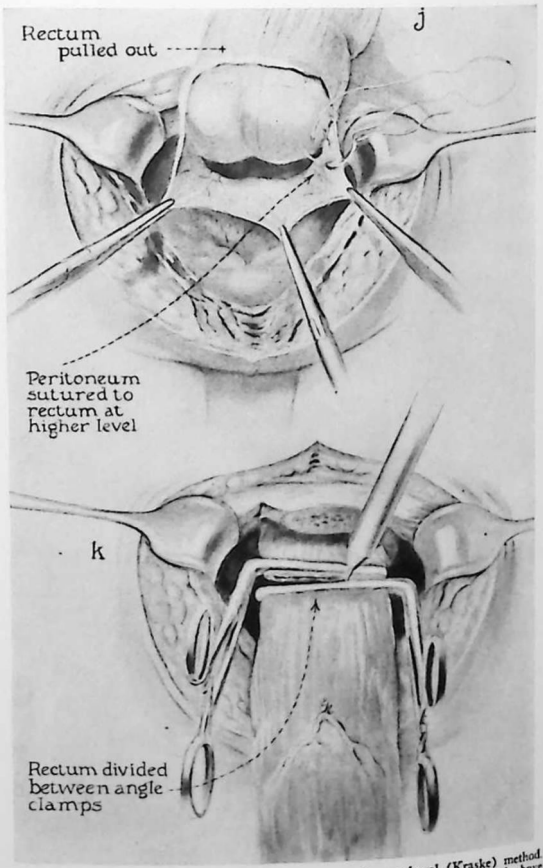


Fig. 1669 (continued). Removal of carcinoma of rectum by the dorsal (Kraske) method. j. Peritoneum is reattached to the anterior surface of the remaining segment of bowel above the proposed line of division. k. The rectum is divided between two right-angled clamps, with knife or the diatherm.

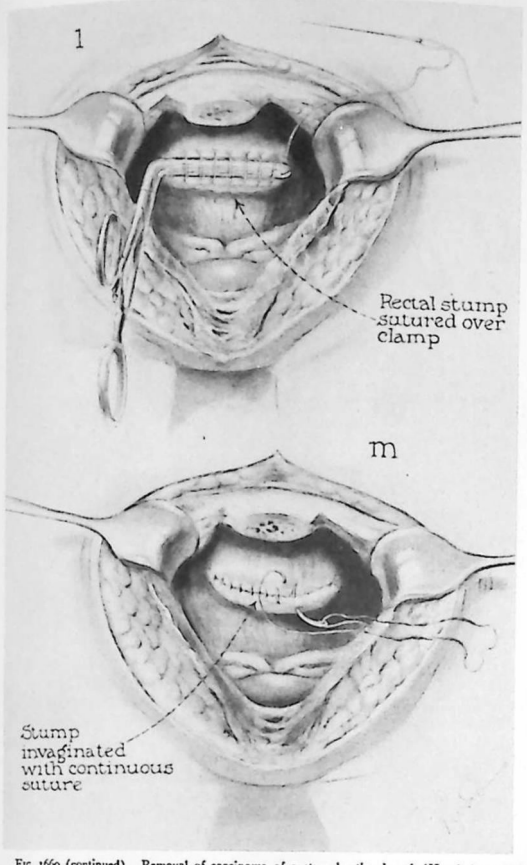


Fig. 1669 (continued). Removal of carcinoma of rectum by the dorsal (Kraske) method. l. The rectal stump is sutured over the clamp (catgut, Pagenstecher linen or silk). m. The rectal stump is invaginated. Over this the suture line is reinforced by a superimposed suture line of catgut which may be either continuous or interrupted.

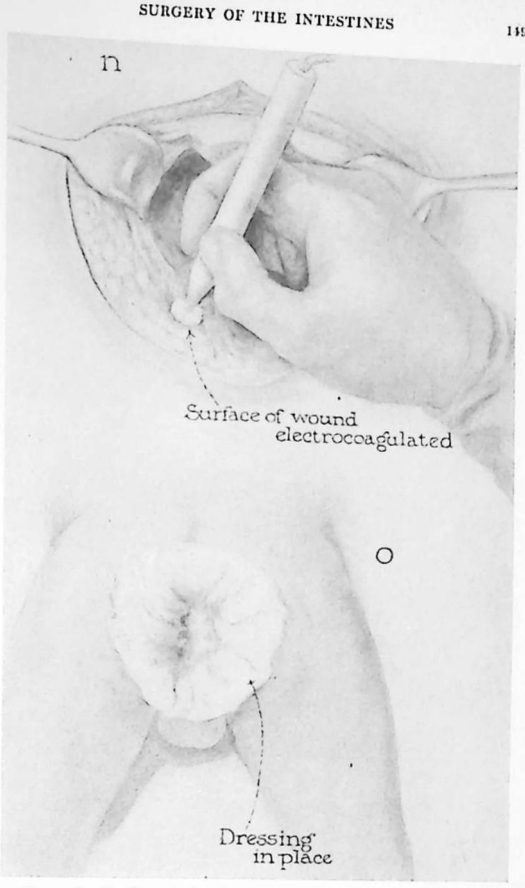


Fig. 1669 (continued). Removal of carcinoma of rectum by the dorsal (Kraske) method, n. The wound surfaces are electrocoagulated to a depth of 2-4 mm. o. Mikulicz tampon.

Step 9. Incise the fascia pelvis visceralis (propria) transversely, joining the two lateral incisions dividing the levator ani muscles (Fig. 1669 e).

Step 10. Obtain a line of cleavage and endeavor to reach the anterior surface of the rectum. Separate it from the seminal vesicles, prostate and urethra (uterus and vagina in the female). In order to accomplish this the fascia propria must be divided longitudinally. Pull the rectum to one side. Identify in the depth, the natural line of division between the prostate and the rectum. The prostatic plexus of veins is here recognized. In this space (zone décollable) blunt separation of the entire circumference of the rectum is accomplished. The separation is continued upward and downward.

Step 11. A gauze sling is now made to surround the freed portion of the rectum which acts as a tractor to displace the bowel in the manipulations to follow (not shown in illustrations).

Step 12. The rectum is now freed from its anterior attachments (posterior wall of the vagina in the female; prostate and seminal vesicles in males).

Step 13. Free the end of the rectum from the sphincter ani and perineal muscles (Fig. 1669 f). Continue the dissection carefully.

Step 14. Isolate, ligate and divide the transverse fascial bands carrying the middle hemorrhoidal arteries (Fig. 1669 g). One should pay particular attention to the firm union between the membranous urethra and the rectum. The indwelling catheter is of help in protecting these structures.

Step 15. Wrap the distal end of the rectum in a compress. Displace it over the sacrum. On its anterior surface the reflected peritoneum is noted (Fig. 1669 h).

Step 16. The cul-de-sac of Douglas is opened. In so doing avoid the ureters.

Step 17. If the carcinoma is limited in extent the freed bowel may now be ablated. In most instances, however, it becomes necessary to bring the bowel further down. To accomplish this, separate the bowel further from the anterior wall of the sacrum to about the height of the sacral promontory. Ligate the superior hemorrhoidal artery, high up (Fig. 1669 i). This vessel is recognized coursing along the posterior wall of the rectum. Thoroughly remove the lymph nodes and fat along with the vessel. Division of the superior hemorrhoidal artery permits the bowel to further descend for a considerable distance.

Step 18. Reattach, with interrupted sutures, the peritoneum to the bowel, above the point of proposed division (Fig. 1669 j).

Step 19. Divide the bowel with the cautery between two right-angled clamps (Fig. 1669 k).

Step 20. Close the end of the proximal loop of the bowel with a running catgut suture (Fig. 1669 l).

Step 21. Invaginate and reinforce the end of the bowel by a superimposed line of catgut sutures (Fig. 1669 m).

Step 22. Peritonealize. Dissect or destroy by electrocoagulation suspicious areas of fat, lymph nodes, etc., in the ischiorectal fossae and wherever encountered (Fig. 1669 n).

Step 23. Mikulicz tampon (Fig. 1669 o).

Step 24. Apply voluminous dressings.

Dorsal Resection of Bowel for Carcinoma

This operation is begun and carried out as described in the previous procedure (amputation) until the rectum carrying the tumor is thoroughly mobilized and sufficient tissue is freed above and below the neoplasm to enable the surgeon to join both ends of the bowel after the diseased segment has been removed.

Clamp the segment carrying the neoplasm above and below the tumor. Cleanse (iodine) both ends of the bowel to be joined. Circular end-to-end anastomosis. The sutures (first row) if they be interrupted, must not be tied too tightly in order to avoid circulatory disturbances. The superimposed serosa suture is of the Lembert type. Unite the soft structures over the anastomosed bowel.

Difficulties and Dangers. Anatomical: Narrow pelvis (male) short mesocolon.

Pathological: Sepsis, hemorrhage, injury to the ureter (especially the left).

COMBINED ABDOMINOPERINEAL OPERATIONS

One stage; Two stage.

Types: (a) abdominodorsal; (b) abdominovaginal; and (c) abdominoperineal.

ONE-STAGE ABDOMINOPERINEAL OPERATION

Step 1. Anesthesia. Spinal or general. Place the patient in Trendelenburg position.

Step 2. Incision. Left paramedian, from symphysis to above umbilicus (Fig. 1670 a). Explore. Pack the small intestines out of the pelvis. Explore again thoroughly. Only large bowel should remain in the field of operation.

Step 3. Deliver the sigmoid and rectum and put them on tension. Adhesions are almost always found to exist in the region of the left side of the pelvic mesocolon and the left iliac parietal peritoneum. These should be divided.

Step 4. Incise the parietal peritoneum along the border of the large bowel. Make the incision encircle the rectum at the culdesac of Douglas. Displace the bowel toward the left side.

Step 5. Ligate the superior hemorrhoidal artery, a little above the promontory of the sacrum at the level of the bifurcation of the aorta. The artery should be ligated below the origin of the sigmoid artery which is to be carefully preserved because the vessel is to supply that loop of the sigmoid which is to be used for the establishment of a permanent colostomy.

Step 6. Incise the peritoneal sheath and the mesentery of the rectum on the median side and close to the bowel. This incision is to meet the first one.

Step 7. Separate the bowel, with the hand in the hollow of the sacrum, down to the perineum.

Step 8. Separate the bladder from the rectum, anteriorly.

Step 9. Ligate and divide the middle hemorrhoidal arteries.

Step 10. Pull up the sigmoid and divide it between clamps with a cautery at its middle.

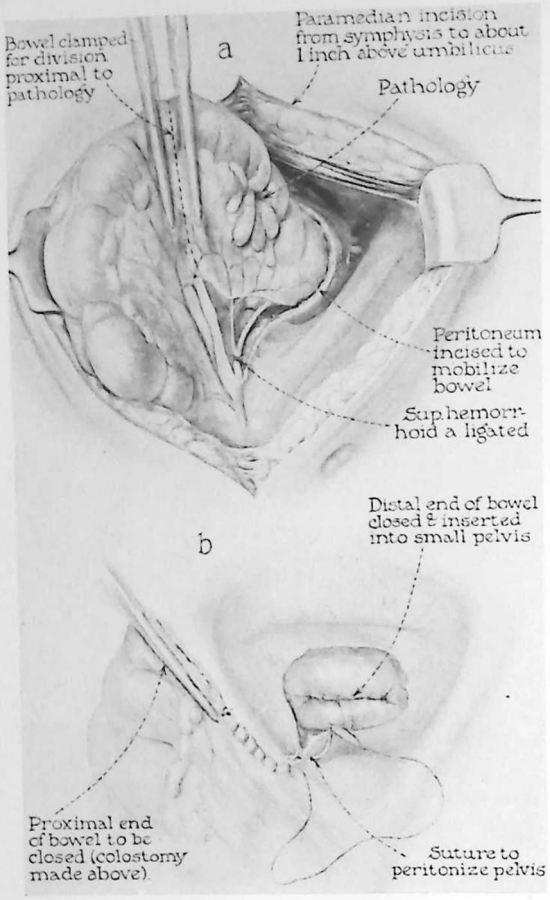


FIG. 1670. Combined abdominoperineal resection of rectum. First stage.

Step 11. Close the distal end of the bowel with continuous catgut or linen sutures (Fig. 1670 b).

Step 12. Superimpose another purse-string suture and invert the stump.

Step 13. Drop the mobilized segment of rectum into the hollow of the sacrum. Suture the peritoneum over it.

Step 14. The clamped proximal end of the bowel is utilized for a permanent colostomy.

The permanent colostomy is made through a stab wound through all the layers of the abdominal wall. Through this opening the proximal end of the divided bowel is passed. It is attached to the skin. The sutures anchoring this end of the bowel should pass through the skin and pick up the taeniae longitudinalis.

Step 15. The abdominal wound is closed in the usual manner.

Step 16. The patient is now turned over on the abdomen (reversed Trendelenburg position) and the perineal part of the operation is performed (Figs. 1668-1669). The bowel should be thoroughly mobilized by now and found free posteriorly and on each side, the middle hemorrhoidal vessels having been divided with the lateral ligaments.

Step 17. Close the anus with a purse string suture.

Step 18. Encircle the anus by an incision which should extend above the sacrococcygeal joint.

Step 19. Remove the coccyx.

Step 20. Divide the levator ani muscles.

Step 21. Incise the fascia propria transversely.

Step 22. Extend the incisions longitudinally along the sides of the rectum and find a line of cleavage (zone décollable).

Step 23. Find your way to the hollow of the sacrum. Here the extraperitonealized and mobilized bowel is found.

Step 24. Separate the bowel from the vagina or seminal vesicles and prostate, respectively.

Step 25. Divide the sphincters. (See also Perineal Proctectomy, p. 1487. Figs. 1666-1667.)

Step 26. Remove the freed segment of bowel.

Step 27. Mikulicz drain.

Two-stage Abdominoperineal Operation

While successful two-stage operations for carcinoma of the rectum show a lower mortality than the one-stage procedure, it must not be forgotten, however, that the two-stage procedure carries with it the danger of gangrene of the distal segment of the bowel as a result of interference with its blood supply (ligation of the superior hemorrhoidal artery) during the period between the first and second steps of the operation. If collateral circulation is adequate, gangrene will, of course not ensue; otherwise the detached segment is in jeopardy.

FIRST STAGE

Anesthesia. Spinal or General.

The incision is the same as in the previous operation.

Exploration. Establish operability of the tumor (degree of involvement, metastases, encroachment of tumor onto bladder or sacrum, etc.). Isolate the

FIG. 1671. Miles' one-stage operation for carcinoma of the rectum. 1. Crushing the pelvic colon at the site of election. The patient is in the Trendelenburg position. The margins of the abdominal wound are widely retracted by a self-retaining claw retractor. The pelvic colon is drawn through the wound and the distribution of the vessels in the mesocolon displayed. A crushing clamp (Miles' pattern) is applied to the part of the bowel supplied by the loop of anastomosis between the first and second sigmoidal branches of the inferior mesenteric artery.

2. Showing the crushed area of the bowel after removal of the clamp. A ligature is passed through the mesocolon close to the bowel on either side of the crushed area, and tied firmly. The interrupted line indicates the incision to be made through the crushed bowel and adjacent portion of the mesocolon.

field of operation. Put the bowel and mesosigmoid on tension. Divide the peritoneum on both sides of the mesorectum. At the level of the rectovesical reflection, incise the peritoneum transversely in front of the rectum as low as possible, joining the two longitudinal incisions previously made. Mobilize on all sides the segment of bowel to be removed. Ligate the superior hemorrhoidal artery. The artery is doubly ligated with silk and divided. The pelvic mesocolon is divided from behind forward to the edge of the bowel. Any vessels encountered in so doing are ligated and divided. The bowel and tumor are thoroughly liberated from the anterior surface of the sacrum. Include in this separation all accessible fat pads, nodes, etc. Continue the separation downward. Ligate the middle hemorrhoidal vessels, continue freeing the bowel from the seminal vesicles, prostate or vagina, respectively. Great care is to be exercised in the lateral regions of the bladder keeping in mind the possibility of injuring the ureters by careless dissection. The dissection is continued until the anterior surfaces of the levatores ani are reached.

Divide the intestine between crushing clamps. The upper segment will serve as a permanent colostomy. It is brought out through a lateral incision and the clamp left on the cut end of the bowel for two or three days, after which it is removed and the colostomy opening permitted to function. The lower end is closed by a continuous catgut suture, the end is inverted and reinforced by a superimposed seromuscular suture. The whole is now covered by peritoneum. A tube may be placed under the peritoneal covering. Close the abdomen. After a fortnight or sooner, if deemed advisable, do the

SECOND STAGE

of the operation. This consists in the perineal removal of the lower bowel. The procedure is about the same as the one described under perineal method. It is usually not difficult to deliver the upper end of the closed terminal portion of the bowel unless adhesions prevent easy access to the tumor mass.

Miles' One-stage Abdominoperineal Radical Operation for Carcinoma of the Rectum*

Step 1. High Trendelenburg position. Make an incision about one-quarter inch to the left of the middle line extending from the symphysis pubis to the umbilicus. If necessary, in stout individuals, this incision may be extended beyond the umbilicus; open the sheath of the left rectus abdominis muscle and draw the latter aside. Open the peritoneum to the entire extent of the incision.

* Brit. Jour. of Surgery, Vol. 2, No. 6, p. 292. October, 1914.

3. Treatment of the divided ends of the bowel. A haemostatic clamp is placed on the mesocolon, and an incision is made with scissors close to and parallel to the bowel for the distance of an inch. A purse-string suture is made to encircle the isolated extremity of the bowel, and the closed end is invaginated.

4. Showing complete division of the pelvic mesocolon and ligature of the inferior mesenteric artery at the seat of election. The portion of the bowel on the left-hand side is that from which the colostomy is eventually made. The incision in the peritoneum, carried forward on the left side, exposes the left ureter as it crosses the left common iliac vessels. The ureter is drawn aside while the ligature is placed around the inferior mesenteric vessels.

5. Showing the rectum and the retrorectal tissues separated from the hollow of the sacrum as far as the sacrococcygeal articulation. After ligature of the inferior mesenteric vessels, the remains of the pelvic mesocolon are divided below the ligature, and the incisions in the pelvic peritoneum are carried forward on either side along the lateral wall of the pelvis. The cellular space in front of the sacrum is opened up as far as the coccyx.

FIG. 1671 (continued). 6. Miles' one-stage operation for carcinoma of the rectum. Showing the separation of the anterior connections of the rectum as far as the upper border of the prostate, and the division of the lateral ligaments. The lateral incisions in the peritoneum have been extended on either side so as to meet in front behind the base of the bladder. The lateral ligaments have been defined as far as the upper surface of the levator ani on either side. These ligaments are then completely divided with scissors, the ureter on the left side having been drawn aside.

7. Showing method of restoring the pelvic floor in the male. A flap of peritoneum has been dissected up from the bladder and drawn backwards until it meets the cut edge of the pelvic mesocolon, to which it is sutured. On the right side the distal portion of the pelvic colon can be seen lying in the pelvic cavity below the new pelvic floor.

8. Showing method of fixing the proximal end of the pelvic colon to form the colostomy. The silkworm-gut suture at the upper angle of the wound has been passed beneath the anterior longitudinal band, and that at the lower angle has included the external longitudinal band.

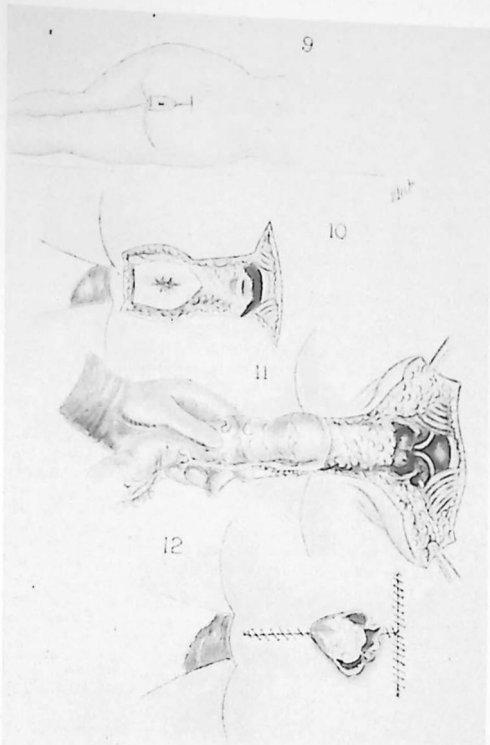


FIG. 1671 (continued). Miles' one-stage operation for carcinoma of the rectum. 9. Showing outline of the incisions in the perineal region.

10. Showing the reflection of the skin flaps and opening of the sacrococcygeal joint. When the surface incisions around the anus are deepened, as much as possible of the ischiorectal fat is included.

11. Showing the pelvic colon and the isolated upper part of the rectum withdrawn from the cavity of the pelvis. If the isolation of the rectum has been efficiently carried out anteriorly, posteriorly and laterally, the bowel can be readily withdrawn, in the manner shown, and the base of the bladder, the vesiculae seminales, with the vasa deferentia and the prostate gland are clearly exposed to view. The levatores ani are then divided close to their origin from the pelvic wall.

12. Showing the perineal wound closed, and a mass of gauze introduced in a sac of green protective, so as to support the pelvic floor. (Redrawn from The British Journal of Surgery.)

Step 2. Introduce a self-retaining retractor and retract the edges of the wound widely (Fig. 1671[1]). Explore thoroughly to ascertain the presence of palpable lymph nodes. The pelvic mesocolon should particularly be carefully examined for plaques and nodules. If present, these are most commonly found (1) along the parietal border following the course of the superior hemorrhoidal and superior mesenteric vessels; (2) along the margin attached to the colon where the paracolic lymph nodes exist and (3) anywhere in the substance of the mesentery itself. When such nodules are present, it is better to look upon the case as inoperable because recurrence is almost certain. Of course, the absence of visible or palpable nodules does not necessarily mean that metastases have not already taken place which are of microscopic size. Nevertheless, even in such contingency an extensive removal of the mesocolon may still succeed in eradicating the disease. On the other hand, Miles points out, a visible spread may exist and the widest possible excision may not get beyond the area of microscopic extension in an upward direction. Also, exploration of the liver is not of much value because where macroscopic metastatic disease of the liver exists, there is almost always obvious extramural carcinosis in the pelvis or in the pelvic peritoneum. Observe the position of the malignancy in the bowel wall. If situated in the anterior wall of the bowel, particular attention should be paid to possible involvement of the bladder in the male or of the posterior wall of the vagina in the female. In such instances, Miles considers the case as inoperable because where the bladder is involved it is impossible to remove the growth completely and if the vagina is the seat of carcinomatous involvement, the additional removal of the uterus and posterior wall of the vagina is too much for the patient to endure. Miles has resorted to such procedure in three cases and all three patients died. The pelvic cavity must be freed from small intestines. Difficulty arises in the operative manipulations by reason of the presence of the small intestines. All of the small intestines is pulled out through the incision and is permitted to hang down outside of the abdomen after being covered by a Cripps abdominal swab wrung out of warm salt solution which should be changed frequently to keep the intestine moist. Miles says "I have done this on a great many occasions and I can confidently say I have never seen any harm result therefrom either from the intestine losing temperature or from its becoming temporarily congested on account of its position."

Step 3. The Pelvic Operation. Deliver the colon through the abdominal wound and note the position of the blood vessels. Sometimes some difficulty is experienced in doing this, because of peritoneal bands of adhesions which, when present, should be freely divided on the outer side of the pelvic mesocolon, thus mobilizing the pelvic colon and permitting its proximal portion to be later utilized in the formation of the colostomy without too much tension. Select the point in the bowel between the anastomotic loops of the first and second sigmoidal branches of the inferior mesenteric artery. Apply to this point an intestinal crushing clamp which is left on for a couple of minutes. In stout individuals the exact distribution of blood vessels in the mesocolon may at times be difficult in which case it is much safer to

apply the clamp a little nearer the middle of the loop than otherwise (Fig. 1671[1-2]).

Step 4. Remove the clamp. A crushed area of bowel corresponding in width to that of the blade of the clamp is now observed. A clamp, the blade of which is about one inch wide, is used. The crushed ribbon of intestine affords sufficient room for dividing the crushed part of the bowel between two ligatures properly placed (Fig. 1671[3]).

Pass a stout ligature through the mesocolon at each extremity of the crushed area and ligate it tightly. This occludes firmly the lumen of the bowel in two places. Divide the bowel with scissors in such a manner that the cut extends into the crushed portion of the mesocolon. Invaginate the ligated ends of the bowel with a purse string suture, the attachment of the mesocolon to the bowel having been first divided for a short distance close to and parallel with the bowel, thus rendering the invagination easier. The distal end of the bowel should be carefully closed to prevent the possible escape of intestinal contents during the subsequent manipulations.

Step 5. Make an incision through the peritoneum on the outer aspect of the pelvic mesocolon at the level of the left sacro-iliac synchondrosis along its parietal border. Define the left ureter through this incision as it crosses the left common iliac artery (Fig. 1671[4]). Here the ureter lies parallel to and in close contact with the inferior mesenteric vessels and if not carefully drawn aside may be included in the ligature applied to the vessels at this point. Ligate the inferior mesenteric artery at a point immediately below the origin of the first sigmoid branch. Occasionally the second sigmoid artery arises from a common trunk with the first. In such event the ligature must be placed below the common trunk and the second sigmoid artery must be ligated separately when the mesentery is divided. Divide the remainder of the pelvic mesocolon, the inferior mesenteric vessels as they lie in its parietal border below the point of ligature. After all bleeding vessels in the proximal portion of the pelvic mesocolon have been carefully ligated the proximal end of the bowel is temporarily dropped into the abdominal cavity.

Step 6. Make an incision beginning at the point where the pelvic mesocolon has been divided on either side of the attachment of the lower portion of the pelvic mesocolon at a distance of about one inch from it. Carry these incisions down into the pelvis running parallel to the mesocolon to the level of the peritoneal reflection. The reason for making these incisions about one inch away from the attachment of the mesocolon is "because the lymphatic vessels which accompany the superior hemorrhoidal vessels extend a little beneath the peritoneum on either side." Miles observed on several occasions plaques of growth to one or the other side of the line of attachment to the mesocolon. Have an assistant draw forward the distal portion of the pelvic colon and open up the connective tissue space in front of the concavity of the sacrum. Insert the fingers of the left hand into this space and detach from the ligamentous structure in front of the sacrum the pelvic mesocolon with its blood vessels and lymph nodes as well as the rectum surrounded in its fascia propria (Fig. 1671[5]). The detachment of these structures is easily accomplished. Care, however, should be exercised not to injure the

median sacral vessels which run along the midline of the anterior surface of the sacrum. Continue the separation of the rectum from the hollow of the sacrum down to the level of the sacrococcygeal articulation. This point can be readily recognized because the fascia propria recti is firmly adherent to the last segment of the sacrum and offers resistance to being stripped from it.

Step 7. Carry forward the incisions in the peritoneum previously made on either side of the pelvis and have them meet anteriorly behind the base of the bladder in the male or in the upper portion of the vagina in the female. It should be remembered that the ureters skirt the lateral wall of the pelvis in their course to the bladder, thus extra caution is necessary not to injure them. Continue the separation of the anterior wall of the rectum by means of blunt dissection. In the male the rectum must be separated from the bladder and seminal vesicles as far as the upper border of the prostate gland. This step requires great caution lest the seminal vesicles or vas deferens be injured. It is also of utmost importance that the separation of the rectum be carried down to the prostate. If this step is not carefully carried out much difficulty will be experienced during the perineal portion of the operation. Separation of the rectum from the vagina is usually easy and need only be carried half way down the posterior wall.

Step 8. Continue the isolation of the rectum from the lateral attachments first on the left and then on the right side. While so doing on the left side, constant vigilance is necessary not to injure the ureter because of its close position to the rectum on this side, while on the right the ureter is somewhat distant from the rectum and need not be molested at its attachment to the parietal peritoneum. The presence of the lateral ligaments of the rectum here render this step of the operation—the isolation of the rectum—the most difficult (Fig. 1671[6]) because of the stout structure of these well developed vertically connected tissue bands composing the ligaments and unless these are completely and thoroughly divided on both sides of the rectum as far as the anal levators, the surgeon will be confronted with much difficulty in withdrawing the rectum through the perineal wound. Miles emphasizes the importance of this step, stressing that the incomplete division of these lateral ligaments during the abdominal part of the operation renders the perineal portion unnecessarily tedious and prolonged. The middle hemorrhoidal arteries run in the substance of the lateral ligaments, they must be ligated and divided.

Step 9. Push all of the isolated portion of the bowel down into the pelvic cavity. Re-establish the floor of the pelvis by properly suturing the peritoneum. "On no account," says Miles, "should the pelvic mesocolon be left in situ with a view to facilitating the closure of this gap because this is directly in line with the upward spread and is, therefore, to be considered highly dangerous tissue. I cannot emphasize too strongly the necessity for completely removing this structure in every case together with a wide strip of the adjacent peritoneum if immunity from recurrence is to be hoped for." Dissect up freely the peritoneum from the lateral walls of the pelvis. In so doing, avoid injury to the ureters. Generally the posterior margins of the peritoneum can be brought together in front of the promontory of the

sacrum without excessive tension. These should be sutured to the pelvic mesocolon at the point where the inferior mesenteric vessels have been ligated. A large pear shaped gap still remains to be closed, the lateral margins of which cannot possibly be approximated. The gaps should be closed as follows: (1) In the male: Dissect up a flap of peritoneum from the bladder and stretch it backwards across the gap and suture it there (Fig. 1671[7]) In the female: Dissect up the innermost layers of the broad ligaments and utilize them to peritonealize the remaining gap. Particular attention should be paid that peritonealization is carried out thoroughly. Miles lost a patient from intestinal obstruction in whom a knuckle of bowel became herniated through a small hole between the sutures in a delicate peritoneum. To reinforce the suture an omental graft may be used.

Step 10. Do a colostomy by using the proximal end of the pelvic colon at a point about one and one-half inches internally to the left of the anterior-superior spinous process of the ilium along a line extending from that process to the umbilicus. Make a short incision through the skin and subcutaneous tissues about one and one-half inches long with its center intersecting the line above alluded to at right angles. Divide now the aponeurosis of the external oblique muscle for about one inch. Separate bluntly the muscular fibers of the internal oblique and transversalis muscles in the direction of their fibers. Create an opening through the transversalis fascia and peritoneum just large enough to admit the finger through which draw up the stump of the proximal end of the pelvic colon and fix it in position at the upper and lower angles of the wound by means of silk worm gut sutures (Fig. 1671[8]).

Step 11. Attend to the toilet of the peritoneum. Close the abdominal wall in the usual manner. Apply dressings. Lower the patient from the Trendelenburg position and turn him into the right dorsal and semi-prone position.

Step 12. The perineal portion of the operation. Close the anus by a purse string suture. Make a transverse incision about four inches long at the level of the sacrococcygeal articulation. Make a long incision from the center of this transverse cut running in the furrow between the nates and carried down to a point one inch from the posterior portion of the anus. Carry incisions from the inferior extremity of this incision to the right and left in horsehoe fashion the anterior extremities of which are joined by a transverse cut (Fig. 1671[9]). Miles stresses the importance of the arms of the horseshoe incision embracing as wide an area of perianal tissue as possible because of the vulnerability of the skin in this region to recurrences. Retract the gluteal skin flaps and expose the coccyx.

Step 13. Open the sacrococcygeal joint and dissect out the coccyx. Deepen the incision surrounding the anus so as to include all of the ischiorectal fat (Fig. 1671[10]). The removal of the coccyx alone suffices to afford ample room for the completion of the operation. Miles states that sufficient room is afforded without even removing the coccyx but he counseled its removal in view of the fact that the coccygei muscles must be removed and the coccyx would be left without lateral support.

Step 14. Make a small transverse incision into the dense connective tissue immediately below the sacrum. Detach from the ventral aspect of the lower-

most piece of the sacrum the attachment of the fascia propria of the rectum. Introduce the index finger into the opening thus created and find the space containing the isolated bowel, provided the latter has been sufficiently detached as indicated above. Make a transverse incision through the coccygei muscles on either side. This incision should extend outwards as far as the sacrosciatic ligaments. Through the space thus resulting the isolated bowel is drawn down to its full extent (Fig. 1671[11]) exposing the base of the bladder, the seminal vesicles with their seminal ducts in the upper part of the prostate in the male and the uterus and upper half of the posterior vaginal wall in the female.

Step 15. Traction is made with the left hand upon the bowel putting the levatores ani on the stretch; if they do not readily come to view it is because the lateral ligaments of the rectum have not been completely divided from above. In such case difficulties present themselves in delivering the detached bowel through the perineal wound; until the lateral ligaments of the rectum are completely divided the levatores ani cannot be successfully dealt with. Divide the levatores ani at their origin from the lateral wall of the pelvis; detach the puboprostatic fibers from the prostate. In cases where the neoplasm is situated on the anterior wall of the ampulla of the rectum, Miles makes the practice of dissecting away the prostatic capsule as well.

Step. 16. Detach the anterior wall of the anal canal from the tissues forming the central point of the perineum avoiding, while doing so, injuring the membranous portion of the urethra.

Step 17. The resulting huge cavity will heal gradually by granulation. Only portions of the skin incision are brought together by sutures. Pack the cavity with strips of gauze to support the new pelvic floor formed only by peritoneum. Avoid having the gauze come in direct contact with the walls of the cavity to circumvent pain during its removal. Miles uses a sheet of green protective about two feet square to line the cavity and then packs gauze into it (Fig. 1671[12]). Apply voluminous dressings. Turn the patient on his back. Dress the abdominal wound; before the patient is removed from the operating table the ligatures closing the stump of the proximal end of the pelvic colon are removed and the open end of the bowel is covered with green protective and a pad of gauze.

Bartlett's One Stage Operation

The Bartletts (Willard and Willard, Jr.) describe a one-stage combined resection of the rectum[1] which they summarize as follows:

"Repeated spinal anesthesia may be used in this method. By liberating the rectum and anus and bringing them, enclosed in a rubber bag, out of the abdominal wound to be used as upward traction, the most difficult part of the operation, deep pelvic dissection, is greatly simplified, since the mesosigmoid is thrown into relief and put on the stretch (Fig. 1672). It is infinitely easier to work from the depths toward oneself than in the opposite direction. Higher division of the sigmoid may be carried out, and the superior hemorrhoidal is cut at a safe point. The posterior attack is shortened, there are no drains or tubes anywhere and there is no risk of a 'blow-out' below the peritoneal closure. One

[1] Archives of Surgery, Vol. 22, pp. 786-793, May, 1931.

may perform a preliminary colostomy for exploration, for relief from obstruction, for washing out the bowel and to enable one to leave the clamp on the intestine indefinitely after resection. With the fecal fistula made in the right upper quadrant, one can perform an adequate exploration and at a subsequent operation work in an abdominal wall and pelvis undisturbed by previous recent manipulation.

"Jones wrote of the abdominoperineal operation: 'The third objection to the operation, the length and difficulty of it in some cases, must be admitted, and

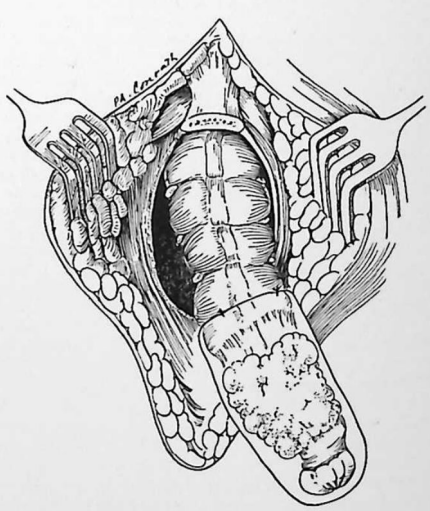


Fig. 1672. Dissection completed from below. Specimen covered with rubber. (Courtesy Dr. Willard Bartlett.)

only those who are willing to accept these conditions as part of the operation should undertake it.' If, as we believe, the operation here presented advances us further along any of the lines fundamental to ideal operations, it will make a sound principle available to practice in the hands of a larger number of surgeons than formerly."

Comment: What operation should be selected in the treatment of carcinoma of the rectum? Dogmatization is dangerous. The surgeon should have at his command a number of procedures suiting a given particular case.

In regard to the actual surgical treatment of carcinoma of the rectum, much progress has been witnessed during the past decade. At the present

time radical extirpations of the rectum and involved tissues, either by the abdominoperineal or abdominosacral routes, are the procedures of choice; and as stated, in early diagnosed small and accessible cases, electrocoagulation alone may suffice. Either method may be carried out by scalpel surgery or electrosurgery; but in the treatment of this malignant condition electrosurgery, in certain cases, is coming gradually but steadily to the foreground under the stimulus of Kolischer, Schmieden, Westhues, Mandl, v. Seeman, Goetz and others. These operations may be carried out in one or two stages.

Conclusions: From available statistical data, abdominoperineal resection or amputation in one stage still shows a distressingly high operative mor-

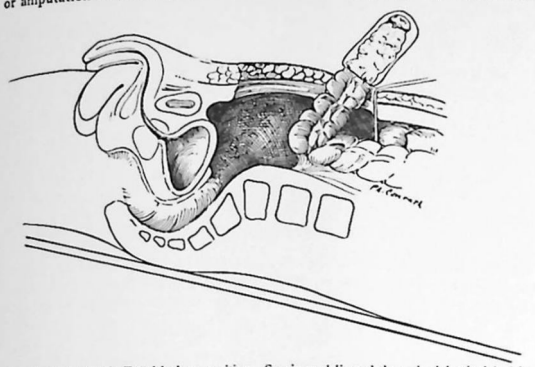


Fig. 1672B. Patient in Trendelenburg position. Specimen delivered through abdominal incision and kept on traction. (Courtesy Dr. Willard Bartlett.)

tality in average hands with the exception of the reports in the hands of some surgeons (Miles, Rankin, Jones, Bartlett, and others). While graded abdominoperineal resections (Rankin) are, in the main, the procedures of choice, the one-stage operation is gaining favor. In fact, Rankin recently lauded Miles' one-stage abdominoperineal resection as best. H. B. Devine* is consistently in favor of first "defunctioning" the large bowel by a special transversostomy followed later by the resection of the affected segment of "defunctioned" bowel coupled with an end-to-end anastomosis; or in selected cases by telescopic rectosigmoid anastomosis or complete ablation of the distal segment of the bowel.

Some are consistent partisans, as is the author, for attacking certain cases of rectal malignant diseases by the combined abdominosacral route, or abdominoperineal operations, others have adopted many stage procedures

* Austral. & New Zealand Journ. of Surg., July, 1932, and Jan., 1934, British Med. Journ., Dec. 28, 1935, Vol. II, p. 1245, Med. Press and Circ., Aug. 7, 1935, Vol. CXC, No. 5022 and "Surgery," Feb., 1938, Vol. 3, No. 2.

as conservative and satisfying. The operative mortality of the one-stage abdominoperineal operation in most hands today is much higher than in graded operations.

Therefore, only surgeons of extraordinary experience in this particular field should resort to the Miles' procedure while those whose experience is that of the average well trained general surgeon, will serve the interests of the patient best by resorting to less exacting undertakings and limit their operations to the procedures described in this chapter, taking advantage of the graded operations of Rankin, or, perhaps, if conversant with the technic, of Devine.

Fig. 1673. Papillary adenocarcinoma of rectum. Removed by electrosurgical technic.

Well-planned, graded electrosurgery often promises gratifying results (Fig. 1673). In the first stage of the operation electrocoagulation of the accessible neoplasm and local sterilization are effected. The chances of infection at subsequent steps of proctectomy are thus minimized. This procedure in itself may suffice in rectal carcinoma of the ampulla, if not advanced. If the latter be the case, it may be a means of palliation. This is followed by colostomy.

The dangers incident to the final stage of the operation (dorsal amputation by electrosurgical means) are also reduced for the following reasons:

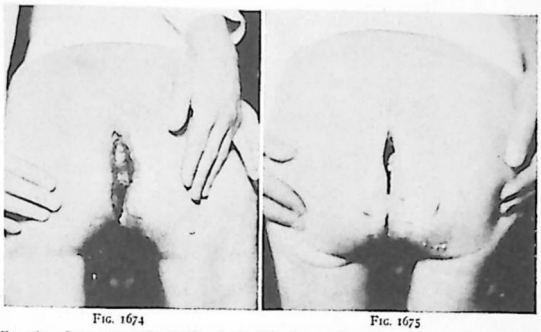


Fig. 1674 Fig. 1675

Fig. 1674. Recurrent carcinoma after classical Kraske operation. Treated by electrocoagulation.
Fig. 1675. Patient 20 days after electrocoagulation of malignant masses.

1. Electrosurgery definitely reduces immediate operative mortality.
2. Local implantations and metastases are often frustrated.

3. Carcinomatous masses that cannot be removed with the scalpel can often be attacked with facility by electrosurgical means. (Figs. 1674-1675-1676.)

4. It is the unanimous experience of surgeons operating with the aid of electrosurgery that their patients are surprisingly free from postoperative shock and pain. Disraeli Kobak has shown that the transmission of pain impulses are prevented by the albuminoid capping of nerves resulting from the division by the diatherm current. Kolischer (1910) pointed out that the coagulation effected by diathermy not only produces a mechanical destruction of the malignant mass but that certain substances and antibodies are thrown off into the circulation which tend to immunize the patients against further progress of the disease and in many instances an arrest of the growth of malignant cells remote from the point of diatherm destruction is observed. This may be attributed to an intense stimulation of the reticulo-endothelial system and its consequent local and general phagocytic action of the macrophytes.

Fig. 1676. Colostomy in case of colloid carcinoma of rectum. Same patient as in preceding Figs. Eight months after operation.

The postulate of Mandl, that the destruction of the lateral chain of lymph nodes including fat, fascia, etc., harboring malignant cells is a sine qua non can certainly be better complied with by electrosurgical means than with the scalpel.

IMPERFORATE ANUS

There are two types of imperforate anus: (1) no anal depression is present; (2) an anal depression is present but does not open into the rectum. Ascertain the following: Is the defect limited to the anal canal? Does it involve the lower rectum or does it extend even higher? Occasionally there is an apparent opening at the anus but higher up a membranous diaphragm prevents the feces from gaining egress. In either event the point is not to wait but to afford an opening for bowel evacuations.

Anal Portion of the Bowel Is Present but Is Not Joined to the Rectum

Step 1. By palpation and inspection find if there is only a thin diaphragm separating the rectum from the anal canal. (Fig. 1677.)

Step 2. Excise or perforate this diaphragm.

After-care. Resort to digital dilatations.

Much Tissue Is Interposed (Fig. 1678)

Make an incision in the midline from the anal depression to the coccyx. Deepen the incision as indicated and proceed as if no anal opening were present (see below) except that after the rectum has been opened and evacuated, suture the margins of that opening to the anal gut instead of the skin.

In days past, a trocar and cannula were used to establish an opening. This procedure is to be condemned. Fatalities resulted from it (peritonitis, opening of the bladder, injury to large pelvic blood vessels, etc.).

No Anal Depression Is Present (Fig. 1679)

Step 1. Make an incision in the median line from the scrotum or fourchette to the tip of the coccyx, carried down to the floor of the pelvis. The incision may be extended later if necessary. If the bowel is not found, retract the

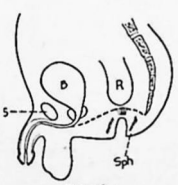


Fig. 1677

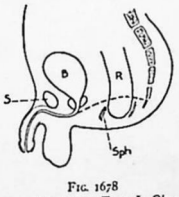


Fig. 1678

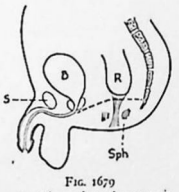


Fig. 1679

Fig. 1677. Imperforate anus and rectum. Type I. Observe in this variety the anus is formed; also there is a septum between the anus and rectum. S. symphysis pubis; B. bladder; R. rectum; Sph. sphincter.
Fig. 1678. Imperforate anus and rectum. Type II. Much tissue is interposed.
Fig. 1679. Imperforate anus and rectum. Type III. Observe here the lower portion of the rectum is absent (after Rudolf Frank).

walls of the wound; search for the bowel by blunt dissection, excising the coccyx and lower segment of the sacrum, if necessary. When found the lower end of the bowel should be freed as much as possible from its surroundings.

Step 2. If the bowel is found situated superficially it should be seized with forceps and pulled down, separating any lateral attachments.

Step 3. Incise the bowel. Clean out its contents by injections of warm water and some mild antiseptic solution. The opening in the bowel is then sutured to the skin with interrupted sutures and the rest of the skin opening closed (Fig. 1680) (Amussat's operation).

Comment: When the bowel is deeply situated it will be more difficult to pull it down without first evacuating its contents and separating it clearly from its lateral connections. In carrying on the dissection, concentrate the work to the hollow of the sacrum instead of in the front (injury to genito-urinary organs). When the bowel has been found, an attempt should be made to suture it to the skin before opening it. This, however,

is not always possible. When every attempt to bring the bowel down fails, do a colostomy.

Anus Is Absent. Rectum Opens into the Vagina

Be in no hurry to operate. Such condition is entirely compatible with life, provided, however, that sufficient room is present for the feces to satisfactorily discharge from the vagina. Cases are of record where women with such congenital defects married, bore children and carried on normally. Sir Charles Ball (quoted by Lockhart-Mummery) reported a case of a woman whose rectum

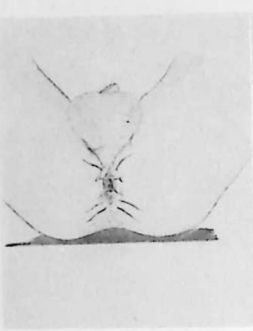


Fig. 1680. Amussat's operation for imperforate anus (after Poppert). The sphincter muscle is only divided posteriorly. The bowel is shown pulled down after it is opened and its margins attached to the skin with interrupted sutures.

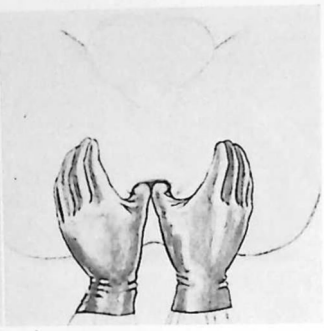


Fig. 1681. Method of dilating the sphincter. Note position of the thumbs which are flexed exerting equal pressure upon the sphincter. The maneuver is to be carried out clear around until sufficient dilatation of the sphincter is obtained.

opened into the vagina; she suffered no inconvenience from the abnormality and was the mother of six children. If an operation is later decided upon some form of plastic procedure may be resorted to.

Rectum Communicates with Bladder or Urethra

This condition is incompatible with life. Operate at once. Establish a perineal opening.

Comment: Prompt diagnosis and proper course of treatment are essential here. M. Kirmisson pointed out, as far back as 1899, that in the great majority of cases of this type there exists in the perineum a complete sphincter apparatus. The practical conclusion here is that it is not essential, where difficulties present, to bring the end of the bowel down to the anus; if placed somewhat behind the anus it will work equally well. In separating restraining bands, remember these often carry the nutritive vessels to the respective segment of bowel. Where space for work is needed, open the peritoneum. Work with deliberation and thoroughness.

arately at the same time. The fistula which often follows should be treated at a later date. Patients suffering from this infection are usually markedly septic and the sooner the pus is evacuated the sooner recovery will take place.

Dangers and Difficulties. It is a rather simple matter to open an ischiorectal abscess. The chief danger lies in destroying the branches of the long pudendal nerve and of spreading the infection by opening into healthy tissues.

In most cases, failure to cure an ischiorectal abscess is due to improper drainage and in leaving the drainage tube in place so long that it forms a fistula. Disappointment due to incorrect treatment happens frequently. To avoid mishaps, the surgeon must also keep in mind the communicating nature of the tract and that the abscess may have broken high in the region of the rectum and that the opening is often in the posterior commissure and is quite small. Careful search should be made for any opening in this region since inability to recognize it is likely to result in failure.

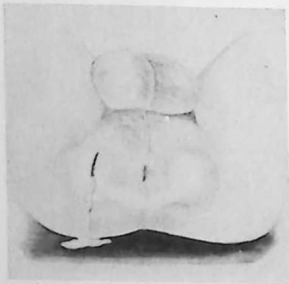


Fig. 1683. Dumbbell-shaped ischiorectal abscess; incision has been made into fluctuating side.

HEMORRHOIDS

Anatomic Points. The anal canal is a slit-like opening by which the rectum communicates with the exterior. It extends from the levator ani to the skin. The lower half of this canal is lined with squamous epithelium. It is directed downward, then posteriorly and is protected by two muscles, the internal and external sphincters. The mucous membrane of the lower half of the anal canal presents a number of rectal folds which are known as the columns of Morgagni. These columns, according to Cunningham, are formed by the infolding of the mucous membrane and contain in their interior some muscular fibers, a vein and an artery. Often, at the lower end of the column a varicose condition of the vein will be noted. This is known as the hemorrhoidal area since hemorrhoids originate here. Folds of mucous membrane resembling the semilunar valves of the heart occur between the columns. These are referred to as the semilunar valves or crypts of Morgagni. A fissure, an abscess, an ulceration or a fistula may originate at the bottom of these pockets.

Hemorrhoids or piles are of three types: (a) external, (b) internal and (c) mixed.

External hemorrhoids are situated below the external sphincter muscle; internal hemorrhoids are situated above the sphincter muscle; mixed hemorrhoids are partly within and partly without the anorectal canal and are covered by both mucosa and skin. Broadly each type requires its own method of surgical removal, but generally speaking, uncomplicated external and internal hemorrhoids are usually treated either by clamp and cautery or excision and suture. For maximum degrees, one of the varieties of the Whitehead operation is em-

FISSURE OF THE ANUS

Divulsion

Local anesthesia. Figure 1681 illustrates the technic of digital divulsion. Observe the position and direction of force of the dilating thumbs.

SIMS' METHOD

Step 1. Place the patient in the lithotomy position.

Step 2. Introduce the left thumb which has been well oiled into the rectum. Dilate the sphincter by exerting pressure toward the posterior commissure.

Step. 3. Introduce the other thumb into the rectum also, and dilate and divulse the sphincter with both thumbs.

Step 4. Excise the fissure completely. Do not cut too deeply (injury to sphincters). Pack with iodoform gauze.

Dangers. Great care should be exercised to avoid injuring the prostate. Do not overstretch; this may result in temporary or permanent incontinence. Be careful not to rupture any muscular fibers; hemorrhage into the muscular tissue may ensue which is likely to be followed by canalization of the blood and connective tissue thus destroying the muscular fibers.

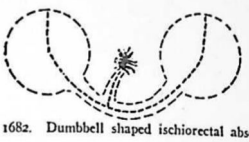


Fig. 1682. Dumbbell shaped ischiorectal abscess.

ISCHIORECTAL ABSCESS

Anatomic Considerations. In this condition, the presence of the blood vessels, nerves and loose cellular tissue running through the cavity is noted. The ischiorectal fossa is formed in the shape of a triangle, the apex being formed by the junction of the obturator fascia with the lower fascia of the levator muscle; the skin, superficial fascia and loose tissue between the anus and the tuber ischium form the base. If an abscess which has formed in this region is not treated surgically it generally emerges between the two sphincters in the posterior commissure. On some occasions it opens through the levator ani and then through the rectum.

It should be borne in mind that there may be numerous small abscesses which must be opened. This is done with the gloved finger after the incision has been made. The experienced surgeon can readily distinguish between healthy and necrotic tissue and is careful to destroy only that which is diseased. The destruction of tissue and the rupturing of blood vessels are to be avoided in order to avoid infection of the adjoining parts. Matters become more complicated when both ischiorectal fossae are involved (Figs. 1682-1683). In these cases Hartman advocates opening both abscesses at a posterior point where they meet which, as a rule, is at the apex of the triangular space. He introduces drainage tubes into both abscess cavities. This procedure does not seem to have a great deal of merit and it would seem preferable to drain both abscesses sep-

ployed. This consists of a circular excision of the entire pile-bearing area followed by the necessary ligation of vascular parts and the complete closure of the circumferential wound by suture. The Whitehead operation is usually reserved for cases in which the pile-bearing area affects a considerable segment of mucous membrane of the bowel and when there is much prolapse of the piles.

Ligature and Suture Operations

Historical Notes. Galen recommended the use of a strong flax thread made to traverse the base of the tumor by means of a needle; the ligature was then tied on each side, and the tumor permitted to slough off. In 1813 the ligature operation was quite popular with French surgeons; but later, owing to some accidents, it lost this popularity.

Excision alone was practiced by such men as Hippocrates, Galen, Celsus, Aetius, Albucasis, Rhazes and others. From this we can see that very little change has taken place since the time of Hippocrates, and that the operations, as then practiced, are still in vogue with slight modifications.

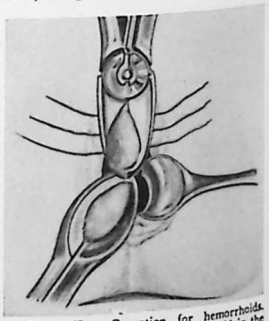


Fig. 1684. Operation for hemorrhoids. The clamp above grasps the hemorrhoid in the long axis of the bowel. Interrupted sutures are shown placed in position which are tied after the hemorrhoid is removed and the hemorrhoid clamp released.

The general operative procedure of the ligature operation for ordinary hemorrhoids is as follows:

Step 1. The patient is placed in the extreme lithotomy position and the orifice of the anus is thoroughly dilated until it remains open and is easy of access. The rectum is washed out and packed with gauze.

Step 2. The hemorrhoids are easily seen and each one is grasped with forceps (Fig. 1684). The mucous membrane of the pedicle of each hemorrhoid is partly divided with scissors or scalpel; the hemorrhoid ligated with stout catgut and then cut off. In the case of large hemorrhoids special clamps are used (Fig. 1685).

Or, the hemorrhoid is clamped, cut off and the edges of the pedicle approximated by interrupted or continuous suture (Fig. 1686).

Step 3. When all hemorrhoids have been removed the gauze tampon is withdrawn from the rectum. The patient is kept constipated for a few days.

CLAMP AND CAUTERY OPERATION

Cusack's Operation

Step 1. Place the patient in the lithotomy position.

Step 2. Grasp the hemorrhoid with a Tuttle forceps. Cut off the skin tabs even with the skin to prevent edema.

Step 3. Place a clamp with the heel directed toward the outer part of the hemorrhoidal tumor. Remove the forceps and excise the pile about ¼

inch from the clamp leaving a stump which is now thoroughly cauterized (Figs. 1687-1688).

Step 4. Release the clamp gradually, and see that the stump is not bleeding as it reenters the anus. Apply the same procedure to the other hemorrhoids.

Step 5. Insert into the rectum a small iodoform wick which has been coated with sterile vaseline; place over this some fluffed gauze.

Fig. 1685. Hemorrhoidal Clamp.

Step 6. With the patient in proper position strap the buttocks with adhesive plaster. Permit the end of the wick to project between the 2 pieces of adhesive plaster. Administer ¼ gr. morphine to the patient before he comes out of the anesthetic. Remove the pack after twenty-four hours. Constipate the patient for 72 hours. At the end of this period give an oil enema and follow with a cathartic.

ELECTROCOAGULATION OF HEMORRHOIDS

Insulate the patient. Local anesthesia. Dilate the sphincter and bring down the hemorrhoids in a pile clamp. Apply a clamp to the base of the hemorrhoids. Grasp the hemorrhoid with a pair of forceps. Touch the forceps with the diatherm needle. The change in color of the pile will indicate the degree of coagulation obtained. Avoid coagulating too deeply. A ligature may now be applied to the base of the hemorrhoid as shown in the illustration.

The destroyed pile usually sloughs off about the ninth or tenth day. The base is represented by a clean granulating wound which heals with a soft pliable scar not tending to stricture formation. Pain is minimal. The results from this method are very gratifying.

After-care. Rectal tubes should be omitted. I believe these should be reserved for "one's enemies." (Binnie.) It is a safe precaution to keep the bowels locked up for a few days. Do not permit anal tags to remain. Patients look upon these as hemorrhoids and often seek their removal, although they give rise to no trouble other than their presence.

WHITEHEAD OPERATION

This procedure is indicated in cases of marked prolapse of the hemorrhoids or an excess of mucous membrane. On account of the uncertainty of primary union, hemorrhage, complicated technic and the formation of a stricture following the operation this method is not a favorite among many surgeons. In skilled hands it has been known to often give more satisfactory results than any other method in certain cases. If the mucous membrane is properly approximated and proper postoperative treatment given, stricture should be avoided.

Particular attention should be given to preparing the patient for this operation; the lower bowel should be cleansed thoroughly to avoid soiling the wound during the operation, which would prevent primary union.

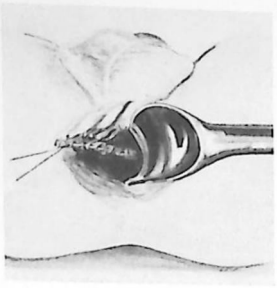


Fig. 1686. Hemorrhoidectomy. After removing the hemorrhoid the crushed base may be sutured as shown in the illustration. (Allen's method.)

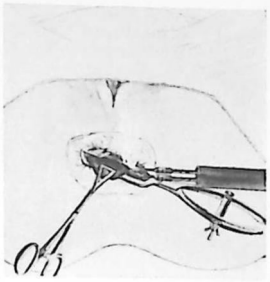


Fig. 1687. Cusack's clamp and cautery operation. Small hemorrhoid removed with light thermocautery.

Step 1. Make an incision in the posterior commissure between the mucous membrane and the skin. Introduce a scissors through this wound and separate the mucous membrane from the adjacent tissue.

Step 2. Continue the posterior incision on both sides up to the anterior commissure where the mucous membrane closely adheres to the muscular wall of the bowel (Fig. 1689). It is advantageous to leave this attachment remain as is. It acts as a fixed point holding the mucous membrane in case the suture does not hold; and in case of infections occurring anteriorly it prevents the involvement of the pelvirectal space.

Fig. 1688. Cusack's clamp and cautery operation for hemorrhoids. Heavy cautery.

Step 3. With a T-forceps, grasp the cuff of mucous membrane; dissect it up with scissors until healthy mucous membrane is reached; detach the region bearing the hemorrhoids from the muscular wall of the rectum.

Step 4. Make a longitudinal incision in the mucous membrane extending from the mucocutaneous margin to a point where the mucous membrane is healthy

(Fig. 1690). Each flap thus formed is grasped with T-clamps and the mucous membrane carrying the hemorrhoids is brought down and held by an assistant.

Step 5. Make a transverse incision in the mucous membrane above the hemorrhoidal region. After each incision, suture the mucous membrane, little by little, to the edge of the mucocutaneous surface as the hemorrhoidal area is being cut off step by step. (Fig. 1691.)

Control hemorrhage from the blood vessels which have been sutured with mattress sutures.

FISTULA IN ANO

Fig. 1689. Whitehead's operation for the removal of hemorrhoids. A cylinder of mucous membrane is shown dissected up and held in the grasp of artery forceps. The index finger of the operator is in the rectum. The gradual dissection exposes the sphincter muscle.

Fistulas may be divided into complete and incomplete. Incomplete fistulas may be external, internal, deep or superficial. Complete fistulas are those where there is a communication between the bowel and the skin surface, or between the bowel and some adjacent organ. (Fig. 1692.)

Anatomic Points. The location of the external opening of the fistula may, to a certain extent, be of great assistance to the surgeon in locating the internal opening and deciding on the method of treatment. If the external opening is within 1½ in. of the anus, and anterior to a line drawn from one tuberosity to the other, the fistulous tract is generally straight and the internal opening will be found anteriorly and close to the external sphincter. If the external opening is within 1½ in. of the anus, and posterior to this line, we may expect to find the internal opening in the posterior commissure between the 2 sphincters. There are exceptions, but these only "prove the rule." (Lynch.)

In 1911 Jerome Lynch described his method of determination of the fistulous tract with peroxide of hydrogen and methylene blue. I found this an excellent method for determining the extent and location of the fistulous tract.

Operations on Anal Fistula

Anesthesia: Local or general anesthesia may be used for fistula operations. When it is necessary to obtain thorough relaxation of the anal sphincter, use spinal or sacral anesthesia. Complete excision may often be done (Fig. 1693).

Fistulotomy or Division of the Fistula

Step 1. The patient is placed in the lithotomy position and the field of operation carefully prepared.

Step 2. Dilate the sphincter ani.

Step 3. Examine for external and internal fistulous openings.

Step 4. Probe the fistula at either opening (Fig. 1694). It may be necessary to force one of the openings. Do not probe into healthy tissue. Inject methylene blue.

Step 5. Replace the probe by a grooved director; incise the fistula (Fig.

1695) down to the director, perpendicular to the sphincter ani (Fig. 1696). Curet the wall of the tract and, if it is not to be sutured, trim off the overhanging skin, creating a clean trough.

Step 6. Examine carefully for other tracts and treat them similarly.

Step 7. Leave the wound open and pack lightly with iodoform gauze. Some close the wound tightly using catgut in the deeper layers and linen or silk superficially. If the tract is extensive the distal portion only may be closed allowing the proximal end to granulate.

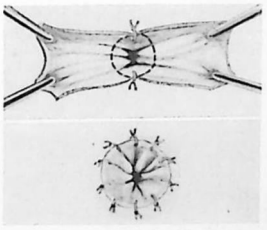


Fig. 1690

Fig. 1691

Fig. 1690. Whitehead's operation for the removal of hemorrhoids. The cuff of mucous membrane is shown split anteriorly through its center. Its edge is attached to the margin of the wound by a suture. The dotted line indicates the line of division of the cuff of mucous membrane in the middle.

Fig. 1691. Whitehead's operation for the removal of hemorrhoids. The illustration above shows the cuff of mucous membrane split in the middle, its upper and lower layers united. The dotted line indicates the circular line of resection of redundant mucous membrane. The illustration below shows the operation completed. The edge of the mucous membrane is united to the margin of the wound.

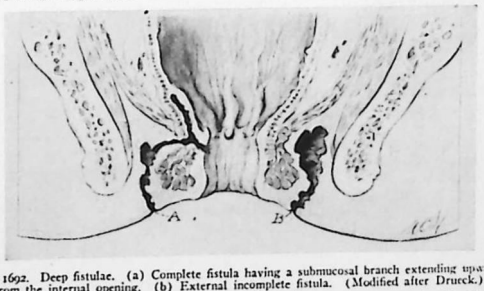


Fig. 1692. Deep fistulae. (a) Complete fistula having a submucosal branch extending upward from the internal opening. (b) External incomplete fistula. (Modified after Drueck.)

If a pack is used, it should be replaced daily for 4 to 5 days, followed by bowel action and sitz baths.

Fistulectomy or Excision of the Fistula

Proceed as in the previous operation, but instead of incising the fistula excise it around a probe as in Fig. 1693. Or, dissection or conization (Fig. 1697).

Step 1. Define the fistulous tract as in fistulotomy.
Step 2. Make an ample elliptical incision around the external opening.
Step 3. The circumincised opening of the fistula is grasped with forceps and, while exerting gentle traction, the entire tract is dissected out together with the adjoining healthy tissue.
Step 4. The wound may be left open and packed lightly, or on occasion, completely closed with interrupted sutures. It is, as a rule, unwise to close the medial end.

Fig. 1693

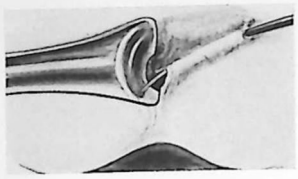


Fig. 1694

Fig. 1693. Complete fistulectomy. Flexible sound extending from cutaneous opening of fistula through internal opening.
Fig. 1694. Fistula in ano. The passage of a sound introduced through the external opening of the fistula emerges through the internal opening and the anal canal.

Kenneth Mackenzie's Fistulectomy

This is indicated particularly in extensive fistulas.

Step 1. Prepare the operative area.
Step 2. Thoroughly dilate the sphincter.
Step 3. Carefully dilate the internal fistulous opening. Uplift the mucous membrane and pare it in the long axis of the bowel. The underlying muscle is trimmed and vivified. If necessary split the internal opening in the direction of the sphincter ani. The rectal wall is then closed by interrupted iodized sutures. The mucous membrane is then closed.
Step 4. A semilunar incision is now made on the involved side just lateral to the external sphincter ani and extended up until it divides the tract flush at its emergence from the bowel. The incision is then curved laterally at the ends making a long deep flap to expose all the accessible branches of the fistula (Fig. 1698).
Step 5. Excise thoroughly with a knife or curved scissors all branching tracts leaving only healthy tissue.
Step 6. Infold rectal wall once or twice over the previous suture line depending on the existing conditions.
Step 7. Flush the field with normal saline solution and close the wound. Drainage is optional.

Ligature Operation

This is done effectively under local anesthesia.

Step 1. Prepare the field of operation as usual.
Step 2. A soft piece of rubber, silk or linen ligature is threaded through the fistulous tract after passing a probe carrying a thread to which the ligature is attached (Fig. 1699).

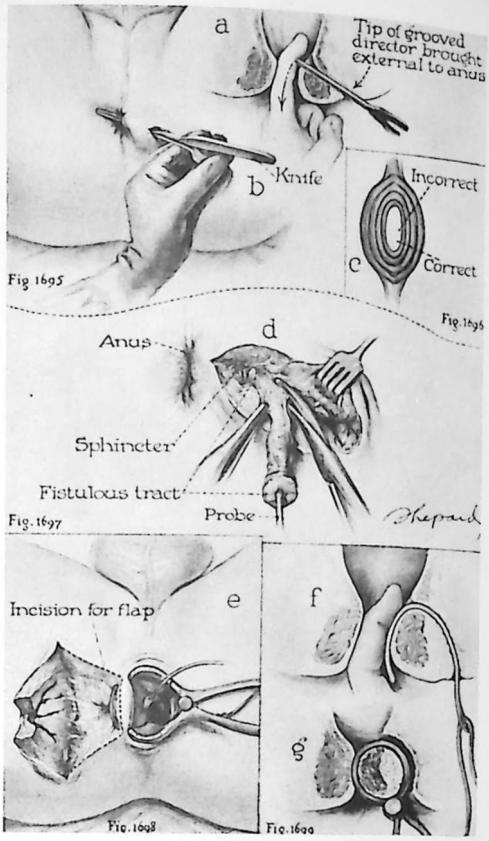


Fig. 1695 (a and b). A probe pointed director has been passed along the fistulous tract and its point brought out of the anus (a). A knife (b) divides the tissues overlying the director.
Fig. 1696 (c). Correct and incorrect method of dividing the sphincter. (Correct and incorrect lines of division of the sphincter.)
Fig. 1697 (d). Method of dissecting fistula.
Fig. 1698 (e). The Kenneth MacKenzie method of operating for fistula.
Fig. 1699. Technic of passing a flexible silver probe threaded with a rubber ligature through a simple direct anal fistula (f). In (g) the method of constricting the area between the fistula, mucous membrane of the anus and the skin by means of the rubber ligature drawn taut is shown. After the desired degree of tension is obtained the ligature is fastened either with a perforated lead shot or other method of fastening.

Step 3. The ligature is then tightly tied as depicted in Fig. 1699 and left in place until it has cut through the tract. This usually requires 3 to 6 days, but in large fistulae it may be much longer. Following this the wound is irrigated daily.

PROLAPSE OF THE RECTUM

Prolapse of the rectum may be complete or incomplete; complete when all coats of the bowel are involved; incomplete when only the mucous membrane is affected (Fig. 1700). The condition may be congenital or acquired. In congenital prolapse the natural supports of the rectum are insecure. Acquired prolapse may be due to a number of causes.

Incomplete Prolapse. Palliative methods, strapping of the buttocks, etc. are often successful. If unsuccessful, resort to Whitehead's operation (p. 1522). Allingham's linear cauterizations will sometimes overcome the prolapse.

Complete Prolapse. In this condition all the coats of the bowel are involved. There are three degrees of complete prolapse.

Fig. 1700. Prolapsed rectum.

LOCKHART-MUMMERY'S OPERATION

Step 1. Proper preoperative preparation of the patient is essential. The bowels must remain inactive for five days after the operation.

Ascertain the degree of the rectal prolapse. Place the patient in the lithotomy position; place a small sandbag under the sacrum. Clean out the rectum (irrigations with lysol—1 drachm to a pint of water). Cleanse the perianal structures with acetone followed by iodine.

Step 2. Make a transverse incision about 2 inches in length at a point half way between the tip of the coccyx and the posterior margins of the anus. Deepen the incision slightly toward the coccyx. Completely divide the attachment of the external sphincter to the coccyx. Dissect backward until you open the posterior rectal space. Avoid opening the rectum during this step of the operation.

Step 3. Introduce a gloved finger through the incision into the posterior rectal space; open the space thoroughly on each side of the rectum and up along the hollow of the sacrum. Usually, there is no difficulty encountered in stripping the rectum because the cellular tissue is loose by reason of the prolapse. Separation upward should be about equal to the prolapse when done. Blunt dissection and asepsis are the keynotes here. The posterior and lateral aspects of the rectum must be freed.

Step 4. Pack the whole area posterior and lateral to the rectum with gauze (2-inch ribbon gauze with a selvage) prepared as follows: Pack a wide-mouthed bottle tight with gauze. Sterilize it. Pour hot melted vaseline into the bottle until full. Heat the bottle in the sterilizer; pour some more vaseline on the gauze until it is thoroughly saturated. Screw the cap on the bottle and return it to the autoclave. Five or six yards of gauze thus prepared should be available and should be packed carefully into the hollow of the sacrum and above the levator ani muscles, this to avoid primary union of the rectum and walls of the pelvis. If more gauze is needed the end of the first supply should be tied to the next pack thus avoiding the possibility of losing some gauze.

Step 5. Close the wound temporarily with a suture. Unless the external sphincter is competent, do some plastic operation on it now or before the patient leaves the bed.
Step 6. Put a small tube in the rectum. Dress.
Step 7. Dress the wound twice daily. Do not remove the packing for a week. At the end of that time give an anesthetic, reopen the wound. Repack the cavity with vaselinized gauze. Leave the ends of the gauze protruding from the wound. Leave this packing in for a week.

Fig. 1701. Lockhart Mummery's incision in operation for fixing the prolapsing rectum anteriorly.

Step 8. Remove packings after a week. Do not repack. Introduce a drainage tube into the cavity. Do not allow the wound to heal before three weeks. The more slowly it heals, the better the result. Confine the bowels for about a week. Give an enema after that, before the packing is removed. Let the patient remain in bed about a month if the prolapse is marked.

Comment: The anterior wall of the rectum is not fixed by this operation. If the prolapse is very marked, Lockhart Mummery fixes the anterior wall at the same time by a modification of McCann's operation, by stitching together the anterior portions of the levator muscles. Lockhart Mummery used this operation for over twenty years in over fifty patients with only six recurrences (two of these patients were mentally deficient).

Fixation of the Anterior Wall of the Rectum (LOCKHART MUMMERY)

Step 1. Place the patient in the lithotomy position. Make an incision as shown in Fig. 1701.
Step 2. Dissect free the lower end of the rectum and anal sphincter for about two inches.
Step 3. Expose the anterior attachments of the levator ani muscles. The opening is narrowed by some catgut sutures introduced from side to side which pick up the sphincter muscle together with the outer coat of the rectum and adjacent structures. Do not enter the rectum.
Step 4. Introduce tension sutures of silkworm-gut; these will relieve tension on the catgut sutures.
Step 5. Close the skin.

Comment: This operation is effective in fixing the anterior wall of the rectum and restoring the normal caliber of the anal canal. It may be used in men and women.

Excision and Amputation of the Rectum for Prolapse

In prolapse of moderate degree this operation is not difficult. In marked prolapse it is dangerous (shock; opening peritoneal cavity; peritonitis; injury to small bowel, etc.). Recurrences are common.

Maes and Rives Operation

Urban Maes and J. D. Rives[1] described their operation for complete prolapse of the rectum which consists of the following steps:

Step 1. Place the patient in the lithotomy position and reduce the prolapse. Make an inverted Y-incision so that the arms include the anus (Fig. 1702 A). Expose the external sphincter.

Step 2. Incise the anobulbar raphé transversely, liberating the sphincter from the middle tendon of the perineum. Excise the anterior quadrant of the external sphincter and suture the muscle end-to-end with U-sutures of chromicized catgut.

Step 3. Expose the levator ani. Expose its mesial borders by means of blunt dissection. Using a finger or a pack in the rectum as a guide; expose the anterior and lateral walls of the rectum as far as the lateral ligaments. A gauze-covered finger serves as a satisfactory blunt dissector for this purpose.

Step 4. Thrust forward the prostate and seminal vesicles. If the culdesac is very deep, gently push up the reflection of peritoneum from the rectum to the prostate exposing the latter anteriorly and the adventitia of the rectum as far as the finger will reach, posteriorly. The upper surface of the levator ani which is covered by the pelvic fascia, now forms the lateral wall of the space.

Step 5. Start at the apex of this artificial vagina and insert sutures to approximate the levators and suspend the rectum. Use chromicized catgut on full curved, round needles. Take a deep bite of the levator and fascia on the right, and carry the needle down an inch or an inch and a half; introduce several transverse stitches across the lateral and anterior aspects of the rectal walls (Fig. 1702). From here direct the needle to a point on the left levator which corresponds to the first bite on the right and take a similar stitch. Insert three or four sutures of the same type at short intervals until the free margins of the levators are reached. When these sutures are tied, they serve to approximate the levator ani, suspend and plicate the rectum and close the depth of the culdesac. The final suture approximates the free margins of the levators but does not include the rectum. This forces the anus backward and reproduces the normal backward angulation of the anal canal.

Comment: Where the pelvic floor is extremely relaxed, the above procedure may be supplemented by fixing the posterior wall of the rectum in accordance with Tuttle's method. In case a mucous membrane prolapse occurs, it may be corrected by linear cauterization or excision. The procedure is not complex and produces very little shock. It is quite practical with spinal or local anesthesia. In a later personal communication (1936)

[1] Surgery, Gynecology and Obstetrics, '35.

Dr. Maes informed me that he had performed several of these operations and that he, as well as those who have used the method found it entirely satisfactory.

REHN-DÉLORME OPERATION FOR RECTAL PROLAPSE

The resection of the mucous membrane is here analogous, in a sense, to the Whitehead operation. It is performed as follows:

Step 1. Make a circular incision at the mucocutaneous junction.

Step 2. The mucous membrane is now dissected from the subjacent structures in the form of a cylinder, care being taken not to inflict injury to the internal sphincter muscle situated immediately under the submucosa at the mucocutaneous junction. In order to successfully perform this step of the operation, two important factors are to be observed: first, to work carefully in the proper line of cleavage; second, perfect hemostasis. When the apex

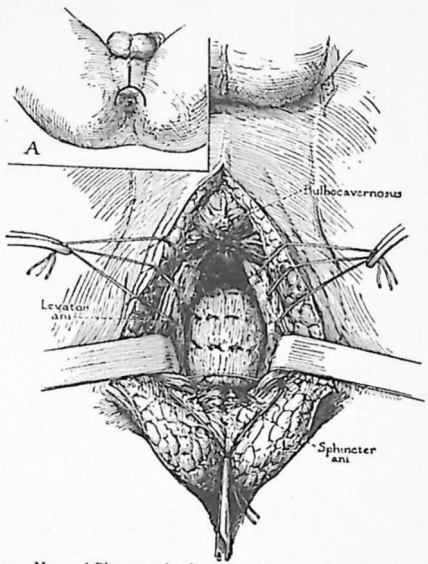


FIG. 1702. Maes and Rives operation for prolapsed rectum. (Surg. Gynec. and Obst., May, 1926.)

of the prolapse has been reached a segment of from 7-10 cm. of the muscular surface of the bowel is exposed (Fig. 1703).

Step 3. This step consists of folding the denuded bowel in an accordion-like manner, by means of 5 or 6 folding sutures of silk or catgut. The suture

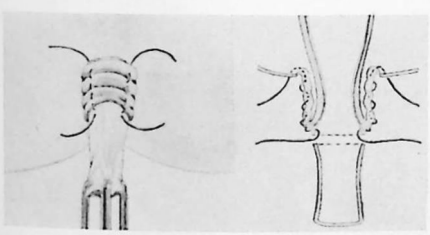


FIG. 1703. The Rehn-Délorme operation for prolapsed rectum. Left: The illustration shows how a cuff of mucous membrane surrounding the rectum has been dissected free to apex of the prolapsus. Two sutures are shown which in an accordion-like manner penetrate the muscularis of the bowel and gather up the structures. Right: Here a cross section is shown of the preceding illustration. The outline below the illustration diagrammatically depicts the cuff of mucous membrane resected.

is begun at the mucocutaneous junction and successive segments of bowel are picked up until the dissected cuff of mucous membrane is reached at the apex. By tying the sutures it will be observed that the mucomuscular tube

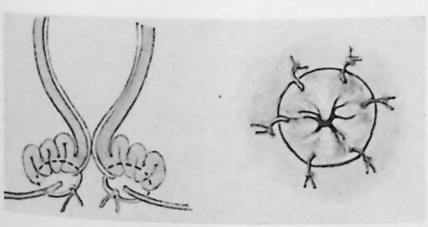


FIG. 1704. The Rehn-Délorme operation for prolapsed rectum. Left: Observe that after the sutures are tied, the musculature of the bowel is folded upon itself tending to close the opening of the bowel; being approximated with the sphincter fortifies its action. Right: The operation is completed; the external interrupted sutures unite the mucous membrane to the skin margin. (After Popper.)

is pleated and the prolapsed segment slips up into the pelvis above the sphincter ani muscle (Fig. 1704).

Step 4. Ablate the dissected cylinder of mucous membrane. The patulous external sphincter may be reinforced and narrowed by catgut sutures so placed laterally as to diminish the outlet.

FIG. 1705

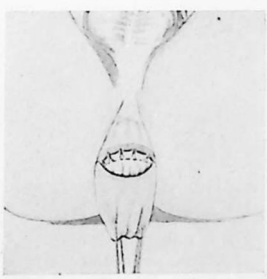


FIG. 1706

FIG. 1705. Mikuliez resection operation for prolapsed rectum. Lateral view of structures concerned in prolapse. In front, one observes the prolapsed culdesac of Douglas; behind the nutrient vessels.

FIG. 1706. The anterior wall of the rectum is divided transversely down to the peritoneum which has been opened transversely. The serous surfaces of the prolapsed culdesac of Douglas are then carefully united with catgut sutures.

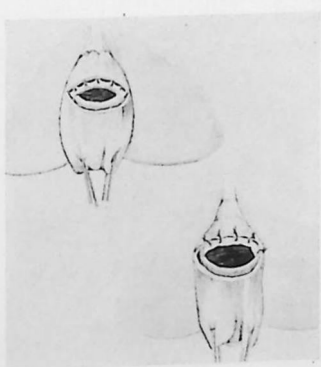


FIG. 1707. Upper illustration shows the anterior wall of the inner portion of the rectal tube opened. Lower illustration depicts the outer and inner mucous membranes united with interrupted sutures.

Comment: The advantage of this method over total resection of the prolapsed segment lies in the fact that the peritoneal cavity is not entered.

Resection Operation for Prolapsed Rectum (Mikulicz, 1889)

Mikulicz was preceded by Vernois, Dieffenbach, Brite and Frank, who laid down the principles of the operation while Mikulicz perfected the technic. (Fig. 1705.)

Step 1. Introduce two traction sutures through the apex of the prolapse. About 2 cm. from the anal fold an incision is made dividing anteriorly the various layers of the bowel. Ligate bleeding vessels (Fig. 1706).

Step 2. Open the peritoneum transversely and completely. Search for prolapsed small bowel; if found, replace it. Now close the peritoneal cavity by suturing the apposed peritoneal surfaces.

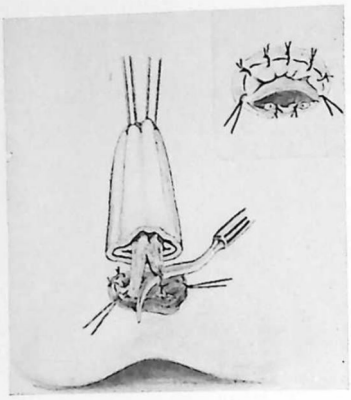


FIG. 1708. Mikulicz resection operation for prolapsed rectum. The prolapse is displaced upward and backward. The posterior wall of the outer and inner tubing of the prolapsed bowel is divided. The blood vessels are ligated as encountered. Ligation and division of the mesocolon. Insert in upper right hand corner: Union of the outer and inner mucous membrane with interrupted sutures.

Step 3. The anterior wall of the prolapsed bowel is now divided. Unite all the coats of the intestinal wall with interrupted sutures all the way around (Fig. 1707). Attend to careful hemostasis. Momentarily leave the ends of the sutures long to be used for traction.

Step 4. Divide the posterior section of the prolapsed rectum (both layers). Displace, while performing this step, the prolapsed segment upward as shown in the illustration. Usually the peritoneum does not appear here, the mesocolon presenting. This will have to be carefully and thoroughly ligated and divided (Fig. 1708).

Step 5. Make sure that all bleeding points are under control. Cut the sutures short. Replace the short stump.

Comment: It must be remembered that this operation gives a mortality of about 10-11 per cent (Lénormand). Less dangerous methods, above described, should first be attempted.

Reid's Method of Treating Irreducible Prolapsed Rectum

Mont R. Reid described a method of treating irreducible prolapse of the rectum[1] as follows:

"A Chinese girl, aged eight, was admitted to the Peking Union Medical College Hospital with an edematous and sloughing prolapse of the rectum which was about 5 inches in length. The condition had been present for a long time and it was obvious that no attempt should be made to reduce it. The external opening of the gut was at the apex of the protruding mass. There was no evidence of intestinal obstruction. It was easy to insert a rubber tubing, about an inch in diameter, into the prolapsed rectum and to pass it through the sphincters well up into the rectum. With this tube thus placed several of us palpated the prolapse surrounding it and were sure there was no herniation of intestine into a peritoneal pouch. At the junction of the skin with the mucosa the edema was less and it was at this point that palpation was most satisfactory and convincing. Consequently the tube was anchored in situ by means of a couple of heavy silk sutures at the apex of the prolapse. Next a constricting rubber band was placed around the prolapse at the normal surface level of the anus and just distal to the external sphincter muscle (Fig. 1709). This band stopped the circulation to the prolapse and also occluded any peritoneal pouch that might have been present. For several hours the child was watched most carefully for evidences of intestinal obstruction. At the end of two weeks, during which time there was normal defecation and expulsion of gas through the tube, the entire prolapse sloughed away. A spontaneous anastomosis had occurred at the level of the rubber band. Tone quickly returned to the muscles and at the time of her discharge from the hospital there was good sphincter control and no evidences of rectal stricture. We believed that this procedure had definitely lessened the chances of peritonitis which would have attended surgical amputation of the prolapse and suture in the presence of so much infection and necrosis."

Reid treated other similar cases with success. He states:

"In the treatment of irreducible and strangulated prolapses of the rectum it seems to us that the method described and illustrated offers, when its use is not definitely contraindicated, a simple solution to a very difficult problem and should lessen very materially the danger of peritonitis. This method or its principle may prove to have value in the treatment of certain types of recurring prolapses in adults, and possibly in connection with total excisions of the rectum when there is any endeavor to restore the anus and to retain normal sphincter control."

Owen H. Wangensteen of Minneapolis had occasion to use Reid's method. He states,[2] "A case is reported in which prolapse of the rectum was treated by strangulating the prolapsed gut by rubber bands, a method recently described

[1] Am. Jour. Surgery, 1933.
[2] Minn. Med., April, 1931.

by Reid. This simple but effectual method apparently is an old one which has been in use for fifty or sixty years. In instances of incarcerated or strangulated prolapse, it should be the method of choice. In adults who may be treated by

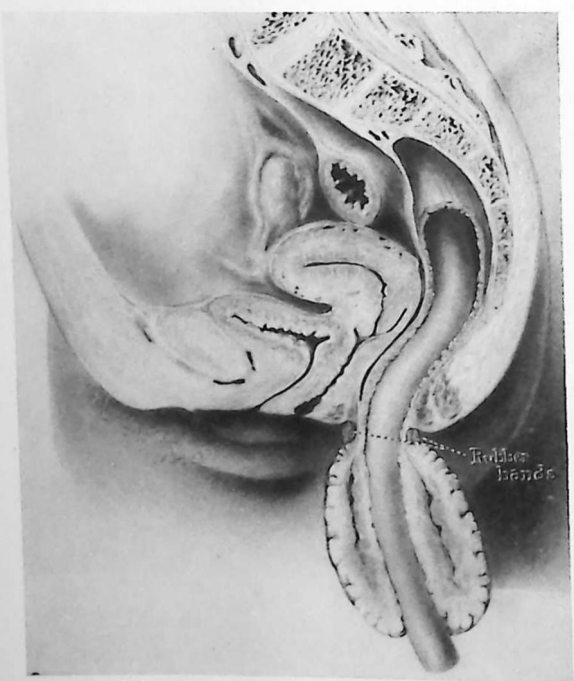


FIG. 1709. Prolapse of rectum is pulled down and a rubber tube, about one inch in diameter, is inserted through sphincters well up into the rectum. Spontaneous amputation and anastomosis occur as a result of constricting rubber bands, which are placed distal to sphincter muscles. This method cannot be used when there exists a hernia sac containing abdominal viscera. (Courtesy of Dr. Mont R. Reid.)

an elective method, this simple means should receive favorable consideration. Prolapse in children, on the whole, I believe, may be as efficiently treated by alcohol injection into the rectal wall or by the Elkehorn operation (p. 1537). In applying an elastic ligature over the prolapse, care should be taken that no coils

of small intestine are in the culdesac, which usually extends down to the apex of the intussusception."

VISCEROPTOSIS

This condition may involve one or all of the organs of the abdomen, consequently the operation indicated may be quite simple or very complicated.

In some instances prolapsed viscera, colon or other portions of the abdominal contents may be an indication for splenopexy, hepatopexy, gastropexy, cecopexy, colopexy, sigmoidopexy or nephropexy. Ceco-, colo-, sigmoido- and gastropexy have in many instances brought relief (see gastropexy).

Surgery is frequently more effective in treating these cases than other methods employed. However, the patient's general condition should be improved prior to undertaking any of these operations.

Cecopexy, colopexy and sigmoidopexy are simple procedures and are practically free from danger. Gastropexy may be indicated if the whole colon is displaced. The technic for these procedures is similar to that employed for sigmoidopexy, which is shown in Fig. 1633 on p. 1449.

Sigmoido- and Proctopexy

Suspension operations may be resorted to either via the abdomen or through the pelvic floor.

Posterior Proctopexy
(Tuttle, Maylard, Fowler, Verneuil, Elkehorn)

The underlying principles of this procedure are: (a) Posterior longitudinal or semicircular incision between the tip of the coccyx and anus; (b) by means of a long-handled needle the muscular coat of the prolapsed bowel is transfixed and carried upward through the wound and brought out at the sides of the sacrum and (c) then tied over a pad of gauze.

SIGMOIDOPEXY
(Allingham's Technic)

Moschcowitz obliterates the culdesac of Douglas and peritoneal folds by introducing purse string sutures in the peritoneum around the bowel and suturing the peritoneum to the pelvic fascia, uterus and serosa of the bowel, thus supporting the prolapsed rectum. In doing this operation avoid the ureter.

SIGMOIDOPEXY
(Gant's Technic)

Step 1. Make a 3-inch long incision in the left rectus or a midline incision 6 inches long.

Step 2. Locate the sigmoid flexure or colon and free it from adhesions. Examine it for ptosis and obstruction.

Step 3. Scarify the surfaces to be apposed and insert a few linen sutures under the longitudinal band and wall of the abdomen (Fig. 1710).

Step 4. Remove portions of the peritoneum on each side of the incision, thus facilitating the agglutination of the bowel and fascial lining.

Step 5. Approximate the fascia and muscle with chromicized catgut in the form of a lock-stitch; close the skin with continuous or interrupted sutures of

catgut, silk or linen. A few interrupted, figure-of-eight silkworm-gut sutures are inserted if the incision is large or has a tendency to pull.

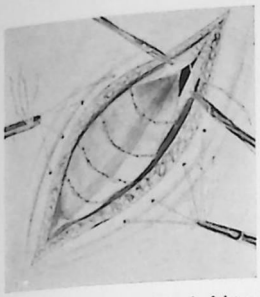


Fig. 1710. Colopexy. Method of introducing suspension sutures to approximate the colon with the transversalis fascia.

Step 6. Tie the linen suspension stitches across rubber tubing and apply a sterile dressing.

Comment: Suture the bowel to the abdomen in the shape of a curve, placing the stitches about 1 inch apart to prevent stasis. In colopexy the bowel is attached to the abdominal wall in one or several places; when dilated it is attached after ceco- or coloplication is done (Figs. 1711-1712).

Phrenocolopexy has been known to overcome coloptosis and stimulate the colon, the latter being due to the movements of the diaphragm.

In cases of ptosis complicated by marked dilatation, colopexy with invagination has been known to be effective. It is accomplished by the scarification and invagination of one portion of the colon into another and suturing the bowel in position. This should be followed by a colopexy.

Fig. 1711

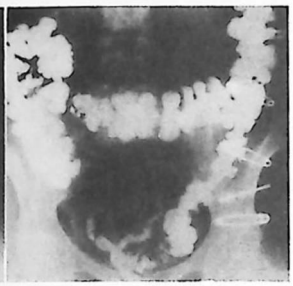


Fig. 1712

Fig. 1711. Marked coloptosis causing persistent constipation and neurosis.
Fig. 1712. Same patient after colopexy; constipation promptly disappeared; gain in weight; general marked physical improvement.

In cases of splanchnoptosis complicated by gastroptosis, Rovsing's gastropexy or Coffey's omentopexy should supplement colopexy, p. 1295. Figs. 1478-1479.

CRYPTITIS AND PECTENOSIS
CRYPTECTOMY; PECTENOTOMY

A number of longitudinal folds lie at the end of the anal mucous membrane. A depression occurs between each group of folds and dips down forming a little pocket which is called a crypt of Morgagni. Foreign bodies of fecal particles sometimes gather in these pockets causing ulceration and sometimes abscesses. The treatment consists in removing these crypts (cryptectomy).

If palliative measures are unsuccessful, the following procedure is resorted to: expose the crypt, fully. Introduce a probe into the crypt. Exert tension on the probe and with a scissors, curved on the flat, excise the entire valve and crypt. Stretch the sphincter gently. Insert a small piece of iodoform gauze

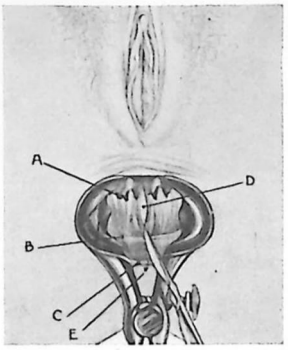


Fig. 1713

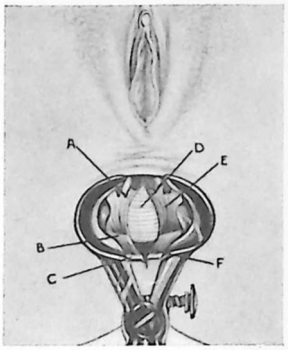


Fig. 1714

Fig. 1713. Pectenotomy. Directly over the midline posteriorly an incision is made through the rectal mucosa parallel to the long axis of the bowel extending from above the pectinate line to below the anocutaneous line. A. pectinate line; B. Hilton's line; C. anocutaneous line; D. pecten band below cut mucous membrane; E. incision line.
Fig. 1714. Pecten band exposed, ready to be incised in the same midline incision. A. pectinate line; B. Hilton's line; C. anocutaneous line; D. pecten band; E. incised anal mucosa; F. sphincter muscle below band.

over the cut surface. After-treatment: local applications of ichthyol or silver nitrate to the raw surface until it is entirely healed.

Manuel G. Spiesman[1] confirmed the studies of Miles and Abel on the relations of the pecten band and its pathology (pectenosis) as well as its relief by pectenotomy. It is depicted in Figs. 1713-1714-1715. The conclusions that Spiesman has drawn from a study of 105 cases of pectenosis are that it is a common chronic anal condition, relieved only by pectenotomy. Anorectal divulsion has proved to be unnecessary and has been replaced by pectenotomy in many instances. Pectenotomy is indicated in anal fissure, fistula-in-ano, cryptitis, papil-

[1] Ills. Med. Jour., Dec., 1916.

litis, pruritus ani, anal spasm; in some types of hemorrhoids and in any other anal condition associated with tightness of the sphincter.

PRURITUS ANI

In long-standing cases of pruritus which have failed to respond to medical treatment and where no definite cause for the itching can be found, a cure may be effected by the following procedure:

Uniterminal Desiccation

The active electrode is brought close to the skin. In aggravated cases the skin is punctured superficially. Dehydration must be complete in the area subjected to treatment. In advanced cases 2-4 treatments may be required. The surfaces subjected to treatment heal in about a month.

Aggravated cases may not yield to simple desiccation; this is also true where the perianal tissues are involved. Under such circumstances, excision of the affected area with the diatherm knife followed by suture of the raw

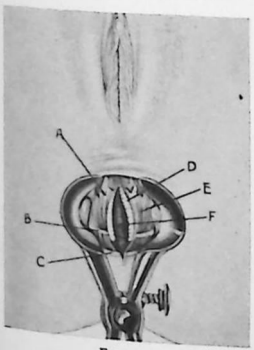


Fig. 1715

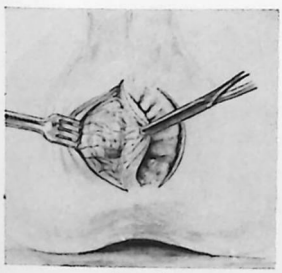


Fig. 1716

Fig. 1715. Pectenotomy. The incision is carried deeper until the complete thickness of the dense fibers of the pecten band are divided and the reddish-brown fibers of the external and internal sphincter are visible. A. pectinate line; B. Hilton's line; C. anocutaneous line; D. pecten band divided; E. anal mucosa divided; F. sphincter muscles below band. (Courtesy of Dr. M. G. Spiesman.)
Fig. 1716. Charles Ball's operation for pruritus ani. Note bilateral incision and exposure of nerves which are accentuated for purposes of illustration.

area will bring about relief. Avoid coagulation during cutting if primary union is the aim.

Ball's Operation for Pruritus Ani

The principle underlying this operation consists of dividing the terminal branches of the nerves which supply the affected skin.

Step 1. Place the patient in the lithotomy position. Make an incision (Fig. 1716) on one side of the anus through the skin and subcutaneous tissue. Retract the flap thus exposing the fibers of the external sphincter. Con-

tinue the incision up to and beyond the mucocutaneous junction. Undermine the skin for a short distance on either side of the original incision with scissors.

Step 2. Make a similar incision on the opposite side of the anus reflecting the flap as in the previous step.

Step 3. Undermine the bridges of skin with scissors. Attend to hemostasis.

Step 4. Suture the incisions after replacing the flaps. Dress. Lockhart-Mummery[1] endorses this operation strongly.

Krause's Operation

This operation is the same as Ball's except that six linear incisions are made radiating from the anus and following a circular path around the anal canal.

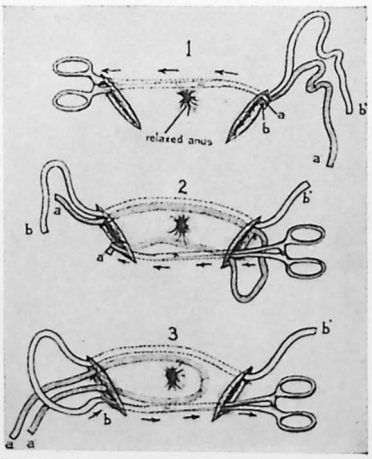


Fig. 1717. Dr. Harvey B. Stone's operation for anal incontinence. Steps in the plastic operation for anal incontinence: 1, clamps are passed subcutaneously in front of the anus grasping the strips of fascia and are about to be pulled from one side to the other; 2, both strips are passed subcutaneously in front of the anus and one posteriorly; 3, the loops of fascia encircle the anus subcutaneously in opposite directions. (Courtesy of Dr. H. B. Stone.)

Instead of making two elliptical incisions there are four lateral incisions, two anterior and two posterior. Between these folds, the skin is dissected up temporarily severing the sensory nerves. Krause claims that the advantage his operation has over Ball's is that the vascularity of the flap is not affected; this has been corroborated by other surgeons.

[1] Brit. Med. Jour., Aug. 21, 1915.

STONE'S PROCEDURE FOR ANAL INCONTINENCE

(Based on Wreden's Principle)

Harvey B. Stone[2] copes with this distressing condition as follows:

Step 1. Place the patient in the lithotomy position after as careful cleansing of the field as possible, including cleansing enemas for two days previous to operation.

Step 2. Make two symmetrical incisions, one on each side, about 4 cm. lateral to the anal margin and slightly posterior to it. These incisions slant somewhat laterally toward their anterior ends, are about 2 cm. long and are carried well into the subcutaneous fat (Fig. 1717).

Step 3. A closed long, curved Kelly clamp is introduced through one incision and by blunt dissection is forced around, through the subcutaneous tissues in front of the anus. Its tip is made to emerge into the other incision. (Fig. 1717 1.)

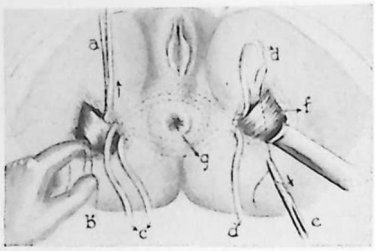


FIG. 1718. The Wreden-Stone operation for anal incontinence. The outer ends of strips of fascia are passed around the bundles of the gluteus maximus muscle. a. Clamp drawing thread under muscle; b. thread. (To be tied to fascia.); c. fascial strip; d. fascia with thread attached; e. drawing fascia under muscle; f. gluteus maximus muscle; g. anus. (After Harvey B. Stone, Arch. Surg., 1932.)

Step 4. Open the clamp and grasp the ends of two strips of fascia, 0.5 cm. wide and from 22 to 25 cm. long. (This fascia may be either autogenous from the patient's fascia lata or prepared by the Koontz method.)

The clamp grasping the strips of fascia is then withdrawn the way it was introduced. This threads both strips of fascia in front of the anus. A second Kelly clamp now grasps the end of one of the strips, is passed again into one of the incisions and is forced to burrow its way subcutaneously to the other incision, this time behind the anal canal. As it emerges into the opposite wound, the strip of fascia clamped in its tip is seized and more of it drawn through the wound. This strip now encircles the anus subcutaneously, entering at one incision, and its opposite end emerging from the same incision (Fig. 1717 2).

Step 5. The clamp which meanwhile has remained in its posterior tunnel, is opened, grasps the free end of the second strip of fascia and is pulled back

[2] Arch. of Surg., Jan., 1932.

the way it was pushed in. It brings back with it the end of the second strip of fascia which now encircles the anus subcutaneously, but in the opposite direction to the first; both protrude through the same incision. (Fig. 1717 3.)

Step 6. From one of the incisions blunt dissection is now carried outward and backward fairly deep in the fat until the mesial edge of the gluteus maximus is reached and identified. A bundle of fibers of this muscle about as thick as the index finger is now surrounded by one end of the strip of fascia protruding from the incision. This may be done easiest by carrying a linen thread in an aneurysm needle around the muscle and using the thread as a tractor, tied to the end of the strip of fascia, to pull the strip around the muscle bundle as shown in Fig. 1718.

Step 7. This end of the strip is now brought back into the incision and tied tightly to its own other end, thus forming a closed loop, one end of which encircles the anal canal and the other encircles a bundle of gluteus muscle (Fig. 1719).

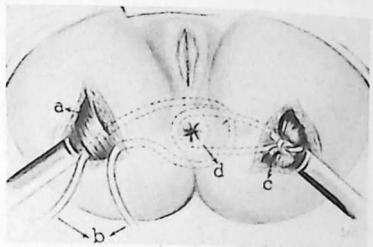


FIG. 1719. The Wreden-Stone operation for anal incontinence. The loops of fascia are tied on the right side and are ready for tying on the left. a. Gluteus maximus muscle, b. fascial strip, c. fascial strip tied to bundles of gluteus maximus muscle, d. anus.

Step 8. Execute exactly the same steps in the other incision with the two ends of the other strip of fascia. The knotted ends of the fascia sink into the depths of the wounds.

Step 9. The skin is closed in the usual manner.

Step 10. Seal the two small incisions with some impervious dressing. Keep the bowels locked up for from seven to ten days following the operation.

Comment: The anus now is encircled by two loops of fascia, running into opposite directions, tied under some tension about bundles of gluteus muscle. When the glutei are voluntarily contracted they will pull the loops still tighter and give a mechanism for voluntary increase in closing pressure on the anal canal.

Stone's method differs from Wreden's and from his own first method by reducing the number of incisions from four to two and by moving these two further from the anal orifice. If infection can be avoided, the percentage of good results should be high. The operation depends on the

utilization of the glutei muscles. If these muscles for any reason are not functioning, this operation cannot be expected to succeed. Also, until the patient learns to use the glutei properly, the full benefit is not obtained. Hence education of the patient in this regard is important. He must be trained to contract the buttocks when necessary. It follows that patients who cannot be taught to do this, because of lack of interest or intelligence, do not improve as much as others. The last case reported by Stone[1] was an instance in point. He states "The anatomic and surgical result was excellent, but the patient did not always remember to use his new power of anal control. Because of this necessity for education, the patients in successful cases do not show as much improvement immediately as they will ultimately."

[1] Stone reported and reviewed five further cases of anal plastic operations with four previously recorded cases. The results in five cases were excellent, in two good and in two unsatisfactory.

CHAPTER 35

SURGERY OF THE LIVER, GALLBLADDER AND BILIARY PASSAGES

OPERATIONS ON THE LIVER

Anatomic Considerations. The greater part of the liver is situated in the right hypochondrium. Portions of the viscus extend into the right and left epigastrium, the right lumbar and right umbilical regions and a small portion into the left hypochondrium.

The subphrenic space is located between the diaphragm and the upper surface of the liver. The ligamentum falciforme hepatis divides this space into two compartments (right and left). Fluid collections in the right subphrenic space may result in

(a) suppurations in the liver and bile passages
(b) appendiceal abscess
(c) empyema thoracis
(d) suppurative lesions of the right kidney

Fluid accumulations in the left subphrenic space may result from

(a) perforation of gastric ulcer
(b) abscess of the spleen
(c) empyema thoracis
(d) suppurative conditions of the left kidney

The Portal Circulation. (Fig. 1720.) The liver receives its blood supply from the (a) hepatic artery and the (b) portal vein.

The hepatic artery, a branch of the celiac axis runs to the right of the lesser omentum (hepato-duodenal ligament). At the porta hepatis, it divides into a right and left branch. The cystic artery usually arises from the right hepatic branch and courses along the cystic duct and the neck of the gallbladder. The gastro-duodenalis artery, a branch of the hepatic artery, runs downward and backward along the medial border of the duodenum. It gives off branches to the common duct. It terminates in the right gastro-epiploic and the superior pancreatico-duodenalis arteries.

The hepatic veins empty into the vena cava inferior. The portal vein drains the pancreas-spleen and the whole of the abdominal portion of the gastrointestinal tract with the exception of the lower part of the rectum and the anal canal.

It takes origin from the union of the splenic and superior mesenteric veins and passes through the lesser omentum to the portal fissure of the liver. The cystic, coronary (left gastric) and pyloric (right gastric) veins empty into the portal vein directly.

The superior mesenteric vein receives the veins of the small intestine, the ileo-colic, the right colic, the middle colic, the right gastro-epiploic and the pancreatico-duodenal veins.

The splenic vein receives the vasa brevia, the left gastro-epiploic, the pancreatic and the inferior mesenteric veins.

The inferior mesenteric vein is formed by the junction of the superior hemorrhoidal and sigmoid veins. In its course it gathers the left colic veins and enters the splenic vein.

Step 5. The liver now lies exposed; it is usually found adherent to the diaphragm. The aspirating needle, which remains in the abscess cavity all the while acts as a guide to the abscess cavity which is taken care of as outlined above.

Subphrenic Abscess

presents difficult problems from the diagnostic, as well as from the therapeutic point of view. Barnard's aphorism, "signs of pus somewhere, signs of pus nowhere else, signs of pus there" depicts the situation aptly.

EXPLORATION FOR SUBPHRENIC ABSCESS

Gas-oxygen anesthesia preceded by morphine or scopolamine is used. The procedure should be practiced in the operating room and everything should be in readiness, if need be, for the drainage of the abscess when located. The needle should be of ample length and diameter. The position of the patient is the same as for empyema. Connect the aspirating needle with a properly functioning aspirating syringe. Introduce the needle in the tenth interspace in the scapular line. If no pus is encountered, withdraw the needle and reintroduce it into the ninth, eighth and seventh spaces. If the abscess is still not located, explore the same spaces in the midaxillary line from below upward. About 3 or 4 inches are traversed by the needle through which, while being slowly withdrawn, suction is made.

Signs that the Needle Has Entered the Subphrenic Space. (a) The sensation imparted to the fingers that two strata have been punctured (the pleura and diaphragm). (b) Fürbringer's sign: The barrel of the syringe will move with the respirations of the patient when the needle has passed the diaphragm. (c) Blood from the lung is frothy and bright red; from the liver it is dark. If all of these fail, open the abdomen and explore. There exists no abscess where one can introduce his hand freely between the diaphragm and the dome of the liver.*

OPERATION FOR SUBPHRENIC ABSCESS

Transabdominal Route. Here the technic is the same as described above in connection with treatment of abscess of the liver (p. 1551).

Transpleural Approach (Fig. 1725). This also is similar to the description given above in dealing with abscess of the liver.

Comment: Alton Ochsner and Amos M. Graves[1] pointed out that the mortality rate in the cases they collected that were drained transpleurally was 39.0 per cent, as contrasted with a mortality rate of 21.1 per cent in those cases drained without contaminating the pleura or peritoneum. In a series of thirty-one cases they operated through a retroperitoneal approach to the subphrenic abscess the mortality was 9.7 per cent. They describe the retroperitoneal operation as follows.

RETROPERITONEAL OPERATION

Step 1. Paravertebral block analgesia. Patient lying on the unaffected side on a kidney rest or sandbag producing a scoliosis of the lower dorsal and lumbar spine.

* Many surgeons are opposed to aspiration of subphrenic abscesses. Ochsner and Graves state if aspiration is resorted to it should be performed in such a manner that the needle does not traverse uninvolved portions of the pleura and peritoneum (needle introduced below the 12th rib and extended upward and forward).

[1] Annals of Surgery, December, 1933.

Step 2. Make an incision over and parallel to the twelfth rib (Fig. 1726). Resect the entire twelfth rib subperiosteally. Avoid injury to the pleura which may be immediately beneath the rib (Fig. 1727).

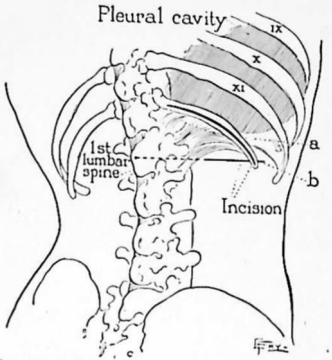


Fig. 1726. Diagrammatic drawing showing skin incision made over and parallel to the twelfth rib and transverse incision through the lumbar fascia and diaphragm at the level of the first lumbar spinous process. (Ochsner and Graves.)

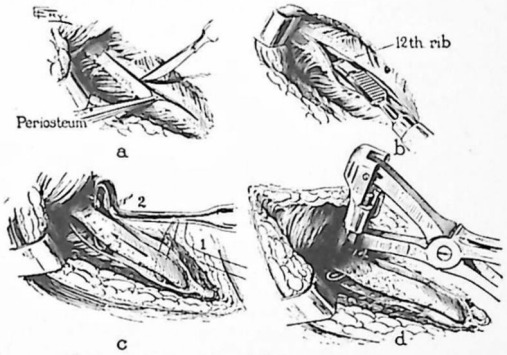


Fig. 1727. Subperiosteal resection of the twelfth rib throughout its entire length. (Ochsner and Graves.)

Step 3. Retract the erector spinae mass of muscles medially and make a transverse incision at right angles to the spine across the bed of the resected rib

at the level of the spinous process of the first lumbar vertebra (Fig. 1728). (It is extremely important that this incision through the bed of the rib be made transversely at this level and not parallel to the rib for only in this way can one be sure that the costophrenic angle of the pleura will not be injured.) A transverse incision at the level of the spinous process of the first lumbar vertebra will invariably miss the pleura (Fig. 1729). (Melnikoff.) This incision passes through the bed of the twelfth rib and the attachment of the diaphragm.

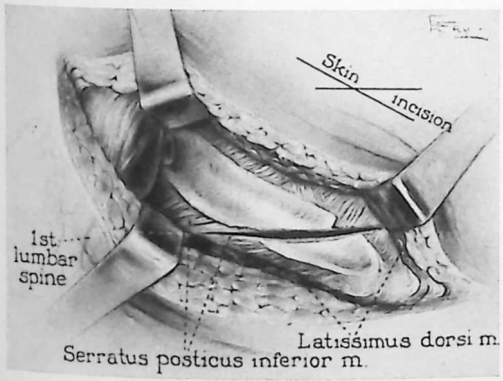


Fig. 1728. Drawing illustrating the transverse incision made through the resected bed of the twelfth rib and the serratus posterior inferior muscle at the level of the spinous process of the first lumbar vertebra. It is important that this incision does not parallel the original skin incision. (Ochsner and Graves.)

Step 4. After the diaphragm has been incised, the renal fascia is encountered (Fig. 1730). This is continuous above and anteriorly with the posterior parietal peritoneum. Displace the kidney downward by means of the index finger. Palpate the infrahepatic space. If indicated (induration in the infrahepatic space) aspirate to determine the presence of suppuration. In cases where a right posterior-superior space abscess is suspected, the peritoneum on the under surface of the diaphragm can be readily separated from the diaphragm with the finger (Fig. 1731). The inflammatory edema invariably present greatly facilitates mobilization of the diaphragmatic peritoneum from the under surface of the diaphragm. This separation may be carried upward as far as the dome of the liver and should be extended until the abscess is reached.

Step 5. Open the abscess cavity by means of the mobilizing finger by plunging the finger through the abscess wall which is adherent to the mobilized parietal peritoneum.

Step 6. Introduce large, soft, fenestrated rubber tubes into the abscess cavity and out through the wound. Through this incision adequate evacuation of abscesses located in the right posterior-superior, right extraperitoneal, the right inferior, and even occasionally right anterior-superior spaces may be accomplished without traversing or contaminating either the pleural or peritoneal cavities.

Comment: The advantage of the retroperitoneal operation is exemplified by the results obtained by Ochsner in a total of thirty-one cases, nineteen of which were previously reported, of which three died, giving a mortality rate of 9.7 per cent. Two of the deaths were probably unavoidable as in each the patient died as the result of the original lesion, which in one was carcinoma of the stomach and in the other was typhoid fever. Abscesses located in the right anterior-superior, the right inferior, the left anterior-inferior, and the left superior spaces can be drained extraperitoneally through the anterior abdominal wall. Obviously, however, the anterior route of drainage would not be used in cases of right inferior space abscesses, if retroperitoneal drainage is employed, because these abscesses, Ochsner states, can be satisfactorily drained by the retroperitoneal approach.

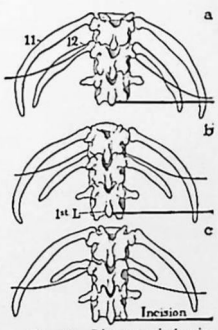


Fig. 1729. Diagrammatic drawing modified after Melnikoff, showing the variation in the relation of the costophrenic angle to the twelfth rib. It is evident that the transverse incision made at the level of the spinous process of the first lumbar vertebra will invariably miss the pleural reflection. (Ochsner and Graves.)

Clairmont pointed out that in right anterior superior and in left superior space infections with abscesses above the liver, the suppurating focus can be approached and drained extraperitoneally without contaminating uninvolved pleura or peritoneum.

Step 1. Make an incision just beneath and parallel to the costal margin through the flat abdominal muscles and transversalis fascia down to the anterior parietal peritoneum.

Step 2. As in the retroperitoneal operation, separate the parietal peritoneum from the under surface of the diaphragm with the index finger.

Step 3. Mobilize the peritoneum upward until the abscess cavity is reached.

Step 4. Open the abscess cavity extraperitoneally through the abscess-wall which is intimately adherent to the mobilized parietal peritoneum. Drain with soft rubber tubes or sheets of rubber tissue brought out through the wound.

ECHINOCOCCUS CYSTS

Solitary Cyst

Remove the cyst unopened, like a tumor, by resection of the portion of the liver carrying it or by marsupialization.

Multiple Cysts

These are treated as follows:

Step 1. Aspirate through a cannula connected with a suction apparatus.

Step 2. Open the cysts with an electrosurgical knife.

Step 3. Sponge out the cyst contents cautiously, avoiding implantations.

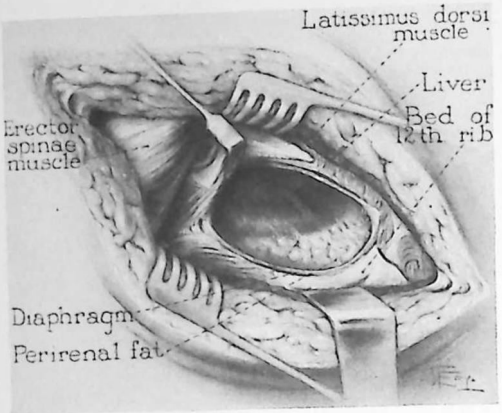


Fig. 1730. Drawing illustrating the operative wound following the transverse incision through the diaphragm at the level of the spinous process of the twelfth lumbar vertebra, exposing the perirenal fascia and the liver. (Ochsner and Graves.)

Step 4. Pack the resultant cavity with iodoform gauze. Some cysts may be peeled out of the liver if not buried in dense adhesions. Above all, thoroughness is essential in these operations.

If the cysts cannot be removed, proceed as above and suture the edges of the opened cyst tightly to the edge of the abdominal incision. Close the rest of the abdominal wall. Introduce drainage tubes and pack.

Marsupialization

FIRST STAGE

(a) Deliver the cyst into the abdominal wound without puncturing it.

(b) Pack gauze around it to form adhesions.

SECOND STAGE

(c) Open the cyst after adhesions have formed. At no time should cyst fluid be permitted to escape into the peritoneal cavity. Voluminous and careful lap packing will usually succeed in effectively isolating the field of operation.

Comment: Harold Dew of Melbourne, Australia, in an admirable communication on the subject[1] writes that the incision should be one that gives most direct access to the cyst. Its position should be ascertained by clinical and radiographic studies. He recommends the vertical paramedian incision. For cysts of the superior quadrants of the liver, a transthoracic approach with costectomy as described above is recommended. Although Dew admonishes

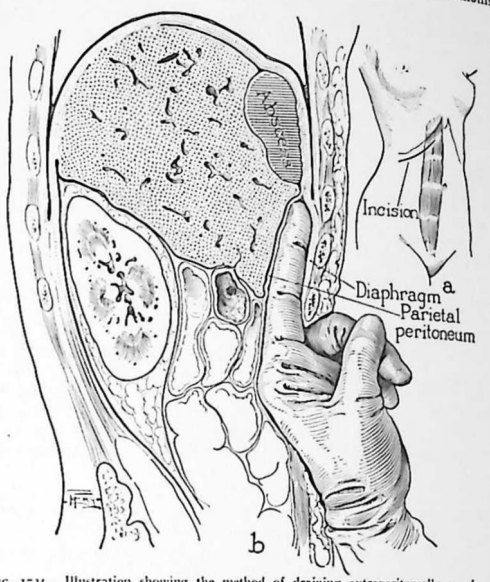


Fig. 1731. Illustration showing the method of draining extraperitoneally an abscess in the right superior space. As shown in (a) an incision is made below and paralleling the right costal margin, passing through the flat abdominal muscles and the transversalis fascia. By means of the finger the parietal peritoneum is peeled from the under surface of the diaphragm until the abscess cavity is reached. The abscess is then drained extraperitoneally without contaminating either the pleural or the peritoneal cavity. (Ochsner and Graves.)

that "since in these cases it is all important to avoid, if possible, opening the pleural cavity, the incision should, therefore, be made as low down and as far forward as convenient. In some cases, however, owing to non-obliteration of the costophrenic angle, the pleural cavity is opened. Suture of the diaphragm to the thoracic parietes may be desirable, but this is difficult to carry out effectively and, owing to the loss of support when the subjacent cyst is evacuated, the sutures often pull through, thus producing a sucking wound with its attendant risks."

[1] S. G. & O., Feb., 1929, pp. 239-244.

In non-urgent cases Dew paints the serous surfaces with 5 per cent iodine solution. He uses tamponade to enhance adhesion formation, after which (two or three weeks later) incision and evacuation of the cyst is carried out in the area between the adhesions, without endangering the pleural cavity with contamination and pneumothorax.

Wide retraction and thorough manual exploration are then done (both lobes of the liver, spleen and neighboring peritoneal folds are thoroughly scrutinized).

Thorough isolation of the field of operation is essential. Dew uses black packs for the layer of packs nearest the cyst "because daughter cysts and scolices show up well against this background."

A two-way syringe of special design is used by Dew which permits evacuation and injection of the hydatid cyst without removal of the needle (Fig. 1732). After evacuation of a sufficient quantity of fluid, pure commercial formalin is injected from a previously charged syringe without removing the needle. About 7.5 cc. of formalin is injected into a cyst about 10 cm. in diameter and allowed to act at least four minutes. The cyst is now opened and the fluid is evacuated

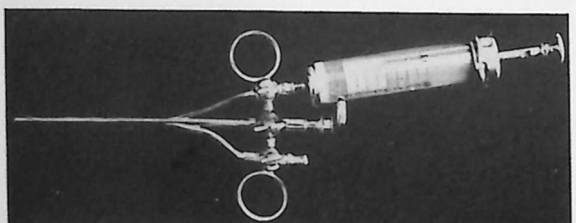


Fig. 1732. Special two-way syringe which permits evacuation and injection of the hydatid cyst without removal of the needle. (Courtesy of Prof. Dew.)

with a suction pump. Solid contents that cannot be evacuated with the suction pump are removed with a spoon. The contents of the sac are evacuated thoroughly. The remaining cavity is swabbed out with 4 per cent formalin and 90 per cent alcohol. Dew admonishes again "no attempt should ever be made to remove the thick fibrous adventitia completely. Not only is this unnecessary but owing to the intimate connection between the adventitia and the hepatic connective tissue and the frequent presence of large veins, such an ill-advised attempt is fraught with great danger and may be followed by a fatal result. In very large cysts partial removal of the extrahepatic portion of adventitia may, however, be carried out to facilitate a closure."

Treatment of the cavity is best shown by the appended diagrams (Fig. 1733).

Liver Resection in Echinococcus Cysts

N. Terebinski (1929) of Moscow, Russia, reported three cases of resection of the left lobe of the liver and two cases of excision of the right lobe of the liver for large echinococcus cysts. Thirty-nine further cases reported by Russian

surgeons show that the removal of encapsulated cysts is a comparatively simple procedure offering good prognosis.

HEPATECTOMY FOR TUMORS OF THE LIVER

A great portion of the liver can be removed without specific injury (Ponfick).

The two important factors in the removal of solid tumors of the liver are (a) proper exposure and (b) hemostasis.

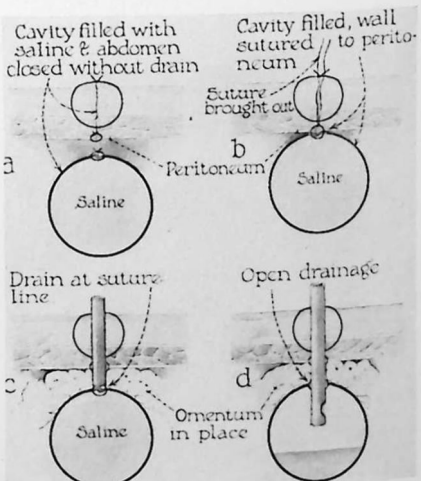


Fig. 1733. Diagram showing various methods of dealing with the cavity of a hepatic hydatid cyst after evacuation and closure of the abdomen. (After H. Dew.)

Tumors of the right lobe are best approached through transverse incisions (Mayo-Robson). Tumors of the left lobe may be effectively exposed through a longitudinal incision in the epigastrium or through transverse exposure. Tumors on the dome of the liver must be approached with the aid of costectomy. The position of the patient as described by Mayo-Robson (p. 1570, Fig. 1737) is of distinct value.

Methods of Hemostasis During the Operation

Temporary elastic ligature. In pedicled tumors a rubber tube acting as a tourniquet may be placed around the pedicle and the tumor removed. In tumors without a pedicle the liver substance behind the tumor is pierced with a cannula. A double elastic ligature is introduced through the cannula and the ends of the ligature are tied on either side of the tumor.

Pringle's Method of Digital Compression of the Portal Vein. In this procedure Langenbuch's suggestion was to divide the coronary and right lateral ligaments allowing the liver to be dislocated and brought to the surface; or make a proper sized costochondral flap which is reflected upward. The Pringle maneuver consists of digital compression of the portal vein at the foramen of Winslow. Excellent temporary hemostasis is thus secured.

Aubray's method consists of applying to the liver, around the tumor to be removed, a series of interlocked sutures of thick silk or catgut. A blunt needle with long curve is used in applying the sutures.

Kousnetzoff's needles for liver suture may be used to advantage. I have devised an olive-pointed needle which can be used effectively and carried on the ordinary needleholder (Fig. 1734).

Each individual ligature, after being crossed with its opposite fellow on the right and left is slowly and steadily tied with such firmness that the liver parenchyma is cut but the vessels remain in the undivided loop. When the whole series of ligatures is tied the tumor is removed with the knife or electrocautery. Little force is to be used in transfixing the liver. Obstacles are often encountered during the transit of the needle; these should be side tracked by a gentle to-and-fro motion and never be forcibly attacked, for these obstacles consist of blood vessels and their transfixion may be followed by severe hemorrhage.

Interlocking gauze strips were used by Leonard Freeman instead of ligatures to secure hemostasis (1904). Freeman experienced difficulty in removing the gauze because the gauze knots cut into the liver substance. Later he modified his technic by securing the ends of the gauze strips with forceps or catgut.

Anschütz's Rules for Liver Resection

1. The incision through the liver substance should be made with a sharp knife and the vessels picked up with forceps and ligated. If blunt force be used in dividing the liver substance, the hepatic vessels will retract, giving rise to difficulties in securing and ligating them.
2. Wherever possible a wedge-shaped piece of liver should be removed; this facilitates closure with suture.
3. No special instruments for the introduction of the sutures is needed. The ligature should be tied slowly but firmly.
4. The elastic ligature may be used in selected cases.
5. Tamponade is unnecessary after suture.
6. Division of the hepatic ligaments is frequently an aid in resection.
7. Do not hesitate to resect the right costal arch and to sever the suspensory ligament wherever access to the dome of the liver demands such exposure.

Kirschner surrounds the segment of the liver to be removed with overlapping sutures of catgut carried on a straight needle which traverses the whole thickness of the liver.

In view of the fact that liver tissue cuts through easily the interposition of the falciform ligament between the sutures and the liver will act as a bolster and prevent cutting through.

Bleeding vessels from the liver are after all best controlled by direct ligation of the respective vessels. When liver surfaces cannot be opposed by sutures, tamponade has to be resorted to. Payr and Martina (1903) recommend magnesium plates to insure hemostasis after liver resections. These are cut into the desired shape and placed at the margin of the defect in the liver. Mattress sutures of strong catgut are passed through the plates and these approximated in such a manner that the defect in the liver is closed. In time, magnesium becomes absorbed. The plates should only be approximated and not too tightly drawn together.

Comment: Garré points out that all complicated methods of suture of the liver are unnecessary and useless and that simple suturing and ligating properly carried out is all that is necessary to obtain excellent results.

Electrosurgery in Tumors of the Liver

Electrocutting currents, properly applied, divide the tissues and smaller vessels are sealed by coagulation.

Electrocoagulation permits destruction of localized tumors with no loss of blood. The tumor is coagulated in layers which are removed by the loop; layer after layer is coagulated until the whole tumor is destroyed. Large tumors may be removed by electrocoagulation.

Primary Carcinoma of the Liver

Dr. Reginald H. Jackson summarizes the subject of primary carcinoma of the Liver as follows (Fig. 1735):

"Primary carcinoma of the liver is a very rare lesion, of especially great interest to pathologists and of increasing importance to surgeons. A cursory review of the available literature reveals such an extreme paucity of cases subjected to surgical treatment that it is a duty to report an authentic case. (Hepatoma type.) The patient, a white woman, aged eighty years, whose chief and practically only complaint was the presence of a large, spherical, epigastric tumor, was subjected to exploratory laparotomy for a probable pancreatic cyst. Operation revealed a globular tumor mass occupying nearly the whole of the left lobe of the liver. No primary source of malignancy present. Physical conditions of growth were such as to invite left hepatic lobectomy. A primary step in the operation was the ligation of the left hepatic artery and the left portal vein. This procedure effectively solved the problem of serious hemorrhage during or after the operation of left lobectomy and greatly lessened the chance of postoperative leakage of bile.

Fig. 1734. Author's olive-pointed needles.

"Embryologic and phylogenetic development of the liver indicate that there should be little or no cross-circulation of blood or bile between the right and left lobes of the liver. McIndoe and Counsellor have shown clearly that such is, indeed, the case in the human. It would, therefore, seem expedient in certain cases of neoplasms of the left lobe to perform partial lobectomy in preference to local resection, to insure:

1. Extensive radical removal of neoplastic tissues.
2. Prevention of serious hemorrhage during or after operation.
3. Prevention of postoperative leakage of bile.
4. Practically primary closure of abdominal wound.

"The operation was made under spinal anesthesia, without any alarming symptoms during or after its performance. Convalescence was uneventful and the patient is now, seventeen months later, enjoying excellent health."

SURGICAL TREATMENT OF ASCITES DUE TO CIRRHOSIS OF THE LIVER

Epiplopexy

According to Binge (1905) the Talma-Morison operation is indicated in

1. Atrophic Cirrhosis of the Liver.
2. Cirrhosis due to Cardiac Disease.
3. Pseudocirrhosis with Chronic Pancreatitis.
4. Chronic Hyperplastic Perihepatitis.
5. Rarely, in Portal Stenosis due to Thrombosis.

The operation is serious. I had some good results from its use and experienced many failures.

There are certain contraindications to the performance of epiplopexy. Some of these are: (a) advanced age, (b) marked cholemia, (c) advanced debility or arteriosclerosis, and (d) chronic interstitial nephritis.

Patients usually succumb in a condition of coma within a few days if operated on in the presence of the contraindications cited.

Drummond in 1896, and Talma in 1898 independently suggested epiplopexy in the treatment of ascites due to cirrhosis of the liver. The object was to establish connections between branches of the epigastric veins and the branches of the portal vein. A portion of the blood of the portal vein thus finds its way through the new avenues created, operatively, into the inferior vena cava. Kousnetzoff, Ito and Onis established the feasibility of this procedure by numerous experimental studies on animals.

The great omentum is usually used in the operation. Körte objects to Morison's operation (omentopexy combined with abdominal drainage) warning of the possibility of infection from this procedure.

Direct anastomosis between the portal vein and the vena cava or Eck's fistula, was suggested by Eck's experiments on animals. Torsi proposed using this method in man. It was first performed by Vidal, with disappointing results. Rosenstein (1912) has had some success with the operation. "This operation," writes Guibe, "ought to be abandoned, because however effectual it may be, it exposes the patients to too great dangers—the danger of alimentary intoxication which might possibly be foreseen and avoided, but speedily the danger of general infection of intestinal origin ensues since the intestinal mucosa does not always oppose a sufficient barrier to microbic invasion." Vidal's patient died four months after the operation and a patient operated on by Thierry de Martel succumbed to anuria in 48 hours. Villard and Tavernier joined the mesenteric to the right ovarian vein, the stoma, however, became occluded by a clot.

TALMA-MORISON OPERATION

Step 1. Local, spinal, nitrous-oxide-oxygen or ethylene anethesia. The abdomen is opened in the midline a little to the right above the umbilicus. A suction apparatus evacuates the fluid from the free abdominal cavity as well as the pelvis and renal pouches. Gauze mops are used in the absence of a suction apparatus.

Step 2. Expose as much of the upper surface of the liver as possible and with a gauze sponge rub it vigorously in all its accessible parts. Treat the spleen similarly.

Step 3. Deliver the omentum into the wound. Rub it with a gauze sponge until it bleeds slightly. Unite it to the parietal peritoneum which has been scarified to the extent of the palm of the hand in the following manner: Evert the abdominal wall, which is now flaccid as a result of the released ascitic fluid. Expose the parietal peritoneum as far from the midline as convenient. The omentum is united to the parietal peritoneum with catgut sutures as far from the midline as possible. The same procedure is practiced on both sides. (Fig. 1736.)

Fig. 1735. A spherical, greyish-white, glistening tumor mass resembling a thick-walled cyst with distinctly engorged veins. No gross evidence of cirrhosis. Removed by Dr. Reginald H. Jackson. Postoperative diagnosis (Dr. Broder): primary liver-cell carcinoma.

Step 4. Close the abdominal wall in layers.

As already pointed out, a second opening made above the pubes in the earlier operations has been abandoned by most surgeons as unnecessary and being a possible source of infection.

Generally the best results from this operation are obtained the earlier the patient submits to the operation. The postoperative mortality is about 20 per cent (Monprofit).

Schiassi's operation consists of suturing the omentum between the layers of the abdominal wall (intramural epiplopexy). The results are no better than with the Talma-Morison procedure described above.

Paracentesis Abdominis

The bowels and bladder should be empty.

Step 1. Cleanse the abdomen. Put the patient in a sitting position. If too weak to sit up, permit dorsal decubitus. Choose the puncture point in the linea alba, at a midpoint between the umbilicus and pubes.

Step 2. Deposit a small quantity of 1 or 2 per cent novocaine solution intra- and subdermally at the proposed point of puncture.

Step 3. Penetrate the abdominal wall gently and firmly with a medium size trocar and cannula.

Step 4. Withdraw the cannula.

Step 5. Permit the ascitic fluid to escape slowly. If the patient complains of faintness during the paracentesis, plug the cannula, thus stopping the escape of fluid until he recovers. If the patient be seated in a small rocking chair and if syncope should supervene the patient can easily be tipped quickly into

Fig. 1736. Epiplopexy (Talma-Morison operation). Interrupted sutures or a continuous suture may be used in fixing the omentum to the abdominal wall. Proceed as illustrated, on both sides.

a recumbent position. After fluid of sufficient quantity has escaped, the cannula is withdrawn.

Step 6. Apply a dressing over the puncture point and apply a tight-fitting abdominal binder.

Precautions. Avoid puncturing a distended bladder or the uterus. A misdirected trocar may inflict injury to the bowel. If fibrin obstructs the cannula, clear it with a probe. Avoid too large calibered trocars. A smaller instrument is preferable, it prevents too rapid egress of fluids.

Permanent Abdominal Drainage

Many methods to drain the peritoneal cavity permanently have been advocated from time to time. These consist of diverting the fluid into the subcutaneous cellular tissues by means of chemically hardened vessels, silver wire bridges, bundles of silk, glass tubes, etc. It is doubtful, says Henschen, whether the hoped for results for these methods will materialize. They are temporary measures at best. However, Kalb's method of subcutaneous drainage is said to have given satisfactory results. It consists of forming a wide connection between

the abdominal cavity and the subcutaneous connective tissue "so that the fluid constantly being formed inside the abdomen is absorbed as in continuous hypodermoclysis." Kirschner refers to the procedure as "window drainage."

Step 1. Place the patient in the Trendelenburg position and elevate the side of the patient which is opposite the surgeon.

Step 2. Open the abdominal cavity by a midline incision; a little more below than above the umbilicus.

Step 3. Remove the ascitic fluid completely.

Step 4. Retract forcibly the side of the abdominal wound opposite the surgeon.

Step 5. While the intestines are held back, or, if need be, after eventrating the intestines, cut a window-opening the size of the palm of the hand through the abdominal wall from within, with the exception of the skin. This is best done with the electrosurgical knife. The external muscle fascia must also be removed so that the subcutaneous fat and the uninjured skin are the only structures between the abdominal cavity and the exterior. Avoid injuring the skin by placing the left hand on the outside of the endangered area. If visibility is limited by adhesions, caution is necessary to avoid injuring the ascending colon on the right side and the descending colon on the left. As a rule, the muscle wound bleeds quite freely.

Step 6. Hemostasis may be difficult in the abdominal window which is hard to get at and under such circumstances control bleeding with a running suture.

Step 7. Close the midline incision without drainage.

Comment: In a short time the skin over the window bulges immensely and the neighboring tissues become infiltrated with fluid. The edema may spread and lead to a marked swelling of the scrotum or the labia majora. The more marked and more prolonged such edema, the better the result of the operation which may also be performed on both sides.

IMPLANTATION OF THE SUPERIOR MESENTERIC VEIN INTO THE INFERIOR VENA CAVA (BAGORA'S OPERATION)

Bagora described this procedure in 1913; it consists of dividing the superior mesenteric vein at the lower end of the meso-ilium and implanting its aboral (distal end) into the inferior vena cava.

Step 1. Enter the abdomen through a right pararectus incision about 6 inches in length beginning about 3 inches above the level of the umbilicus.

Step 2. Evacuate the ascitic fluid.

Step 3. Bring the terminal portion of the ilium out of the abdominal cavity and expose the terminal meso-ilium. Locate and isolate the superior mesenteric vein for about a distance of 2 inches. The vein lies close to the superior mesenteric artery. Place a ligature at the proximal end of the exposed vein. Be careful to leave a number of veins proximal to the point of ligation to avoid diverting the whole supply of blood of the small intestine from the portal circulation.

Step 4. Place a clamp on the superior mesenteric vein a couple of inches distal from the ligature. Divide the vein close to the ligature.

Step 5. Replace the bowels into the abdominal cavity and permit the vein to hang free upon the lower surface of the meso-ilium.

Step 6. Incise the parietal peritoneum of the posterior abdominal wall in front of the inferior vena cava. Expose the anterior wall of the inferior vena cava for a distance of about 2 inches.

Step 7. Grasp the anterior wall of the inferior vena cava with a blood vessel clamp in the long axis of the vein.

Step 8. Make a small opening in the vein held by the forceps.

Step 9. Place 4 sutures equidistant from one another and unite the circumference of the open end of the superior mesenteric vein with the opening created in the inferior vena cava. The sutures must penetrate the entire thickness of both vessels to be united and their ends are left long.

Step 10. Place a row of continuous sutures between each of the two sutures left long which act as traction sutures. Avoid purse string action or constriction.

Step 11. Close the incision made in the parietal peritoneum of the abdominal wall.

Step 12. Close the abdomen in the usual manner.

IMPLANTATION OF THE SAPHENOUS VEIN INTO THE PERITONEAL CAVITY (ROUTTE'S OPERATION)

Routte described this procedure in 1907. This operation consists of implanting the large saphenous vein into the peritoneal cavity, the object being to have the saphenous vein gather the ascitic fluid and direct it to the femoral vein and thence to the general venous circulation. The return flow of blood from the femoral vein into the free peritoneal cavity is prevented by the valves in the vein.

Step 1. Expose the long saphenous vein on the anterior surface of the thigh through an incision placed about 3 cm. lateral to the pubic spine and 4 cm. below it. Carry the incision downward and slightly mesially for a distance of about 10 cm.

Step 2. Expose the long saphenous vein and divide it at a distance of about 10 cm. from the femoral vein; ligate its distal end.

Step 3. Make an incision on the anterior abdominal wall a little above Poupart's ligament to the extent of about 3 cm. Divide the peritoneum for 2 cm. only. Aspirate the ascitic fluid. Create a subcutaneous tunnel between the upper and lower skin incisions.

Step 4. Bring the long saphenous vein connected with the femoral through this tunnel. Bevel the edges of the vein and suture the margins of the open peritoneum to the open end of the vein. An anastomosis is thus formed between the peritoneal cavity and the venous circulation.

Step 5. Close the wound without drainage.

Comment: Successes are reported from this method by some authors while others reported failures (occlusion of the anastomosis; obliteration of the saphenous vein).

OPERATIONS ON THE GALLBLADDER

Historical Notes. Gallstones have first been noted, it is asserted, by Gentile de Foligno of Padua about 1348. Marcellus Donatus shared, according to some, the same distinction. He died in 1348. He described an incarcerated stone in the ampulla of Vater. While Fabricius Hildanus removed gallstones from man, contemporary

historians believe that this operation was performed on the dead. The first allusions to the removal of biliary calculi from the living are found in the writings of Van der Wiel (1687), Amyard (1739) and Müller (1742). However, these procedures were not deliberate, being incidental to other operations. To Jean-Louis Petit (1743) belongs the credit of deliberate planning and carrying out the removal of stones from the gallbladder.

Thudichum (1859) proposed cholecystostomy in two stages. To Bobbs (1867), an American surgeon, belongs the credit of having done the first cholecystostomy in one stage. However, he did not plan the operation deliberately, for at operation he thought he was dealing with an ovarian tumor. The first successful cholecystostomy was performed by Kocher in 1878. Lawson Tait, Keen and others soon followed.

The first successful cholecystectomy was done by Langenbuch in 1882. Courvoisier and Thiriar, French surgeons (1885) and Ohnage, an American, in 1887 were first to repeat Langenbuch's success. It took several years before England accepted the procedure as worth while, Lawson Tait opposing its introduction. Cholecystenterostomy was performed at the suggestion of Nussbaum by von Winiwarter in 1882. The anastomosis was made between the gallbladder and the transverse colon. Animal experiments carried out by Cozi resulted in his pointing out that the duodenum, as an avenue of union, would be much preferable because of ascending infections from the colon which are sure to follow.

Choledochostomy as a deliberate procedure was first performed by von Winiwarter.

Langenbuch suggested to Kümmel (1885) the feasibility of supraduodenal choledochostomy. The operation proved unsuccessful. In 1884 Courvoisier and Knowsley and again Thornton in 1889 performed the operation successfully. Mobilization of the duodenum with retroduodenal choledochostomy was introduced by Haasler in 1898. Transduodenal choledochostomy was done by Kocher in 1894 and duodenocholodochotomy by McBurney in 1898.

Choledocho-enterostomy was devised by Riedel in 1888. The first successful performance of this operation is credited to Sprengel in 1891.

Various valuable contributions to biliary surgery which lead to its present-day perfection were made by Hans Kehr, Lord Moynihan, the brothers Mayo, Mayo-Robson, Deaver and others.

Anatomic Considerations. The gallbladder is divided into a fundus, a body and a neck. The cystic duct is located in a peritoneal fold and runs from the neck of the gallbladder to the lesser omentum and opens into the right side of the hepatic duct at an acute angle. Its mucous membrane projects into the lumen as a continuous spiral ridge, known as the valve of Heister. It is this valve-like arrangement of the mucous membrane that often prevents the passage of a probe into the common duct. The cystic artery accompanies the duct, usually on the left side.

The common hepatic duct is formed in the depth of the transverse fissure by the union of the right and left hepatic ducts. It courses in the right free margin of the lesser omentum for about an inch and after joining the cystic duct it becomes the common bile duct which is about 9 to 10 cm. long. It is divided into four parts: (a) supraduodenal portion, (b) retroduodenal portion, (c) pancreatic part and (d) intraduodenal portion. It runs along the right free margin of the gastrohepatic omentum in front of the foramen of Winslow with the portal vein and the hepatic artery to its left. It descends behind the first part of the duodenum and thence in a groove on the posterior surface of the head of the pancreas, the superior mesenteric vein being to its left and in close association with the inferior vena cava. It then passes along the internal border of the second part of the duodenum. Here it is crossed by the pancreaticoduodenalis artery. It then unites with the pancreatic duct (duct of Wirsung) forming the ampulla of Vater and finally opens on the top of the papilla in the second part of the duodenum.

The ampulla of the common duct is surrounded by the sphincter of Oddi, a delicate layer of unstriped muscle fibers. It is of importance to recall that when the gallbladder contracts the sphincter of Oddi relaxes (Meltzer). A number of lymph nodes are situated along the course of the common bile duct in close relation to its walls. One

the gallbladder to a receptacle attached, by adhesive plaster, to the side of the patient.

CHOLECYSTECTOMY

Indications

1. Tumors (carcinoma, etc.).
2. Contracted gallbladder.
3. Hydrops and hypertrophy of the gallbladder.
4. Some cases of gangrenous or phlegmonous cholecystitis.
5. Empyema of the gallbladder (some cases).
6. Degenerative changes (incrustations).
7. Fistulae; serious trauma (gunshot and other wounds).
8. Cholelithiasis.

This operation may be performed from above downward or from below upward. Incision, position of patient, etc., are the same as in the previous operation.

Step 1. Isolate and divide the falciform ligament. Traction on this structure will aid to better expose the extrahepatic biliary passages. If adhesions prevent proper exposure, they must be divided. A clear view of the operative field is a sine qua non. Moynihan's maneuver of delivery of the liver may sometimes be of aid. It consists of seizing the edge of the liver with gauze and gently dragging it down from its shelter beneath the costal arch and bringing it out of the wound by a rotating movement. This, however, is not always possible.

Step 2. Isolate the cholecystoduodenocolic and hepatoduodenal ligaments. Be thoroughly familiar with the surgical anatomy of the parts (see above).

Isolate and visualize the extrahepatic biliary passages. Upon this step the success or failure of the operation frequently depends. If inflammatory adhesions surround the parts, dissect them away. Isolate the field of operation by properly placed lap-packs. A good self-retaining retractor over these renders excellent service. Additional retractors may be used when needed, keeping in mind, however, to get along with as simple an armamentarium as is consistent with good work.

Step 3. Grasp the fundus of the gallbladder with a pair of forceps. With another pair engage Hartmann's pouch (Fig. 1741a) (Moynihan's gallbladder forceps). Traction on the latter will expose the region of the cystic duct. The next important task is to identify and visualize the biliary passages. In view of the fact that variations in the arrangement of the bile duct and arterial supply occur in about 70 per cent of cases (Flint) it is apparent how important it is to see the structures concerned before subjecting them to surgical manipulations. Dissect out the cystic duct. Occasionally Hartmann's pouch overhangs, and is intimately adherent to, the common duct, in which event they should be separated by gentle dissection. Blunt longitudinal separation of the fat and cellular tissue about the cystic duct will bring the structures to view. By working from the neck of the gallbladder downward or from the duct upward the continuity of these is established (Fig. 1741b).

Step 4. Pass a curved artery forceps behind the cleared cystic duct. Open and spread the forceps behind the duct. Throw a chromic catgut ligature around the cystic duct and artery simultaneously. Tie them together but do not crush them. Excessive force applied here may cause the ligature to cut through and give rise to biliary leakage. For safety, place two ligatures about ¼ of a cm. from one another. Grasp the proximal portion of the cystic duct with another forceps and divide the duct with scalpel or scissors. Touch the divided ends with carbolic acid or iodine (Fig. 1741c).

Caution. Before applying the ligature to the cystic duct make sure that it is sufficiently separated from the common duct, thus avoiding injury to the latter.

Step 5. Dissect the gallbladder by sharp dissection from its bed, keeping constantly in mind to avoid injury to the bed of the gallbladder. A strip of peritoneum should be permitted to remain on either side of the ablated gallbladder to facilitate proper closure of and protection of the gallbladder bed.

Step 6. A continuous or interrupted catgut suture closes the defect in the gallbladder bed by bringing the edges of the peritoneum together. Do not penetrate the liver tissue while passing the needle in approximating the peritoneal edges (Fig. 1741d).

Drainage is often omitted by many surgeons. In classical cholecystectomy I prefer to use what Lord Moynihan so aptly described as a "conscience drain." It can do no harm and may avert disaster in case of unexpected biliary leakage (Fig. 1741d). (See author's operation, p. 1580.)

Subserous Cholecystectomy

This was described by Witzel in 1906:

Step 1. Incise the serosa on the surface of the gallbladder beginning at the fundus and extending to the cystic duct on both sides.

Step 2. Find the line of cleavage between the serosa and muscularis and separate the former from the latter along the line of incision shelling out the gallbladder from its serous covering.

Step 3. Clamp the cystic duct. Ligate it. Unite the serous leaflets with catgut sutures.

Comment: This operation can only be done in the minority of cases. The majority of gallbladders coming for operation are so altered by pathologic changes that to perform a subserous enucleation is very often an impossibility.

Moses Behrend[1] justly stresses the pertinent factors in reduced mortality in cholecystectomy in which he points out the important rôle played by spinal anesthesia, the administration of glucose by venoclysis and hypodermoclysis, as well as the proper selection of cases. His conclusions are pertinent and follow:

1. An intimate knowledge of the common and special anatomy of the bile passageways.

2. Spinal anesthesia, because of the relaxation it affords, has greatly reduced the mortality.

[1] American Journal of Digestive Diseases and Nutrition, Vol. II, No. 4, March, 1935.

3. Glucose and blood transfusions before and after operations are of great value.

4. Do not operate as an emergency on acute cases.

5. Put the stomach and intestinal tract at absolute rest.

6. Do not explore the common duct unless there is some very good reason.

7. The less we institute drainage, at operation, the better.

8. Never perform a cholecystectomy in the presence of jaundice.

9. Whenever possible remove the gallbladder within its peritoneal fold.

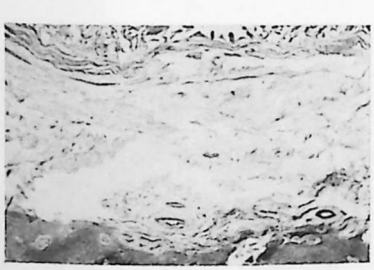


Fig. 1742. Bile ducts in the gall bladder bed.

ELECTROSURGICAL OBLITERATION OF THE GALLBLADDER

Cholecystelectrocoagulectomy

Author's Operation:

Rationale. In selected, uncomplicated cases the removal of the gallbladder with the scalpel yields a mortality of 1 or 2 per cent; and in the hands of those not especially trained, particularly in patients over forty years of age with coexistent hepatic and cardiorenal disease, the mortality is 10 per cent or even higher. Mortality advances rapidly with age. It is much greater in males than in females. This is explained by Tixier on an anatomic basis, a narrow configuration of the lower male thorax and consequent inaccessibility of the structures as compared with females.

Fatalities following classical cholecystectomy are caused by the following factors:

1. In 15 to 25 per cent of individuals there are enlarged bile capillaries and even large-sized bile ducts running in the gallbladder bed (Figs. 1742-1743). A removal of the gallbladder with the cold scalpel necessarily opens these bile passages and bile leakage results.

2. Bile, whether sterile or not, has proved to act as a true chemical poison in the peritoneal cavity. Bakes[1] observed bile issuing from the wound 230 times in 346 cases of simple cholecystectomy. He and many other surgeons were im-

[1] Bakes, J. J. (1928). Zbl. f. Chir., 55, 1858.

pressed by the postoperative appearance of bile in the dressing "in nearly all the cases."

3. After classical cholecystectomy the gallbladder bed cannot always be obliterated by sutures; the resulting raw, rather large open surface is often responsible for bile leakage.

Fig. 1743. Bile duct in gall bladder.
From section shown in preceding illustration.

Experimental studies for a number of years have convinced the author* that if one could substitute a dry, non leaking surface instead of a discharging cavity, as the gallbladder bed represents following cholecystectomy, it would be a great

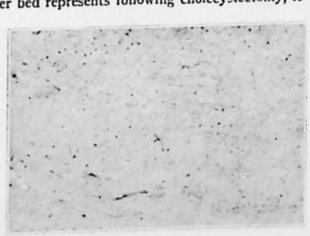


Fig. 1744. Electrocoagulated gall bladder consisting of a hyaline network of inert tissue.

step in the right direction. This thought has been brought to fruition by electrocoagulation. It has been shown that electrosurgical coagulation, properly performed, converts the tissues into a hyaline-like, dry, aseptic, inert tampon (Fig. 1744). It is important to understand the differences between fulguration, car-

* Thorek, M. (1933) *Illinois Med. J.*, 64, 425.
—— (1934) Surgical Errors and Safeguards, Philadelphia and London.
—— (1935a) *Arch. Phys. Ther.*, 16, 207.
—— (1935b) *Amer. J. Surg.*, 30, 389.
—— (1937) *Arch. Phys. Ther.*, 18, 278.
—— (1938) Lancet, London, Jan. 1st, p. 15.

bonization and coagulation, terms often used promiscuously and not well understood.

Monopolar sparking from a high frequency transformer (of Tesla, D'Arsonval, Oudin) was termed sideration by Keating-Hart and electrodissection by Clark, and later, fulguration by Pozzi. Nagelschmidt introduced the now accepted term diathermy. Bipolar diathermy for surgical purposes was first called voltaization bipolaire and later electrocoagulation by Doyen; Delherme and Laquerrière spoke of endothermy showing that the heat is produced in the patient's body. George Wyeth, in 1926, simplified the terminology by coining the terms medical and surgical diathermy. Henschen speaks of exsiccation, charring, Heitz-Boyer of étincelage a l'intensité, Cushing of dehydration, Kowarchik of electrotomy, von Seemen of "Schmelzschnitt" etc.

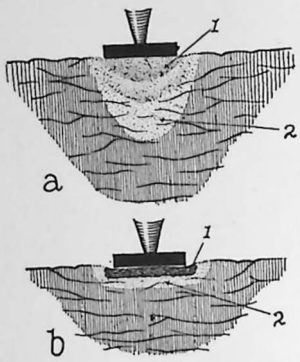


Fig. 1745. Diagram of effects of electrocoagulation and of carbonization. In a. one observes the degree and extent of electrocoagulation when correct technic is used. The dense area immediately under the electrode (1) indicates that here the action is of greatest intensity. It gradually decreases as indicated in the diagram. (2) Marginal action is seen to extend for some distance from the border of the electrode. When improperly used and too much current is applied charring results immediately under the electrode b. Such eschar insulates the area acted upon and further effects of coagulation are frustrated. (1) dielectricum. (2) limitation of action.

If a flat electrode of bipolar current is firmly applied to a tissue surface and a current of proper voltage and sufficient amperage is permitted to pass through it, dehydration and coagulation of the tissue-proteins result in a few seconds. This is manifested by the white color assumed by the tissue thus treated. This is called electrocoagulation. On the other hand, if this same electrode is not applied firmly or if used as a unipolar or even bipolar instrument, a small air space (dielectricum) intervenes between the electrode and tissue, and sparking, fulguration, and carbonization with black discoloration of the tissues result. A reapplication of the electrode to such fulgurated or carbonized surface will stop further current penetration and prevent coagulation from taking place (Fig. 1745). Also, in cauterization, the heat is brought to the tissues from the outside by the heated instrument, while in bipolar electrocoagulation the heat is produced in the patient's body, 75,000 to 3,000,000 or more oscillations per second depending upon the type of apparatus used (short-wave). When the liver is subjected to the electrocoagulating bipolar current definite tissue changes take place (Fig. 1746).

Electrocoagulated surfaces within the abdomen do not slough; electrocoagulated tissues on the surface are thrown off, or extruded, while within the abdomen they become encapsulated and are absorbed. Furthermore, electrocoagulated surfaces on parenchymatous organs develop an affinity (positive chemiotaxis) for serous surfaces, attracting contiguous organs covered with serosa

(bowels, stomach, etc.). I have observed agglutination three hours after electrocoagulating the surface of the liver. Firm union takes place in a comparatively short time (Fig. 1747).

The capillaries and blood vessels of an electrocoagulated area do not thrombose but a recession of the column of blood ensues within the vessel, above and below the point of contact of the electrode, and the vessel walls coalesce with the

Fig. 1746. Effects of electrocoagulation on liver tissue. First division: a. zone of vacuolation, b. zone of palisade cells, c. primary zone of necrosis, d. primary zone of demarcation. Second division: e, f. secondary zone of necrosis, g. secondary zone of demarcation. (After Kuntzen and Vogel.)

contiguous homogenous, hyaline-like structures mentioned (Figs. 1748-1749). Such changes do not take place with fulguration or carbonization. Hemostasis as a result of diathermy does not take place by thrombosis but by collapse and fusion of the walls of the vessels (Ellis). Coagulation thrombosis is in sharp contradistinction to true thrombus formation (Aschoff). In electrocoagulated tissues in the gallbladder bed secondary hemorrhage does not occur, because of the pressure exerted by the sequestrated, coagulated mass against the contiguous tissue.

Fig. 1747. Electrocoagulation of surface of liver with graft of falciform ligament. Brindle bulldog. Specimen removed seven weeks after operation. An area the circumference of a nickel was electrocoagulated to a depth of about 2 cm. A freely detached portion of the falciform ligament was sutured over it. Note firm union of falciform ligament to electrocoagulated surface of liver. Arrow points to area described.

Fig. 1748. Mesentery of guinea pig. Electrocoagulation with small ball-electrode along course of mesenteric vessels followed by subserous injection of India ink of the lymph vessels of the mesentery and wall of bowel. Arrow points to spot of coagulation followed by complete interruption of lymph vessels and spindle shaped narrowing and closure of blood vessels. Note that adjacent lymph vessels, not touched by the electrode, remained unaffected. (Zschau.)

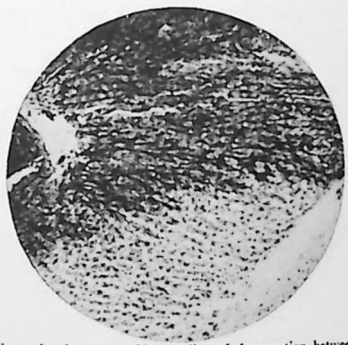


Fig. 1749. Liver of guinea pig. Observe line of demarcation between coagulated zone, or coagulating cut, and zone in which blood capillaries are filled with India ink. The blood capillaries remained empty for a distance of 3 mm. Here also the closure of the blood capillaries as in the case of the lymph capillaries is effected not by thrombosis but by coalescence, or coagulation, and junction of the vessel wall. (Zschau.)

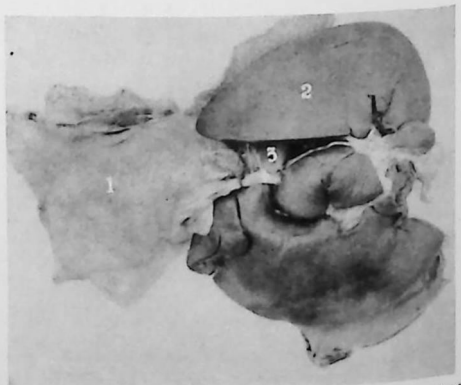


Fig. 1750. Results of cholecystelectrocoagulectomy with falciform ligament implantation in a police dog. Specimen removed seven weeks after operation: 1. falciform ligament; 2. lobe of liver; 3. gall bladder bed; 4. ligated cystic duct. Fine adhesions between falciform ligament and gall bladder bed; firm union of lower end of falciform ligament with stump of ligated cystic duct.

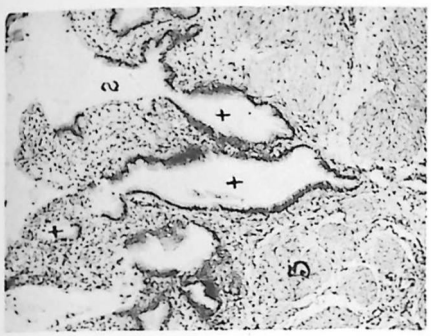


Fig. 1752

Fig. 1751. Chronic cholecystitis. + Mucosa. 2. Rokitansky-Aschoff sinuses. 3. Muscularis.
Fig. 1752. Effects of carbonization on gall bladder with chronic inflammation. Observe portion of Rokitansky-Aschoff sinus (right) persisting. Entire muscularis and serosa unaffected. Large vessel at bottom of section markedly engorged.

The operation described below is based upon the following factors:

1. The posterior gallbladder wall and bed of the gallbladder may be effectually electrocoagulated and their structure converted into an inert, dehydrated, hyaline-like, aseptic tissue.

Fig. 1753. Effects of forced carbonization on wall of inflamed gall bladder. (1) Eschar. (2) Rokitansky-Aschoff sinus in transverse section. (3) Muscularis. (4) Serosa. Note excellent state of preservation of layers of gall bladder past the mucosa.

2. Electrocoagulated borders of the gallbladder may be approximated with sutures.

3. The ligamentum falciforme hepatis may be completely detached and when superimposed over an electrocoagulated surface will become intimately united with it (Fig. 1750).

4. The abdomen may be closed without drainage provided the cystic duct is securely ligated and the cystic artery closed by double ligation.

Historical Notes. In 1928, E. H. Trowbridge described electrosurgical cholecystectomy with recovery, and E. Heymann speaking before the Berlin Medical Society in May, 1930, stated that for some time past he has removed gallbladders by dissecting the gall bladder from its bed as in the classical procedure with the diatherm knife instead of the scalpel and that for some years past he removed also the appendix, portions of the stomach, etc., by the same means. About the same period a number of others, Keysser et al., and Mirizzi reported that they had performed electrosurgical cholecystectomy with the diatherm knife instead of the scalpel. Drainage was used. It is obvious that the methods these observers resorted to were in no way different from classical cholecystectomy except in substituting the cutting electric

current instead of the scalpel, therefore, leaving the gallbladder bed unprotected. The results were about the same as in classical cholecystectomy. Stimulated by surgeons who for many years preceded him with the use of the hot iron, in 1928, Pribram* used carbonization, at first with the Paquelin burner and a year later with the diatherm apparatus. His object was "carbonization" of the mucous membrane of the gallbladder; this he termed "mucoclasis." He aimed at "burning, charring and carboniza-

Fig. 1754

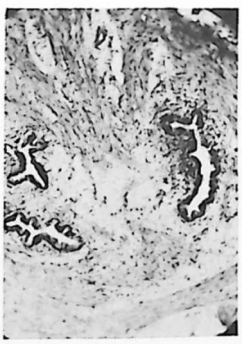


Fig. 1755

Fig. 1754. Reason for failure of mucolasis. Mrs. M. L. Chronic cholecystitis nine months after electrocarbonization of mucous membrane of gall bladder (mucoclasis). No relief of symptoms. Regeneration of mucous membrane and persistence of inflammation (round cell infiltration, and the like). Relieved by electrocoagulation of entire gall bladder wall. Reduced from photomicrograph.

Fig. 1755. Reason for failure of mucoclasis. Mrs. A. M. Chronic cholecystitis eight months after (mucoclasis) electrocarbonization of the mucosa. Note remnants of Rokitansky-Aschoff sinuses and diffuse round-cell infiltration. Below in center of field, an aggregation of polymorphonuclear leukocytes. Reduced from a photomicrograph with a magnification of 105 diameters. Persistence of symptoms. Relieved by total obliteration of gall bladder wall by electrocoagulation.

tion" and not at coagulation. In 1933 and even as recently as 1934, Pribram* still speaks of "carbonization." He says, "Originally, I used the Paquelin burner to destroy the mucous membrane. This proving ineffective, I used Hadenfeld's hot iron such as is used in Bier's clinics. The burning effect was excellent. In spite of this it did not meet with the desired effects, because: first, the heat introduced into the abdomen was too great; second, the danger of explosion." He then describes a diatherm apparatus designed by Keysser. It is significant that while working with fulguration, Pribram continues to speak of "charring" and "carbonization." He says: "One must not approximate the electrode snugly. One must just barely touch it, and when sparking results, the mucous membrane will be destroyed promptly. Avoid deep penetration." Pribram's mucoclasis is, therefore, a fulguration method aiming solely at destruction of the mucous membrane of the gallbladder. It is ineffective to eradicate gallbladder disease because the charred area prevents the current from reaching the

* Pribram, B. O. (1928), Med. Klin., 24, 1187. (1929), Zbl. f. Chir. (1933), C. R. Congr. Int. Lith. Bil., Paris.

depths of the affected zone in the gallbladder wall, viz.: the Rokitansky-Aschoff sinuses (Luschka's glands) which harbor infection (Figs. 1751-1752-1753).

The futility of simple fulguration of the mucosa of the gallbladder in advanced cases is obvious. I used Pribram's method on a number of patients. Some patients thus operated were not relieved of their symptoms and presented themselves for reoperation. Regeneration of the mucous membrane of the gallbladder mucosa was found. The diseased layers of the gallbladder were little or not affected at all (Figs. 1754-1755). It appeared that the entire gallbladder should be destroyed to attain better results. Later, Albertin[1] has shown that Pribram lost 9 patients in a series of 310 cases in which he used his method of mucoclasis. Combination methods gave disappointing results. In 1930, some years after Trowbridge, Heymann and Pribram reported their methods of electrosurgical cholecystectomy and gave them a trial, L. S. Whitaker[2] also used the cutting current in removing the gallbladder. Later, he

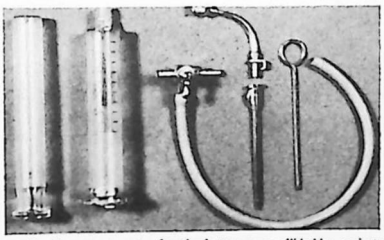


Fig. 1756. Component parts of author's two-way gallbladder aspirator.

disregarded the admonition of Pribram and drained his patients thus treated with the result that he lost 3 of 16 patients, a mortality of 18.75 per cent.

AUTHOR'S OPERATION

Thorough preoperative preparation of the patient is imperative.

Step 1. Wherever possible subarachnoid block is the anesthetic of choice, otherwise inhalation anesthesia is chosen. The patient is placed in the Mayo-Robson position (Fig. 1737) with the lower thorax and upper abdomen sufficiently elevated. Where the bipolar current is used a large, flat, indifferent electrode is snugly applied over the sacrum. Where short wave is used no insulating electrode is needed. Preferably a simple, median pararectus longitudinal incision is made beginning at the lower costal margin and extending to about the level of the umbilicus. Exposure must be thorough (Fig. 1738).

Step 2. Mobilization of the falciform ligament. This structure is completely detached from its attachments to the anterior abdominal wall, and is placed into a receptacle of warm salt solution. In detaching the falciform ligament from the anterior abdominal wall, some small vessels are severed; these must be carefully ligated. Pack the viscera out of the way and obtain good exposure by efficient retraction. Where the falciform ligament is too small a segment of omentum should be used as a free graft.

[1] Albertin, M. R. (1933) Lyon Chir., 30, 207.
[2] L. S. Whittaker, 1930, New Engl. Journ. Med., 203, 718. (1935) Ibid., 213, 596 and 67A.

Step 3. The biliary passages are explored and the gallbladder is aspirated, using an especially designed aspirator (Figs. 1756-1757) which permits evacuation of the gallbladder contents into a receptacle via a rubber tube. After

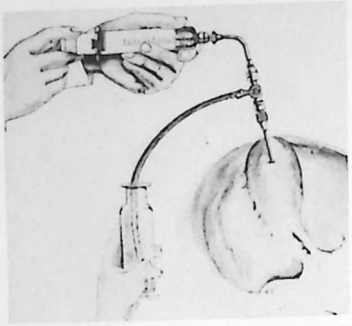


Fig. 1757. Author's two-way gall bladder aspirating syringe in use.

aspirating its contents, the gallbladder is filled with hexylresorcinol (S. T. 37) or other antiseptic solution. Only about 5 per cent of bile contains microorganisms while their presence in the gallbladder walls may be demonstrated in over 70 per cent of cases. For that reason I introduce an antiseptic into the gallbladder before opening it.

Fig. 1758. Aspiration of the gall bladder; cystic duct and artery have been doubly ligated. The ligatures are cut short.

The extrahepatic biliary passages are explored next. The cystic artery and duct are ligated doubly and jointly, cutting both ligatures short (Figs. 1758-1759-1760). Experience has taught me not to attempt extensive dissections in searching for the cystic artery if it is not easily isolated, but to splint it with the ligature to the cystic duct. This procedure should be followed, particularly in inflammation about the hepatoduodenal ligament. The frequent, abnormal course of the artery should be kept in mind.

Step 4. Open the gallbladder and evacuate its contents. A non spilling gallbladder content receptacle (Fig. 1761) collects the evacuated material without spilling it. Old fashioned gallbladder spoons are too shallow and offer

no protection against contamination from spilled contents. My instrument consists of a cone-shaped container measuring 2¼ inches in diameter and 2 inches in depth, mounted on a shaft of suitable size. A close-fitting cover

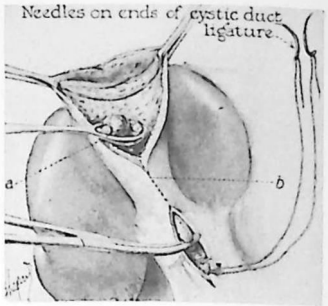


Fig. 1759. Gall bladder is opened along its entire length with an ordinary pair of scissors. Electric cutting scissors have been discarded by the author after having proved ineffective. The gall bladder is cleared of its contents.

is hinged and held open when in use by means of spring friction clips. Slight pressure upon the cover releases it so that the material cannot spill during its removal. The front part of the receptacle is somewhat concave allowing sufficient latitude for proper contact with the subcholecystic structures, and its edges are rodded, thus avoiding injury to the liver.

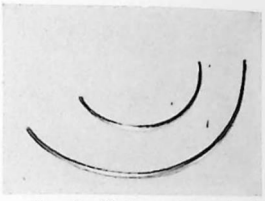


Fig. 1760. Needles used by author in operations on the liver and biliary passages. The smallest size is used for ligating the cystic duct and artery; the larger to suture the liver in emergency operations. One extremity of the needle is olive pointed, thus avoiding injury to the liver substance.

Step 5. Split the gallbladder longitudinally from above downward with an ordinary pair of scissors. Grasp half of the gallbladder wall with an insulated angiotribe forceps or an ordinary artery forceps sheathed in rubber tubing. In closing the forceps, the gallbladder wall is crushed and the blood vessels coursing in it are reduced by compression to a mere ribbon (Fig. 1762). With a pair of ordinary scissors remove the redundant portion of the gallbladder wall. Apply an electrode (see insert in Fig. 1762) along the exposed margin of the gallbladder which is held in the forceps. The current will electrocoagulate it but will not pass beyond the insulated part of the angiotribe forceps. Release the forceps; a compressed coagulated ribbon of tissue remains

(Fig. 1762-c). Repeat the procedure the same way all around. Electrocoagulate the remaining portion of the posterior wall of the attached gallbladder, which has not as yet been acted upon. I use a short-wave apparatus.

In my early cases I thought it advisable to electrocoagulate slowly but experience has taught me that quick, decisive coagulation has yielded the best results. The reasons for this are:

A low voltage and high amperage current is used on a rather moderate-sized electrode. On this unit (Fischer), as the voltage drops, the amperage increases. This affords prompt, thorough dehydration and a sharply defined line of demarcation between the coagulated and noncoagulated tissue. Tissue thus coagulated will retain less moisture than tissue coagulated more slowly. Less heat is radiated to the contiguous tissues. Another reason for substituting rapid coagula-

Fig. 1761. Author's non-spilling bile container.

tion with a smaller electrode is that slow coagulation results in heating of the tissues to quite an extent beyond the electrode, about 0.5 cm. to each mm. There is no sharp line of demarcation in slow coagulation; the tissue changes are gradual.

When the diatherm electrode is used it should be applied snugly to avoid carbonization. The current should be turned on only after the electrode is firmly applied and should be shut off before the electrode is removed from the coagulated surface. Avoid fulguration and its attendant carbonization. It will defeat the purpose of the operation. Any bleeding from the branches of the cystic artery is controlled by grasping the vessel and touching the artery forceps holding it with the electrode. Hemostasis will promptly result (Ward's procedure).

There is now an area represented by the electrocoagulated posterior wall of the gallbladder attached to the gallbladder bed.

Step 6. Approximate the electrocoagulated edges of the gall bladder by a few interrupted sutures (Fig. 1762-d).

Step 7. Some peroxide of hydrogen on a sponge is applied to the gall bladder bed area. The falciform ligament is now removed from the receptacle of warm salt solution. One end of the detached falciform ligament is sutured to the upper end of the united, coagulated gallbladder bed. The lower third of the ligament is now stitched to the lowermost end of the approximated, electrocoagulated surface and the free end of the ligament is placed, but not sutured against the doubly ligated end of the cystic duct and artery. An effective serous covering is thus formed over the gallbladder bed and cystic duct (Figs. 1763-1764).

Step 8. The laparotomy packs and retractors are now removed; the field of

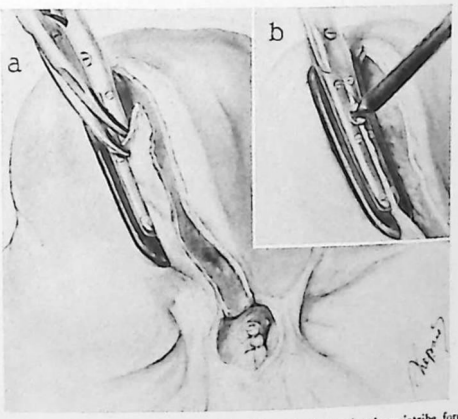


Fig. 1762. a. Opened gall bladder crushed with author's insulated angiotribe forceps and redundant portion of gall bladder removed with ordinary scissors. b. Remaining strip of gallbladder in grasp of forceps being electrocoagulated with short-wave current. The current passes through the forceps but not beyond the insulated protector.

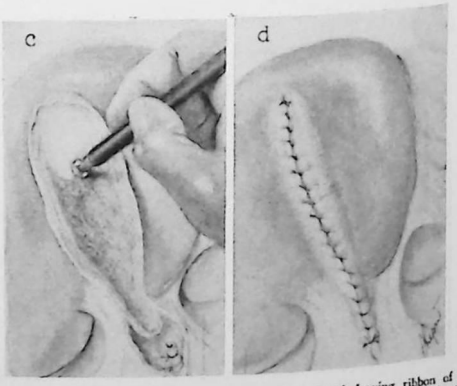


Fig. 1762. c. The insulated angiotribe forceps are removed, leaving ribbon of crushed and electrocoagulated strip of gall bladder tissue all around gall bladder bed. The posterior wall of the gall bladder in the middle of this ring is being electrocoagulated. d. Strip of electrocoagulated and crushed ring of tissue of gall bladder united with sutures.

operation is dried, the bridge elevating the operative field is lowered and the abdominal wall is closed in the usual manner without drainage.

What becomes of the structures in the gallbladder bed after the operation described? The answer to this has been given based upon animal experimentation. Recently, a postmortem examination was done on a patient who died of acute pulmonary tuberculosis on whom I performed this operation eighteen

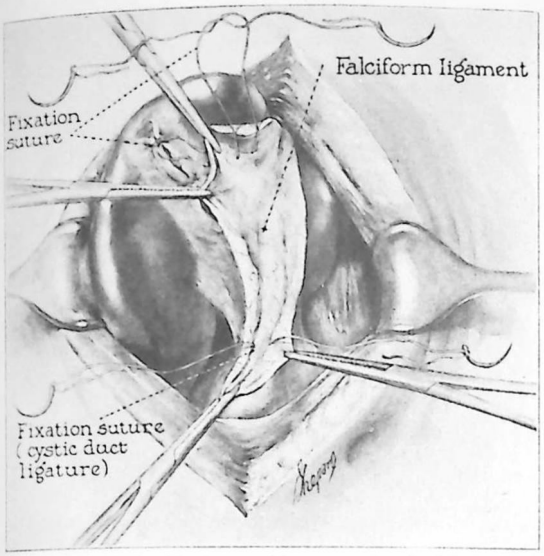


Fig. 1763. Note borders of the electrocoagulated area approximated with fixation sutures. Additional interrupted sutures of fine catgut may occasionally be used to approximate the borders of the electrocoagulated zone along its entire extent. The mobilized falciform ligament is fixed over the closed, electrocoagulated surface. Note placement of sutures.

months prior to her last illness. Figure 1765 shows the histologic structure of the transplanted falciform ligament. The gallbladder bed is represented by unaltered cords of liver cells.

Comment: Electrosurgical obliteration of the gallbladder when carefully carried out may be used in simple and complicated cases of gallbladder disease without resorting to drainage. It reduces mortality to a minimum and cuts hospitalization. The much dreaded age factor in these operations loses its terror. Shock is absent. Failures and fatalities in clas-

sical cholecystectomy after the operation are frequently due to bile leakage, as a result of an inability to obliterate and cover the gallbladder bed which contains bile capillaries and often larger bile ducts, in 15 to 25 per cent of the cases (Figs. 1766-1767). Drains invite bile seepage. The method described seals these openings by electrocoagulation. A sterile, hyaline, dry protective layer is substituted for a raw, unprotected surface. The falciform ligament is superimposed over this area. Drainage is entirely omitted.

This operation must not be confused with mucoclasis practiced with

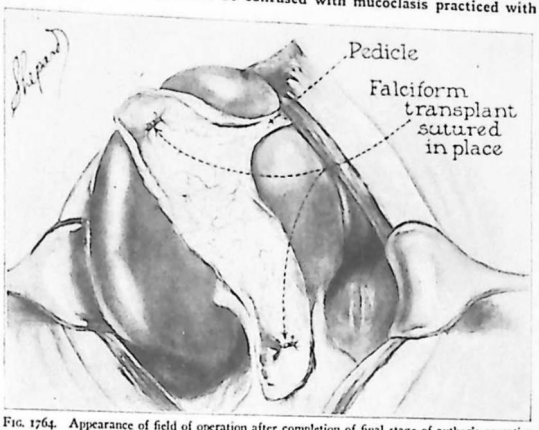


Fig. 1764. Appearance of field of operation after completion of final stage of author's operation of electrosurgical obliteration of the gallbladder.

the cautery or diatherm fulguration which aims at burning or carbonization of the mucous membrane of the gallbladder, or with so-called electrical or "electrocholecystectomy" where, instead of the scalpel, the diatherm cutting knife is used. These are entirely different procedures. Mucoclasis is an ancient procedure which Pribram adopted and called mucoclasis.[1, 2]

A prerequisite to the achievement of satisfactory results is a patent common duct. An occluded cystic duct from any cause is an indication for cholecystelectrocoagulectomy. With electrocoagulation the surgeon has under control any degree of penetration he wishes to accomplish (Fig. 1768). Electrocoagulated areas of intra-abdominal organs tend to heal by encapsulation. They do not interfere with wound healing. On the contrary, they heal promptly when the wound is closed securely. Therefore, drainage is not only undesirable but is distinctly deleterious. Many patients succumb because of drainage. It prolongs the healing process and

[1] Zentrbl. f. chir., 1928; No. 17, p. 775.
[2] Lancet, May 21, 1938, p. 1186.

predisposes to infection. The operation described eliminates the necessity of drainage and its unpleasant sequelae. Concomitant affections of the extrahepatic biliary passages must be treated accordingly. Where choledochostomy or hepaticostomy is indicated, these may be done, in conjunction with the procedure described above.

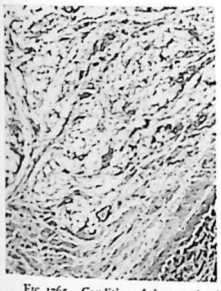


Fig. 1765. Condition of tissues of gall bladder bed one and one-half years after author's operation (low magnification). Observe histologically normal section of liver. All that remains of the gall bladder bed is a strip of connective tissue. The transplanted falciform ligament shows its characteristic normal structure.

Electrosurgical or electrocholecystectomy, so-called, is nothing more than classical cholecystectomy where the electric cutting knife is substituted for the scalpel. It has contributed nothing to the improvement of the old method and has added the danger of explosion by sparking or fulguration. Furthermore, if coupled with drainage as practiced by Whitaker more drawbacks are added in the form of increased mortality of 18.75 per cent.

Up to date, September, 1938, I performed this operation on 309 consecutive, unselected cases of gallbladder disease. Others (Kellogg, Warren, Finlayson, De Victoria, Wegeman, Baller

Fig. 1766

Fig. 1767

Fig. 1766. Gall bladder removed elsewhere by classical cholecystectomy. Note large portion of liver tissue included with the gall bladder. a. The latter, it is stated, could not be separated from the liver on account of extensive adhesions between liver and gall bladder bed (magnified 25 diameters). Note dilated bile ducts (b) extending to the torn surface of the liver.
Fig. 1767. Same as preceding (magnified 95 diameters) extending to the surface of the torn liver edge. Classical cholecystectomy elsewhere. Death five days after operation.

and Montgomery, Griffiths, Niland, R. N. Smith, Bailey, Love, Best) performed it 115 times making a total of 438 cases. There were three deaths.

One patient died from undiagnosed, ruptured subdiaphragmatic abscess 10 days after the operation; another from massive pulmonary collapse and the third from pneumonia two weeks after the operation. The mortality rate in this series of cases was therefore about one-half of one per cent.

Rodney Maingot's Technic of Cholecystectomy Combined with Choledochostomy

Maingot routinely combines cholecystectomy with choledochostomy in chronic cholecystitis.[1]

Step 1. (Fig. 1769.) Insert a strip of gauze into the foramen of Winslow with a pair of long dissecting forceps. This prevents blood and bile from gaining access to the lesser peritoneal cavity after the common-duct has been opened. Tear carefully, by means of dissecting forceps, the cystico-duodenal fold, or if this happens to be absent, the free edge of the gastrohepatic omentum just below Hartmann's pouch, as well as the anterior leaf of peritoneum of the common hepatic duct, the cystic and the common bile duct. This stripping must be done very cautiously in order to avoid injury to the fine network of small veins overlying the biliary passages (Zuckerkandl's plexus).

Fig. 1768. Effects obtained from bipolar electrocoagulation of muscular tissue. Note smooth action and degree of coagulation produced at will. Observe depth of penetration in upper specimen showing no carbonization and sagittal section of electrocoagulated area in the lower specimen. Note degree of penetration and marginal action of current. A strand of fascia blocked the progress of the coagulating process.

Step 2. Isolate thoroughly the duct-structures and demonstrate these (hepatic, cystic and common bile duct). Clear the cystic duct of its fatty envelope, trace it upward into the neck of the gallbladder and downward to where it joins the common ducts.

Step 3. Pass an aneurysm needle carrying a No. 1 catgut-suture or a silk ligature beneath the cystic duct (Fig. 1770a). Ligate the duct about ½ inch away from its junction with the common-hepatic and common-bile ducts. Tie this ligature. Apply another ligature of the same type in a similar manner a little nearer the gallbladder. Leave this second ligature long. Place a hemostat on its end and use the ligature as a tractor which will aid in recognizing the stump of the cystic-duct during the subsequent steps of the operation (Fig. 1770b).

[1] Post-Graduate Medical Journal, Aug., 1937.

Step 4. Place a pair of curved artery forceps on the cystic duct about ⅛ inch away from the second ligature and close to the neck of the gallbladder. Lift the duct cautiously upward and divide it with a knife, scissors, diathermy needle or cautery.

Step 5. Make a careful search for the cystic artery and occasionally for the right hepatic artery or the main trunk. Remember the possibility of anomalous cystic arteries or the possibility of the presence of more than one artery. Maingot dissects the cystic artery out with meticulous care and traces it to

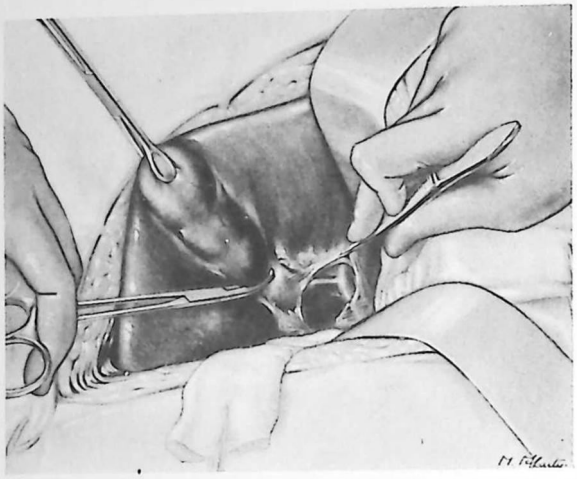


FIG. 1769. Cholecystectomy and choledochostomy. The cystic duct, the hepatic duct, and the common bile duct are being displayed by dissecting the peritoneal investment at the right border of the gastrohepatic omentum. Note especially the position of the retractors and the strip of gauze which has been placed in the foramen of Winslow. (Courtesy of Mr. Rodney Maingot.)

a point where it is clearly seen to enter the gallbladder. When the artery is thus isolated, it is under-run by an aneurysm needle (Fig. 1771) threaded with silk and ligated as close as possible to the gallbladder. Maingot believes that many so-called "liver deaths" or unexplained fatalities following cholecystectomies are due to ligature of the main hepatic artery or its large right branch which are mistaken for the cystic artery.

Step 6. Divide the loose peritoneal reflection on either side of the gallbladder with a knife or diathermy blade (Fig. 1772). Occasionally, Maingot resorts to Wilkie's method of infiltrating the loose peritoneum around the gallbladder with dilute saline or novocaine solution. This produces a diaphanous sodden wheal which renders the separation of the gallbladder a simple and

bloodless procedure and greatly facilitates the suturing of the margins of the liver bed.

Step 7. When about two-thirds of the gallbladder has been dissected free from its bed, the resulting raw surface on the gallbladder bed is obliterated by a series of closely inserted interrupted catgut sutures of thick plain catgut while the gallbladder itself is used as a tractor to keep the liver in a position well up in the wound (Fig. 1773).

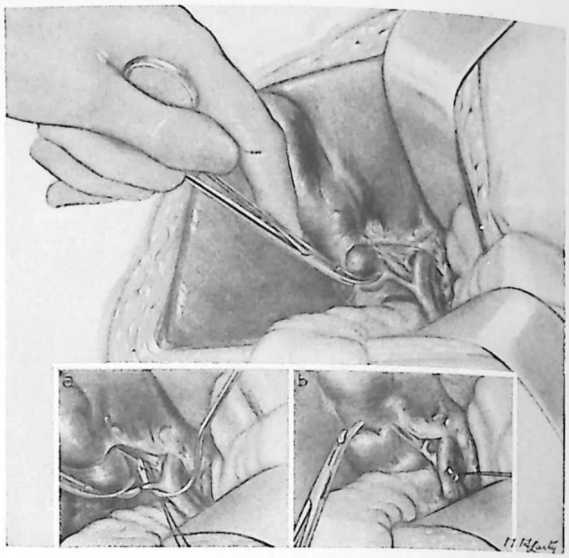


FIG. 1770. Cholecystectomy and choledochostomy. This illustration shows the methods of tying the cystic duct and exposing the cystic artery. The cystic duct is ligatured and divided before the artery is dissected free. If, however, the artery comes easily into view, this may be ligatured and divided first. (Courtesy of Mr. Rodney Maingot.)

Step 8. Isolate the common bile duct. Pack the area around it off with Macintosh squares. Introduce two stay-sutures opposite one another through the anterior surface of the common bile duct about ⅛ inch or more apart and about 1/3 inch below the insertion of the cystic duct.

Step 9. Lift these sutures upward exposing the common duct. Make a small nick with a small sharp-pointed knife between the sutures and between the taut anterior wall of the bile duct. As soon as the bile duct is open, bile will appear which is immediately aspirated by means of a metal suction tube.

Step 10. Enlarge the opening in the duct gradually until it is about ½ inch in length.

Step 11. Palpate the ducts systematically once more and express their contents toward the opening just created. Stones which will be felt may be "milked" toward the incision in the duct and thence removed with forceps. If there be much biliary-sand irrigate the duct with warm salt solution, pass through a small rubber catheter attached to a Record syringe. Ascertain whether the

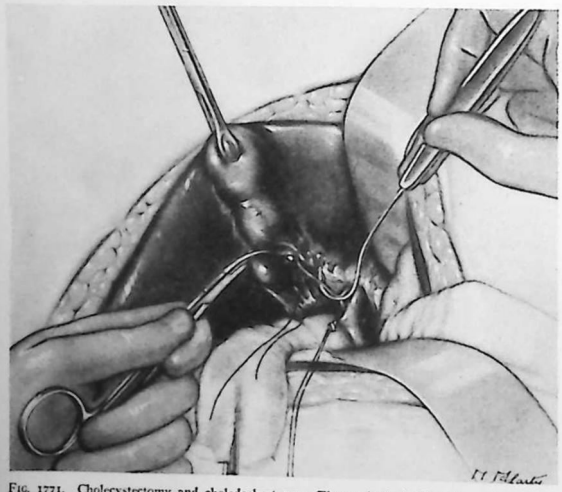


FIG. 1771. Cholecystectomy and choledochostomy. The method of tying the cystic artery in continuity. (Courtesy of Mr. Rodney Maingot.)

papilla is patent by passing graduated Liston sounds or elastic bougies and, if so, gently dilate the lower end at the papilla. Make sure that the lower end of the sound is in the duodenum by palpating through the anterior wall of the duodenum while the sound is being rotated.

Step 12. Explore the common hepatic-duct and its main branches by means of the Desjardins forceps. Pass it upward in search for stones which may have escaped detection. Pass then the forceps downward into the duodenum, gently withdrawing it with its blades slightly open. This insures further dilatation.

Step 13. Pass a small rubber catheter through the papilla into the duodenum and inject through it some saline solution. If the solution comes back to the wound it is evident that the point of the catheter has not negotiated the terminal portion of the duct. In such event, further attempts should be made until the saline solution flows freely into the duodenum. Where a stone is

firmly impacted in the ampulla and cannot be dislodged upward so that it may be extracted through the incision in the common-duct, or forced downward into the duodenum, mobilize the duodenum, make an incision on its anterior wall opposite the point of impaction. Introduce a metal sound into the duct and force the impacted stone upward so that it lies almost on a level with the incision in the duodenum. Make now an incision over the

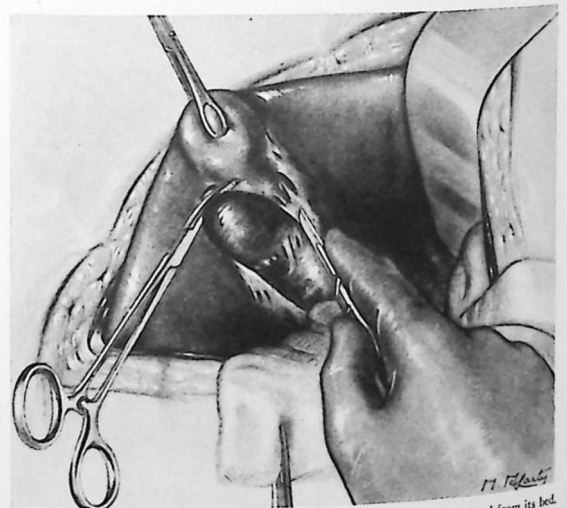


FIG. 1772. Cholecystectomy and choledochostomy. The gall bladder is being freed from its bed. (Courtesy of Mr. Rodney Maingot.)

stone through the posterior wall of the duodenum and extract the stone. Repair the wound in the posterior wall of the duodenum by the method described by Kellogg and Maingot. Pass a rubber catheter through the incision of the common duct downward until the point of the catheter emerges in the duodenum. Its point must project against the posterior wall of the duodenum. Close the incision in the anterior wall of the duodenum with three layers of sutures.

Step 14. Insert another rubber catheter through the incision in the common duct upward into the right hepatic duct.

Step 15. Close the opening in the common duct around the two catheters.

Step 16. Complete the cholecystectomy.

Comment: The ends of the catheter are made to emerge at the top and bottom of the abdominal wound when it is closed. Connect the ends of the

catheters by means of a glass tube so that the bile can flow from one tube into another without difficulty. The catheter in the hepatic duct may be allowed to drain into a bottle on the side of the patient while the tube in the duodenum may be utilized for feeding purposes (saline and glucose solution). When bile is seen after some time to issue clear, the tubes may be removed. In the average case a T-tube is inserted and closed around the

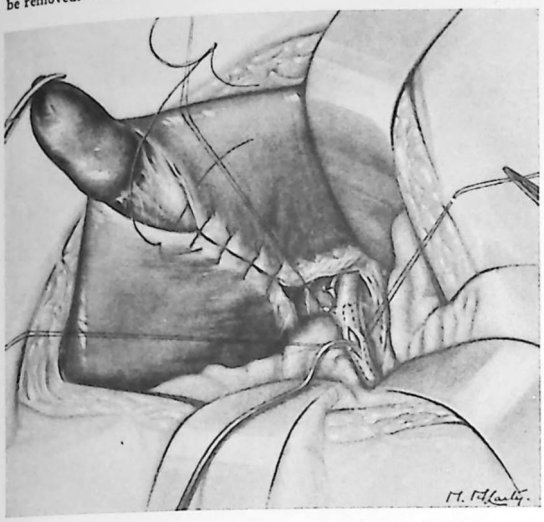


Fig. 1773. Cholecystectomy and choledochostomy. The gall bladder is used as a tractor, the liver bed is partially sutured at this stage, and the T-tube has been inserted into the common duct. (Courtesy of Mr. Rodney Maingot.)

duct with interrupted sutures, thus frustrating leakage. The long limb of the tube must be securely anchored to the abdominal wall and led to a small medicine bottle which is fixed to the patient's dressings or the side of the bed. Never remove the tube when there is fever, muddy bile or clay-colored stools. Four ounces of bile are introduced into the rectum daily. The tube should be removed when the bile is clear.

CHOLECYSTANASTOMOSIS

Cholecystogastrostomy, Cholecystoduodenostomy

This operation is useful in establishing a communication between the gallbladder and the stomach or the gallbladder and the duodenum or jejunum. Usually the duodenum is selected for the anastomosis (Fig. 1774).

The operation was conceived independently by Harley Gaston and Nussbaum. Winiwarter of Liége (1880-1881) first performed it. Mayo-Robson performed it first in England.

Indications

1. Chronic cholemia (obstructions of the common bile duct).
2. Tumors of the head of the pancreas.

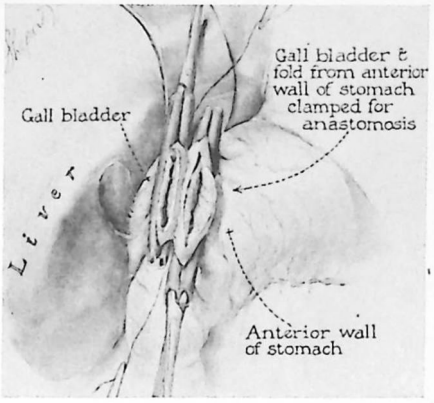


Fig. 1774. Cholecystogastrostomy. Anastomosis of the gallbladder to the stomach is accomplished by employing the method of joining two segments of intestine. If the fundus of the gallbladder is very redundant, its dome may be cut away, and if its wall is extremely thin, a blood vessel clamp is used instead of any other kind of clamp.

3. Injuries to the common duct when ligation of the duct becomes necessary.
4. Tumors of the common bile duct.
5. Stricture of the common duct.
6. Certain forms of biliary fistulas.

Contra-indications

1. Small and atrophied gallbladder.
2. Calcified gallbladder.

The technic of the operation is essentially that of a lateral anastomosis (which see p. 1394).

Step 1. Expose the gallbladder as described above.

Step 2. Aspirate the gallbladder. Grasp it with a gallbladder anastomosis forceps of Mayo-Robson type. A curved Doyen intestinal clamp may be used.

Step 3. Approximate the gallbladder to the stomach (cholecystogastrostomy) or to the duodenum (cholecystoduodenostomy). If difficulty is experienced in bringing up the duodenum, it is mobilized by Kocher's method (see p. 1615. Fig. 1787). Occasionally it becomes necessary to detach the fundus of the gallbladder somewhat, from its liver bed, to obtain ease of approximation.

Step 4. The two viscera, held in clamps, are now placed side by side and the surrounding territory is packed off with warm lap sponges. The first (outer) suture line of fine Pagenstecher linen unites the serous surfaces of the gallbladder and duodenum or stomach. The needle is laid aside.

Openings are now made into the viscera to be united. These are about ¾ of an inch in length and ½ inch shorter than the serosa suture.

The second (inner) through-and-through suture of fine chromic catgut unites all the layers of the posterior surface of duodenum or stomach and gallbladder and continues similarly on the anterior wall as in gastro-enterostomy (which see p. 1338). After the inner suture is tied and cut the outer suture which is left long is picked up and is continued as a serosa suture along the anterior surfaces until it reaches its starting point, where it is knotted and cut short.

Step 5. Remove the clamps and lap sponges. Cleanse the viscera with warm salt solution. The suture line may be reinforced by a few tags of omentum or, as I prefer it, with the detached or pedicled falciform ligament. Drainage is unnecessary.

Step 6. Close the abdomen in the usual manner.

Comment: While the duodenum is usually chosen to make the anastomosis, it is often difficult to bring it satisfactorily in contact with the gallbladder without undue tension. Anastomosis to the stomach is preferable because it is easily approximated to the gallbladder, its wall is more suitable than that of the duodenum which occasionally contributes to the formation of a duodenal fistula, a complication which is rather difficult to cope with. The entrance of bile directly into the stomach is of no moment. The anastomosis of the gallbladder with the jejunum is beset with many technical difficulties and may give rise to unpleasant complications. All in all, cholecystogastrostomy seems to be, for the reasons given, the procedure of choice.

Commenting on the advantages of cholecystogastrostomy, Albert Jentzer points out that:

(a) Cholecystogastrostomy is an operation of great value when carried out with meticulous care and on proper indications. The gallbladder must be free from inflammatory changes; the cystic and hepatic ducts must be patent and the pylorus open.

(b) Cholecystogastrostomy is an operation for diverting the current of bile and not one intended for drainage. It is not capable of producing changes in the gastric mechanism to bring about cures for gastric ulcers.

(c) Mechanical obstruction of the ductus choledochus communis is a definite indication for cholecystogastrostomy. Autonomic pancreatitides, inflammatory changes in the biliary passages are to be treated by cholecystogastrostomy, duodenostomy, etc.

(d) An exact diagnosis is of paramount importance. Ascertain the exact indications for surgical therapy (Reaction of Wohlgemuth, etc.).

(e) Where the mechanism of a given case of jaundice is obscure, it is wisest to do a cholecystogastrostomy.

(f) The technic of the operation is simple.

(g) The results following the procedure are satisfactory, particularly when the affection is not of neoplastic nature.

OPERATIONS ON THE BILIARY PASSAGES

Anatomic Considerations (see p. 1545).

In the absence of complications there is usually no difficulty in identifying the common duct lying along the free edge of the hepatoduodenal ligament. Split the peritoneum, parallel to the duct. Strip the loose connective tissue away from the surface of the duct.

Do not overlook stones in the hepatic duct. When observed here, they may be washed out by irrigating the bile ducts. Irrigations must be gentle and never too forceful. Remember that destruction or removal of the gallbladder often overcomes the activity of the sphincter of Oddi affording free passage of calculi into the duodenum. (Fig. 1775.)

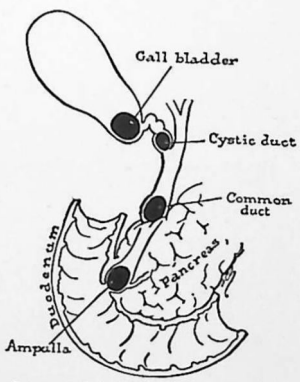


Fig. 1775. Common site of obstructions in the biliary tract.

CHOLANGIOGRAPHIC DEMONSTRATION OF BILIARY DYSSYNERGIA

Best and Hicken[2] point out that:

Cholecystograms, as sponsored by Graham and Cole, furnish valuable evidence regarding the gallbladder, but they are of little value in disturbances of the common bile duct. Spasm of the lower end of the common duct (biliary dyssynergia), and other obstructive lesions of the extrahepatic bile ducts may be diagnosed by injecting opaque substances into the biliary tract. The biliary tract may be visualized by injecting radiopaque fluids into the common duct during operation. The injection of radiopaque substances postoperatively, through catheters, tubes or fistulas, has been designated delayed cholangiography. A satisfactory contrast medium nonirritating to the tissues such as lipiodine, thorium dioxide sol. and hippuran are most suitable; however, each of these has its advantages and disadvantages. These solutions must be absolutely sterile and must be warmed to 120° F. at the time of injection. Lipiodine (Ciba) is a nonirritating iodized oil which apparently exerts a soothing, therapeutic influence in the common duct. Best and Hicken used it in the presence of biliary infection com-

[2] J.A.M.A., Vol. 107, No. 20.

plicated by high temperature. Lipiodine is very viscid and some difficulty may be encountered in injecting it into the biliary tract through a small bore needle, as is necessary in making an immediate cholangiogram. If a large caliber needle is used, the oil seeps out from the puncture wound and infiltrates the extraductal tissues, giving a hazy, indefinite cholangiogram. Smaller stones in the common duct may be obscured.

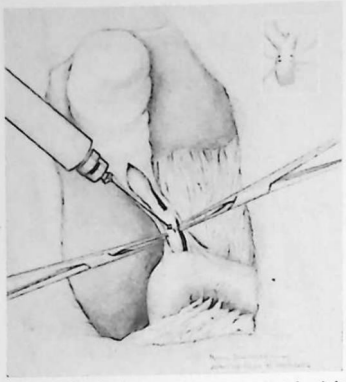


FIG. 1776. The common bile duct is exposed; a 23-gauge short, beveled needle attached to a 20 cc. syringe is used to identify the common duct and 10 to 15 cc. of hippuran solution are injected. A small bead stop placed ⅛ inch from the point facilitates the procedure. It is not always necessary to grasp the duct with Allis forceps. An x-ray plate is placed beneath the patient before beginning anesthesia (a tunnel facilitates its removal), and then, following injection, a sterile sheet is laid over the operative field, a bedside x-ray unit is brought to the table and a roentgenogram taken. This is developed during the removal of the gall bladder. A less satisfactory method is to inject 30 cc. of radiopaque solution into either the gall bladder or the stump of the cystic duct. (Courtesy of Drs. Best and Hicken.)

Thorium dioxide sol. gives an excellent pattern of the bile ducts. Some assert that it has carcinogenic properties. This fear seems unwarranted.

Hippuran is a 48 per cent aqueous solution of organic iodide and has proved to be a very satisfactory cholangiographic medium.

Mirizzi showed in 1932, that the common bile duct could be visualized at the operating table by injecting it with radiopaque substances.

CYSTICOTOMY

This operation consists of opening the cystic duct followed by immediate repair. The operation is only of historical interest and was often used by surgeons some decades ago for the removal of stones in the cystic duct or for the relief of hydrops of the gallbladder occasioned by the obstruction of the cystic duct by biliary calculi. The procedure was first performed by Lindner in 1891. In some cases, however, it may be used.

Step 1. Expose the cystic duct. Incise it.

Step 2. Remove the stone or stones.

Step 3. Close the wound in the duct by two rows of catgut sutures. Do a classical cholecystostomy.

HEPATICOTOMY

This procedure is analogous to the preceding except that it is the hepatic duct which is attacked surgically. It was first performed by Kocher in 1889—not premeditatedly but accidentally, for Kocher thought he opened the gallbladder when as a matter of fact he got into a much dilated hepatic duct. The inaccessibility of the hepatic duct makes this operation a difficult one. Wherever possible, it is best to attempt to "milk" the stone into the common duct or into the gallbladder whence it is removed.

EXPLORATION AND DRAINAGE OF THE BILE DUCTS

Supraduodenal Choledochotomy and Choledochostomy

Langenbuch-Kümmell's Operation

Step 1. Make an ample incision. Thorough exposure. Explore the bile passages thoroughly. If the gallbladder is distended aspirate its contents. In common duct stone, the gallbladder is usually shrunken. (Fig. 1777.)

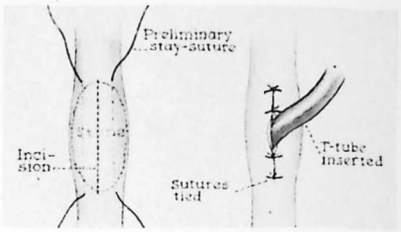


FIG. 1777. Choledochostomy and choledocholithotomy.

Step 2. Endeavor to deliver the liver as described above and displace it to the right. Place lap packs as indicated. Locate the stone. Endeavor to "milk it" upward into the gallbladder. If unsuccessful, introduce two fine plain catgut stay sutures longitudinally into the duct on either side of the stone. These steady the duct during the operative manipulations and later can be used to close the opening made in the duct.

Use the sutures as tractors. Make sure you are dealing with the duct. If in doubt introduce a delicate needle into the structure; aspirate; if it be a vessel, blood will issue (Deaver) (Fig. 1778).

Grasp the stone between two fingers, incise longitudinally over the stone and extract it with forceps. Explore the duct with finger or scoop. Make sure that the exploring instrument has entered the duodenum proving the patency of the passage. Pass the instrument into the hepatic duct (Fig. 1779). Clear the passages of concretions. Remove bile accumulating during

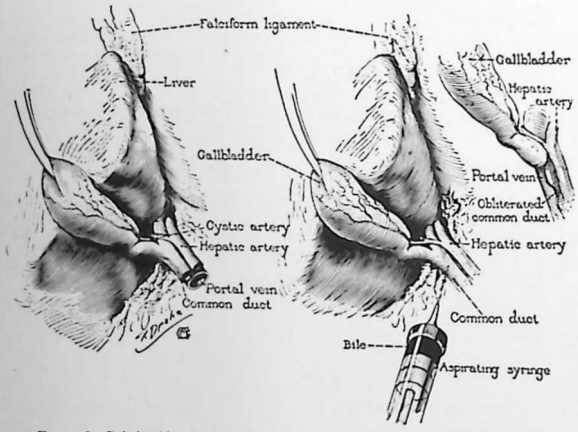


FIG. 1778. Relationship of the common bile duct, portal vein and hepatic artery. Aspirating syringe method of identifying the common bile duct. (Waltman Walters, Surg. Gynec. Obst.)

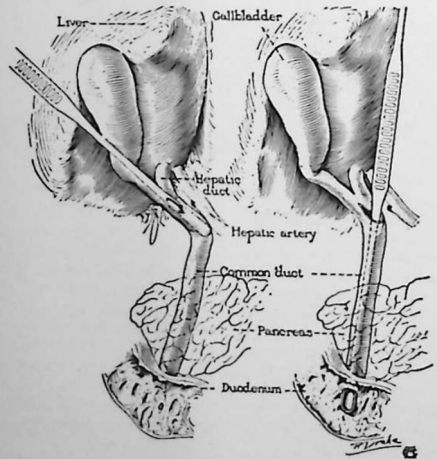


FIG. 1779. Direction of the common bile duct, especially the horizontal midportion. (Waltman Walters, Surg. Gynec. Obst.)

the operation with a suction apparatus. Exploration of the biliary passages routinely in every gallstone operation is advocated by some, to be omitted only because of technical difficulties or absolute assurance from external examination that no concretions exist. It should not be omitted in the presence of jaundice. Alternate introduction and withdrawal of the finger from the duct, as advocated by Mayo, may produce sufficient suction to bring out

FIG. 1780. Drainage of the hepatic duct by Mayo-Robson hepaticus drain. (Waltman Walters, Surg. Gynec. Obst.)

stone particles. Wicks of gauze of proper size introduced into the ducts and briskly removed will often dislodge and bring to the surface small particles of concrements.

Moynihan's rotation procedure often proves useful in the removal of an impacted stone where dense adhesions exist. It is indicated when the gallbladder is shrunken and when the separation of dense adhesions would jeopardize the patient. The procedure consists in passing the left hand transversely inward in front of the pylorus and above the stomach along the gastrohepatic omentum and rotating the common duct up into the wound.

Step 3. Treatment of the wound in the duct.

Method I

(a) Perform cholecystostomy.
(b) Close the opening in the duct with interrupted catgut sutures.
(c) Introduce a cigarette drain down to but not on the sutured wound in the duct.
(d) Close the abdominal wall as described above.

Method II

In view of the fact that drainage of the biliary tree is necessary by reason of the existing cholangitis and pancreatitis, this method is most commonly used.

(a) A soft rubber catheter (No. 25 to 30 French) with its end cut off and an aperture made about one-half inch from its extremity is passed through the opening made in the duct and directed upward toward the hepatic duct (hepaticus drainage, Mayo-Robson) (Fig. 1780) for about an inch or so. The catheter is fixed in place by a catgut suture. The rest of the opening in the duct is closed by interrupted catgut sutures. The stay sutures, previously placed, may be used instead of the interrupted sutures, by bringing the former together and tying them securely. A tab of omentum may be used around the catheter for further protection. Introduce a rubber or cigarette drain into Morison's pouch. Close the abdomen. The catheter is permitted to remain a week or two longer, if deemed advisable. The cigarette drain is removed about the third day.

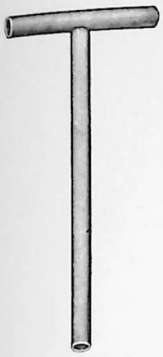


Fig. 1781. Kehr's tube.

(b) A T-tube of Kehr may be used instead of the method described (Fig. 1781) and the closure of the wound of the duct effected as indicated in (a).

Comment: In operations on the biliary passages exposure must be ample. In affections of the common bile duct, it should be dealt with first before operative procedures are carried out on the gallbladder. Do not mistake enlarged and calcified lymph nodes in the gastrohepatic omentum for calculi. Avoid injury to the portal vein or the hepatic artery. Thorough exposure and careful operating are essential. If in doubt aspirate the structure in question as recommended by Deaver. Should the portal vein be punctured, the bleeding can readily be controlled by the application of pressure for a few moments to the aperture made by the needle.

The course and direction of the common duct should be noted by thorough exploration (Fig. 1778). In splitting the peritoneal covering of the common duct avoid injury to the venous plexus of Zuckerkandl. These vessels should be pushed aside or divided between ligatures.

Fatalities resulting from accidental ligation of the hepatic artery have been reported. Roscoe R. Graham of Toronto recently reported reviews of the literature and 27 previously reported cases.[1] He concludes:

[1] British Journal of Surgery, Vol. XX, No. 80, 1933.

Ligation of the hepatic artery is always a serious, but not necessarily a fatal, accident.

The prospect of liver necrosis increases steadily as the point of ligature moves toward the periphery.

The extent of necrosis and the absence of clinical and laboratory evidence of its existence in the case he reported is remarkable.

The rather delayed development of liver insufficiency in man contrasts sharply with the findings in experimental animals, and makes successful operative interference in the former a possibility.

Kirschner advises opening the common duct through a separate longitudinal incision in its anterior wall, a few centimeters below the opening of the cystic duct "from which it is not always possible to probe in the direction of the liver." If the progress of the flexible probe is impeded during the exploration of the duct it should be bent to conform to the direction of the duct.

If gravel is contained in the ducts it should be washed out with salt solution introduced through a soft rubber catheter on the nozzle of a glass syringe. Avoid forcing a probe which meets obstruction at the lower end of the duct because false passages may result which may eventuate in retroduodenal cellulitis and peritonitis.

Where a stone is inextricably impacted in the less accessible parts of the ducts, try the injection of ether through a rubber catheter passed to the stone in the common duct and there anchored. Inject a drachm of ether once or twice daily. This method is recommended by O. B. Pribram who assured me that it succeeds in all cases. In my own cases it has not invariably proved successful. It is worth trying. Waltman Walters[1] succeeded with this ether method in dislodging an impacted stone aided by the use of amyl nitrite.

CYSTOCHOLEDOCHOSTOMY

Halsted-Reid Operation

Step 1. Expose the cystic and common duct thoroughly.
Step 2. Ligate the cystic artery. Clamp the cystic duct and divide it about 2 cm. from its origin.
Step 3. Excise the gallbladder. Incise the common duct and remove all discoverable stones.
Step 4. Pass a probe as large as possible into the duodenum. Stretch the stump of the cystic duct and, if need be, use for stretching a clamp or other instrument (Fig. 1782).
Step 5. Introduce a tube of selected size (catheter) through the cystic into the common duct, before suturing the incision in the latter (Fig. 1783). The catheter is maintained in place by a stitch of catgut No. 00, passed through its side into the wall of the cystic duct.
Step 6. Close the incision in the choledochus by one or preferably two rows of interrupted fine silk sutures (No. 0). Reid used several times the finest catgut (interrupted sutures) for the inner row of sutures (Fig. 1784).
Step 7. Test the line of suture by injecting salt solution through the tube and protect the suture lines from the drains by overlaid fat or other tissues.

[1] Surg. Gynec., Obst., Nov., 1937.

Step 8. Place three or four very thin Halsted drains or slender cigarette drains about the rubber catheter. Make the cystic duct hug the catheter closely. Reid admonishes that the employment of the largest possible size of tube,

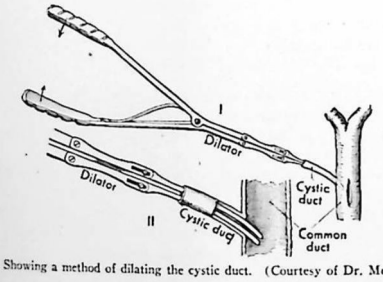


Fig. 1782. Showing a method of dilating the cystic duct. (Courtesy of Dr. Mont R. Reid.)

in the unjustified hope that perhaps a stone may escape through it, is inadvisable.

Step 9. Close the abdominal wound in layers; use sutures of silk reinforced by two or three through-and-through stitches of silkworm-gut.

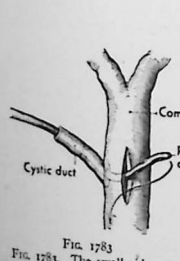


Fig. 1783

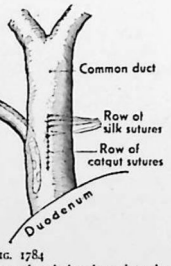


Fig. 1784

Fig. 1783. The small side openings are made in the catheter after it has been introduced through the cystic duct and pulled out of the opening in the common duct. It is then returned to the common duct and anchored to the cystic duct before the incision of the common duct is closed. In this way one assures the final position of the end of the catheter.
Fig. 1784. Cysticocholedochostomy completed except for the second row of sutures in the common duct. (Courtesy of Dr. Mont R. Reid.)

Comment: The drains are removed, some on the second or third day, the remainder on the fourth or fifth day. The catheter in the duct should not be disturbed until there is reason to believe that the wound in the common duct is firmly healed. In case of obliteration of the cystic duct, one

should make a second opening in the choledochus just large enough to admit a small tube and completely close the original incision (Fig. 1785). The operation may occasionally be difficult or even impossible. In all of Reid's cases the tube has been pointed toward Vater's diverticulum, and in none of these did it become kinked or obstructed. The curve of the tube is probably supported by the cystic duct and the under surface of the liver. When the cystic duct is too small to admit a tube of the required size it should be dilated with either a fine clamp or special instrument The tube Reid usually employed is a catheter, size No. 16 of the French scale but a No. 12 suffices. The tube should be snugly embraced by the cystic duct which, if too large, should be reduced in size by a stitch or two. Occasionally one may have to split the duct for a short distance to facilitate the introduction of the stretcher.

Orr's Improved T-Tube for the Drainage of the Common Bile Duct

Because of the difficulty in introducing the ordinary T-tube into the common bile duct, and because of the pain and trauma incident to its removal, Thomas G. Orr[1] devised a modification which removes in a large measure these two objectionable features (Fig. 1786).

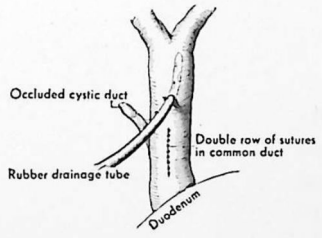


Fig. 1785. A method of avoiding the placing of a tube through the incision of the common duct when a cysticocholedochostomy cannot be done. (Courtesy of Dr. Mont R. Reid.)

By cutting a notch in the tube, as shown in the illustration at 2, the two short arms of the T can be readily folded together, as in 3, when being introduced into the common duct. The ordinary T-tube is not sufficiently flexible to fold readily when being withdrawn from the duct as shown at 4. When notched, as in 2, the short arms of the T fold smoothly together and may be withdrawn through a relatively small opening, as in 5.

RETRODUODENAL CHOLEDOCHOTOMY

Haasler's Operation

This operation is rarely performed. Mayo-Robson reminds us that in an experience of nearly 200 cases of choledochotomy he has yet to meet with a case in which he could not work the calculus backward to the first portion of the duct whence he could remove it, or reach it from below after laying the papilla open. He, therefore, cannot see the necessity of this modification of the operation of choledochotomy.

Besides, it must be remembered that the inferior vena cava is in close proximity; or the duct may be covered with pancreatic tissue. Again, inasmuch as this portion of the duct is not covered by peritoneum, a fistula may result.

Should it, however, become necessary to resort to this procedure it is performed as follows:

Mobilize the duodenum by Kocher's method (Fig. 1787). Displace the

[1] Ann. Surg., 1935.

duodenum inward, thus exposing the duct coursing behind, in its retroduodenal or upper pancreatic portion. Here it lies beneath the surface of the pancreas which must be incised. Locate the stone; incise the duct over it and remove the stone. Close the opening made in the duct with a double layer of interrupted catgut sutures. Replace the duodenum and suture it in place. Drain with a rub-

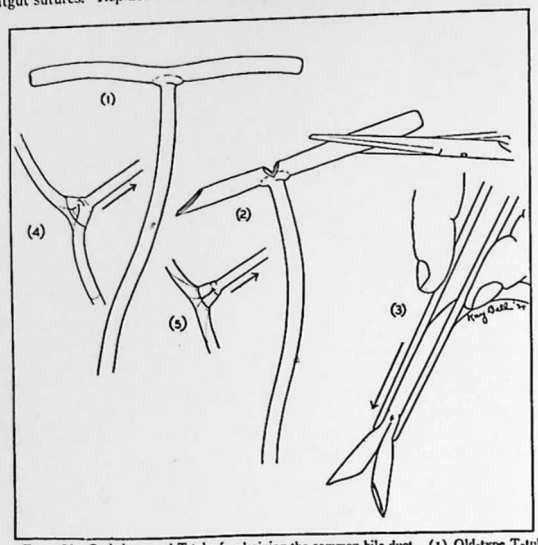


FIG. 1786. Orr's improved T-tube for draining the common bile duct. (1) Old-type T-tube. (2) T-tube notched and shortened. (3) Grasped in long, smooth thumb forceps ready for introduction into the common duct. (4) Shows large opening in common duct required for removal of old-style tube. Note point of angulation. (5) Shows smooth folding of modified tube when being withdrawn from common duct.

ber tube bringing its distal end out of the loin at the outer side of the right kidney. Cholecystostomy may supplement this procedure, if deemed advisable.

TRANSDUODENAL CHOLEDOCHOTOMY

There are two varieties of this operation:

(a) Transduodenal choledochotomy (Kocher's operation).

(b) Transduodenal (ampullary) choledochotomy (McBurney's operation).

Transduodenal Choledochotomy (Kocher's Operation)

This procedure is used in removing an impacted stone from the lower part of the common duct, but not in the ampulla of Vater. The technic is that of dividing the anterior and posterior wall of the second portion of the duodenum, the stone is palpated and the wall of the duct incised over the impacted calculus

exposed as in Kocher's operation, except that the incision in the posterior duodenal wall is made at a slightly lower level (Fig. 1788 a). The edge of the papilla is incised sufficiently to permit the stone to be extracted. Explore the duct and clear it of stones or gravel. The rest of the operation is conducted as outlined in the previous procedure. What has been said about drainage holds good here also. When drainage is used, the drains should never be carried down to the duodenum. Duodenal fistulae will result from ignoring this precaution.

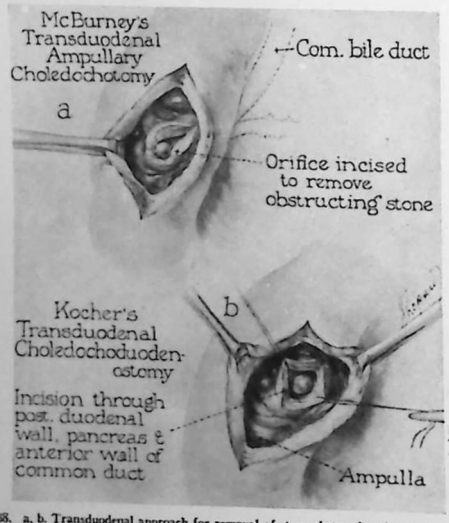


FIG. 1788. a, b. Transduodenal approach for removal of stone obstructing the common bile duct.

Difficulties Encountered During Choledochotomy Operations. The presence of a calculus in the common duct, particularly in its lower divisions is often difficult to foretell with any degree of certainty.

Inflammatory thickenings of the duct or the tissues (pancreas) surrounding it may mimic the presence of a stone. Diagnosis is often very difficult for no less an authority than Moynihan speaking on the question in his monumental work[1] admonishes that "We all have to pass through a time of difficulty. I feel much more confident about the matter," he says, "than I did ten years ago. I do not find the old difficulties disturbing me, as they used to so painfully. But that is only to confirm what I have so long believed that in no department of surgery is long practice so helpful, and, indeed, so necessary, as in that which deals with cholelithiasis."

[1] Abdominal Operations, W. B. Saunders Co., 1926.

(Fig. 1788 b). To facilitate the operation, particularly in obese individuals mobilization of the duodenum and its delivery into the wound, together with the head of the pancreas, is, if thorough work is aimed at, essential. After the duodenum is opened its contents are aspirated, after first protecting the surrounding structures with lap sponges. An incision is made over the stone, the divided margins of the duct are caught in lateral sutures which are left long to act as retractors. The stone is removed, the duct is explored from above and below and its patency assured. Before an incision is made into the duct, every effort should be made to extract the stone through the ampulla. After clearing the duct, the incision into it and into the posterior duodenal wall are closed with fine

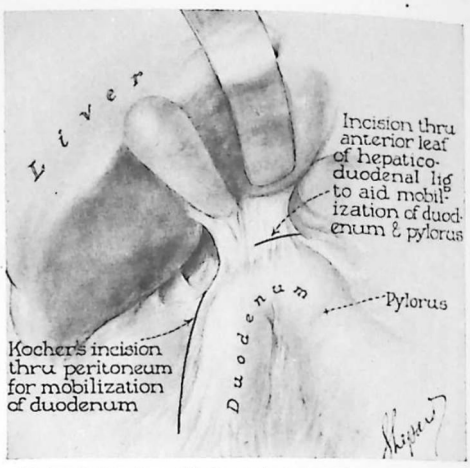


FIG. 1787. Kocher's incision for mobilization of duodenum. The duodenum and pylorus may be further mobilized by an incision shown on the right.

interrupted through-and-through catgut sutures. The incision in the anterior duodenal wall is closed transversely with two rows of chromic catgut sutures. A third row of interrupted (mattress) sutures of Pagenstecher linen is a worthwhile precaution. Over this, a flap of omentum or of falciform ligament is sutured. It protects the anterior duodenal wall from possible leakage. Secure closure is the safeguard. If soiling has taken place, or if a concomitant cholangitis exists, drainage should be resorted to. With meticulous technic without soiling, closure of the abdomen may be permissible. Nevertheless, I still am partial, under such conditions, to Moynihan's "conscience drain."

Transduodenal, Ampullary, Choledochotomy (McBurney's Operation)

This operation is resorted to if the stone is impacted in the ampulla of Vater and cannot be removed in any other way. The stone in the papilla is

OPERATIONS FOR IRREMOVABLE OBSTRUCTIONS OF THE COMMON DUCT

Choledocho-enterostomy

RIEDEL'S OPERATION

This is a short-circuiting procedure in cases of irremovable obstruction of the lower end of the common duct. It consists of joining the dilated duct with the duodenum or some other part of the intestine.

Step 1. Mobilize the duodenum as already described (Fig. 1787). Such mobilization must be thorough and enable the operator to bring the duodenum up and to be applied without tension to the side of the dilated supraduodenal portion of the common bile duct.

Occasionally, if the common duct is enormously dilated it may be brought down to meet the duodenum to which it is to be joined.

Step 2. Apply a curved clamp forceps to the duodenum; and in marked dilatation of the duct a similar clamp is applied to it. The two clamped viscera are placed side by side in position for anastomosis.

Step 3. Make a transverse opening in the duodenum and in the dilated duct, about ¼ of an inch in length. If the duct is narrow, a longitudinal incision should be made into it. In view of the small size of the structures to be joined, very fine instruments should be used. Those used for blood vessel surgery are excellent for the purpose.

Step 4. Unite the opened viscera, with a two-row suture anastomosis; an outer serosa suture of fine Pagenstecher linen and an inner through-and-through suture of fine, chromic catgut embracing the entire thickness of the walls to be joined. The anastomosis is performed on the same principles as detailed under cholecystanastomosis (which see, p. 1602).

Step 5. Close the abdomen without drainage.

If the obstruction is benign and the operation successfully executed, excellent results will follow.

If, for some reason (adhesions, etc.) the duodenum cannot be utilized for anastomosis, the jejunum is mustered into service. The operation consists of bringing up a loop of jejunum about 20 inches from the jejunoduodenal flexure, and anastomosing it to the dilated duct. In order to avoid kinking and consequent intestinal obstruction, this should be supplemented by a jejunojejunostomy.

CHOLEDOCHECTOMY

DOYEN'S OPERATION

This operation is resorted to in cases of tumors of the common duct or in strictures of the duct following surgical intervention.

The supplementary procedures at the surgeon's disposal after the tumor or stricture is resected are: (a) end-to-end union with or without drainage; (b) the distal end of the duct may be closed and the proximal end implanted into the intestine; (c) both ends of the duct may be closed and cholecystenterostomy performed.

RECONSTRUCTIVE OPERATIONS ON THE COMMON BILE DUCT

Damage to the common duct usually results from pressure of calculi or accidental injuries during surgical operations, followed by fistulae or strictures. In stenosis or division of the common duct, several procedures are available.

Resection of a Scar with End-to-End Anastomosis

When during an operation it is discovered that the duct has been divided, a direct end-to-end anastomosis of the duct is a comparatively simple matter. A prerequisite is: careful union of the divided ends without tension. The story is different when a union has to be made some time after the accidental division of the duct—the duct ends are then often found retracted and difficult to mobilize sufficiently to approximate them without tension.

If, after a resection of a stricture the gap is not too wide, a direct end-to-end anastomosis may be done.

Step 1. Identification of the structures is of paramount importance. This is often beset with many difficulties.

Step 2. Separate the structures involved carefully, painstakingly and with deliberation.

Step 3. Clear the foramen of Winslow.

Step 4. Liberate the duodenum from its attachments (Fig. 1787, p. 1615).

Step 5. Define the gastrohepatic omentum. Avoid the portal vein. Even after months of disuse the lower end of the duct does not shrink in diameter and is of quite normal size.

Step 6. Excise the stricture or freshen the ends of the divided duct.

Step 7. An end-to-end union of the ends of a divided duct demand meticulous technic and fine suture material (fine Japanese silk and thin straight or curved needles 1 cm. long).

W. J. MAYO'S METHOD

Step 1. The structures are dissected out until the ends of the hepatic and common ducts lie free.

Step 2. Several chromic catgut stay sutures are introduced, catching the tissues behind the duct ends; these, when tied, obliterate the posterior space and bring the hepatic and common ducts into a position for suturing (Fig. 1789a).

Step 3. A few catgut through-and-through sutures are placed so as to unite the duct ends posteriorly.

Step 4. The open end of the common duct is split along its anterior surface, one-third of an inch, as advised by C. H. Mayo.[1] The split in the free border of the common duct increases its caliber to a considerable extent; it is thus more readily coapted to the dilated hepatic duct.

Step 5. A T-tube of appropriate size is now introduced, one arm extending about one inch into the hepatic duct, to its primary division, and the other arm, if possible, through the entire length of the common duct until its free end passes into the duodenum (Fig. 1789b).

Step 6. The gap about the T-tube is closed with chromic catgut sutures.

Step 7. The tube is fastened to the hepatic and common ducts, respectively,

[1] Surg. Gynec. & Obst., 1916

with an absorbable suture and the line of union protected by such omental and peritoneal tissues as are available. Moynihan prefers to use two tubes instead of a T-tube which is not so easily withdrawn. He also lays stress on the mobilization of the duodenum and the use of supporting sutures to relieve tension on the suture line.

Step 8. A few rubber tissue drains properly arranged in the abdomen are supplemented, and the abdominal wall is closed.

Comment: The T-tube is permitted to remain in place from one to several months or until clamping of the projecting end is borne without distress.

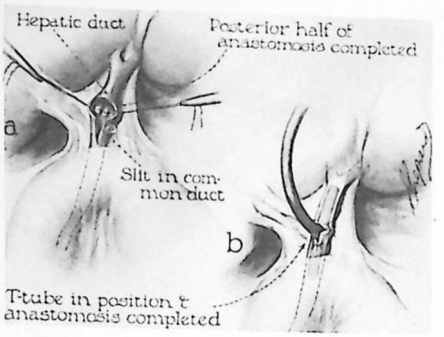


Fig. 1789. a, b. W. J. Mayo's method of end-to-end anastomosis of the hepatic and common ducts. The posterior half of the two ducts are joined first then a short slit is made in the anterior wall of the common duct to help admit a T-tube. The tube in place, the slit and anterior walls of the ducts are sutured.

DIRECT HEPATICODUODENOSTOMY AND HEPATICOGASTROSTOMY

W. J. MAYO'S OPERATION

If the lower end of the common duct cannot be defined, the union of the upper end of the common hepatic or common bile duct to the mobilized duodenum comes under consideration. An implantation of the open end of these ducts into the duodenum reproduces normal conditions more nearly than any reconstructive operation except an end-to-end anastomosis of the common bile duct.

To this phase of biliary duct surgery, W. J. Mayo again contributed much. His original article[1] reports two successful hepaticoduodenostomies.

The operation (Fig. 1790) consists of:

Step 1. Mobilization of the duodenum and suturing it to the contiguous tissues in order to retain it in contact with the severed ends of the hepatic duct.

Step 2. Severing the hepatic duct above its constricted portion.

[1] Amer. Jour. Surg., 1905.

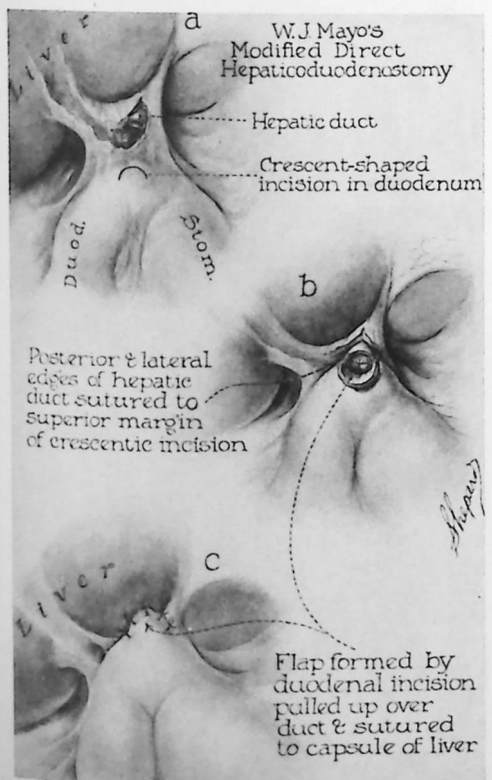


Fig. 1790. Hepaticoduodenostomy. a, b, c. Method of direct anastomosis of hepatic duct and duodenum, particularly applicable when dealing with a short stump of the duct.

Step 3. Ligation of the inferior portion of the common duct.

Step 4. Preparation of the superior portion of the duct.

Step 5. Make an elliptical incision in the duodenum about the diameter of the duct, embracing all its coats, at the point at which approximation with the duct is thought most easily accomplished (Fig. 1790a).

Step 6. Placing sutures from the mucomembranous side through all the coats of the bile duct and duodenal wall to form the posterior half of the anastomosis (Fig. 1790b).

Step 7. Placing two rows of sutures alternately externally and internally in such a manner that the two rows complete the anterior half of the anastomosis, the inner row penetrating the full thickness of the wall of the duct and the duodenum while the outer line penetrates only the serous coat (Fig. 1790c).

Sullivan and McArthur suggested the introduction of a short rubber tube into the duct over which any form of anastomosis becomes considerably easier. C. H. Mayo states that their technic makes excellent scaffolding on which to reconstruct the duct. The tube may be permitted to remain in situ for long periods.[1]

W. J. Mayo later modified his method of hepaticoduodenostomy. Donald C. Balfour[2] describes that modification as follows: "After freeing the structures from adhesions and their thorough isolation and mobilization, a slightly curved incision about 2 cm. in length is made in the duodenum embracing all its coats. The posterior margin of the opening thus produced and the posterior edge of the prepared stump of the hepatic duct are sutured in a mucomucous union. The anterior margin of the duodenal incision is not sutured to the edge of the hepatic duct, but is brought up as a flap over the anterior aspect of the bile duct and is sutured to the under surface of the right lobe of the liver, the sutures passing into the capsule of the liver and into the side tissue." (Fig. 1790.)

DIRECT HEPATICOJEJUNOSTOMY

In 1908 Monprofit reported to the French Surgical Congress his advocacy of direct hepaticojejunostomy or choledochojejunostomy by the Y-method.

INDIRECT HEPATICODUODENOSTOMY

In cases where the condition of the patient prohibits extensive dissections, or when it is found that it is impossible to free the structures from adhesions and to successfully bring them together to be united, failure will surely result if direct junction is attempted.

Indirect junction of the biliary tract with the intestinal canal by scaffolding the breach with a rubber drainage tube, to allow the formation of a new duct around and to replace the rubber tube, should then be attempted.

Arthur G. Sullivan[3] has shown that:

1. Reconstruction and regeneration of a bile duct can take place about a rubber drainage tube which bridges a gap in a defective bile duct or between the superior end of a severed bile duct and the duodenum;

2. Reconstruction of the bile duct can be accompanied by utilizing neigh-

[1] T. B. Mouat. Lancet, July 23, 1938, p. 181.
[2] Annals of Surgery, 1921.
[3] J.A.M.A., 1909.

boring structures and slightly traumatized omentum which is placed about the rubber tube;

3. After a duct is formed from neighboring tissues and the omentum, epithelization takes place on the inner surface of the newly formed duct walls by means of outgrowths of epithelium from the mucous membrane.

Jenckel's Indirect Hepaticoduodenostomy

Jenckel's operation was performed by him in 1905; he reported it in 1910. He preceded Sullivan's classic experiments. Figure 1791 depicts the operation. Jenckel operated on a patient on whom a cholecystectomy had been performed eight months previously; he found that the common bile duct and the lower

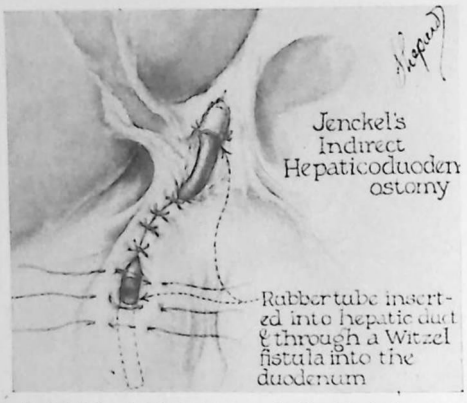


FIG. 1791. Jenckel's indirect hepaticoduodenostomy. A rubber tube placed to communicate between the hepatic duct and the duodenum.

portion of the hepatic duct were obliterated; the stump of the hepatic duct and the duodenum were so bound down by adhesions that mobilization of the structures was impossible. He then performed his operation which consisted of inserting one end of a rubber tube the size of his little finger and slightly shorter than the hand, in the hepatic duct, the other end of the tube he inserted obliquely in an opening in the duodenum through a Witzel fistula. When Jenckel thought that epithelization had taken place within the reconstructed duct, he removed the tube at a subsequent operation. His patient reported well four years after the operation.

Walton's Plastic Hepaticoduodenostomy

A. J. Walton performed this operation in 1914 and described it in Surg. Gyn. and Obst., 1915. He reconstructed the common bile duct and made a new communication into the duodenum. The reconstruction was made necessary by the obliteration of the common bile duct.

A tongue-shaped flap was cut from the duodenum and, at first, reflected downward (Fig. 1792 a). The defect in the duodenum was closed except for an aperture at the base of the flap, about the size of the bile duct. One end of a rubber drainage tube was placed in the opening in the duodenum and the other end in the stump of the bile duct. The flap was then reflected upward over the tube (Fig. 1792 b, c, d). The tip of the flap was sutured to the anterior margin of the bile duct end. The lateral margins of the flap were sutured to the serous surfaces of each other along the sides of the rubber tube. This canal, with its anterior and lateral aspects lined with mucous membrane and its posterior aspect lined with the serous surface of the duodenum, formed a new bile duct. Eleven days after the operation the tube was passed from the intestine. There had been no leakage of bile from the wound (study Fig. 1792 and legends in conjunction with text).

CHOLEDOCHOPLASTY

MOYNIHAN'S OPERATION

The first plastic operation on a bile duct without the use of a graft was performed by Moynihan in 1904. He reported his case in the British Medical Journal in 1905. The case was one of stricture of the common duct, which was incised longitudinally through the stricture and for some distance above and below it. The edges of the incision were united transversely. A drainage tube was passed upward and another tube downward. Moynihan prefers this to a T-tube arguing that tubes may be removed with greater facility than can a T-tube, without traumatizing the sutured bile duct. The tubes were removed on the eleventh day. No bile flowed into the intestine until the fifth week. External drainage ceased in the ninth week. Four years after the operation the patient reported well.

OPERATIONS FOR EXTERNAL BILIARY FISTULAS

Discovery of the underlying etiologic factor and its removal are essential to success in this class of cases.

Closure of gallbladder fistulae are treated on the same basis as intestinal fistulae, viz.: (a) excision of the structures leading to the fistula; (b) inversion of the gallbladder; (c) closure with one or two rows of sutures; (d) closure of the abdomen with or without drainage, depending on existing conditions.

Whenever possible cholecystectomy should be performed making sure, of course, that the bile enters the intestine.

Numerous methods have been devised to implant a biliary fistula directly into the gastro-intestinal tract. Of these Czerny's operation, Von Huberauch's direct implantation of a freely dissected biliary fistula into the pylorus, Marsani's procedure, and Roith's and William's operation are outstanding examples.

Operations for the Establishment of a Direct Communication Between the Parenchyma of the Liver and Alimentary Tract

These consist, essentially, of some form of hepatocholangio-enterostomy, hepatocholangiogastrostomy, hepatocholangioduodenostomy, or hepatocholangiojejunostomy. The latter was first suggested by Langenbuch in 1837 and consisted of effecting an anastomosis between the intestine and the smaller hepatic ducts.

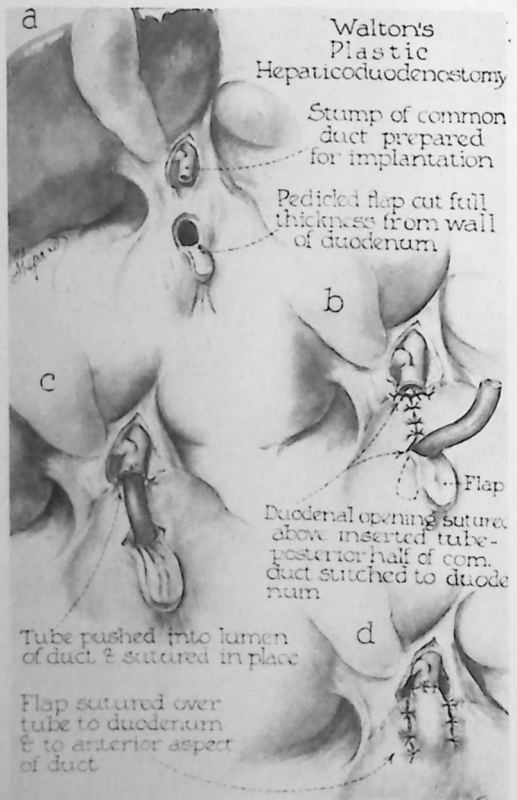


FIG. 1792. a, b, c, d. Walton's plastic hepaticoduodenostomy. A full-thickness, pedicled flap from the duodenal wall is formed over a rubber tube and sutured to the stump of the common bile duct.

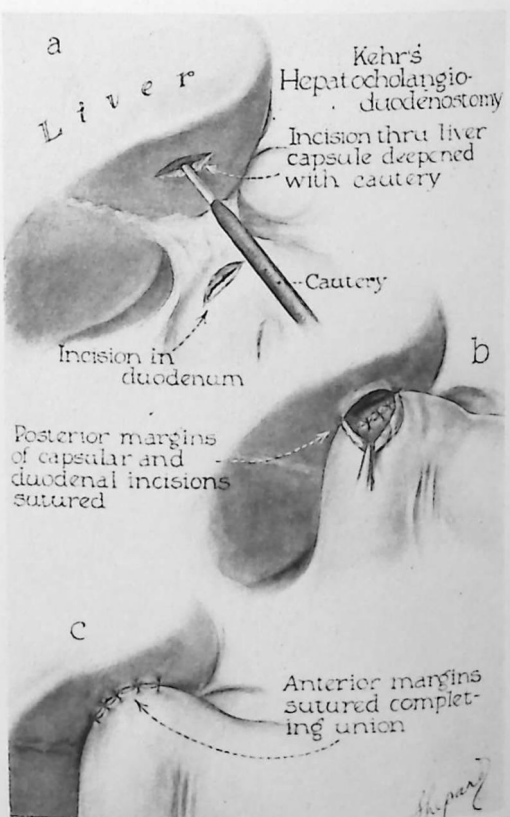


FIG. 1793. a, b, c. Kehr's method of establishing a communication between the liver parenchyma and the duodenum (Hepatocholangioduodenostomy).

It finds its indication in cases where there is a permanent obstruction of the common and main hepatic ducts or of the common and cystic ducts.

KEHR'S OPERATION

Step 1. Exposure of the gallbladder; position of the patient, anesthesia, etc. as described above. If necessary, remove the gallbladder.

Step 2. Excise, from a convenient portion of the lower margin of the right lobe of the liver, a strip of liver tissue about two and one-half inches in length and about one inch wide. With the thermocautery burn a hole in the liver to such a depth that several moderate sized bile ducts are opened (Fig. 1793).

Step 3. Choose a segment of bowel, preferably the duodenum (hepatocholangiduodenostomy) or stomach (hepatocholangiogastrostomy). If the stomach is under tension use the jejunum (hepatocholangiojejunostomy) and proceed as follows: make an opening in the segment of bowel selected about two or two and a half inches in length and suture it to the margins of the wound in the liver.

CHAPTER 36

SURGERY OF THE PANCREAS

Anatomic Considerations. The pancreas has no distinct capsule. It is disposed transversely across the upper part of the posterior abdominal wall. It is divided into a head, neck, body and tail (Figs. 1794-1795).

The head occupies the concavity of the duodenum. It is covered in front by the beginning of the transverse colon. It lies posteriorly on the common bile duct, inferior vena cava and right renal vein. The uncinate process is that portion of the pancreas which projects upward and backward behind the neck. It is separated from the

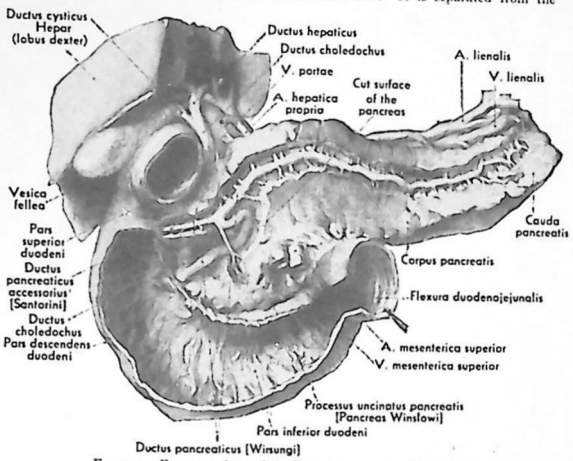


FIG. 1794. Excretory ducts of the liver and pancreas. (Spalteholz.)

latter by the superior mesenteric vessels. The neck is about an inch long. It is situated in front of the uncinate process and the beginning of the portal vein. The body proceeds across the second lumbar vertebra and passes upward toward the spleen. It is in relation posteriorly with the aorta having the celiac axis above and the superior mesenteric artery below. Both these vessels groove the gland. It then lies upon the left crus of the diaphragm, the left adrenal and the left kidney and its vessels. It is separated from the posterior surface of the stomach, which it supports, by the lesser peritoneal sac (omental bursa). The tail projects toward the gastric surface of the spleen.

Blood Vessels and Lymphatics. The arterial supply is derived from: (a) the pancreaticoduodenalis, a branch of the gastroduodenal; (b) the inferior pancreaticoduodenalis, a branch of the superior mesenteric; and (c) some branches from the splenic artery. The lymphatics drain into the following nodes:

(a) Left gastric (coronary)
(b) Subpyloric
(c) Mesenteric and
(d) Suprapancreatic (pancreaticosplenic)

The lymphatics of the pancreas and those of the gallbladder and biliary passages freely intercommunicate, this being the reason why chronic pancreatitis often follows cholecystitis and cholangitis.

The Pancreatic Ducts. The chief excretory duct of the pancreas is the duct of Wirsung, or ductus pancreaticus, which beginning near the end of the tail runs through the middle of the organ toward its head and then terminates, in most instances, into

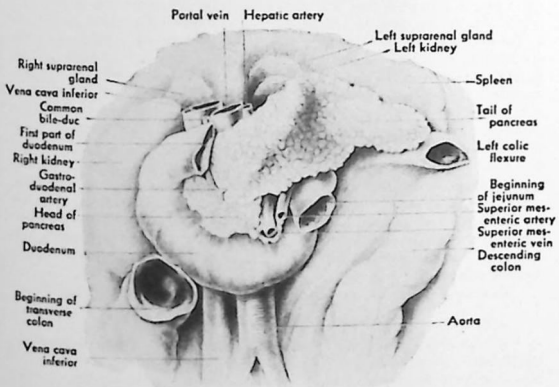


FIG. 1795. Anterior aspect of pancreas *in situ*; the organ is exceptionally broad, and covers more of left kidney than usual; peritoneum has been removed. (Piersol.)

the floor of the ampulla of Vater. The biliary papilla presents one opening which is common to the pancreatic and common bile duct. Sometimes both ducts empty into the duodenum separately and at other times the pancreatic duct joins the common bile duct outside the duodenal wall in which case both the ampulla and the papilla are absent.

The duct of Santorini or accessory pancreatic duct comes mainly from the lower portion of the head of the pancreas and empties separately in the head of the duodenum ¾ of an inch above the papilla. It communicates with the duct of Wirsung in the substance of the pancreas.

METHODS OF SURGICAL APPROACH TO THE PANCREAS

There are several routes by which the pancreas may be reached (Figs. 1796-1797).

1. Through the gastrohepatic omentum above the stomach;
2. Through the gastrocolic omentum below the stomach;
3. Through the transverse mesocolon back of the colon and stomach;
4. By retracting inward the second part of the duodenum;

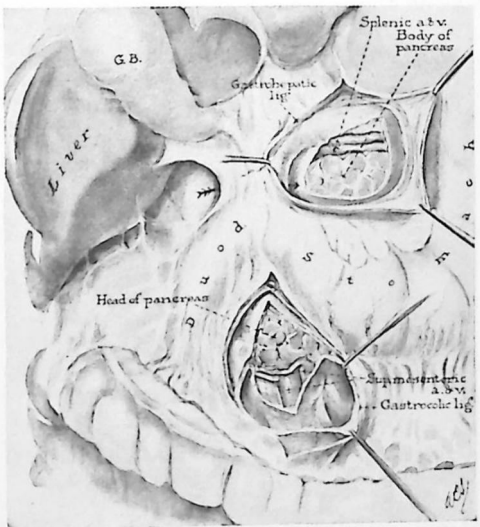


FIG. 1796. Approach to the head of the pancreas through the gastrocolic ligament with exposure of the superior mesenteric vein. Approach to the body of the pancreas is obtained through the gastrohepatic ligament. (After Guleke. Ergebn. d. Chir. u. Orth., Vol. IV.)

5. By mobilizing the duodenum to expose the posterior part of the head of the pancreas;
6. Reaching the tail of the gland by raising the stomach, pushing the splenic flexure of the colon downward and inward and incising the reflection of the peritoneum passing from the colon to the abdominal wall;
7. From the loin behind the peritoneum (this dorsal approach is difficult: spine, large vessels, muscle masses). It is only to be used rarely (posterior abscess).
8. Through the stomach.[1]

[1] Bessel Hagen—Arch. f. Klin. Chir., 1900, lxii, 157.

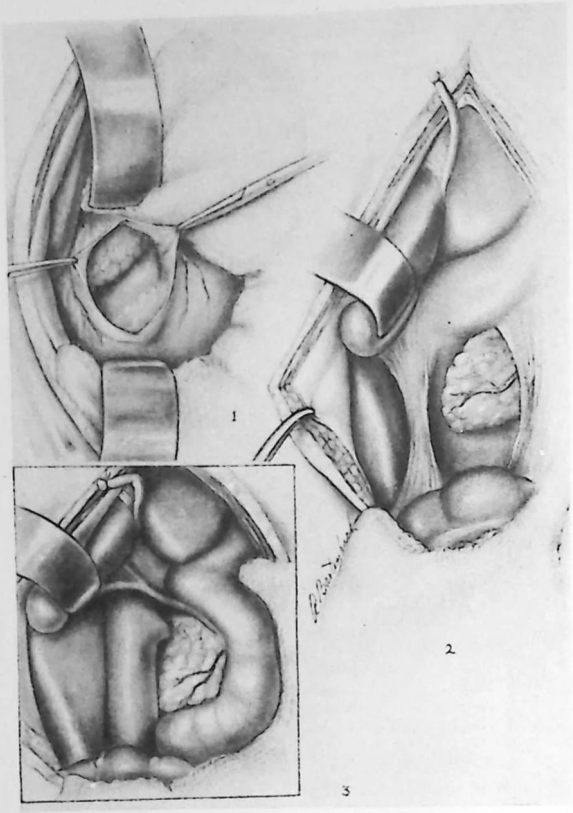


FIG. 1707. Exposure of the pancreas (after Körte). 1. Approach to the pancreas between the liver and the stomach. The liver is displaced upward with a retractor and the stomach is pushed downward. The gastrohepatic ligament is divided, its borders being separated with an artery forceps. One observes the body of the pancreas exposed above the lesser curvature of the stomach. 2. Exposure of the head of the pancreas from the front, in the duodenal recess. Observe the liver displaced upward and the gastrocolic ligament divided. 3. Exposure is made through an L-shaped median incision with the longer limb of the incision directed to the right. The liver and gall bladder are displaced to the right. The duodenum has been mobilized by dividing the peritoneum and displaced toward the median line. Observe the exposure of the posterior aspect and of the pancreas and common bile duct. In the depth of the wound the vena cava is seen.

The chief dangers encountered in operations on the pancreas are: (a) hemorrhage, (b) escape of pancreatic juice and (c) pancreatic asthenia (Whipple). The pancreas when excised or injured bleeds freely. The vessel walls are friable and difficult to ligate. Tamponade (temporary) usually controls bleeding from the pancreas. Free drainage should always be resorted to in operations on the pancreas. When sutures are used to arrest hemorrhage they should be of substantial catgut and cutting through the friable pancreatic substance thus guarded against. Pancreatic juice drainage causes fat necrosis, and degeneration of the tissues acted upon; it acts as a powerful irritant of the peritoneum. The natural defensive forces are vitiated in the peritoneum and peritonitis often supervenes. Pancreatic asthenia presents a peculiar symptom complex (anorexia, asthenia, nausea, hypotension, exhaustion). Intravenous glucose solution (5 per cent) followed by insulin is advocated by Moynihan in the treatment of this condition.

INJURIES TO THE PANCREAS

STAB AND GUNSHOT WOUNDS

Operation must be undertaken without delay.

Step 1. Explore for injury to other organs.
Step 2. Repair damage to contiguous structures.
Step 3. Hemostasis.

Comment: In extensive injuries to the pancreatic tissue, lacerations must be carefully sutured; repaired surfaces of the pancreas should be afforded the added protection of omental grafts. In every case of pancreatic injury packing and thorough drainage are essentials and are not to be omitted, or, if need be, resection of much damaged tissues must be resorted to. Important structures to be avoided are: the main duct, the superior mesenteric artery and the portal vein. If the general condition of the patient prohibits careful repair, or when the injuries are so extensive that hope for successful repair is meager, resort to tamponade and drainage. Drainage may be done through the anterior or posterior abdominal wall. Rubber tubes are best suited for the purpose. In injuries to the pancreas during operative procedures (gastric resection for ulcer or carcinoma), when properly sutured, drains may be omitted.

In operations of this type the point of entry for exploration is usually through the gastrohepatic omentum, thence into the lesser peritoneal cavity.

Injury to the Pancreas Without External Evidence

As soon as the diagnosis is made, exploration should be done without delay. It is better in these cases to err on the side of safety and do an exploration.

RUPTURE OF THE PANCREAS

Comment: Charles S. Venable[1] reviewed the literature and reported 5 cases of rupture of the pancreas, two of which were those of Dr. W. B. Russ and Omar Roan. He points out that injury to the pancreas may not always be measured in terms of the severity of pain experienced by the

[1] S.G.O., Nov., 1932.

patient or the degree of collapse. Exploratory operation is justifiable when injury to the pancreas is suspected. Linen is preferred to catgut for suture material; the latter seemed an apparent cause of activation of trypsinogen in one of the cases reported. Venable approaches the pancreas through the mesocolon. He aspirated the fluid, sutured the rent in the pancreas with linen and inserted a drain through the gastrocolic omentum. He keeps the patient on a pure carbohydrate diet which renders the pancreatic secretion almost free from trypsin and steapsin and he protects the skin with xeroform. Volkmann[1] has operated on 32 cases of injuries of the pancreas with only one death. He used silk for his ligature, and abstained from using gauze tampons as he considered that this leads to fistulae or pseudocysts.

OPERATIONS FOR PANCREATITIS

ACUTE NECROSIS OF THE PANCREAS

Anesthesia. If not contra-indicated, spinal anesthesia is advisable.

Step 1. Incision: Paramedian, supra-umbilical approach either through the gastrohepatic or gastrocolic omentum.
Step 2. Isolation of the pancreas by hot lap sponges after thorough suction of the accumulated blood and pancreatic juice.
Step 3. Incision into the capsule of the pancreas for decompression. Isolated foci of inflammation are opened with scalpel or electrosurgical knife.
Step 4. The wound in the pancreas is packed from the outer surrounding structures. Thorough drainage is essential. A drainage tube is often used.
Step 5. Exploration of the biliary passages if the condition of the patient permits, otherwise prompt termination of the procedure outlined. In the former case cholecystostomy will be of great aid.
Step 6. Close the abdominal wound partially. Do not remove the packings too early.

SUBACUTE PANCREATITIS

In these cases the prognosis is better than in the acute variety of the disease. The pancreas is exposed, isolated and explored as in acute necrosis. Accumulations of pus are located by palpation and, if found, they should be evacuated and drained by a rubber tube or tamponade. In evacuating a pancreatic abscess through the anterior abdomen, one is running the risk of contamination and eventual peritonitis unless extraordinary precautions are taken to protect the general peritoneal cavity. Often it is advisable, after having located the abscess, to close the incision at the anterior abdominal wall and to reach the accumulation of pus after a posterior incision (left or right) in the costovertebral angle is made. The majority of cases are drained from the front. Necrosed portions of the pancreas are sloughed off in these cases.

OPERATIONS FOR CHRONIC PANCREATITIS

Chronic pancreatitis usually eventuates from some form of disease of the biliary tract. Therapy should, therefore, be directed to the latter, although surgi-

[1] Arch. f. Klin. Chir., Dec., 1928, 677.

cal approach to the former, still advocated by some (splitting of the capsule of the pancreas, tamponade), is of debatable value.

The methods at our disposal for the relief of chronic pancreatitis are:

1. Cholecystostomy
2. Cholecystenterostomy
3. Cholecystectomy or cholecystelectrocoagulectomy supplemented by drainage of the common bile duct.

For technic of these operative procedures see preceding chapters.

Comment: De Quervain (1934) in discussing the treatment of chronic pancreatitis observed that the sooner properly selected surgical lines are instituted, the better it is. He favors cholecystostomy as the first step. If at the end of a few months the symptoms do not regress, anastomosing the gallbladder either to the stomach, duodenum or jejunum supplemented by an entero-anastomosis (Braun's operation) is counseled. The choice of procedure is determined by the conditions found at the time of operation.

Certain patients are extremely sensitive to the influx of bile into the stomach. De Quervain endeavors to obviate this by a proper anastomosis placed lower down. In one case this re-routing by a cholecystduodenostomy has given good results. In some cases, particularly in the absence of marked peripancreatitis, the question of decortication of the pancreas may come under consideration. The various forms of pancreatitis may certainly interfere with the passage of bile through the ducts under consideration. De Quervain stresses the fact that the existence of chronic pancreatitis and its manifold manifestations should be kept in mind from a diagnostic as well as therapeutic point of view.

H. Zoepffel described in 1922[1] a clinical entity under the term

PANCREATIC EDEMA

This condition frequently follows acute pancreatitis. Recovery frequently takes place spontaneously. Early operation is always indicated, for this symptom complex often leads to much pancreatic damage and operation may be called for at a time not so propitious as in the early stages. The treatment consists of

(a) Multiple incisions at various points
(b) Tamponade
(c) Cholecystostomy.

The question of whether a cholecystostomy or a cholecystectomy should be done following chronic pancreatitis is much debated. The late Judd advocated cholecystectomy, speaking of it as a definitely curative procedure. E. Archibald and E. J. Mullally[2] are in favor of cholecystostomy. The philosophy of Judd's cures following cholecystectomies is based upon a supposed paralysis of the sphincter of Oddi; that no such paralysis takes place has been pointed out by E. Archibald[3] who also showed that acute paralysis of Oddi's sphincter does not frequently follow the removal of the gallbladder. Besides, the leaving of the gall-

[1] Deutsche Ztschr. f. Chir.
[2] Canadian Med. Ass'n Jour., Toronto, 1913.
[3] S.G.O., 1919.

bladder behind gives the surgeon the assurance of an avenue for subsequent cholecystostomy should such contingency arise. Archibald advises in cases of persistent recurring attacks of pancreatitis to divide the sphincter of Oddi as a means of providing permanent drainage of bile. His experimental work on animals convinces him of the efficacy of such procedure although he tried it only on one human being.

OPERATIONS FOR PANCREATIC STONES

PANCREOLITHOTOMY

Historical Notes. Heston noted this condition as early as 1867; Graaf records the occurrence of stones in the pancreatic duct. Later, in 1700 Bonetus, in 1857 Galeati, in 1765 Morgagni, in 1769 Greding, and in 1788 Cowley substantiated the finding of stones in the pancreatic duct.

Stones in the pancreas are rare. If diagnosed by x-ray, the operation is performed as follows (Mayo-Robson):

Step 1. Make an incision 3 to 4 inches long, about an inch to the right of the midline.

Step 2. The papilla of Vater is laid open, its edges are seized with Allis forceps and drawn into the wound.

Step 3. The duct of Wirsung is explored with probes and concretions removed by proper-sized forceps. If the stones are more deeply placed in the ducts, Robson suggests approaching the pancreas through the gastrohepatic omentum or through a slit in the transverse mesocolon. By "separating bluntly the duodenum from the parietes, the back of the pancreas may be readily reached" (Robson). The calculi are then exposed by incising the structures overlying them and are then extracted with forceps or scoop.

Step 4. Hemorrhage is arrested by linen ligatures.

Step 5. The duct is sutured with fine catgut sutures, the gland substance coapted with linen sutures and the capsule repaired.

Step 6. Drainage should be instituted (tube or cigaret drains).

OPERATIONS FOR PANCREATIC CYSTS

H. R. Mayhorner and Hamlin Mattson give the following classification of pancreatic cysts:

I. Cysts resulting from defective development
  1. Cysts in infants
  2. Cysts associated with polycystic disease of the kidney
  3. Dermoid cysts
  4. Inclusion cysts
II. Cysts resulting from trauma
III. Retention cysts
IV. Neoplastic cysts
  1. Cystadenoma
  2. Cystadenocarcinoma
  3. Teratomatous cysts
V. Cysts resulting from parasites.

No matter what variety of pancreatic cyst one encounters, operation is always indicated (Figs. 1798-1799). In view of the fact that many of these cysts have been known to develop into malignant conditions later, the earlier the cyst is subjected to surgical therapy the better. The accepted methods of treatment at the present time are:

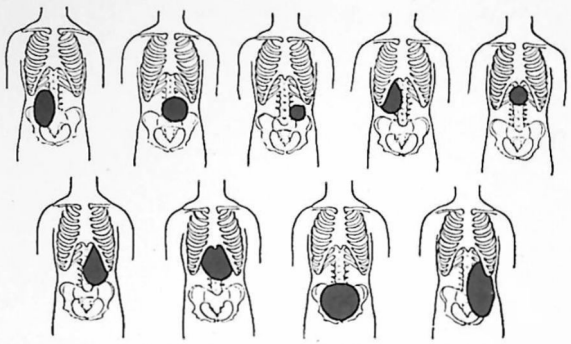


FIG. 1798. Diagram of position of pancreatic cysts simulating tumors. (After Mayo-Robson.)

(a) **Marsupialization.** This consists of the following steps:

1. Incision over the most prominent part of the tumor.
2. Proper exposure of the cyst.
3. Small incision into the cyst wall with introduction of an aspirator for evacuation of the fluid.
4. Exploration of the interior of the sac and ascertaining the relation of the cyst wall to the pancreas.
5. Suturing the edges of the incision in the cyst sac to the edges of the abdominal wound.
6. Drainage.

(b) **Extirpation.** In cystadenomas recurrence is the rule. Complete excision is the ideal treatment. Although the latter is quite a difficult proposition entailing mature surgical judgment and much dexterity, it often happens, and this is fortunate, indeed, that pancreatic tumors are surrounded by a dense fibrous capsule which may on occasion be shelled out of the pancreas without serious damage to the parenchyma. The danger of hemorrhage, of course, must always be kept in mind. Careful operating, calm and judicious step by step procedure will often be rewarded by success. A line of cleavage between the tumor and pancreas is often difficult to ascertain. In such cases, there is great danger of hemorrhage and setting up of acute pancreatitis. "For these reasons," E. Archibald admonishes in speaking of this class of cases, "attempts at extirpation must

often be abandoned even when one has succeeded in separating the cyst wall almost down to its origin in the pancreas; there it is better to abandon it unless by good luck the shelling out process should be found to be easy. It is on the whole advisable to open the cyst wall in the beginning and investigate the interior with the finger. If, at the bottom, one feels the papillomatous tumor, one may attempt extirpation, but if the entire inner lining of the cyst is smooth one should assume that the case is one of pseudocyst and one had then better do a simple drainage with marsupialization for the latter is undoubtedly much the safer procedure."

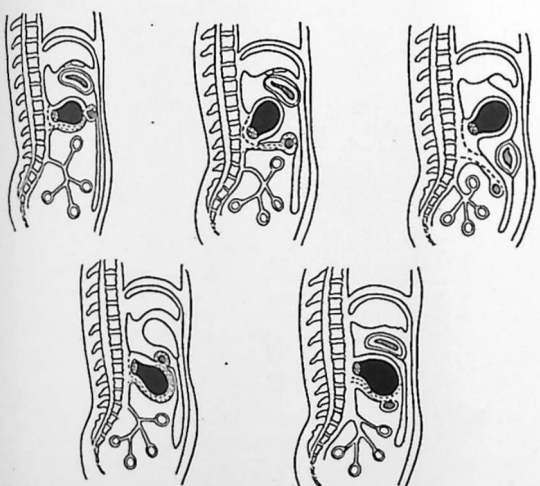


FIG. 1799. Routes taken by various cysts in advancing toward the surface. (Mayo-Robson.)

One must remember that marsupialization is often followed by infection. Again one must not lose sight of the fact that it is much worse to cope with an infection with hopes for final closure of the sinus than subject the patient at the time of operation to a major procedure which may cost his life.

Wohlgemuth's treatment of persistent discharging fistula will frequently yield to a properly regulated antidiabetic diet. In some cases, marked success has followed Wohlgemuth's procedure. In others, it has failed.

Doyen devised an ingenious operation in this class of cases which consists of dissecting out the fistulous tract and implanting it into the small bowel or the stomach. Successful reports have followed this procedure, particularly in long-standing cases.

Figure 1800 depicts the case of a tremendous-sized pancreatic cyst extirpated by the author. Recovery followed. The microscopic examination of the cyst wall revealed the following:

The wall of the cyst is lined by a high columnar mucous producing cell. Underneath the epithelium there are pancreatic acini with occasional islands of

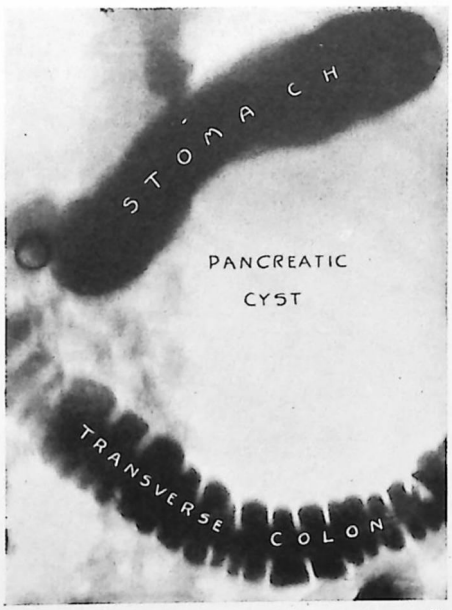


FIG. 1800. Enormous sized pancreatic cyst extirpated by the author. Recovery. X-ray showing enormous size of cyst displacing stomach upward and transverse colon downward.

Langerhans. In some places the epithelium changes its character somewhat, becoming more polygonal and extending into the underlying tissue where they show some irregular mitoses. Here some brownish blood pigment is contained in mononuclear cells. Round cells are seen throughout the wall.

Cysts Within the Pancreas

There are two methods of treatment: suture to the abdominal wound with drainage; excision.

The former is the more conservative procedure; the latter is more dangerous (hemorrhage, injury to contiguous structures). It should be performed only when it becomes evident that the cyst may be shelled out without taking undue chances. Contra-indications to excision are extensive adhesions about the cyst to contiguous structures.

Marsupialization of Pancreatic Cyst

Step 1. Open the abdomen through a supra-umbilical incision in or near the midline. Explore the abdomen; note the presence and extent of adhesions, the position of the cyst (above, behind, or below the stomach; behind or below the transverse colon), and the position of the most prominent point of the cyst (Figs. 1798-1799).

Step 2. Approach A: Cyst located above or behind the stomach. Use a vertical opening made bluntly in the gastrohepatic omentum.

B. Cyst located between the stomach and the transverse colon. Use a vertical opening made bluntly through the gastrocolic omentum.

C. Cyst located behind or below the transverse colon. Deliver the great omentum and transverse colon through the abdominal wound; displace them upward in the same manner as in posterior gastrojejunostomy. Bluntly separate the transverse mesocolon in an avascular area. This exposes the cyst. Avoid injury to the middle colic artery or any of its important branches.

D. Transgastric route (Hagen).

E. Lumbar route: If one remembers that the tail of the pancreas lies in front of the left renal vessels the exposure of any portion of the hilus of the kidney will afford access to the left extremity of the pancreas. The technic therefore is that of exposure of the hilus of the kidney by the lumbar route.

Step 3. After exposure of the cyst aspirate the fluid by an appropriate evacuation apparatus. Make an opening in the cyst to permit the passage of a drainage tube which should be fixed to the cyst wall by a catgut suture. Introduce one or two purse string sutures around the tube which is depressed, while the purse string suture is being tied similar to treating the tube in doing a Kader or Stamm gastrostomy. Avoid injury to the vessels coursing in the vicinity. If injured, they should be ligated.

Step 4. Attach the cyst by means of interrupted sutures to the aponeurosis or, as some surgeons prefer, to the skin.

Step 5. Close the abdomen about the drainage tube, in layers.

Excision of the Cyst

Moynihan says, "The extirpation of a pancreatic cyst is seldom necessary and is rarely capable of successful accomplishment." These cases, when this is possible, constitute the great minority. A prerequisite is absence of adhesions and the cyst must be pedunculated. Remove the cyst according to general surgical principles. Always drain.

Persistent Pancreatic Fistulas

These will close promptly, according to Wohlgemuth and Karcioski, under a rigid antidiabetic diet.

TOTAL PANCREATECTOMY

This is extremely difficult, if not impossible, in cases of malignant disease. Billroth in 1894 removed the entire pancreas and the patient recovered. Ruggs (Bologna) removed a carcinoma of the pancreas weighing 23 ounces, via the lumbar route. His patient died after six months. Cades removed a tumor of the tail of the pancreas about the size of a child's head in 1895. The patient recovered. Terrier's patient (1892) died. The tumor weighed five pounds. Franke in 1901 removed the entire pancreas. The patient recovered. While total pancreatectomies are formidable undertakings, partial removal of the pancreas is a promising procedure if well executed under favorable conditions, particularly if the disease is located in the tail of the pancreas. Operation is greatly facilitated by the use of the electrosurgical knife. Desjardins elaborated the technic of pancreatectomy on the cadaver. Desjardins' operation[1] consists of complete excision of the duodenum, partial excision of the pancreas, cholecystenterostomy and gastroenterostomy.

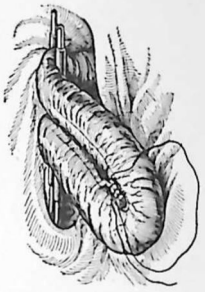


Fig. 1801. Pancreatoenterostomy. Suturing arms of intestinal loop together with primary Lembert suture. (Coffey.)

Figures 1801-1802-1803-1804-1805-1806 depict the technic of Coffey's pancreatoenterostomy.

Comment: In writing on The Problem of Cancer of the Pancreas[2] Howard M. Clute states:

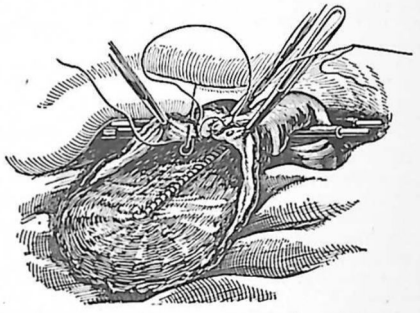


Fig. 1802. Pancreatoenterostomy. Converting two arms of intestinal loop into a single lumen by continuation of through-and-through suture. (Coffey.)

"It is now becoming more generally accepted that the seriously jaundiced patient who apparently has cancer of the pancreas should have a

[1] Revue de Chirurgie, June 10, 1907.
[2] J.A.M.A., July, 1936.

surgical exploration for two purposes: (1) to make as certain as possible that the jaundice is due to cancer of the pancreas and not to common duct stones or pancreatitis, and (2) to consider anastomosis of the gallbladder or common duct to the stomach or intestine for the purpose of relieving the jaundice.

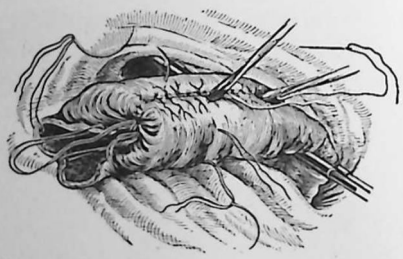


Fig. 1803. Pancreatoenterostomy. Passing intestinal traction sutures into the lumen and out through the wall of the intestine. (Coffey.)

"It must be recognized, however, that simple exploration in cancer of the pancreas carries a definite mortality with it and that the average length of life after exploration is less than with no operative procedure. In my experience the average length of life in cancer of the pancreas unoperated

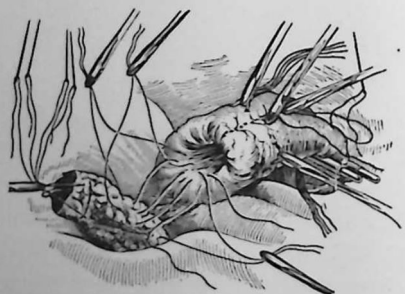


Fig. 1804. Pancreatoenterostomy. Preparing to introduce cut end of pancreas into lumen of inverted gut. (Coffey.)

on is 7.2 months after the diagnosis is first made, and after simple exploration it is but three months. Exploration, therefore, is not advisable in the far advanced cases and should not be done unless one has a reasonable certainty that at least a biliary intestinal anastomosis can safely be made.

"Biliary intestinal anastomoses also carry a heavy immediate mortality, which varies in different clinics, doubtless because of a difference in the selection of cases. These patients, furthermore, are prone to develop later difficulties from infection of the biliary tract from the anastomosis. These factors, however, should not condemn the procedure. The postoperative improvement which these jaundiced patients obtain from a successful short-

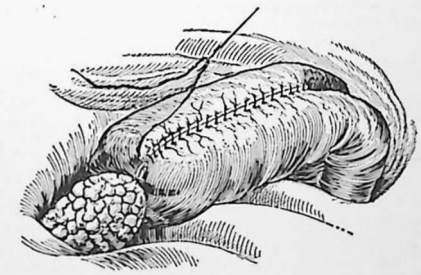


Fig. 1805. Pancreatoenterostomy. Complete operation with primary sutures. (Coffey.)

circuiting operation is often remarkable, and the majority are at least temporarily relieved of their jaundice. There are occasional cases in everyone's experience of patients who live several years after this procedure. The average duration of life after this operation is but seven months, however, even when the unusually long survivors are included.

"In all these operative procedures for pancreatic cancer it is evident

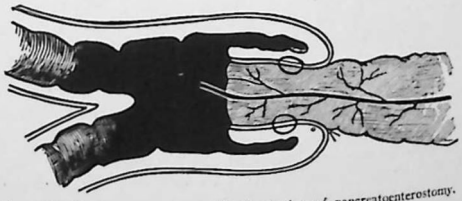


Fig. 1806. Pancreatoenterostomy. Sectional view of pancreatoenterostomy.

that the surgery is undertaken only at the terminal stage of the disease and is complicated by the presence of obstructive jaundice, which is usually of long duration. Can we not hope to develop diagnostic methods and clinical acumen sufficiently keen to permit us to approach malignant lesions of the pancreas at earlier stages, and with the plan of undertaking radical removal of the malignant process?

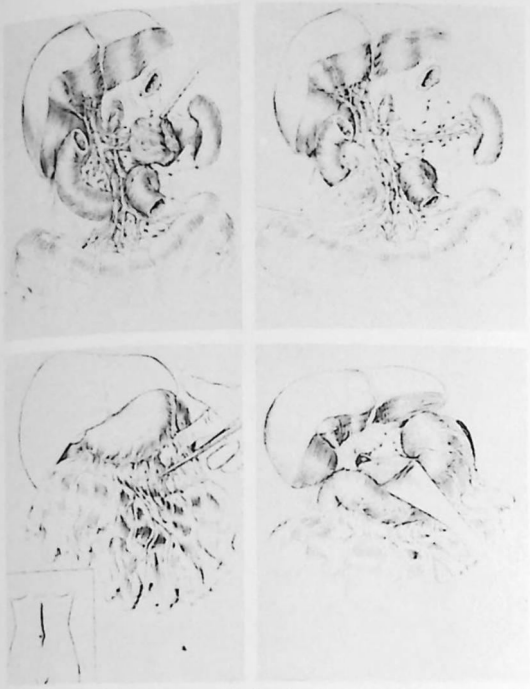


Fig. 1807. Head of the pancreas turned back to show the numerous lymph nodes to which metastases may spread. The relations of the superior mesenteric vessels, portal vein and common bile duct to the pancreas and duodenum are clearly revealed.

Fig. 1808. Tail of pancreas turned back. Note the pancreatic branches from the splenic artery and vein that have been ligated. The numerous lymphatic glands behind the pancreas are seen.

Fig. 1809. Starting the surgical approach to the pancreas by dividing the gastrocolic omentum. Great care must be taken to avoid injury to the middle colic artery.

Fig. 1810. Approach to the pancreas may be made by dividing the gastrohepatic omentum and displacing the stomach downward. Exposure of the tail of the gland is less complete by this method. (Courtesy, Dr. H. M. Clute and the Jour. Amer. Med. Assn.)

"The literature of cancer of the pancreas is filled with statements to the effect that, because of its deep situation and the difficult approach, radical removal of the pancreas is either impossible or at least most unwise. Most studies of pancreatic malignancy have come from medical men and pathologists. Surgeons until recently have but rarely discussed radical

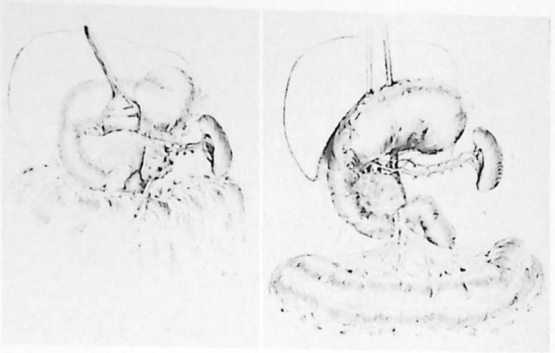


Fig. 1811 Fig. 1812

Fig. 1811. The parietal peritoneum over the pancreas has been divided and the tail lifted with a double hook. Each branch of the splenic artery and vein is dissected and divided as the removal of the tissue continues.

Fig. 1812. The dissection has been carried over to the superior mesenteric vessels. The cut end of the pancreas has been folded over with catgut sutures. (Courtesy, Dr. H. M. Clute and the Jour. Amer. Med. Assn.)

pancreatic operations save in the light of palliative measures for the relief of jaundice."

Clute's operative technic is depicted in Figs. 1807-1813.

PARTIAL PANCREATECTOMY

General or spinal anesthesia. Elevate the body with a bridge on the operating table.

Step 1. Make a longitudinal or transverse incision.

Step 2. After exposure of the pancreas, pack the stomach off above and the transverse colon below.

Step 3. Divide the peritoneal covering along the lower margin of the pancreas exposing its tail which is grasped with sponge-holding forceps and pulled upward. At this step one must keep in mind the intimate connection of the pancreas with the splenic vessels.

Step 4. Dissect carefully, ligating vessels as they present themselves until the head of the pancreas where it is joined to the body is exposed.

Step 5. Remove the involved portion of the pancreas. This should be accomplished while rubber-covered forceps, such as are used in resection of the intestines, or a rubber band encircles the pancreas before the affected part is ablated.

Step 6. Ligate the stump of pancreas with interrupted sutures, preferably of silk.

Step 7. Hemostasis.

Step 8. Introduce a rubber tube or cigarette drain reaching to the resected portion of the pancreas.

Step 9. Suture the gastrocolic omentum around the drain.

Comment: It is pointed out (E. Holman) that in doing a partial pancreatectomy, the splenic artery may be ligated and the spleen removed as an integral part of the operation. It is better, however, to preserve the spleen wherever possible (Horsley). McCoggin prefers to secure the pancreatica magna artery early in the dissection. Pancreatic fistulae usually close promptly provided no infection ensues.

Fig. 1813. The incision in the gastrocolic omentum has been closed about a cigarette drain that leads to the cut end of the pancreas. (Courtesy, Dr. H. M. Clute and the Jour. Amer. Med. Assn.)

HYPERINSULINISM

WHIPPLE'S TECHNIC OF TREATMENT[1]

Step 1. A. O. Whipple has used both spinal and ether anesthesia. The former is apt to wear off before the operation is completed, unless pentocaine is used. At present he inclines to the use of the drop ether method of anesthesia.

Step 2. The Whipple incision. This consists of a transverse incision made about two or three cm. above the umbilicus following a curved direction with the convexity upward. Both recti abdomini muscles and the rest of the abdominal wall are divided. The incision may be extended laterally, if required. This incision affords ample exposure and a satisfactory approach to all parts of the pancreas. No postoperative hernia resulted following the use of this incision in Whipple's cases or in the cases of those who have resorted to its use (Bailey and Cutler).

Step 3. Division of the gastrocolic omentum affords free inspection of the entire pancreas.

Step 4. Since islet tumors are most frequently found in the tail or body of the pancreas, these situations should be inspected first. Should a tumor not be found on the anterior surface, divide the peritoneal attachment along the

[1] Jour. Intern. de Chir., Vol. III, No. 3, 1938.

inferior border, dissect bluntly and elevate the posterior surface of the body and tail of the pancreas and inspect thoroughly. If no tumor is found, resort to painstaking palpation. Islet tumors feel like discreet nodules which impart a sensation of being firmer than the surrounding pancreatic tissue even when deeply imbedded in the body and head of the pancreas.

Step 5. If, after meticulous inspection and palpation, no tumor is discovered in the body or tail of the pancreas, resort to mobilization of the duodenum by incising the peritoneum along the curve of the duodenum. This affords access to the posterior surface of the organ and permits thorough digital exploration of the head of the pancreas. This is important. In four of Whipple's patients, the tumors were located in the posterior aspect near the ampulla of Vater and meticulous dissection was required to avoid injuring the papilla in removing the tumor.

If one adenoma is found, the same meticulous search must be persisted in because more than one tumor may be present. In three of Whipple's ten patients more than one tumor was discovered.

During the removal of the adenoma, bleeding is, as a rule, easily controlled and the nodule shells out with facility. Drainage is omitted unless there is leakage from the pancreatic duct.

Step 6. Resection. If no tumor is discovered after painstaking exploration, resection will have to be resorted to. Where the body and tail (to the left of the superior mesenteric vessels) have been removed, the results in Whipple's cases have been much better than with the resection of a small portion of the gland (tail). In order to carry out a radical resection, Whipple counsels the removal of the spleen in order to control hemorrhage by ligating the splenic vessels which supply the body and tail of the pancreas. Splenectomy will be facilitated by an extensive division of the gastrocolic omenta through the lesser peritoneal sac. It is then possible to remove the spleen, the tail and body of the pancreas *en masse*. This step will enable the surgeon to identify the inferior mesenteric vein and the superior mesenteric vessels.

Step 7. The bed of the pancreas should be drained by means of rubber dam, tubing or cigarette drains after ligating the pancreatic duct.

Comment: Whipple points out that by far the greatest number of operated cases have been reported from America; and the major advances in the study of the syndrome by the description of its complex symptoms, the blood chemistry, differential diagnosis and the therapy, both nonoperative and operative, belong to American authors. Hypoglycemia may be present with no demonstrable lesion of the pancreas or any other organ; lowering of the blood sugar can apparently be due to disturbances of the physiology of the liver, of the anterior lobe of the hypophysis, the cortex of the adrenal, the thyroid, the sympathetic nervous system and possibly the hypothalmus as well as the result of overactive islet tissue in the pancreas. The use of fine silk for all small vessels and a heavier grade for the larger vessels will prevent the digestion of ligatures when catgut is used in pancreatic tissue. Whipple uses fine interrupted silk sutures for repair of the abdominal wall; this was followed by primary

union in all cases. As for results and prognosis, the discovery and removal of all the islet tumor tissue gives "brilliant and lasting cures of the hypoglycemic state." In thirteen of Whipple's cases there was only one death, and the latter in a patient with carcinoma of the islands (personal communication). This is, indeed, a brilliant achievement taking into consideration that up to the present no material help was offered to these patients.

RETROPERITONEAL TUMORS

Retroperitoneal neoplasms which are solid may be either lipomas or sarcomas. The operative procedure is the same for both. If sarcoma is recognized, it is rarely removed unless its removal relieves the patient of extreme pain.

Lipomas originate mostly from the peritoneal and mesenteric fat and sometimes become enormous in size.

In their development retroperitoneal tumors thrust the intestines toward the front or side; they may grow into the mesentery and they sometimes surround organs like the kidneys, vena cava, etc. Diagnosis is rarely established before the abdomen is opened.

In operating: (a) obtain sufficient exposure so that removal, if indicated, may be done under ocular guidance. (b) Incise the peritoneum over the tumor so as not to injure the intestines or blood vessels. (c) In removing a growth from the iliac veins, vena cava or similar structures, rather leave a part of the growth than injure these structures. If any of the important blood vessels have become injured accidentally, repair these without delay. (d) If a kidney is involved, it should be removed, provided the other organ is in good condition (ureteral catheterization, functional tests, pyelography, etc.)

CHAPTER 37

SURGERY OF THE SPLEEN

Anatomic Considerations. (Figs. 1814-1815.) The spleen is situated in the left hypochondrium behind the stomach, beneath the ninth, tenth and eleventh ribs.

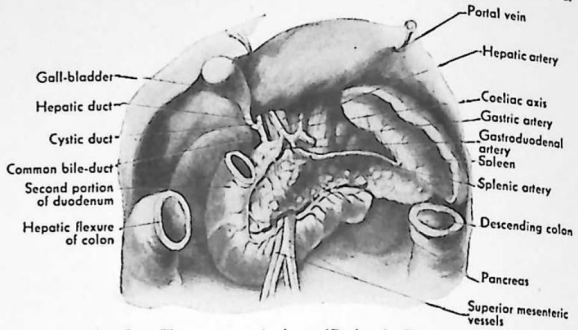


FIG. 1814. The pancreas and spleen. (Davis. Applied Anatomy.)

The average weight of the spleen in man is approximately seven ounces (Sappey). Its shape is principally determined by the condition of the splenic flexure of the colon.

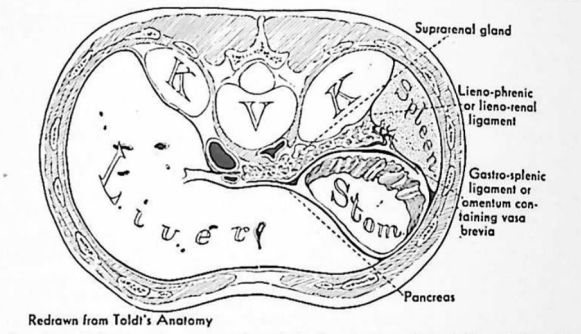


FIG. 1815. Diagrammatic representation of the important surgical relations of the spleen. (Courtesy of Dr. D. C. Balfour.)

Many liken it to a coffee bean, others refer to it as an irregular tetrahedron. The spleen is completely surrounded by peritoneum. It is fixed to the adjacent viscera by two folds:

the gastrosplenic omentum (ligament) containing the vasa brevia and the left gastro-epiploic vessels; and the lienorenal ligament conveying the splenic artery and vein. The splenic vessels are frequently attached to the tail of the pancreas. It is well to remember that the spleen is situated behind the stomach rather than to the left of it. The highest level of the spleen is opposite the body of the ninth thoracic vertebra, its lowest level opposite that of the first or second lumbar vertebra.

Relations. The diaphragmatic surface of the spleen is in relation with the diaphragm and the ninth, tenth and eleventh ribs. Its renal surface is in contact with the left kidney, while its gastric surface shows an impression from the tail of the pancreas and the stomach. The basal surface rests upon the splenic flexure of the colon and the phrenicocolic ligament. The hilum is on the gastric surface.

Arteries of the Spleen. The splenic artery, a large tortuous vessel, is a branch of the celiac axis. It breaks up about an inch from the spleen, into six or more branches. These enter the hilum one above another. The branches of the splenic artery do not anastomose with one another. The main branch, after leaving the celiac axis passes behind the lesser peritoneal sac (omental bursa) along the upper margin of the body of the pancreas and in front of the left suprarenal body and kidney, thence directly to the hilum. Here it is contained, as already stated, in the lienorenal ligament. The splenic veins accompany the arteries; their branches unite to form the principal vein.

The Lymphatics. The deep set emerge from the hilum and after picking up the superficial lymph vessels empty into a small group of lymph nodes at the tail of the pancreas.

INJURIES TO THE SPLEEN

While tamponade and suture have their champions in the treatment of injuries to the spleen, splenectomy is coming constantly to the fore as the method of choice in the treatment of severe rupture of the spleen. It was first successfully performed in 1893 by Riegues.

SUTURE OF THE RUPTURED SPLEEN

Suture of the spleen is indicated where the rent is small and the condition appears remediable. Strong catgut sutures are used; they are introduced some distance from the edge of the tear; Nuzum's linked mattress suture may be resorted to where the gland structure seems quite friable. The method for placing this suture is as follows:

Step 1. Insert a long needle armed with stout catgut through the spleen, approximately one-half inch from the lacerated edge. Traverse the incision to an equal distance on the opposite side to a point corresponding to the entrance point. Direct the needle straight through.

Step 2. Introduce the needle three-quarters of an inch from the last point of exit on the same side of the incision and direct it back again through the spleen.

Step 3. Traverse the incision as before but in the opposite direction making the needle exit on the same side of the incision as it first entered and immediately opposite the point where it was inserted on the opposite side.

Step 4. Tie the ends together, loosely. Pass the suture under the strand opposite where the knot of the suture is tied. In this way two parallel strands are linked across the incision. When this is tied, the torn edges are approximated and hemorrhage is checked.

SPLENECTOMY FOR RUPTURE

Step 1. Reach the spleen through a left transrectus incision beginning at the left costal margin and extending downward to a distance sufficient to afford adequate exposure.

Step 2. Pass the left hand into the opened abdomen and palpate the injured organ. Seek the pedicle at once. Compress it in the fingers thus temporarily arresting hemorrhage. Retract the wound to the left.

Step 3. Aspirate the escaped blood, or mop it away with gauze packs.

Step 4. Deliver the spleen into the wound, still exerting digital pressure on the pedicle. Should delivery of the spleen be hampered by adhesions, these must be divided under ocular control. If the incision is inadequate, it should be enlarged by a transverse limb extending to the left. Pack the colon out of the way. Pulling on the greater curvature of the stomach usually brings the spleen to view. A body elevator on the operating table is a great aid to bring the operative field into better position.

Treatment of the Pedicle. This may be divided between clamps and ligatures en masse, or by separate clamping and individual ligating. Each method has its protagonists. I personally prefer mass ligation supplemented by additional fortification of the pedicle by as many ligatures as needed. Stout catgut or silk may be used. An important point to remember is, to ligate close to the hilum, even at the expense of leaving a portion of spleen tissue behind, instead of jeopardizing an often elusive pedicle.

Step 5. Clear the abdominal cavity of clots.

Step 6. Explore the other organs (liver, kidneys, etc.) for possible injury.

Step 7. Close the abdomen in layers.

Transfuse the patient when indicated.

OPERATIONS FOR FLOATING SPLEEN

SPLENOPEXY

This consists of anchoring the spleen in cases of wandering or floating spleen. There are a number of methods of accomplishing this. Authorities concede to Rydygier priority for publishing the first case in 1895, although Tuffier claimed to have done the operation in 1882.

Rydygier's Method

Step 1. Open the abdomen, freely exposing the spleen.

Step 2. Make a transverse incision through the parietal peritoneum between the ninth and tenth ribs.

Step 3. With the fingers insinuated through this incision, separate the peritoneum from the parietes, below the incision. A pocket thus results with its mouth directed upward. The space is made sufficiently large to accommodate the lower half of the spleen. If the entire spleen is deposited into a pouch thus produced, its weight may enlarge it to such extent as to render the operation a failure. To avoid this introduce a few catgut sutures through the peritoneum and part of the contiguous parietes, immediately below the lower limit of the pouch. This will prevent further separation of the peri-

toneal flap from the abdominal wall. After placing the lower end of the spleen into the pocket produced,

Step 4. free the edges of the peritoneal flap forming the pouch, and unite them to the gastro-splenic ligament by one or more catgut sutures.

Step 5. Close the abdomen in layers.

Fig. 1816. Basil Hall's method of splenopexy. Note that the lower pole of the spleen is inserted into a pocket prepared for it under the parietal peritoneum. A series of interrupted or continuous sutures are applied around the upper and lower margins of the pocket, thus limiting the size of the pocket.

Bardenheuer's Method

Step 1. Make an incision, after the patient is placed on the right side, extending from the tenth rib to the iliac crest, in the axillary line.

Step 2. At the level of the tenth rib, an incision is made at right angles to the first.

Step 3. Divide the soft tissues down to the peritoneum.

Step 4. Strip the peritoneum up over an area rather larger than that of the spleen.

Step 5. Open the peritoneum, explore and bring the spleen out through this opening.

Step 6. Suture the peritoneal wound around the exteriorized spleen and to the pedicle of the spleen. It is advised, by some, to pass a stout suture through the lower end of the spleen which is tied around the tenth rib.

Step 7. Close the wound in the soft parts.

Comment: At the close of this operation, when properly performed, the spleen lies in a retroperitoneal pouch, its pedicle is fixed to the peritoneal wound and its body is suspended from the tenth rib.

Basil Hall's method of splenopexy is depicted in Fig. 1816.

Kouwer's Method

This consists of causing adhesions to form between the spleen and its surroundings, the result of tamponade.

SURGERY IN ABSCESSES, CYSTS AND TUMORS OF THE SPLEEN

The operative procedures here consist of:

1. **Evacuation and drainage (splenotomy).**
2. **Removal of the the spleen (splenectomy).**

If the pleura is obliterated by adhesions, the abscess may be reached by the transpleural route. Propping and Harrington advise a posterior approach through an incision commencing at the tip of the twelfth rib, toward and along the edge of the eleventh rib. Or, the tenth rib (about three inches) is removed in the posterior axillary line, the diaphragm is perforated and the abscess cavity entered. Where the lower pole is chiefly involved in the suppurative process, an anterior approach is best. This may be accomplished in one or two stages.

Splenectomy should only be resorted to where there is a comparative absence of adhesions and where the operative risk is nominal.

In cysts, splenectomy is not always necessary, in fact, it may be contra-indicated. In tumors, removal of the spleen is the only recourse.

Step 1. Open the abdomen.

Step 2. Isolate the spleen from the rest of the peritoneal cavity by means of laparotomy sponges.

Step 3. Ascertain the position of the abscess by means of an exploratory needle.

Step 4. Where pus is found, incise the spleen and evacuate the pus.

Step 5. Drain with rubber tube and tampon. Tamponade must be voluminous so as to isolate the spleen from the rest of the abdomen.

Step 6. Close the abdomen leaving sufficient drainage space, particularly at the upper and lower angles.

Splenectomy

Conditions which may require removal of the spleen are as follows:

1. Anomalies of position (excessively mobile spleen)
2. Injuries:
   - Wounds
   - Lacerations
   - Rupture from trauma
   - Spontaneous rupture
3. Tumors of various types
4. Suppurations
5. Infections:
   - Tuberculosis
   - Malaria
   - Syphilis
6. Splenomegaly, from many causes, viz.:
   - Chronic infectious disease
   - Idiopathic (?) splenomegaly
   - Banti's disease
   - von Jacksch's disease
   - Cirrhosis of the liver
   - Hemolytic jaundice
   - Purpura hemorrhagica
   - Thrombophlebitis of the splenic vein
   - Hematemesis of obscure etiology

Splenectomy may be an operation of extreme simplicity or beset with almost unsurmountable hardships.

The patient is placed in the exaggerated Mayo-Robson position (marked lordosis).

Step 1. Make a midline incision beginning at the ensiform cartilage and continue it downward for a distance commensurate with the size of the spleen to be removed. Balfour advocates a left Bevan incision (Fig. 1817).

Step 2. Thorough orientation and exploration are essential. Do not sever adhesions blindly. The attachments of the spleen by adhesions to the omentum, colon and abdominal wall should be doubly ligated and divided under visual observation. Adhesions to the diaphragm present serious difficulties in many cases. Balfour admonishes, "in the late stages of splenic anemia, all adhesions to the anterior border of the spleen, which may be not only extensive, but also contain large venous trunks, should be divided between ligatures. This should be done with extreme gentleness, because any rough handling of the adhesions is not only liable to tear the friable veins, but is likely to tear the spleen and engage the attention of the surgeon unnecessarily as well as obscure the operative field." And Hartmann, in the past, advised, in cases of marked adhesion of the upper pole of the spleen, to abandon the operation; otherwise disaster is invited. This admonition has been abandoned by most surgeons, and such adhesions are severed with the fingers and temporarily compressed by hot lap sponges (Fig. 1818). If the adhesions here require ligation, these are temporarily clamped and dealt with later.

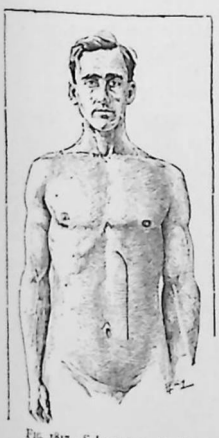


Fig. 1817. Splenectomy. Incision to expose spleen. (Courtesy of Dr. D. C. Balfour.)

Step 3. Deliver the spleen into the wound leaving it for the moment suspended on its pedicle. A large hot lap sponge is introduced into the space previously occupied by the spleen. As many additional lap-packs as are necessary to temporarily arrest hemorrhage are superimposed on the first lap-pack. W. J. Mayo pointed out that these packs effectually arrest venous oozing and obviate subsequent ligation, if left in situ for a sufficient time (until the splenectomy is completed). In cases where the spleen is mobile, the pedicle may be ligated by simple transfixion. A clamp is applied to the pedicle near the spleen and the pedicle is divided between the ligatures and the clamps and the spleen removed. Fedoroff's method consists of treating the pedicle of the spleen with two clamps as is practiced in the case of nephrectomy.

The structures carrying the vessels to the spleen are, as stated above, the gastrosplenic omentum and the lienorenal ligament (Fig. 1819).

When the spleen is not mobile, ligation of the pedicle en masse is impossible without simultaneously ligating the tail of the pancreas. Under such conditions

rotate the spleen toward the left, exposing the omentum and ligament carrying the blood vessels; the vasa brevia and the left gastro-epiploic vessels course in the gastro-splenic omentum from the splenic artery to the stomach. These vessels are carefully ligated (doubly) and divided together with the gastrosplenic omentum, as close as possible to the spleen (Figs. 1820-1821). Balfour emphasizes that "in dealing with the upper edge of the gastrosplenic omentum it must be remembered that here the fundus of the stomach is normally in very close apposition to the spleen . . . a number of surgeons have reported operative in-

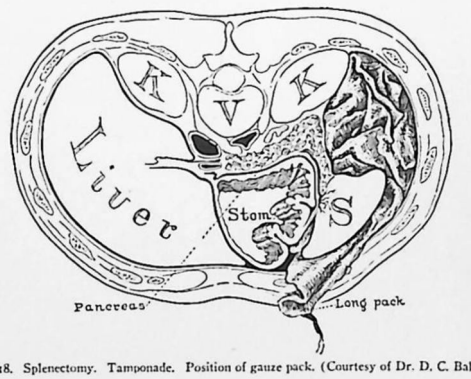


Fig. 1818. Splenectomy. Tamponade. Position of gauze pack. (Courtesy of Dr. D. C. Balfour.)

juries to the stomach." In ligating friable vessels a stout catgut suture is preferable to finer material which tends to cut through the vessel wall.

Step 4. When one feels assured that the pedicle is securely controlled, the gauze packs beneath the diaphragm are removed. If bleeding recurs, a suture carried on a long needleholder is made to surround the bleeding point which is ligated. Raw surfaces are covered and the abdomen is closed.

Comment: Discussing hemostasis during splenectomy, Walter D. Wise[1] reviews the following salient points: As already pointed out in another section of this work, the removal of the spleen may be a simple procedure or may be beset with many difficulties. With a free splenic pedicle, the former pertains. In cases of long-standing disease where the spleen is much enlarged and bound down by many adhesions and is accompanied by a diseased liver, serious difficulties may be encountered. Wise points out that in a well developed case of Banti's disease as well as in other conditions, the blood vessels of the spleen may be enlarged, tortuous and short; while the

greater curvature of the stomach, the tail of the pancreas and the splenic hilus are in close approximation. Under such conditions, the classical methods of clamping and ligation or ligation by the use of the ligature carrier "do not work out well," because the vessels are so short and easily injured, that neither of the methods mentioned is free from danger of profuse hemorrhage or from injury to the stomach and pancreas. Also, in traumatic rupture of a normal spleen, the operation is often simple, but rupture, traumatic or spontaneous, of a much enlarged, diseased and adherent spleen is often quite a serious problem. In a case of well advanced Banti's

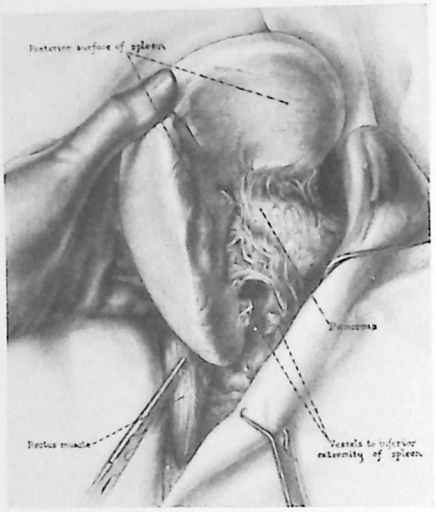


Fig. 1819. Splenectomy. Blood vessels of the spleen. (Courtesy of Dr. D. C. Balfour.)

disease with large tortuous vessels in the pedicle of the spleen and in another case of Banti's disease with spontaneous rupture of a spleen weighing 1700 Gm., Wise used a method of dealing with the pedicle "which seemed safe and greatly simplified the operation."

The spleen was freed from its adhesions, lifted up and a large hot pack placed in its fossa. The pedicle was clamped with a rubber-covered intestinal clamp far away from the spleen. If the pedicle is short, there is grave danger of including some part of the stomach and the pancreas. If one proceeds as pointed out, complete control of hemorrhage is obtained and the tail of the pancreas can be freed from the splenic hilus, if necessary, and the vessels in the pedicle ligated at the option of the surgeon. The rubber-shod clamp avoids injury to the stomach and even though the pancreas is compressed by it for a few minutes, no damage results.

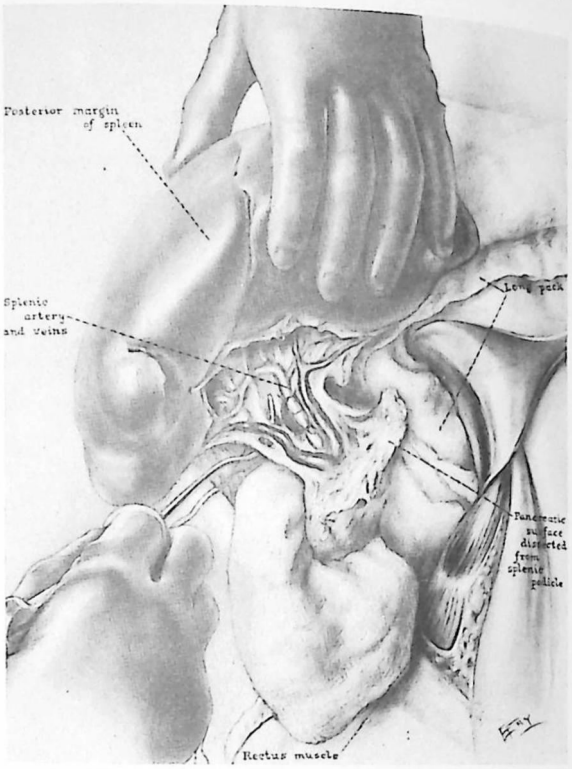


Fig. 1820. Splenectomy. Method of dealing with the vessels of the spleen. (Courtesy of Dr. D. C. Balfour.)

Wise further stresses that when the vasa brevia are tied individually and close to the greater curvature of the stomach, one feels some apprehension that during an attack of severe vomiting, the ligatures may become dislodged, particularly if catgut is used, causing severe hemorrhage. He

further counsels for the sake of greater security that the vessels after being ligated individually be buried with a purse string suture of silk down in the

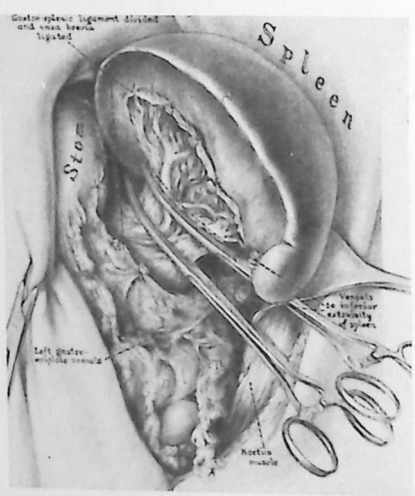


Fig. 1821. Splenectomy. Clamps and ligatures in ablating the spleen. Courtesy of Dr. D. C. Balfour.)

border of the stomach. While this may appear as a minor point, the possibility of a second hemorrhage may be prevented by its use.

CHAPTER 38

HERNIA

Anatomic Considerations. The structures concerned in operations for oblique inguinal herniae are the following: (Figs. 1822-1823-1824-1825.)

The skin, subcutaneous fat and superficial fascia. In dividing these structures the following blood vessels are encountered:

(a) The superficial epigastric; (b) the superficial external pudic and (c) the superficial circumflex iliac. These are all branches of the femoral.

The aponeurosis of the external abdominal oblique muscle and its contingent structure, viz.: the external abdominal ring, which is a triangular aperture in the aponeurosis of the external oblique muscle. It serves as the place of exit of the spermatic cord. It is bounded laterally and mesially by a thickening of the fibers of the external abdominal oblique fascia called respectively the external and internal pillars. The external pillar is continuous with Poupart's ligament (ligamentum inguinale) and is attached to the spine of the os pubis. The internal pillar is attached to the anterior surface of the body of the pubic bone. The hypogastric branch of the iliohypogastric nerve emerges, just above and somewhat medially to the external inguinal ring, by perforating the aponeurosis of the external abdominal oblique muscle. The pillars are reinforced by the arcuate fibers.

Fig. 1822. Ancient Greek terra-cotta piece showing hernia. (Collection of Prof. Steineg.)

The Internal Oblique, Transversalis Muscle and "Conjoined Tendon." The arched fibers of the internal oblique muscle take origin from the outer third of Poupart's ligament and arching over the spermatic cord are inserted into the outer edge of the sheath of the rectus abdominis muscle; its inferior portion joins the transversalis muscle becoming tendinous and forms the conjoined tendon which is inserted into the crest of the os pubis and pectineal line. The ilio-inguinal nerve courses along the surface of the internal oblique muscle.

The cremasteric muscle and cremasteric fascia form a series of curved loops which become longer as they progress downward, the lowermost reaching the testes and becoming attached to the tunica vaginalis. These muscular loops are held together by the cremasteric fascia.

The Spermatic Cord (funiculus spermaticus). Its principal structures are: (a) the spermatic artery; (b) the spermatic veins (plexus pampiniformis) and (c) the vas deferens. The spermatic artery is a branch of the aorta. The right spermatic vein empties into the inferior vena cava. The left spermatic vein empties most frequently into the left renal vein. It is well to remember that the vas deferens is supplied by a fine vessel, the arteria deferentialis, derived from the middle or inferior vesical artery. The fascial and muscular structures of the cord derive their blood supply from the deep epigastric and other vessels.

The processus vaginalis plays an important rôle in congenital hernia which develops when the process remains open. In the adult it is found obliterated as a cord of tissue within the spermatic cord. The nerves of the spermatic cord are derived from the sympathetic and the genital branch of the genitocrural nerve. The lymph vessels empty into the iliac and lumbar vessels.

The coverings of the spermatic cord are composed of a fibrous sheath formed by the continuation of the structures of the abdominal wall through which the cord passes. These from within outward are: (a) the internal spermatic fascia; (b) the

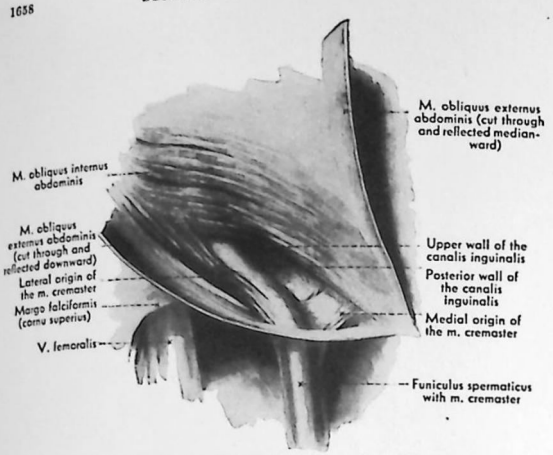


FIG. 1823. Right inguinal canal in the male (second layer), viewed from in front. (Spalteholz.)

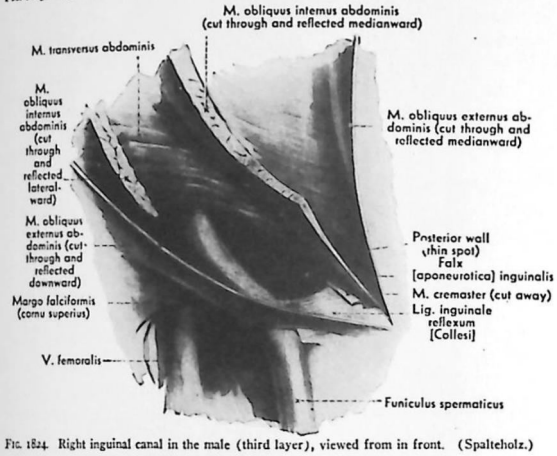


FIG. 1824. Right inguinal canal in the male (third layer), viewed from in front. (Spalteholz.)

cremasteric fascia and muscle (from the internal oblique) and (c) the intercolumnar fascia (from the external oblique muscle).

Poupart's ligament (lig. ilio-inguinale) extends from the anterior superior spine of the ilium to the spine of the os pubis.

The deep epigastric artery plays an important rôle as a landmark in determining whether a hernia is direct or indirect.

Hesselbach's triangle is bounded internally by the outer margin of the rectus abdominis muscle, externally by the deep epigastric artery and below, by the inner half of Poupart's ligament. Examined from within the abdomen this space is seen delineated by three folds. In the central fold lies the urachus, in the outer fold the deep epigastric artery and between the two the obliterated hypogastric artery. There are three depressions between these folds: the outer depression (external inguinal fossa) is situated in the outer side of the deep epigastric artery and

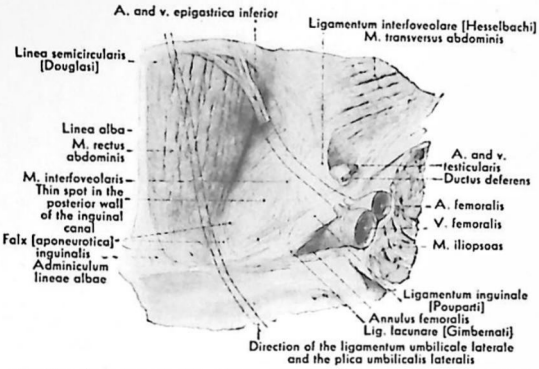


FIG. 1825. Posterior wall of the right inguinal canal in the male, viewed from behind. (Spalteholz.)

corresponds to the site of the internal abdominal ring. The middle depression (middle inguinal fossa) lies between the deep epigastric and the obliterated hypogastric arteries, while the inner depression (internal inguinal fossa) lies between the obliterated hypogastric artery and the urachus. An oblique or indirect inguinal hernia always passes through the external inguinal fossa. A direct inguinal may pass through the middle or internal inguinal fossa (Fig. 1841, p. 1681).

The Transversalis Fascia, Internal Inguinal Ring, Properitoneal Fat and Peritoneum. Normally the peritoneum smoothly covers the upper surface of the internal inguinal ring. In case of hernia, the peritoneum bulges into and through the internal inguinal ring.

The inguinal canal is the channel through which the spermatic cord and an indirect inguinal hernia pass. Its proximal opening is a depression in the transversalis fascia, the so-called internal inguinal ring; its distal opening is the external inguinal ring. Its posterior wall is made up of the transversalis fascia, upon which courses the deep epigastric artery, and the falx inguinalis. Its inferior boundary is Poupart's ligament. It is covered by the internal oblique muscle at its internal extremity, and for the rest of its extent it is covered by the aponeurosis of the external oblique muscle only.

The femoral point lies mesial to the midpoint of Poupart's ligament where the external iliac artery becomes the femoral.

INGUINAL HERNIA

OPERATIONS FOR INDIRECT (OBLIQUE) ACQUIRED INGUINAL HERNIA

(Herniotomy—Herniorrhaphy—Hernioplasty)

Bassini's Operation

Anesthesia. General, infiltration or spinal.

Local Anesthesia (Figs. 1826-1827). Outline two wheals (Points 1 and 2) through which the first needle punctures are made. Point 1 is about three fingers'

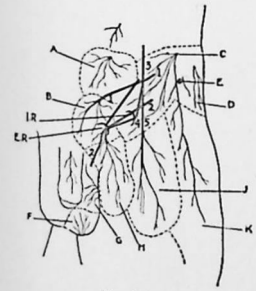


FIG. 1826

FIG. 1827

FIG. 1826. Operation under local anesthesia for the radical cure of inguinal hernia, Cushing's method. The peripheral distribution, and the relation of the trunks of the inguinoscrotal nerves to the main incision. A, anterior cutaneous of 12 D.; B, anterior cutaneous of 1 L. (ilio-hypo); C, lateral cutaneous of 12 D.; D, lateral cutaneous of 1 L.; E, anterior superior spine; F, superficial perineal of pudic; G, inferior pudendal of small sciatic; H, ilio-inguinal or genitocrural; I, R, internal ring; E, R, external ring; J, crural branch of genitocrural; K, external cutaneous. 1, ilio-hypogastric nerve. 2, ilio-inguinal nerve. 3, genitocrural nerve, its genital 4, and crural 5, branches.

FIG. 1827. Blocking of nerves for operation of inguinal hernia. Infiltrate the ilioinguinal, and iliohypogastric nerves and the subcutaneous tissues; then deposit the anesthetic solution under the aponeurosis of the external oblique muscle. Additional infiltration is used, when needed, while operating on the deeper structures.

breadth medial from the anterior superior spinous process of the ilium, while point 2 lies directly opposite the pubic bone outside of the external inguinal ring. Inject about 20 cc. of the anesthetic solution (about ½ per cent novocaine) into the musculature situated between point 1 and the anterior superior spinous process of the ilium. In so doing, introduce the needle through the aponeurosis of the external abdominal oblique muscle and while depositing the solution, direct the needle obliquely toward the anterior superior spinous process, moving the needle forward until the point of the needle reaches the iliac crest.

The next step consists of taking a long needle which is introduced through

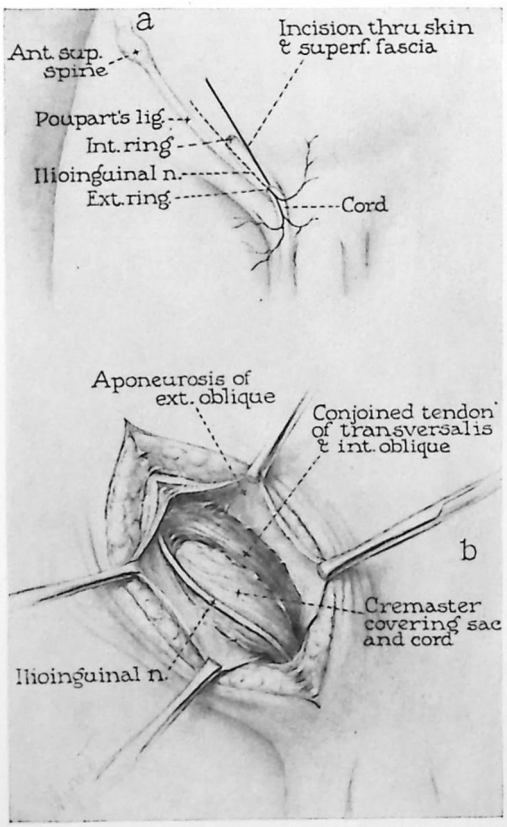


FIG. 1828. Operation for indirect inguinal hernia: a, Relation of incision to the inguinal rings and the cord. b, Exposure after dividing the external oblique which is split in the direction of its fibers.

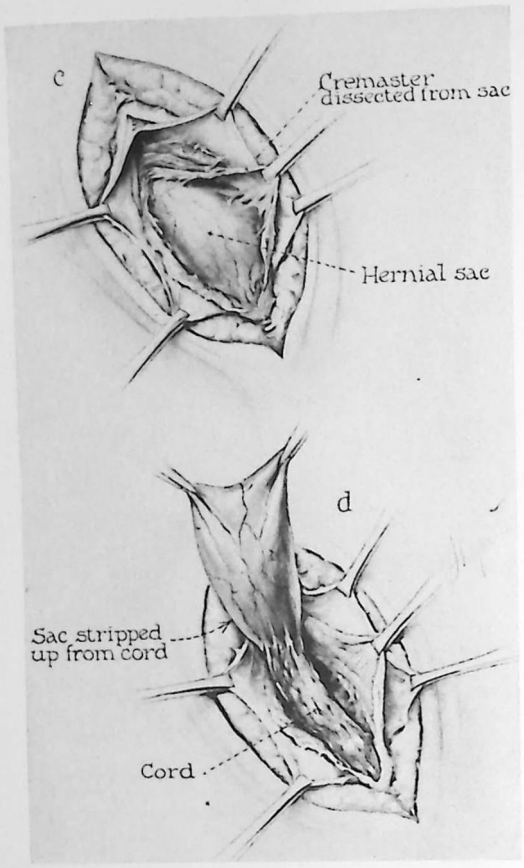


FIG. 1828 (continued). Operation for indirect inguinal hernia. c. The hernial sac is uncovered. d. The peritoneal sac is dissected upward from the cord as high as the internal ring.

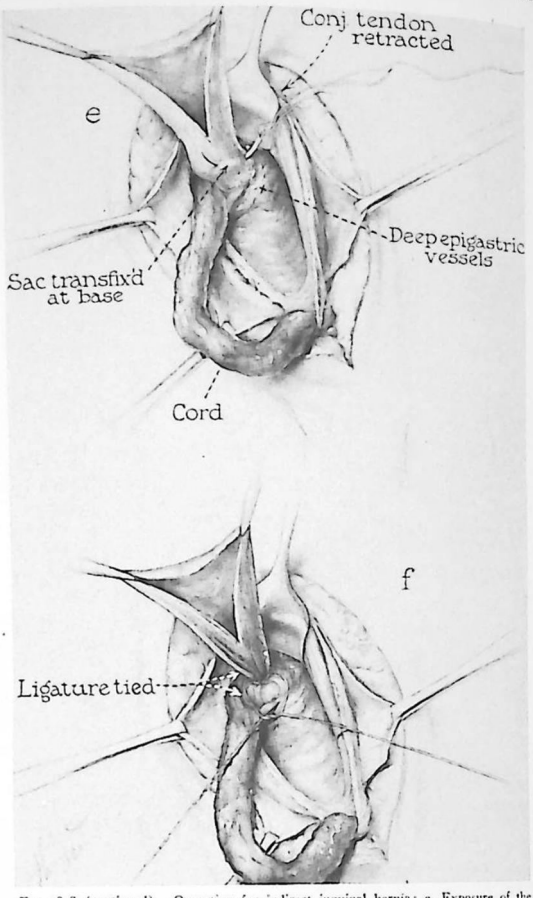


FIG. 1828 (continued). Operation for indirect inguinal hernia: e. Exposure of the base of the sac external to the deep epigastric vessels, the sac has been opened and contents, if any, returned to the abdominal cavity. f. The transfixed sac is ligated as close to the neck as possible.

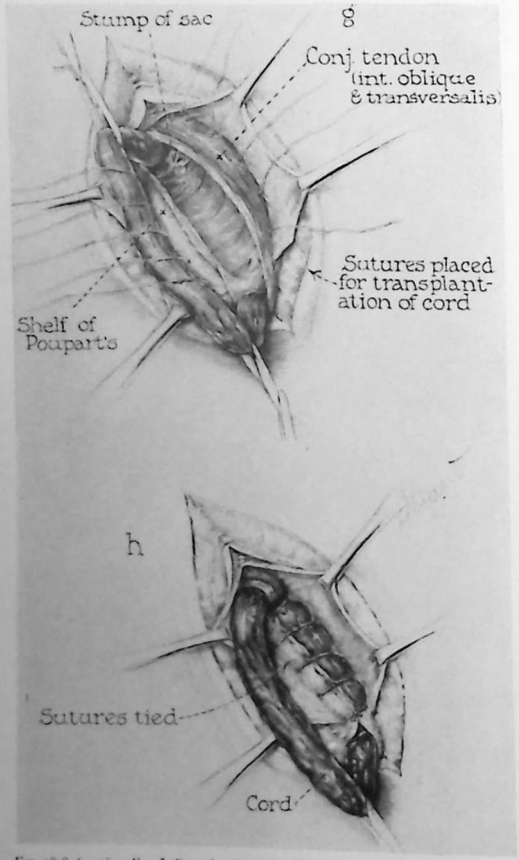


FIG. 1828 (continued). Indirect inguinal hernia: g. The redundant sac has been cut off and the stump is shown retracted beyond the ring: h. Suture of conjoined tendons to Poupart's ligament. The cremaster is included in these sutures.

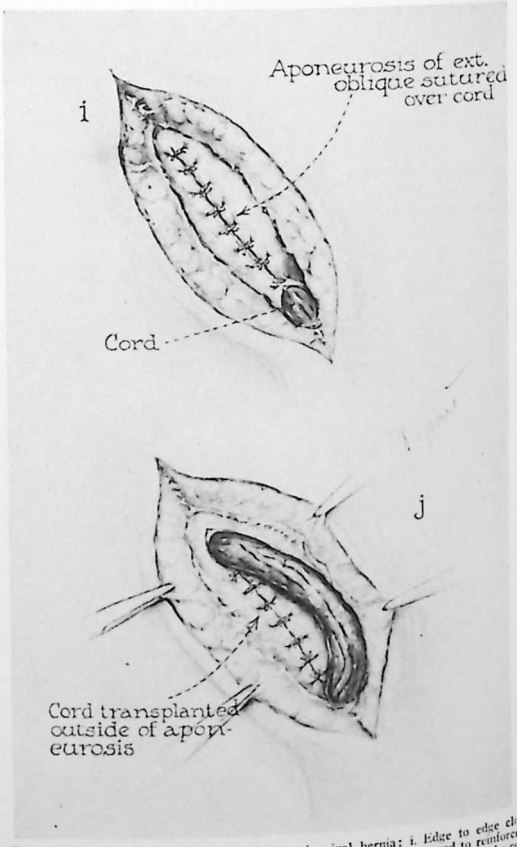


FIG. 1828 (continued). Operation for indirect inguinal hernia: i. Edge to edge closure of external oblique. The aponeurosis may be overlapped from above downward to reinforce the closure. j. Method of closing the aponeurosis, underneath the cord (transplantation of the cord).

point 1 and depositing the anesthetic fluid along both sides of the inguinal canal. The point of the needle may be guided by introducing a finger through the external abdominal ring. Now introduce a needle at point 2 and inject, after the pubic bone has been reached, from 10 to 20 cc. of the solution into the inguinal canal, under the fascia.

The illustrations depict the method of procedure (Figs. 1826-1827).

Step 1. Incision. Make an oblique incision (Fig. 1828 a) about half an inch above and parallel to Poupart's ligament from a point opposite the anterior superior spinous process of the ilium to the spine of the os pubis.

Step 2. Deepen the incision and expose the fascia of the external abdominal oblique muscle. The incision severs the superficial epigastric vessels running at right angles to it. Ligate these carefully. The superficial external pudic and the superficial circumflex vessels are also encountered. They are all branches of the femoral vessels.

Step 3. Expose and identify the components of the external abdominal (inguinal) ring (external and internal pillars and arcuate fibers). Introduce through the external ring a grooved (or Kocher) director, and divide the aponeurosis of the external abdominal oblique muscle from the external ring along the line of incision for two or three inches (Fig. 1828 b).

Step 4. Retract the edges of the aponeurotic flaps and separate the upper flap inward and the lower from Poupart's ligament. With the aid of gauze on the index finger or handle of the scalpel strip and expose the lower leaf of the divided external oblique from the underlying structures. The contents of the inguinal canal are now exposed. The ilio-inguinal nerve is seen and avoided.

Step 5. Identify the conjoined tendon (transversalis and internal oblique muscles). Expose, fully by retraction, the structures concerned. Raise en masse the hernial sac and cord.

Step 6. Completely isolate, by stripping and dissection, the sac from the spermatic cord (Fig. 1828 c and d) as high as possible in relation to the internal ring.

Step 7. Open the sac. Examine its contents. If normal, return them to the abdominal cavity. If strangulated, proceed as outlined under strangulated hernia (p. 1696) (Fig. 1829).

Step 8. Ligation of the sac (Fig. 1828 e). Retract the conjoined tendon. Transfix the hernial sac at its base as high as possible with chromic catgut. Avoid injuring the deep epigastric vessels. Tie the ligature (Fig. 1828 f); encircle the neck of the sac and tie the ligature once more.

Step 9. Cut off the redundant sac (Fig. 1828 g). The stump of the sac will retract beyond the internal ring (correct procedure).

Step 10. Insinuate a strip of tape under the cord and retract it out of the way.

Step 11. Introduce beneath the cord, from before backward and from within outward, successively five or six No. 2 iodized catgut sutures uniting the conjoined tendon and transversalis muscle and the lower fibers of the internal oblique with Poupart's ligament. Tie the sutures (Fig. 1828 h). Approximate but do not strangulate the tissues concerned.

Step 12. Replace the cord on its new floor. Unite the divided halves of the aponeurosis of the external oblique with interrupted sutures (single No. 2 iodized catgut) (Fig. 1828 i). Make sure that the cord is not constricted at its exit from the newly constructed external ring. Atrophy of the testicle may result from not observing this precaution. The tip of the little finger should be introduced into the external opening to ascertain the degree of freedom the cord is allowed.

Step 13. Close the skin with interrupted silkworm-gut or silk sutures.

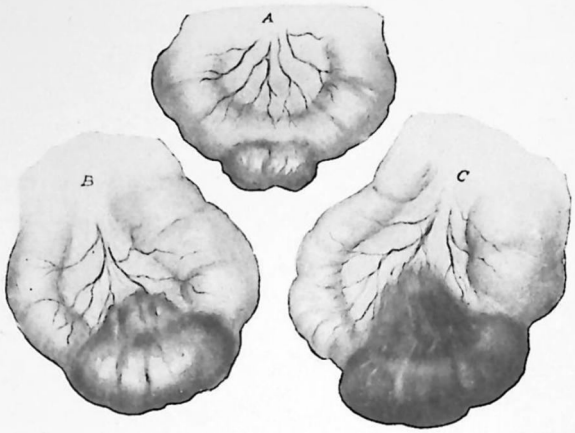


FIG. 1829. Degrees of injury to strangulated bowel. A. Here the changes are not marked. Bowel may be reposited and reestablishment of circulatory balance as a rule expected. B. In this instance the circulatory changes are marked although the serosa has not as yet lost its luster. Hot packs and patient expectant observation will often reward one by seeing the circulation reestablished. Do not replace bowel before that is accomplished. C. Bowel definitely gangrenous. Never reposit it. Resect.

Comment: A modification of the typical Bassini operation, which I have used for over twenty-five years in a large series of cases, consists of reinforcing the newly created floor by superimposing and suturing over the united conjoined tendon and Poupart's ligament the external oblique fascia (Fig. 1828 j). The cord is thus resting on a double floor. The skin and subcutaneous structures are united, as before, over the transplanted cord. This method has served me well. The cord is not jeopardized by reason of its superficial position.

Accidents and Difficulties in Inguinal Hernia Operations

Injury to the Spermatic Artery. Accidental division of the artery may result in necrosis or atrophy of the testicle. However, it often is observed that after such accident the testicle retains its circulation by way of the deferential artery and no ill effects result.

Injury to the Spermatic Cord. Undue trauma to the cord during hernia operation may be followed by thrombosis of the veins. If extensive, infarction of the testis with subsequent atrophy may ensue.

Division of the Vas Deferens. If this accident should happen, the divided ends should be repaired.

Injury to the Bladder. The perivesical fat in the space of Retzius is frequently encountered during ligation of the sac. It indicates the close proximity of the bladder. The bladder itself may partly herniate. It may be included in the ligature, bruised or actually incised. If ligated, necrosis, sloughing and fistula formation may result. If discovered in time, the ligature should, of course, be promptly released. If the bladder is opened, it should be closed by two or three superimposed layers of sutures.

Injury to the Intestine. In such casualty immediate repair should be done. The intestine may be encircled and strangulated while carelessly ligating the sac. Disastrous consequences may ensue. The sac should always be closed under direct ocular supervision.

Injury to the Deep Epigastric Vessels. Prompt ligation should be done.

Injury to the External Iliac Vessels. Careless introduction of the needle may injure these vessels. Guiding the needle, under ocular inspection from within outward, with protection of the deep vessels (by proper retraction and ample exposure) will tend to avoid such accidents.

In a personal communication, A. Rendle Short writes:

"To prevent hematoma of the scrotum after operation for hernia or varicocele, I conclude the operation by passing a silkworm-gut stitch through the bottom of the scrotum and well up on the abdominal wall over the rectus muscle, so that the scrotum is lifted up in front of the abdomen and made the highest point instead of the lowest. Since adopting this procedure a good many years ago, I have never had any trouble with the hernia wound from hematoma or suppuration."

FERGUSON-COLEY'S MODIFICATION OF BASSINI'S OPERATION

The principal difference in this important modification of Bassini's operation is that the spermatic cord is not transplanted.

The two operations are exactly the same up to the point of suturing, which is carried out as follows: Suture the internal oblique and transversalis muscles and conjoined tendon to Poupart's ligament with interrupted sutures, being careful not to disturb the spermatic cord, thus bringing the united muscles in front of the cord instead of behind it as is done in the Bassini operation. In this way the point of emergence of the spermatic cord in the abdominal wall is changed from the upper to the lower angle of the suture line.

The procedure following the suturing is the same in both operations.

ANDREWS' OPERATION

This operation is the most important modification of the Bassini operation. Its principles are based on the appreciation of the rôle that the fasciae play in the retention of the abdominal contents within the peritoneal cavity, and the subsidiary rôle exercised by the muscles. Andrews' operation differs from all others in that the buttress overlying the weak part of the abdominal wall is made up not

merely of muscle, but also of one of the strongest soft structures in the human frame, the aponeurosis of the external oblique muscle.

Step 1. Make an incision beginning at the external inguinal ring, extending upward and outward for a distance of 3 or 4 inches, depending upon the existing amount of subcutaneous adipose tissue. The skin incision should not be extended too far down on account of the danger of injuring vessels and the inconvenience in dressing the wound. Clamp and ligate the epigastric and cutaneous vessels. Expose the aponeurosis of the external oblique muscle by retracting the skin and subcutaneous fat.

Step 2. Incise the aponeurosis of the external oblique muscle in the direction of its fibers and extending to and through the external inguinal ring. Divide the intercolumnar fibers and fascia. By exercising care the hypogastric branch of the iliohypogastric nerve which penetrates the upper part of the aponeurosis can usually be spared injury. The aponeurosis should be handled as little as possible for the remainder of the procedure. Be careful not to cut it away from the underlying internal oblique muscle. Retract the lower flap and lift up the cord. Expose Poupart's ligament up to its attachment to the spine of the pubis by wiping away with gauze the superimposed areolar tissue.

Step 3. Incise the cremaster muscle and cremasteric fascia; lift up the spermatic cord and look for the hernial sac; this is always found on the inner side of the cord; attempting to reach it from the outside entails much traumatism and twisting. Hernial sacs, if of long standing, are usually quite easily identified by their pale color and thickness; at other times the sac is so delicate and translucent as to be hardly noticeable. Isolation of the sac is rendered easier by beginning the search at a point somewhat distant from the internal inguinal ring. According to Moschcowitz, it is important to remember that both the hernial sac and the spermatic cord are covered by the infundibuliform fascia; it is necessary, therefore, first to split this structure. If this is done, the peritoneum of the sac is easily liberated without sharp dissection. The contents of the sac are reduced before isolation. Adhesions, if present, are dealt with in the usual manner.

Handling of the Omentum. Some surgeons advocate excision of the omentum stating that it is an unnecessary organ and recurrence is not so apt to take place if it is removed. However, these arguments are given little credence by other operators. The removal of large portions of the omentum is often followed by (a) slipping of a ligature causing secondary hemorrhage which sometimes proves fatal; (b) a retrograde thrombosis followed by annoying and sometimes dangerous gastric and intestinal disturbances; (c) chronic inflammation originating around the ligatures resulting in the accumulation of large exudates which sometimes cause painful tumors. (See epiploitis, p. 1734.) In addition to strangulation, irreducibility is the only indication for extirpation of the omentum.

Method of Removing the Omentum. Important points to be kept in mind are: (a) only ligatures made of catgut should be used; (b) individual pedicles should be no thicker than the little finger; (c) ligatures should be fastened securely so that there is no slipping.

After replacing the contents of the hernial sac into the abdominal cavity, liberate any adhesions which may be present. If the neck of the sac is small, traction upon it will prevent further prolapse of the intestine during the procedure; if the neck is wide, well-placed lap sponges will prevent the bowels from protruding.

Grasp the edge of the incision made into the hernial sac with artery forceps and cut away all tissues on the liberated sac. A finger introduced into the sac is of aid.

Avoid injury to the vas deferens during this procedure; it results from carelessness; if injured, repair the vas at once.

Avoiding Injury to the Spermatic Cord. Great care should be exercised to avoid injuring the vessels of the spermatic cord; injury to the spermatic artery is likely to be followed by necrosis of the testis; while injury to the spermatic veins (pampiniform plexus) may cause thrombosis and orchitis. The smallest bleeding points should be ligated, thus precluding the formation of a hematoma which might prevent primary union and thus invite recurrence.

The sac should be isolated up to the point where the neck merges with the general peritoneal cavity. Carefully avoid injuring the peritoneum as this makes suturing or ligation of the sac difficult. High ligation of the neck of the hernial sac is the keynote to success in hernia operations, no matter of what type.

Avoiding Injury to the Bladder. A quantity of adipose tissue is often encountered in isolating the sac at its upper part; this should be handled very carefully as the bladder is immediately under it. Liberate the bladder from the peritoneum by means of blunt dissection; continue the dissection up to the obliterated hypogastric artery which is recognized by its similarity to the vas deferens. Retract the bladder and ligate the sac as follows:

If the neck of the sac is narrow, lift it up by means of slight traction. At about the middle of the neck, pass through a curved Mayo needle armed with No. 2 iodized catgut; tie it first on each side and then en masse in the groove created by the first ligature.

If the neck is wide, insert a purse string suture within the sac. The superfluous part of the sac is now cut away about ½ cm. distant from the ligature. The ligated stump slips back spontaneously if this step of the operation is performed correctly; the peritoneal cavity discloses, under ideal conditions, only a slight puckering of the peritoneum around the internal inguinal ring. Dimples or saccules permitted to remain may be the cause of recurrence. After all bleeding has been controlled, replace the cord in its bed.

Step 4. Retract the skin and subcutaneous adipose tissue. Expose the cut edge and anterior flap of the aponeurosis of the external oblique muscle. Expose the edge of Poupart's ligament. Introduce double No. 2 chromicized catgut sutures carried on small curved needles as follows: On the upper (mesial) side, each suture catches the aponeurosis of the external oblique and the united internal oblique and transversalis muscles; the next sutures transfix the aponeurosis of the external oblique muscle and conjoined tendon; toward the middle, the upper sutures grasp the aponeurosis of the external oblique muscle and the border of the sheath of the rectus muscle (Fig. 1830). All sutures on the lower (lateral) side should firmly grasp the shelving edge

of Poupart's ligament. In placing the sutures on the upper side, the ilio-inguinal nerve should be carefully avoided. In placing the sutures through the shelving edge of Poupart's ligament care should be taken to draw back the tissue so as to give a good view of Poupart's ligament, thus avoiding its tearing or splitting when the sutures are tied. Also, injury to the deep

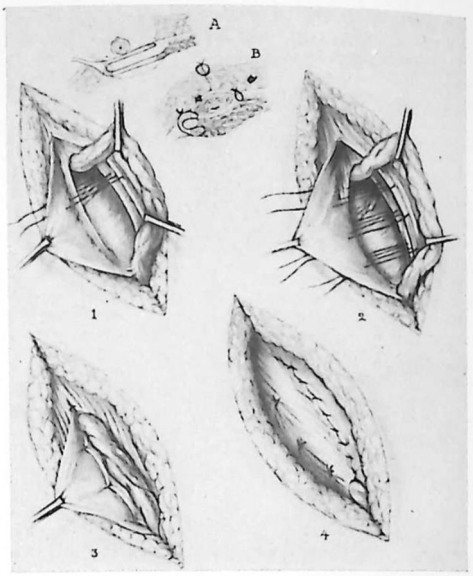


FIG. 1830. Andrew's operation for inguinal hernia (after Printy). 1. One Andrews' suture inserted. 2. Three sutures inserted and ready to tie. 3. Sutures tied. 4. Lower flap of external oblique aponeurosis sutured over cord. A. Cross-section of Andrews' suture. B. Cross-section of completed repair.

epigastric and external iliac vessels may be caused by inserting the needle too deeply. Enough sutures should be inserted so that when they are tied the inguinal canal is closed with an open space at the lower angle big enough for the emergence of the cord. The lowest suture is made on the pubic spine. If the sutures are properly tied no muscle is visible in the operative field.

Step 5. Expose the greater part of the surface of the aponeurosis of the external oblique muscle by retracting the skin and subcutaneous fat on the upper half of the incision. Unite the anterior surface of the upper part of the

aponeurosis of the external oblique to the cut edge of the lower flap of the aponeurosis with No. 2 chromicized catgut.

Step 6. Close the skin and subcutaneous adipose tissue with either interrupted silk sutures (obese patients) or Michel clips (thin patients).

Step 7. Dress the wound by placing a number of gauze pads over it; over this, apply a snug-fitting spica bandage leaving the penis, scrotum and anus free.

WISE'S METHOD OF REPAIR OF INGUINAL HERNIA

Step 1. Make a skin incision a little above the usual site, parallel to Poupart's ligament and continue it through the external oblique so as to obtain a broad lower flap of external oblique aponeurosis.

Step 2. Split the cremaster muscle, the cremasteric fascia, the infundibuliform fascia and any adventitious layers of fascia covering the sac and spermatic cord; dissect freely and preserve these parts.

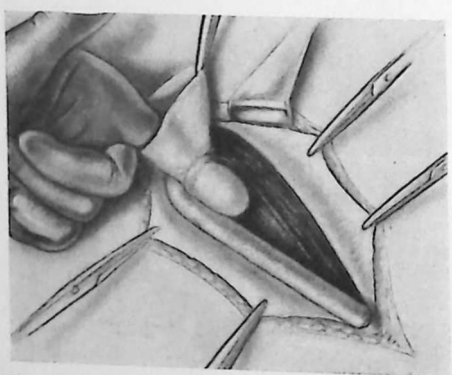


FIG. 1831. Showing the sac dissected free to the internal or lateral ring. A finger in the sac, through the ring, shows a pouch that, when present, can readily be removed as part of the sac. (Courtesy of Dr. W. D. Wise.)

Step 3. Free the hernial sac in the usual manner. Most of the dissection is done with the sac open and the finger inside. With this finger, investigate the internal or lateral ring, the strength of the transversalis fascia and also whether there is a direct sac or anomaly of the indirect sac.

A diverticulum or pouching is often discernible in the region of the neck or the fibrous circle where nature has attempted to effect a closure that would seem an ideal site for recurrence. (Fig. 1831.) This should be removed with the sac, as high as possible. Transplant the ligated pedicle if it seems advisable. Lift the cord and hold it out of the way with a broad wet tape or sponge, never with a ligature (possibility of damaging the intima of the veins with ensuing thrombosis). (Fig. 1832.)

Step 4. Suture the transversalis fascia if that structure be thick and strong enough. Suture the cremasteric muscle either edge to edge, under the cord,

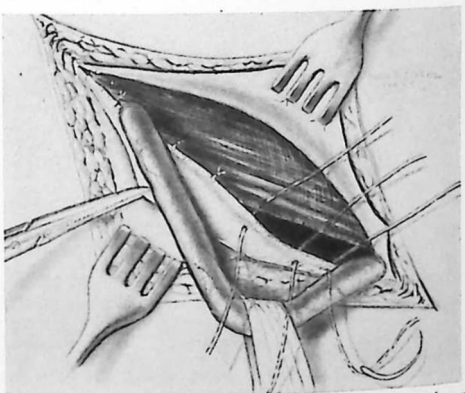


FIG. 1832. Showing the internal oblique muscle and conjoined tendon being sutured to Poupart's ligament beneath the cord. An attempt is made to place the muscle under the shelving edge of Poupart's ligament. (Courtesy of Dr. W. D. Wise.)

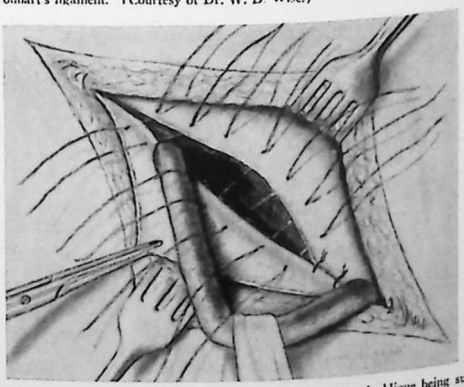


FIG. 1833. Showing the upper flap of the aponeurosis of the external oblique being sutured to Poupart's ligament beneath the cord. (Courtesy of Dr. W. D. Wise.)

or carry the lower edge under the margin of the conjoined tendon and internal oblique.

Step 5. Bring the internal oblique and conjoined tendon down to Poupart's ligament in Bassini fashion (Fig. 1832). Suture the upper leaf of the external oblique to Poupart's ligament (Figs. 1833-1834); place the sutures between those previously inserted.

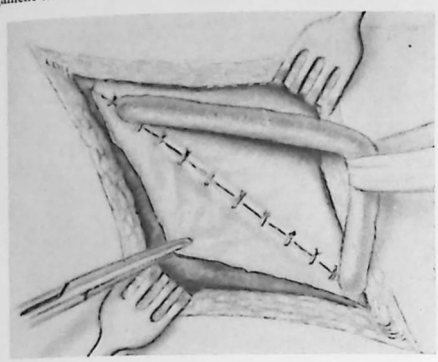


Fig. 1834. Showing the upper flap of the external oblique aponeurosis sutured to Poupart's ligament. The cord between the sutures after being carried lateral to its normal point of exit.

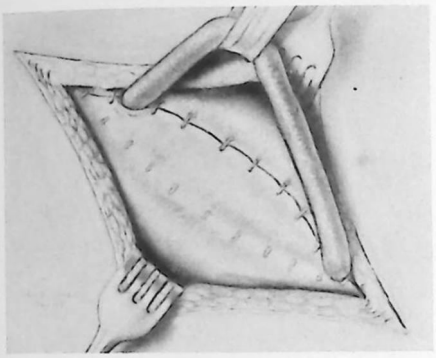


Fig. 1835. Showing the lower flap of the external oblique aponeurosis overlapping the upper flap. The cord emerging between sutures with no transverse slit in the lower flap as is sometimes recommended. (Courtesy of Dr. W. D. Wise.)

Step 6. Carry up the lower leaf of the external oblique and flap it over the upper leaf and suture it there. (Fig. 1835.) These layers are all beneath the cord which is left subcutaneous and treated in the manner shown in the illustrations. Close the superficial fasciae with plain catgut. To prevent the formation of too sharp an angle over the edge of the lower leaf of the external oblique, suture the cord in a gradual curve to the subcutaneous tissues.

Comment: This procedure is followed in all direct and indirect hernias, except in children and adolescents; it has been used in so-called "inoperable" direct hernia, and recurrent double direct hernias, with success.

It is contraindicated in cases of undescended testicle. To assure union, free all structures to be approximated. This method gives a broad approximation of fascia to fascia. Employing the external oblique aponeurosis in this way should preclude the necessity of free fascia transplants or other foreign material except sutures and ligatures.

The repair of inguinal hernia in the female, by any method, is usually more successful than in the male.

Walter D. Wise utilizes the pectineus fascia in certain forms of inguinal hernia.[1] He points out that transplantation of the cord in the repair of hernias is in the majority of cases a good procedure. It is resorted to in all direct hernias, regardless of the size, in all recurrent hernias, and practically all patients over 25 years suffering with the indirect variety. Recurrences are now fewer than with the cord left in its bed. Following the lead of A. C. Harrison, Wise uses the imbrication method of carrying the edge of the external oblique down to Poupart's ligament along with the internal oblique and conjoined tendon. This is done with a figure-of-eight or double row of interrupted sutures and the edge of Poupart's ligament is brought up and sutured to the external oblique with interrupted sutures. The cord is placed between the external oblique and the subcutaneous tissues. Wise recalls that the medial end of Poupart's ligament is reinforced by Gimbernat's ligament and is, in most instances, strong enough to meet the demands of any hernia operation; nevertheless, in some patients the ligament is weak, frayed, or so thin that it does not seem equal to the responsibility placed upon it. The figure-of-eight suture is started in the pectineus fascia and muscle, passing it through Poupart's ligament, catching the conjoined tendon and then the shelving edge of Poupart's ligament, back to the edge of the external oblique, thence through Poupart's ligament again to pick up the pectineus fascia and muscle. The junction of the pectineus fascia and muscle with Poupart's ligament gives a much greater sense of security.

MERMINGAS' METHOD OF HERNIOPLASTY

K. Mermingas of Athens points out[2] that two important factors have in the last two decades been established: First, recurrences after hernia operations are rather frequent; second, that a second locus minoris resistentiae created by the operative procedure is responsible for the reappearance of a protrusion. With the introduction of the Bassini method the profession was divided into those who insisted on a thorough repair of the inguinal canal and those who maintain that the

[1] Surgery, Gynecology and Obstetrics, July, 1922.
[2] Zbl. f. Chir., 63, Nr. 35, 1936.

repair of the canal is of no consequence (Hoffmann, Lorthioir, Lameris, Mermingas, Sudeck). The pendulum swung in the latter direction some years ago but has of late returned to the classical Bassini or its modification. Mermingas recalls that fifteen years ago he introduced an operation which he termed the "supra-inguinal method."[1] He operated on 379 cases and in this series a careful checkup revealed practically no recurrences but some of these patients while freed from their oblique inguinal hernias developed direct hernias. The patient looks upon such event as a "recurrence" which in reality is not; it is the occurrence of a "new herniation." Another disadvantage of the original procedure consists of the fact that an existent direct hernia at the time of operation may be overlooked.

In order to obviate these drawbacks of his original procedure, without interfering with its advantages, Mermingas has in the last three years modified his method which in substance consists of:

(1) Exposure of the aponeurosis of the external abdominal oblique muscle by the usual incision along the inguinal canal.

(2) Fashioning of a flap of aponeurosis from the oblique muscle (higher up than before) about three fingers' breadth above Poupart's ligament (Fig. 1836). Note the auxiliary incisions above and below, the latter dividing the internal pillar of the inguinal canal. This enables the complete delivery of the spermatic cord with the hernial sac (if such be present) through the external inguinal ring. By reflecting the aponeurotic flap thus fashioned the topography of the region is clearly defined (conditions at the external ring, along the inguinal canal, width and resistance of the ring, relation of the musculature to Poupart's ligament, etc.).

(3) According to the conditions found, the further course of the operation is planned. If an oblique inguinal hernia exists, Mermingas performs his "supra-inguinal method" which essentially consists of:

Step 1. Splitting of the fascia to external abdominal oblique muscle (Fig. 1836).

Step 2. Separation of the fibers of the transversalis and internal oblique muscles high up, corresponding to the level of the internal abdominal ring (Fig. 1837).

Step 3. Exposure and dissection of the hernial sac and spermatic cord (Fig. 1837).

Step 4. Division of the peritoneum above the neck of the hernial sac. In cases where the omentum is united by adhesions to the fundus of the sac and cannot be replaced, it is pulled up through the neck of the hernial sac; in so doing the sac together with the scrotum is pulled up in glove-like fashion and the adhesions severed under ocular guidance and thorough ligation is done. If the hernia is on the right side the high opening of the peritoneum permits easy removal of the appendix, if such be deemed advisable.

Step 5. Close the peritoneum and hernial aperture. Keep the cord out of the way and underneath it unite the borders of the internal oblique and transversalis muscle (Fig. 1838).

Step 6. Extirpate the distal portion of the sac completely, wherever possible; if too large, leave it behind, although such step may later cause symptoms necessitating further intervention.

Step 7. Finally, closure of the inguinal canal is accomplished with much ease, thanks to the thorough exposure obtained by the dissection practiced as out-

[1] Zbl. f. Chir., 1920, No. 28 and Arch. klin. Chir., 132:655.

lined. The fascia of the external oblique muscle may now be closed above or below the spermatic cord as the surgeon prefers (Fig. 1839).

Comment: Such is the procedure in oblique inguinal hernias. This procedure tends to avoid recurrence by reason of proper anatomic recon-

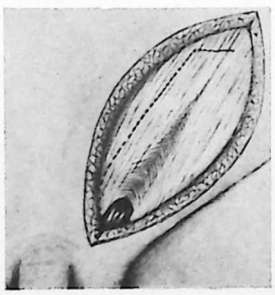


Fig. 1836

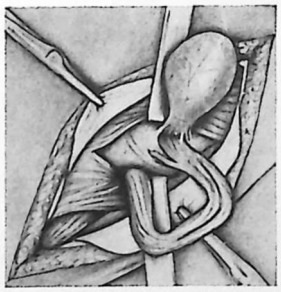


Fig. 1837

Fig. 1836. Mermingas' method of herniorrhaphy. Incision of aponeurosis of external abdominal oblique.
Fig. 1837. Method of division of the muscle fibers of the internal abdominal oblique and transversalis muscles, corresponding in position approximately to the inner abdominal ring. Division of the transversalis fascia. Exposure of the hernial sac.

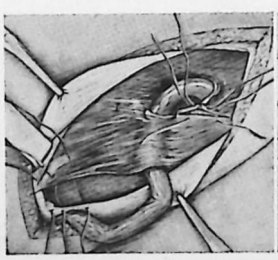


Fig. 1838

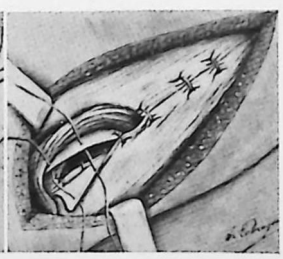


Fig. 1839

Fig. 1838. The borders of the internal abdominal oblique and transversalis muscles are united below the spermatic cord which is displaced upward. Closure of the lower portion of the structures with or without transplantation of the cord.
Fig. 1839. Method of closure of the external abdominal oblique. (Courtesy of Dr. K. Mermingas.)

struction of the parts concerned (highest possible closure of the peritoneum; proper muscular reinforcement without tension because the mus-

cles are joined without participation of Poupart's ligament; possibility of excellent reconstruction of the external inguinal canal).

In cases of direct hernia the operative procedure is different.

Observe the relations of the hernial sac to Hesselbach's triangle, the deep epigastric vessels which it often "rides," etc. In such cases the steps are as follows:

Step 1. Careful dissection of the hernial sac.
Step 2. Excise the hernial sac or invert it without being opened and "purse string" it by appropriate sutures.
Step 3. Reinforce by muscular buttress.
Step 4. Detach the aponeurotic portion of the rectus abdominis muscle from its osseous attachment to the bone and unite it with the median portion of Poupart's ligament or aponeurotic flap. (Mermingas here again stresses the importance of free dissection of aponeurotic flaps for reasons stated above.)
Step 5. Close the other aponeurotic structures beneath the spermatic cord.

Comment: Mermingas has operated on 276 oblique inguinal hernias; 40 direct hernias and 28 oblique and direct hernias combined. In 141 cases appendicectomy was also done. One patient died on the third day after the operation from a hitherto unexplained putrid infection.

A careful study of the cases after three years and six months yielded the following information: Of 97 patients there was definitely no recurrence in 96. The 97th case refused examination, his physician writing that there is "some tumefaction at the operative site." Thus no recurrence has thus far been noted and Mermingas concludes that the excellent results obtained by his method are due to

(a) the formation of a wide aponeurotic flap, the base of which corresponds to Poupart's ligament;

(b) the splitting of the aponeurosis mesial to the arch of the external inguinal opening;

(c) complete freeing of the spermatic cord;

(d) complete exposure of the parts concerned in the operation and

(e) the "supra-inguinal" method of attack of oblique inguinal hernias.

Philip Turner's Operation[1]

Philip Turner describes an operation for the purpose of strengthening and repairing the weakened inguinal tissues, particularly the opening in the transversalis fascia. The essentials of the operation consist of making a pedicle flap of the fascia lata with its base at Poupart's ligament. The flap thus obtained is used for the purpose of strengthening the fascial boundary of the canal. The flap is turned upwards underneath Poupart's ligament and brought into the inguinal canal. It is then sutured to the margins of the gap which have been carefully defined at an earlier stage in the operation.

OPERATION FOR OBLIQUE INGUINAL HERNIA IN THE FEMALE

This is essentially the same as the radical operation in the male, the round ligament being treated in a manner similar to the spermatic cord, or, the ligament is sutured to the structures of the inguinal canal.

[1] Guys Hospital Reports, 1933, lxxxiii, 233.

CONGENITAL INGUINAL HERNIA

The difference between a congenital and an acquired hernia is as follows: The testis, in its descent into the scrotum, is always accompanied by an outgrowth of the peritoneum, the processus vaginalis peritonei. After the descent of the testis, the peritoneum becomes shut off at the internal inguinal ring and

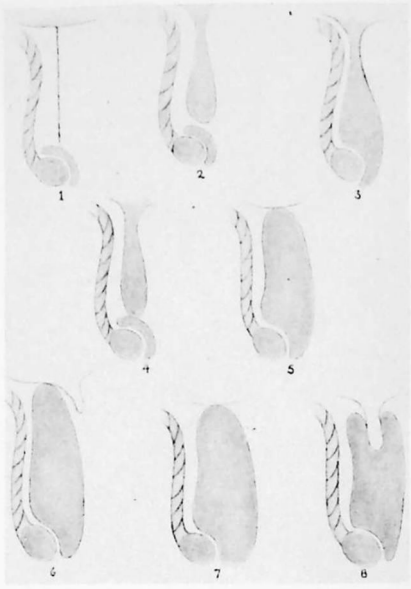


Fig. 1840. Types of inguinal hernia (after Moschcowitz). 1. Normally descended testis. 2. Ordinary scrotal hernia. 3. Congenital hernia. 4. Hernia into the funicular process. 5. The condition as it exists prior to the formation of an encysted hernia. 6. Hernia in front of an encysted hydrocele. 7. Encysted hydrocele. 8. Encysted hernia.

just above the testis. The intervening portion becomes obliterated and remains as a fine cord-like structure within the confines of the spermatic cord; the distal portion persists and becomes the tunica vaginalis (Fig. 1840[1]).

This obliteration is subject to various maldevelopments. Where the processus vaginalis has failed to become shut off at both the testicular and the abdominal ends (Fig. 1840[2-3]) a complete hernial sac, which communicates above with the general peritoneal cavity results. This variety is known as "congenital inguinal hernia." Hernial contents may find their way into the sac before, during or soon after birth, or not until late in life.

Anatomically, there are certain other well-marked differences between a congenital hernia and an acquired hernia. The sac of a congenital hernia is very apt to be exceedingly thin, so that its isolation is decidedly more difficult, particularly in the region of the hernial neck. The isolation is rendered more difficult by the further fact that not infrequently the component parts of the spermatic cord are not gathered into a distinct strand, but are spread out over a wide area of the sac. Not infrequently there are to be seen ridges or elevations within the lumen of the sac, which are very probably incomplete attempts on the part of nature to effect an obliteration. These ridges may be the causes of a subsequent strangulation, thus representing entirely intrasaccular, instead of the usual extrasaccular causes of strangulation. Moschcowitz described two such cases.

In females the processus vaginalis is called the canal of Nück, and, as in the male, this canal becomes obliterated and remains as a thin cord accompanying the round ligament. Failure of obliteration of the canal of Nück may give rise to a congenital inguinal hernia in the female. Its recognition and differentiation from an acquired hernia are very difficult.

The essential difference in treating a congenital hernia and an acquired one is in handling the sac. This step, isolation of the sac, is difficult in children because of the fact that the tissues of the cord often spread over a large part of the sac which is very thin and easily torn. After its isolation, the sac may be treated in any of the following ways:

(a) Ligate the sac at the internal inguinal ring; evert and suture the rest. When completed, the serosa is everted and in contact with loose cellular tissue.

(b) Ligate the sac at the internal inguinal ring; dissect it at the testicular end and suture it in such a manner as to form a new tunica vaginalis. Obliterate the intervening portion. This seems to the author an unnecessary refinement of technic. It is best to

(c) Ligate the sac at the internal inguinal ring and to dissect it free as far as its attachment to the testis.

Hernia into the Funicular Process

Here the vaginal process is shut off at its inferior extremity only, forming a normal tunica vaginalis while the remainder of the canal remains open (Fig. 1840[4]).

This type of hernia differs from the ordinary acquired scrotal hernia in that the lower end of the sac and the tunica vaginalis are intimately adherent, while in an acquired scrotal hernia this part of the sac is free. In hernia into the funicular process, the tip of the sac must be dissected from the tunica vaginalis; this often leads to an opening up of the tunica vaginalis; this, however, can be promptly repaired.

The operation consists in sharp dissection of the inferior extremity of the sac from the tunica vaginalis. Otherwise, the treatment is the same as that described for acquired inguinal hernia (p. 1660).

Encysted Hernia

In this variety, the proximal end of the processus vaginalis has been shut off, the remainder of the sac remaining unobliterated. If a hernia results, a por-

tion of the peritoneum lining the general peritoneal cavity will protrude into a completely shut off serosal sac (Fig. 1840[8]).

Upon opening the sac in this type of hernia, one will find no hernial contents or any connection with the peritoneal cavity. If such sac is excised or its posterior wall divided another sac will be encountered containing the hernial contents. This form of hernia is rare and differs from the usual form of acquired hernia in presenting an extra sac containing the testis and the marked difficulty

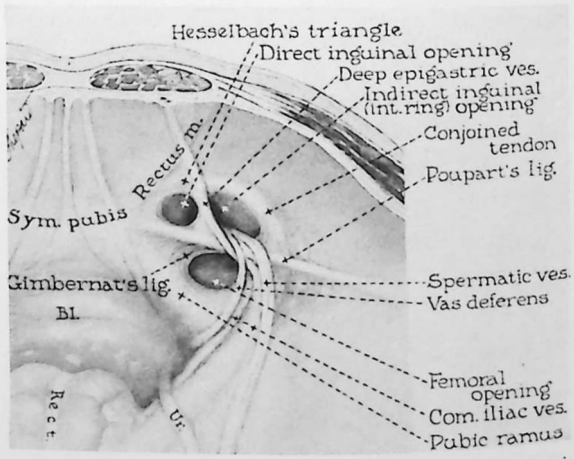


Fig. 1841. Semischematic drawings showing the internal openings of indirect and direct inguinal and femoral hernia.

encountered in excising the sac, particularly at its upper end where it is attached to the distal end of the true hernial sac.

Operation. The two sacs may create no small amount of difficulty in their identification as well as in their isolation and extirpation. Essentially, however, the operation here does not differ from that of the ordinary form of acquired inguinal hernia.

Hernia Complicated by Hydrocele

Hydrocele as a complication of hernia is of frequent occurrence (Fig. 1840 [6, 8]).

DIRECT INGUINAL HERNIA

A direct inguinal hernia is one that makes its appearance on the medial side of the deep epigastric artery. In other words, it emerges through the space bounded externally by the deep epigastric artery and vein and below by Poupart's

(ilio-inguinal) ligament. Its floor is formed by transversalis fascia, behind which is found properitoneal fat and lastly peritoneum The coverings of a direct inguinal hernia are from within outward: (1) Peritoneum and properitoneal fat. (2) Transversalis fascia. (3) Intercolumnar fascia. (4) Subcutaneous fat, superficial fascia and skin. Because of its close proximity the bladder is exposed to injury in this type of hernia (Figs. 1841-1842).

The problem of radical cure of direct inguinal hernia is different from that of indirect hernia. The sac here is usually small, short with a broad base. When the sac is not large, it is not opened. It is inverted with as many purse string sutures as seem feasible in a given instance. If the sac is large it is opened, the contents reduced and the sac ablated. The posterior wall of the canal must be reinforced by stronger tissues than those that make up its anatomy (Fig. 1843 a).

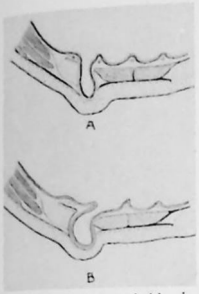


Fig. 1842. Direct inguinal hernia. A Point of emergence of the hernia internal to the deep epigastric artery. A study of the diagram shows that the internal abdominal ring and the inguinal canal do not take part in the makeup of the hernia. B. Supravesical inguinal hernia. Here the hernia emerges as above, internal to the deep epigastric artery, but the hernial contents assume a different position than in the preceding variety.

Anatomic Considerations. A hernia emerging from the abdomen on the central side of the deep epigastric artery, is called a direct inguinal hernia. The space through which it passes is lined by the border of the sheath of the rectus muscle, covered by the deep epigastric vessels and is immediately over Poupart's ligament. The transversalis fascia forms the floor, behind which lie the properitoneal fat and peritoneum. It is covered in front by the intercolumnar fibers and fascia which are over the external inguinal ring. The coverings therefore consist of: (a) peritoneum and properitoneal fat, (b) transversalis fascia; (c) intercolumnar fascia and (d) skin, superficial fascia and subcutaneous fat.

In unusual cases the hernia emerges from the abdomen higher up and either escapes through an opening in the internal oblique muscle or pushes this muscle ahead. In the latter case, the internal oblique muscle is included in the coverings.

Direct inguinal hernias are usually small and rarely descend into the scrotum. The peritoneal sac is smaller than the size of the hernial mass would indicate because much of the protruding mass is made up of properitoneal fat. The precautions listed regarding the proximity of the bladder in oblique inguinal hernia should be emphasized here, as there is great danger of injuring the bladder in this type of hernia.

Bloodgood's Operation (1898)

This consists in principle of incising the rectus sheath for a distance of about two inches and suturing the muscle and its sheath with the conjoined tendon and internal oblique to Poupart's ligament. (Fig. 1843 b.)

Causes of Failure in Hernia Operation

Recurrences are observed in the best of hands. The surgeon who records no recurrences keeps, as a rule, lax records or his patients do not return to him after the recurrence of the hernial protrusion.

It must ever be remembered that hernias originate along the path of the spermatic cord. Inasmuch as such an opening must always be left in repairing hernias (unless the testicle be sacrificed) there always will remain a locus minoris resistentiae in the transversalis fascia, at the point of exit of the cord structures, affording opportunities for hernias to recur. An effort is made during herniorrhaphy to reinforce this vulnerable point by forming a buttress, in front of it, from the contiguous muscular and fascial structures.

The most important causes for failure are:

1. Too low ligation of the sac.
2. Slipping of a ligature from the neck of the sac.
3. Inadequate suture material. Absorbable sutures not offering sufficient resistance to the action of body juices are often the cause of failure.
4. Excessive force in tying sutures. Approximation, not strangulation should be observed.
5. Wound infection. Asepsis is the keynote to success. Meticulous hemostasis is of equal importance. Preference should be given to interrupted instead of continuous sutures.
6. Too early resumption of work. Sufficient time should be allowed for thorough cicatrization before the patient is permitted to resume strenuous duties. Disregarding of this rule is often responsible for recurrences.

Andrews' imbrication stitch may be employed to good advantage in repair of direct hernias. Each suture "penetrates" the following five points: (1) The lateral aponeurotic flap of the external oblique muscle close to Poupart's ligament; (2) the conjoined tendon; (3) Poupart's ligament; (4) the medial aponeurotic flap of the external oblique muscle; (5) anterior to the point of entrance in the external oblique aponeurosis.

The lateral flap of the aponeurosis of the external oblique is then overlapped and sutured to the medial flap.

INTERSTITIAL HERNIA

An interstitial hernia, generally speaking, is one that finds its way into the interstices or planes of components of the abdominal wall and does not follow the course of the spermatic cord into the scrotum. Such hernias may then be found.

1. between the aponeurosis of the external oblique and the subcutaneous adipose tissue;
2. between the aponeurosis of the external oblique and the internal oblique;
3. between the internal oblique and transversalis muscles;
4. between the transversalis muscle and transversalis fascia;
5. between the transversalis fascia and peritoneum.

The three clinical varieties encountered are: Inguinosuperficial hernia (Küster); interparietal hernia; properitoneal hernia (Krönlein).

Inguinosuperficial Hernia (Küster)

In this variety, the hernia slips into the internal inguinal ring, through the inguinal canal and emerges through the external inguinal ring; it then passes

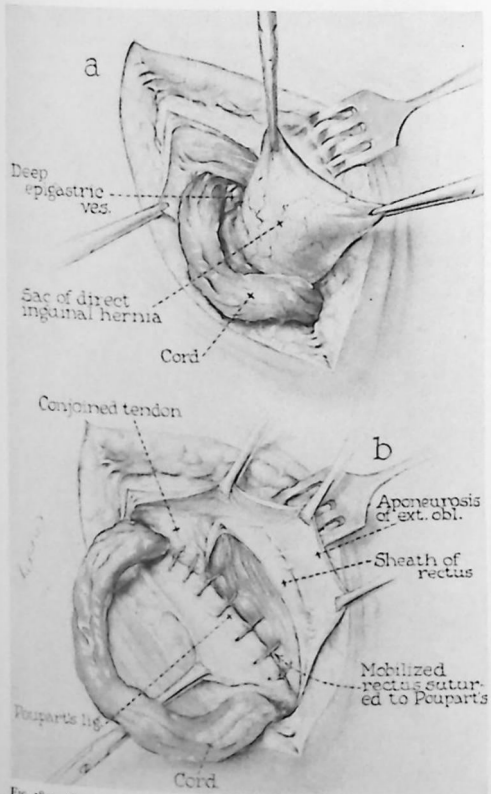


Fig. 1843. Operation for direct inguinal hernia on the right side. a. If the sac is small it may be returned to the abdomen without ligation after inverting it with one or more purse-string sutures. b. Bloodgood method of reinforcing the closure in direct inguinal hernia by incising the rectus sheath and suturing the muscle and the lateral lip of the sheath to Poupart's ligament. The conjoined tendon may be included in these sutures.

upward and outward remaining upon the aponeurosis of the external oblique (Fig. 1844). Not infrequently an undescended testis accompanies this variety of hernia. From without inward, the coverings of such hernias consist of: skin, subcutaneous adipose tissue, transversalis fascia and peritoneum, while posteriorly, the peritoneum, aponeurosis of the external oblique muscle and the remaining structures of the abdominal wall form its coverings. In its travel, the hernia displaces the external inguinal ring upward and outward bringing it to be directly opposite the internal inguinal ring.

The surgical treatment here is the same as for an ordinary oblique indirect inguinal hernia with the exception that the hernial sac is isolated from the anterior surface of the aponeurosis of the external muscle before the latter is divided.

Fig. 1844

Fig. 1845

Fig. 1844. Inguino-superficial hernia. Here the hernial protrusion emerges through the external inguinal ring but does not descend into the scrotum (scrotal hernia); instead it remains in the subcutaneous tissues.

Fig. 1845. Subfascial hernia. In these cases the hernial protrusion occupies the space between fascia and muscular planes.

SUBFASCIAL HERNIA

For depiction of this variety see Fig. 1845.

INTERPARIETAL HERNIA

In this variety, the hernia travels, after it emerges from the internal inguinal ring, upward and outward between one or another of the fascial or muscular components of the abdominal wall. (Fig. 1846.)

The coverings of the hernia here vary according to the plane of the abdominal wall into which the protrusion found its way. The most frequent site is between the aponeurosis of the external oblique and internal oblique muscles. The surgical treatment again varies according to the location of the hernia. Free and meticulous dissection is essential.

PROPERITONEAL HERNIA

This form which was originally described by Krönlein spreads out between the parietal peritoneum and transversalis fascia instead of passing through the

internal inguinal ring; it may, therefore, spread in any direction. The surgical anatomy of this variety of hernia is very complex. In the majority of instances the hernial sac and its contents (scrotal-inguinal hernia) are pressed back through the external inguinal ring, inguinal canal and internal inguinal ring into the abdomen until the fundus of the sac is just beyond the internal inguinal ring. If the hernia is forced out and the fundus of the sac is forced into the pelvis instead of back through the internal inguinal ring, a properitoneal hernia develops. (Fig. 1847.)

The surgical treatment of properitoneal hernia differs from operations performed for the relief of other varieties of hernia.

FIG. 1846

FIG. 1847

FIG. 1846. Interparietal hernia. The hernial protrusion in these cases finds its way into the strata of the deep abdominal muscles.

FIG. 1847. Properitoneal hernia. The hernial protrusion in these instances is situated in a pocket of peritoneum as shown in the illustration.

Step 1. Make an incision in the midline of the abdomen or at the outer border of the rectus abdominis muscle.
Step 2. Place the patient in Trendelenburg's position.
Step 3. Incise the obstructing hernial ring.
Step 4. Reduce the hernial contents.
Step 5. Evert and excise the hernial sac. If there is an additional inguinal sac, a separate incision is necessary.

ABNORMAL HERNIAL CONTENTS

1. Hernia of the bladder.
2. Hernia of the ureter.
3. Hernia of the ovary.
4. Hernia of the fallopian tube.
5. Hernia of the uterus.
6. Hernia of the appendix.

HERNIA COMPLICATED BY APPENDICITIS

In this condition, the patient usually suffers from symptoms which suggest an inflammatory process of the appendix. Physical examination reveals a

hernial sac which is painful to palpation; this will cause confusion and strangulation of a loop of bowel will be diagnosed. The true nature of the condition is disclosed by operation. The appendix may be removed through the hernial incision. Where acute appendicitis is found, the repair of the hernia should receive secondary consideration—the relief of the acute appendicitis should be the primary aim.

SLIDING HERNIA

HERNIA OF THE LARGE INTESTINE

The surgeon should be acquainted with the varieties of these types of hernia. Serious damage may be inflicted by the uninitiated. The peritoneal structures in this class of cases have become detached from the colon so that instead of being fixed, the bowel becomes mobile. The peritoneum of the internal inguinal ring by reason of such mobility is dragged toward the scrotum and hernias result. (Figs. 1848-1849.) This variety of hernia is known as "sliding hernia."

HERNIA OF THE CECUM

The cecum is situated below the ileocecal valve and is completely surrounded by peritoneum. It cannot, therefore, become the sliding part of a sliding hernia but merely prolapses into the hernial sac. It may usually be reduced with facility. Should it be accompanied by a sliding hernia of the ascending colon and, perhaps, with adjacent portions of the small intestine, its reduction becomes a matter of difficulty.

FIG. 1848. Sliding hernia of the ascending colon (sacless hernia). The first part of the ascending colon has descended through the hernial opening. Note that portions of the ascending colon are not surrounded by peritoneum. In this case, the cecum is seen hanging free in the abdominal cavity. (After Schmieden.)

Treatment

The surgical treatment of sliding herniae is much more complex and difficult than the treatment of ordinary herniae of the cecum, transverse colon and sigmoid flexure which are treated the same as any simple form of inguinal hernia.

Sliding herniae occasioned by a "pushing" mechanism are usually very small. The usual hernial incision is used. Difficulty in locating the sac is not infrequently encountered. At times it requires mature judgment not to open inadvertently the lumen of the bowel. The most important point is to recognize the hernial sac. The sac is usually so small that with the aid of a little blunt dissection it may be pushed back into the retroperitoneal space. Insert deep sutures, care being taken that the intestine is held out of the way while the sutures are tied.

A sliding hernia brought about by a "pulling" mechanism is usually of large size. It is easily recognized. The hernial contents are usually easily replaced, "but when a piece of intestine resists all efforts at reduction, the surgeon knows he is dealing with a sliding hernia. The uninformed or incompetent sur-

geon, at this stage of the procedure, may do considerable harm but the capable surgeon at once recognizes the situation and enlarges the incision in the sac, inspects this piece of intestine for more certain identification" (Moschcowitz).

Step 1. Make an incision in the middle of the anterior surface of the sac.
Step 2. Free the spermatic cord; continue liberation of the mass until the sac and herniated intestines are lifted up from the back of the hernial space. Avoid injury to the blood vessels. Hold the intestine and sac up perpendicularly.
Step 3. Fasten the sac in place with interrupted sutures; a sort of artificial mesentery has thus been formed. No further trouble should be encountered if the intestine and vessels have been properly liberated.

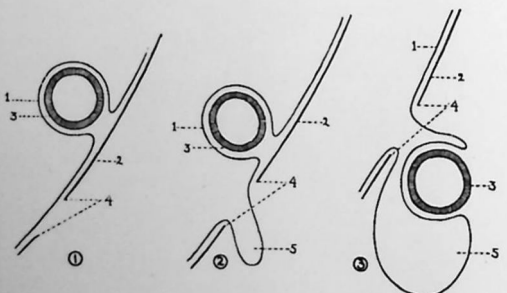


FIG. 1849. Sliding hernia of descending colon by sliding mechanism. 1. first stage; 2. second stage; 3. third stage; 1. peritoneum; 2. transversalis fascia; 3. descending colon; 4. internal inguinal ring; 5. sac of hernia. (After Moschcowitz.)

Step 4. Reposit the intestine.
Step 5. Since it is impossible to ligate the sac, the rest of it is united with a running suture.
Step 6. Now do a radical hernia repair.

FEMORAL HERNIA

Anatomic Considerations. The following anatomic structures should be given due consideration in the diagnosis and treatment of femoral hernia. (Figs. 1841-1851.)

(a) Skin, subcutaneous tissue and superficial (cribriform) fascia; (b) long saphenous (saphena magna) vein and its tributaries; (c) the fascia lata of the thigh; (d) Poupart's ligament and its continuation (Gimbernat's and Cooper's ligaments); (e) the transversalis fascia and the sheath of the femoral vessels; (f) the femoral and external iliac vessels; (g) Scarpa's triangle and the tissues forming its boundaries; (h) peritoneum and properitoneal fat.

There are over one hundred operative procedures described and recommended for the relief of femoral hernia. This bespeaks the uncertainty of the

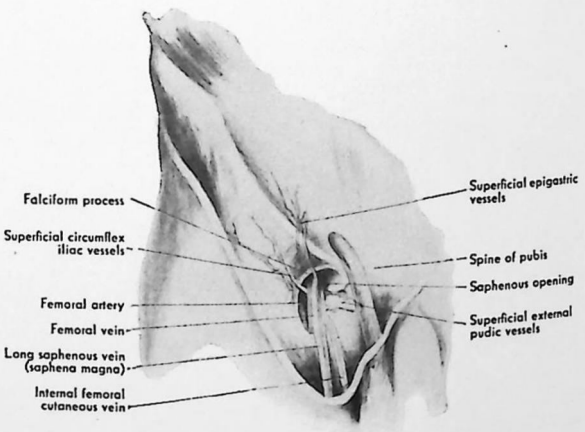


FIG. 1850. The saphenous opening (fossa ovalis). (Davis, Applied Anatomy.)

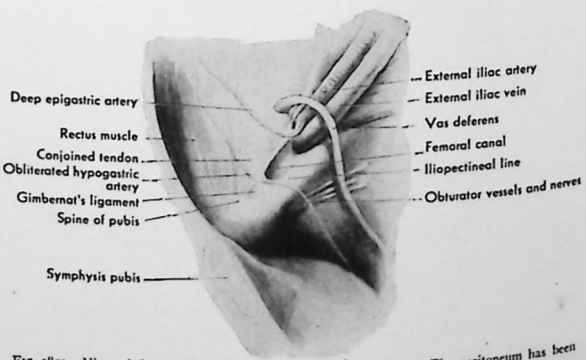


FIG. 1851. View of the inguinal and femoral regions from within. The peritoneum has been removed. (Davis, Applied Anatomy.)

methods suggested. The following procedure has, on the whole, given good results. Two routes are available, the inguinal and the femoral route.

Inguinal Route

Anesthesia may be spinal, general or local.

Local Anesthesia. The first wheal is made as in point 1 in operations for inguinal hernia. (Fig. 1852.)

Points 2 and 3 are situated mesially and laterally from the hernial protrusion and in relation to Poupart's ligament.

Point 4 is situated below the protruding hernial mass. Now inject intramuscularly beginning at point 1, directing the needle toward the anterior superior spinous process of the ilium in exactly the same manner as in infiltrating the tissues for operation in inguinal hernia.

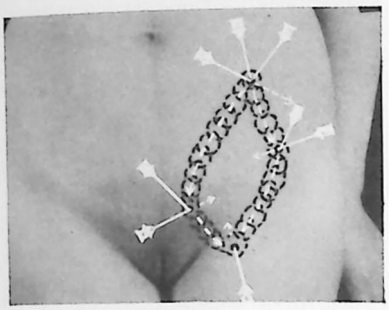


Fig. 1852. Infiltration anesthesia for radical operations of femoral hernia.

Introduce the needle again at right angles at point 1 and deposit about 5 cc. of novocaine solution at each point, under the fascia, in fan-shape expansion mesially and laterally in relation to the hernial sac to a point below Poupart's ligament.

At point 4 deposit about 10 cc. of the novocaine solution around the neck of the hernial mass, as close to it as possible. At point 2 deposit the necessary quantity of anesthetizing fluid to render the tissues here insensitive.

Step 1. Incision. This is about three inches in length running parallel with and about one inch above Poupart's ligament. Ligate and divide the superficial vessels as in the operation for indirect, oblique inguinal hernia.

Step 2. Incision of the aponeurosis of the external abdominal oblique muscle over a grooved director passed through the external inguinal ring.

Step 3. Expose and retract the round ligament or spermatic cord. Poupart's ligament forms a valuable guide to the neck of the sac. Retract the conjoined tendon, internal oblique and transversalis muscle thoroughly.

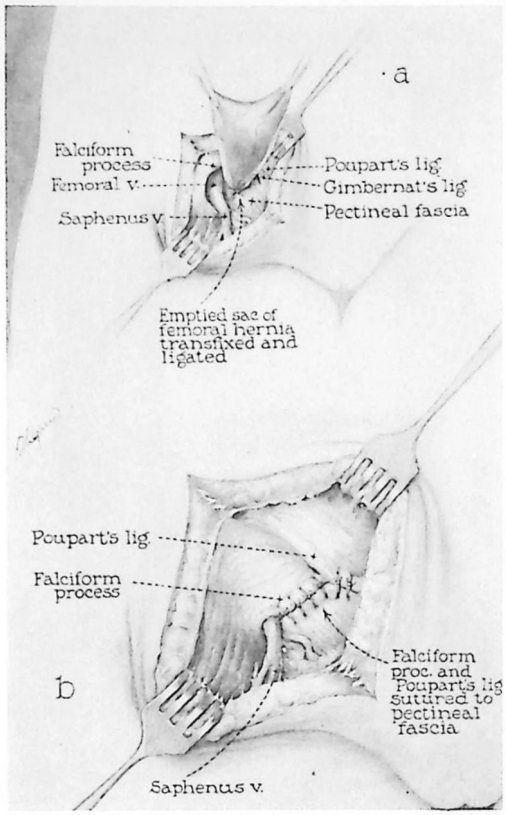


Fig. 1853. Operation for femoral hernia.

Step 4. Incise the transversalis fascia. As soon as this is done approach the neck of the sac.

Step 5. Dissection and exposure of the sac. This step may be beset with many difficulties. Here the internal saphenous vein empties into the femoral. It is encountered lateral to the sac. Guard it! The sac is isolated and dissected upward as high as possible (Fig. 1853a).

Step 6. Open the sac, reduce its contents. This is often difficult to accomplish (adhesions, inflammatory changes). If reduction is difficult it is necessary to enlarge the constricting ring. Great care should here be exercised. An anomalous obturator artery may wind around the neck of the sac. Do not forget the close proximity of the femoral vein, which is fragile and easily

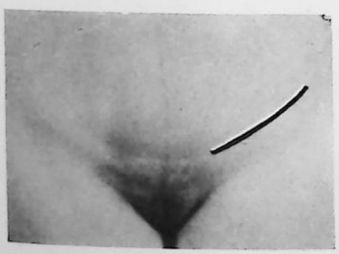


Fig. 1854. Incision for the Lotheisen operation for femoral hernia.

injured by careless manipulations. Keep in mind the close proximity of the bladder. Ligate the sac by transfixion or purse string suture.

Step 7. Closure of the femoral opening. This space is bounded anteriorly by Poupart's ligament, mesially by Gimbernat's ligament, posteriorly by the os pubis, pectineus muscle and fascia attached to the iliopectineal line. Laterally, the femoral vein is situated. Study Fig. 1850, p. 1689.

The falciform process and Poupart's ligament are sutured to the iliopectineal line (pectineus fascia). The opening cannot, of course, be entirely obliterated because room must be left for the passage of the femoral vessels Figs. 1855-1856 depict the anatomic relations.

Step 8. The divided deep structures must be carefully united.

Step 9. Close the superficial structures. Dress.

The femoral approach often is simpler (Fig. 1853), although the abdominal approach is sometimes resorted to. (Fig. 1854.)

In strangulation, the inguinal route is to be preferred. A vertical incision, parallel with and mesial to the femoral vessels is made. It is begun about 1½ inch above Poupart's ligament and is continued ventrally over the hernial protrusion for as long a distance as is demanded in a given case. Look out for the saphenous vein. Locate the falciform process of the fascia lata and position of femoral vessels. Look for the sac. Dissect it out. Ligate and excise it high at

the femoral ring. Deal with its contents as suggested above. Keep in mind the close proximity of the femoral vessels and bladder. If difficulties of exposure arise here, approach the hernia from above. Close the wound as described in approach via the inguinal route.

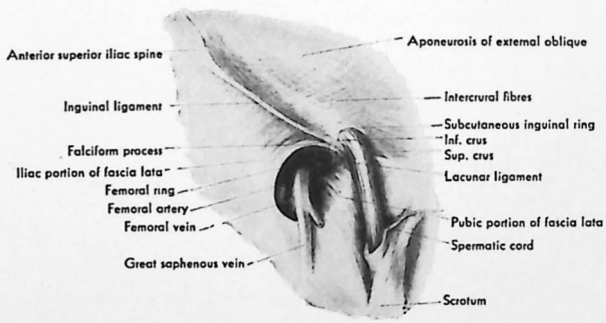


Fig. 1855. Dissection of right inguinal region, showing external abdominal ring and saphenous opening in fascia lata. (Piersol.)

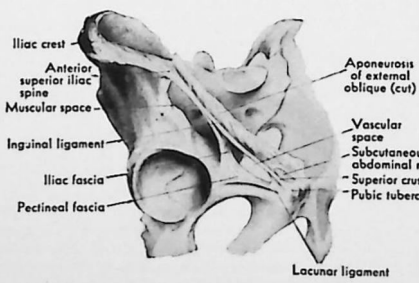


Fig. 1856. Deep dissection of right half of pelvis, showing attachments of iliac fascia. (Piersol.)

UMBILICAL HERNIA

Anatomic Considerations. Varieties: (a) congenital; (b) infantile and acquired. Congenital umbilical hernia is due to a developmental defect. In the embryo the umbilicus transmits:

(1) The vitelline duct, passing from the umbilical vesicle to the small intestines; (2) The umbilical arteries, two in number. These are called the hypogastric arteries while within the abdomen, empty into the internal iliac via the superior vesical arteries;

(3) One umbilical vein, traversing the round ligament on its way to the liver; the stalk of the allantois, called the urachus, on entering the abdomen whence it courses down to the bladder. At birth these structures are imbedded in a myxomatous tissue (Wharton's jelly) and are covered with amniotic tissues, which form the umbilical cord.

Where development is interfered with, a cleft remains in the umbilical region into which intestines or other organs may protrude. If only the intestine protrudes,

Fig. 1857. Umbilical (ventral) hernia.

it forges its way into the umbilical cord and a congenital umbilical hernia results. If this be the case, the intestine may be seriously injured and death result if caution is not exercised during the ligation of the umbilical cord. If the urachus remains patulous a urinary fistula may form. The hypogastric arteries become obliterated. They present two fossae opposite Poupart's ligament. Into these fossae direct inguinal herniae may pass (Fig. 1841). The umbilical vein also becomes obliterated.

Infantile umbilical hernia appears soon after birth.

Acquired umbilical hernia is the form usually seen in adults (Fig. 1857). An umbilical hernia is not always a hernial protrusion through the umbilicus, but at one side of it. An umbilical hernia has the following coverings:

1. Skin (no subcutaneous fat).
2. Superficial fascia.
3. Much attenuated transversalis fascia.
4. Peritoneum.

Mayo's Operation for Umbilical Hernia (1894)

Local Anesthesia. Outline four points of entry for the needle of the syringe carrying the anesthetic solution. (Fig. 1858.) Infiltrate from these points the surrounding structures in a ring-like manner. (Figs. 1859-1860.) Here also the finger may be introduced through the hernial opening and, by palpating the

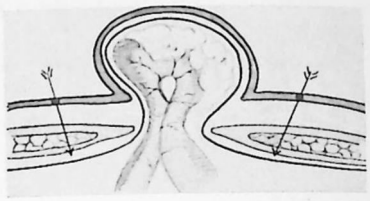


Fig. 1858. Operation for umbilical hernia under local anesthetic. Arrows point through areas of infiltration with the anesthetic solution.

point of the needle, its direction may be controlled. In irreducible hernia, this is a rather difficult task. The more experienced surgeon will find it easier to infiltrate the tissues concerned. When in doubt, it is best first to infiltrate the skin, after that the fascia, followed by the muscle and peritoneum which are infiltrated under visual guidance.

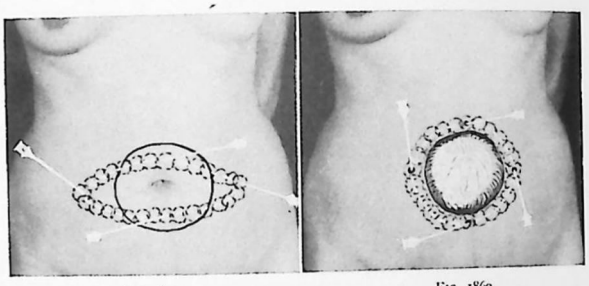


Fig. 1859 Fig. 1860

Fig. 1859. Oval line of infiltration in operations for umbilical hernia.
Fig. 1860. Circular infiltration anesthesia in operations for umbilical hernia.

Step 1. Transverse elliptical incisions (Fig. 1861 a) are made around the umbilical hernia. These are deepened to the base of the hernial protrusion and made to meet at the linea semilunaris (the outer borders of the recti abdomini muscles).

Step 2. The aponeurotic structures at the neck of the hernial sac are carefully

dissected away and the peritoneum opened (Fig. 1861 b). Insert protecting fingers ahead of the scissors thus avoiding injury to the sac contents, while entering the abdominal cavity.

Step 3. The fibrous and peritoneal covers of the hernia are incised in a circular fashion. The constriction found here is divided. Operate with deliberation and care. The cohesion of the overlying structures predisposes the bold operator to injure the sac contents which most frequently consist of small intestine, omentum, transverse colon and occasionally stomach. The hernial contents are examined. The bowel is returned to the abdomen. The adherent omentum is ligated and divided. Remove it with the sac of the hernia. The structures must be freed from one another and from the hernial sac. (Fig. 1861 c.) Chain ligation of the omentum is advantageous. As much of the omentum as necessary should be removed. Very large irreducible and adherent hernias often require resection of the intestine. In such cases only sufficient intestine should be removed to permit reposition of the sac contents. As little of the ileum as is consistent with safety should be resected. Severe diarrhea and metabolic disturbances follow too great sacrifice of the ileum.

Step 4. Approximate the margins of the hernial opening with forceps. In whatever direction overlapping proves easiest lies the index for the proper direction for closure.

Step 5. A transverse incision (one to three inches long) is made in the aponeurosis on both sides of the umbilical ring.

Step 6. Beginning one inch or more above the margin of the upper flaps, introduce three or four mattress sutures of heavy chromicized catgut, the loop firmly grasping the upper margin of the lower flap (Fig. 1861 d). Formerly it was deemed advisable to suture the peritoneum separately but this has been found by experience to be unnecessary. When the mattress sutures are tied, the lower aponeurotic flap slides upward and the upper flap downward resulting in overlapping and fortification of the opening.

Step 7. Retract the upper flap and examine the suture line. Any gaps present are closed with additional interrupted sutures. The lower edge of the upper flap is united to the outer surface of the lower flap with a sufficient number of interrupted sutures of chromicized catgut (Fig. 1861 e).

Step 8. Close the skin with interrupted sutures of silkworm gut. Avoid formation of dead spaces. The suture line may be reinforced by button tension sutures (Fig. 1861 f). Apply voluminous dressings.

Comment: Some patients object, for religious or esthetic reasons, to part with their umbilical pits. Under such circumstances I have reimplanted the ablated umbilicus on numerous occasions; or dissected the umbilicus permitting it to remain attached on a pedicle during the operation and replaced during the closure of the abdominal wall. Under aseptic conditions primary union may be expected.

STRANGULATED HERNIA

The time honored aphorism not to permit the sun to rise before a strangulated hernia is relieved, where taxis failed the night preceding, should be impressed on practitioners of medicine.

Prompt Herniotomy Should be Done. The life of the patient depends

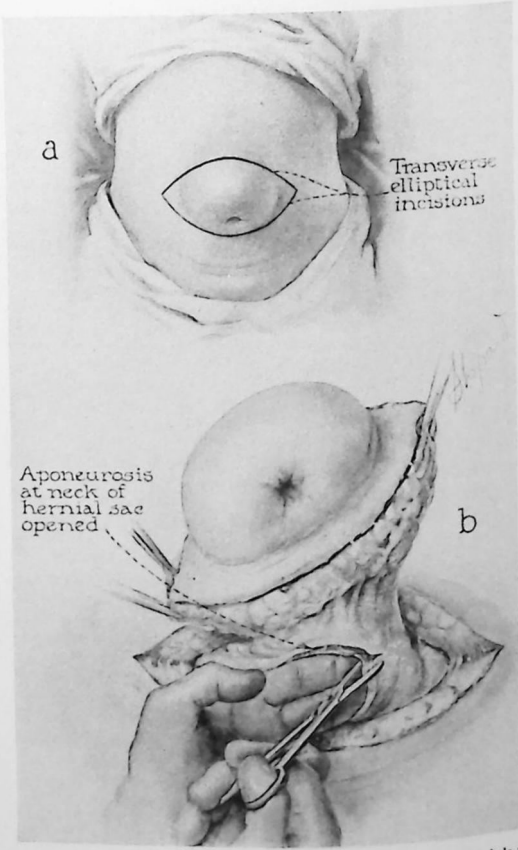


Fig. 1861. Mayo's operation for umbilical hernia. a. The elliptical incisions include almost all of the skin covering the hernial sac. b. When opening the abdomen at the hernial ring the contents of the sac are protected by inserting the fingers ahead of the scissors.

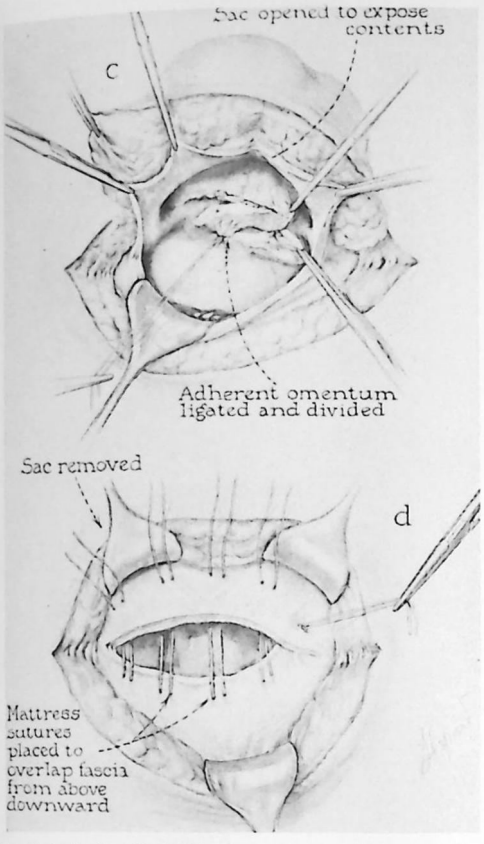


FIG. 1861 (continued). c. The bowel has been returned to the abdomen and any attached omentum is cut away with the hernial sac. d. The mattress sutures are placed for the beginning of the overlapping of the fascia.

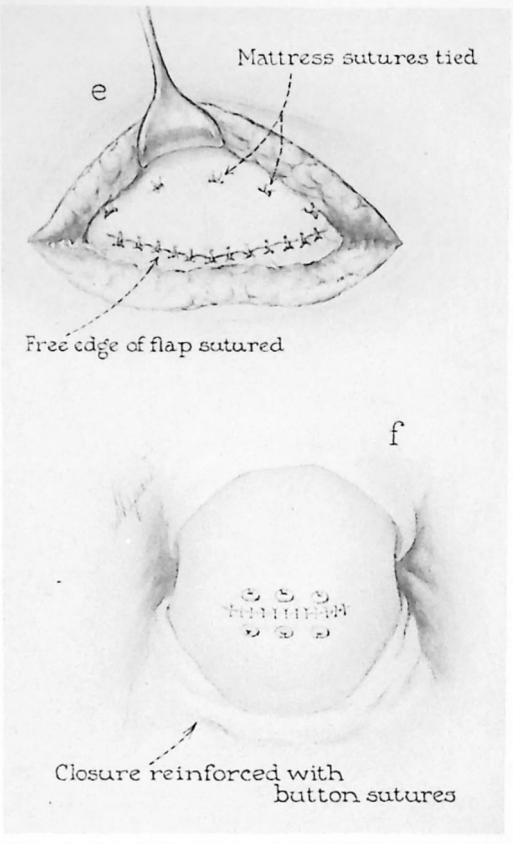


FIG. 1861 (continued). e. Completed closure of the abdominal fascia. f. Closure of superficial fascia and skin.

upon the prompt decision of the surgeon to operate. The surgeon's guiding posts are (1) relief of strangulation; (2) the proper care of the strangulated contents and (3) cure of the hernia. In this class of cases the latter is of least importance.

The surgeon is confronted with the following problems:

(a) Is the liberated bowel definitely viable?

(b) Is the bowel definitely non viable?

(c) Is the nutrition of the bowel in doubt?

(d) What is the condition of the patient?

(e) How badly is the intestine involved?

(f) How well equipped is he to do a resection, if such is deemed feasible? If the patient is old and feeble and the condition of the bowel extremely bad, resect. Remember immediate resection of gangrenous bowel is attended by a very high mortality. Use it as a last resort. Judgment must be used. The shorter the loop to be resected the better the prognosis. One's experience and judgment are paramount in formulating prognosis. **If in doubt, do not resect—exteriorize. Drain the contiguous area and decompress by enterostomy.**

If resection and anastomosis is decided upon observe the following:

(a) Remove the portion of bowel in healthy tissues.

(b) Perform either end-to-end or lateral anastomosis depending upon which procedure you master best.

Should one resect in the hernial wound or through a separate celiotomy opening? Either is correct, provided however, the bowel can be manipulated freely without embarrassment to the surgeon's manipulations. Should a decompression enterostomy accompany the resection? By all means; it is a safe precaution.

Where the bowel is hopelessly gangrenous and exteriorization is decided upon, proceed as follows:

1. Exteriorize the affected segment including some healthy bowel. Resect the gangrenous portion, wherever possible, in healthy tissue.
2. Insert a Paul tube in each opened end.
3. After a fortnight, or longer, if necessary, reestablish the continuity of the bowel.

Cokkinis recommends the following procedure for exteriorization:

Step 1. Bring out of the wound the strangulated coil with 18 inches of proximal and 6 inches of distal intestine. Establish a lateral anastomosis as far as possible from the necrosed segment; return the anastomosed part to the abdomen.

Step 2. Do a Witzel enterostomy proximal to the anastomosis; bring the catheter out through a stab wound.

Step 3. Fix the strangulated coil with a border of viable intestine at each end by a rod passed through its mesentery; close the wound snugly around its base. If the bowel is distended, insert a self-retaining catheter for drainage. Cokkinis advises local anesthesia.

Step 4. After 24 to 48 hours, resect the exteriorized loop of bowel with the thermocautery; tie a Paul's tube into each open end. In jejunal cases inject into a distal tube the contents escaping from the proximal end, thus insuring the patient proper nutrition.

Step 5. After the Paul's tubes come out, close the fistula. If a lateral anastomosis was done, simply free, close and invaginate both ends of the bowel, thoroughly asepticize the skin and return them through the opening in the peritoneum. If an anastomosis was not done, perform it now. This, however, is difficult and dangerous at this stage of affairs.

Hot applications to the strangulated bowel are often rewarded by a recurrence of viability, provided, however, that the constriction did not last too long. If the bowel is viable, return it to the abdominal cavity. (Fig. 1829, p. 1667.) If hopelessly affected, the following courses are open to the surgeon.

(a) The necrotic part of the bowel may be left in the wound after carefully packing off the rest of the peritoneal cavity. After a time the necrotic part thus exposed will slough off with the formation of a fecal fistula. This can be repaired later when the condition of the patient permits it.

(b) If the necrotic area is very limited in extent, it may be inverted toward the intestinal lumen and held there by properly placed superimposed Lembert sutures (one or two rows).

(c) The necrotic part may be resected (see entero-anastomosis).

(d) Gangrenous omentum should be ligated in a healthy section and excised by chain ligation.

(e) In gangrene of the bowel when resection comes into consideration the following questions confront the surgeon:

1. If the bowel is obstructed, is the obstruction such as to indicate an immediate entero-anastomosis?
2. Is the general condition of the patient such that an enterostomy should be performed?
3. Is the bowel so gangrenous and the patient's condition so desperate, that leaving the strangulated loop in the dressings with packing off of the peritoneal cavity and doing an enterostomy above the obstruction is the logical procedure?

Aldo Bianciardi reports the case of a man 63 years of age who was taken to the hospital in a desperately ill condition, suffering from some indistinguishable abdominal complex for which a laparotomy was done. The condition found was that most of the small intestine had herniated through an opening in the mesentery. There was no evidence of traumatism and apparently the hernial orifice had been in existence for a fairly long time (if originally it had not been congenital). About 2 yards of the intestine was necrotic. The man died about 12 hours after operation (stercoremia, gangrene and shock). The ileum (the necrotic part) was strangulated. This teaches that one must think of the possibility of strangulated internal hernia.

In every case of simple hernia, taxis should be attempted. Taxis, it must be remembered, while often effective, is dangerous.

A patient once came under my attention whose case had been diagnosed as strangulated hernia by a physician who had zealously sought reduction by vigorously applying taxis. The patient's condition was none too good when admitted to the hospital. He was in shock. The tissues were freed under local anesthesia—the intestines were found to be ruptured. The rents were repaired and drainage was instituted; the hernia was ignored. On account of the patient's condition, a speedy, unfinished closure was made. Hypodermoclysis and stimu-

lants were to no avail and death occurred fourteen hours later. The patient paid with his life for the forcible taxis.

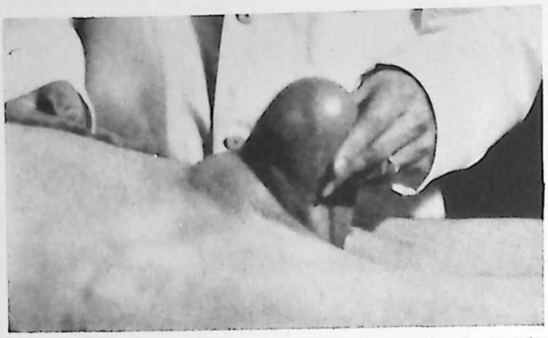


FIG. 1862. Strangulated hernia. Note resistance encountered by pressing the strangulated mass against the external inguinal ring.

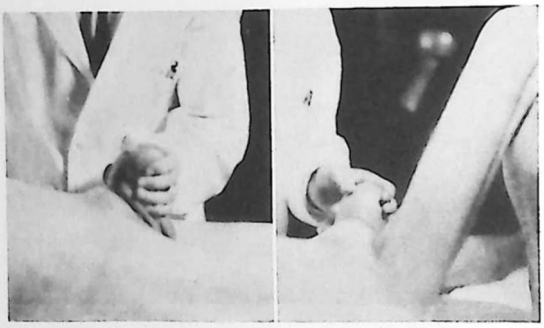


FIG. 1863 FIG. 1864

FIG. 1863. Wrong method of attempting taxis. Note that the operator is grasping the scrotum and is applying much force to the strangulated structures against the resisting ring. This is a dangerous procedure.

FIG. 1864. Proper method of applying taxis. Note the relaxed condition of the abdominal muscles, proper position of the lower extremities and gentle attempts to maneuver the hernial contents past the inguinal canal. The patient should be placed in the Trendelenburg position.

Gangrene of the bowel is likely to occur any time after six hours subsequent to the beginning of the strangulation (Figs. 1862-1863-1864). In this condition the application of force is particularly dangerous.

Taxis is always accompanied by the danger of serious injury to the distended loops of intestine or vascular system; it may also be responsible for false reduction.

In cases of suspected strangulated hernia, keep in mind torsion of the spermatic cord (p. 1993). Also, if taxis does not give encouraging results at once in treating a strangulated hernia, discard it and resort to herniotomy. However, it often becomes necessary to reduce a hernia by methods other than surgery,

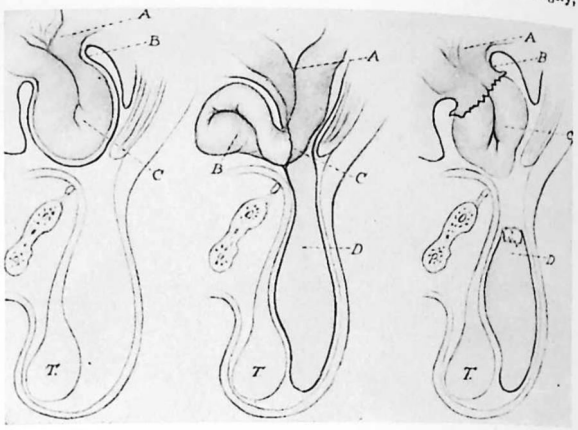


FIG. 1865 FIG. 1866 FIG. 1867

FIG. 1865. Reduction en masse. The whole mass may be reduced carrying the constricting ring (B) with it. A sense of false security that satisfactory reduction has been accomplished will result. Guard against it. (C) shows both the strangulated mass and the sac pushed above the internal ring.

FIG. 1866. During the reduction the sac may be ruptured and its contents (intestine, omentum, etc.) pushed into the extraperitoneal cellular tissue. The strangulated loop is displaced at (B) through the tear in the sac (C) into the extraperitoneal cellular tissue. The empty sac is shown in (D).

FIG. 1867. Through a circular rupture of the sac below the neck a false reduction may ensue. Note the neck reduced with the strangulated loop and strangulation persists. (B) neck. (C) strangulated loop. (D) empty sac. (After Lejars.)

as in cases where the patient's condition does not warrant operating, where the type of hernia precludes surgery and where no surgical facilities are available. Taxis must then be used. Figs. 1865, 1866, 1867, 1868 show "apparent reductions."

When the above conditions exist, never try to replace the bulk of the hernial protrusion all at once. Gentle, continuous pressure should be exerted, permitting the bowel to be reposited slowly and without injury.

After successful operation for hernia, the patient should not be allowed to return to work until thorough cicatrization has formed a barrier to intra-abdominal pressure. Otherwise, a recurrence is likely to take place. The patient should be kept in bed for about 3 weeks; if his work requires much physical exertion, he should not resume it for two months following the operation.

In the case of a new-born, be on the alert for **amniotic hernia** (Fig. 1869). Other types of hernia occurring at this time should not be operated on immediately as they frequently respond to palliative measures such as wearing a truss.

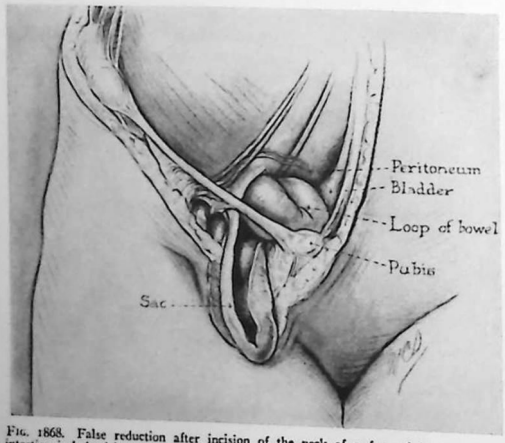


FIG. 1868. False reduction after incision of the neck of a femoral hernia. Note that the intestine is lodged between the pubes and the peritoneum of which the anterior surface is in plain view. Note that the hernial sac is opened, its neck incised and empty, but still strangling the intestine. A valuable object lesson! Unless the hernial contents are definitely reposited into the abdominal cavity one can never be sure of successful reduction. (After Faraboeuf.)

FIG. 1869. Infant with amniotic hernia.

Obstetricians should always be on the lookout for **hernia into the umbilical cord** while delivering the child. I know of two cases where a loop of intestine was incised in cutting the cord when such hernia was present.

It should be remembered in repositing hernial contents that the more room there is in the hernial sac, the less room there is in the abdominal cavity. It may be possible to reposit the contents of a large hernial sac into the abdomen, but if the tension is too great the patient will either succumb or the wound will burst open, resulting in eventration and other unpleasant sequels. There are occasions where extraordinary voluminous hernias are better left alone (see Voluminous Hernias).

The omentum should not be ligated near the bowel as a piece of intestine may accidentally be included.

An affected pampiniform plexus often clears up following the cure of the hernia since oftentimes pressure from the hernia brought about the condition.

Ligatures should be sufficiently secure to bring about approximation but not so tight as to cause strangulation.

The hernial sac should be cut, whenever possible, flush with the surface of the peritoneum, and extirpated entirely.

After the incarcerated intestine has been freed, each loop must be carefully examined for signs of gangrene. The soundness of the intestine involved in the hernia must be assured before it is reposited into the abdominal cavity. The intestine immediately outside the sac should also be carefully examined. Viability may be assumed if the bowel responds to pinching, if it bleeds, if it is shiny and elastic and if no gangrenous spots are discernible. The last are often found where you least expect it.

Devitalized bowel often responds favorably to treatment with hot saline solution. However, it should be kept in mind that perforation of the involved segment may take place up to the seventh or eighth day after strangulation.

When **gangrene of the bowel** is definite, intestinal resection should include considerable adjacent intestine. Strangulation of omentum may cause embolic gastrointestinal ulcers occasioned by thrombosis in the mesenteric vessels.

In incarcerated inguinal hernias, intestinal hemorrhages occur in 50 per cent of the cases where forcible taxis has been used.

While dividing the tissues causing strangulation, exercise great care to avoid injury to the incarcerated bowel and bladder wall. It should always be done under visual guidance and preferably from without inward.

If **conservative methods** are indicated, administer morphine, place the patient on his back, raise his hips, flex the thighs on the abdomen and allow him to rest for an hour. The hernia may reduce itself during that time.

If the patient is vomiting, resort to gastric lavage. When resecting **gangrenous intestine**, resect it at the hernial opening if convenient. Place a warm moist laparotomy sponge into the inguinal wound; cover it with sterile towels; open the abdomen from above; bring the intestine through the wound; resect. Close the inguinal region, or the femoral, as the case may be. Institute ample drainage.

These operations are not simple and the beginner should make it a point, whenever possible, to have an experienced colleague at his side to aid him.

Hemorrhagic infarcts or subserous hematomas appearing on an incarcerated loop of intestine are indications for resection. These are likely to cause secondary intestinal stenosis from the formation of scar tissue. This dictum pre-

supposes that the surgeon is well acquainted with the technic of resection; if he is not, it is better for him to follow a more conservative course.

TAXIS

Dr. Roger T. Vaughan, in speaking on reduction of hernial protrusions, stresses the importance of thoroughly understanding the indications and contra-indications before attempting to reposit the strangulated or incarcerated mass. Vaughan admonishes that taxis is always indicated in patients who are considered bad operative risks; also, when the strangulation is of short duration, except when much tenderness, redness and edema are present. He points out that hydroceles have been mistaken for hernial protrusions and attempts at reduction made. It is obvious that nothing can be accomplished by such attempts other than injuring the parts concerned. It is also well to remember that the lower portion of a hernial sac may permit transillumination when a serous transudate from an antecedent congestion is present and thus mislead one to the belief that he is dealing with a hydrocele instead of a hernia. Where much blood is intermingled with the serous fluid no transillumination will, of course, be found. Soft and small hernias are reposited with greater ease than large and firm masses. In order of frequency of reduction, inguinal hernias may be reposited with greatest facility, femoral next, while umbilical and ventral hernias are the most difficult ones to reposit.

The essential factor in reducing hernias is to resort to a diffuse, steady pressure with massage of the neck of the hernia, especially if resistant. The object of massage is to displace the edema from the neck of the hernia and to return the fluid in the strangulated bowel to the intestine above.

All manipulations must be gentle and under no circumstances should violence or sudden jerky movements be resorted to. Keep slowly changing your grip on the hernial mass and change position frequently to avoid fatigue.

In attempting to reduce inguinal, femoral and infraumbilical hernias, stand the patient on the back of the neck or head as nearly as possible (Vaughan's hanging position). This position is not of much help in umbilical and supraumbilical hernias.

Before attempting reduction, resort to gastric lavage and a cleansing 2-quart enema. Give morphine only (never ether or ethylene) when familiar with the methods of taxis and their dangers. Patients who should not be subjected to taxis will usually resent it because of the pain attending the maneuver.

After reduction has been accomplished, listen to the abdomen. If the obstruction is relieved, normal peristaltic sounds will be heard. Allow the patient to drink some water. If the obstruction is not reduced, the patient will continue to vomit. In cases where water is borne well, give oleum petrolatum (2 or 3 ounces). Follow this with cleansing enemas.

If stool appears in all enemas followed later by oil, the obstruction is probably reduced. Test the stools for occult blood. The reason for this is that the mucosa is first to ulcerate where strangulation is present before the muscular and peritoneal coats lose their viability.

In diffuse peritonitis, hernias quickly come down becoming incarcerated and irreducible. They are very tender. The abdomen in such instances is silent. Reduction is likely to be difficult because of tenderness and is not apt to be permanent. Be sure that the hernia came down before the pain set in in the abdomen, if you diagnose strangulated hernia.

In cases of carcinoma of the colon and some obstructions of the small bowel, the distended abdomen causes the hernia to come down but reduction of it does not relieve the symptoms of obstruction.

On occasion, you may be able to reduce a gangrenous hernia; usually, however, the patient will not even permit you to try this maneuver because of the intense pain produced. Should you succeed in reducing the hernia, symptoms of obstruction will persist.

Successful reduction of a hernia is not attained by forcible maneuvers or violence but by patience and persistence; the usual time consumed is about one-half hour.

Increased intra-abdominal pressure is responsible for causing the hernia to emerge from the abdomen; therefore, steady, external pressure must aim to reposit it.

The half-hour rule limit in attempts at taxis does not hold good in patients who are not operable because of cardiac decompensation, advanced age, etc. In such cases the time is extended, for these individuals may be saved in no other way except by taxis provided the strangulation did not last too long.

Hernial protrusions that have been down for only a day or less can usually be reposited, especially the inguinal variety which tends to strangulate more slowly than do femoral hernias. If only partial reduction can be attained, it will suffice provided, however, that the obstruction is relieved as shown by the test alluded to above. Incompletely reduced hernias are always a source of worry.

To Dr. Vaughan's preceding valuable aphorisms the following dicta should be added: Reduction reduces operative mortality enormously; it does not make operation unnecessary—merely safer.

When the distention has disappeared and there is no occult blood in the stool, operate. It is imperative to differentiate between incarcerated, strangulated, inflamed and obstructed hernias. A 2-quart enema and the x-ray are often of considerable diagnostic help.

LITTRE-RICHTER'S HERNIA

Richter's hernia is a rare, unusual type of hernia. While this represents a form of strangulated hernia, it is characteristically associated with partial intestinal obstruction which is usually present in strangulated hernia; only a part of the circumference of the bowel is caught and strangulated. The involved portion may rapidly become gangrenous although the lumen of the intestine remains open, to some degree. The portion of the engaged bowel resembles a small diverticulum of the bowel wall (Fig. 1870).

In Richter's hernia the sac is usually small and this factor prevents the engagement of the entire circumference of the bowel. The condition of the strangulated portion of the bowel wall depends on how long strangulation has been present and the size of the neck of the sac. In many of the earlier cases in which gangrene was present subcutaneous rupture led to fecal fistulae. In most of these the fistula persisted; in only a rare case did the fistula close spontaneously (Hildanus).

Historical Notes. In 1700, Littré described 3 cases in which only a portion of the bowel wall was found in the hernial sac; two of these were hernias later recognized as involving Meckel's diverticulum but the third could not be identified from his report. He believed that these diverticula were the result of the intestinal wall being pulled out into the sac. It was not until 1815 that Meckel described the diverticulum that now bears his name, thus explaining the true nature of Littré's 2

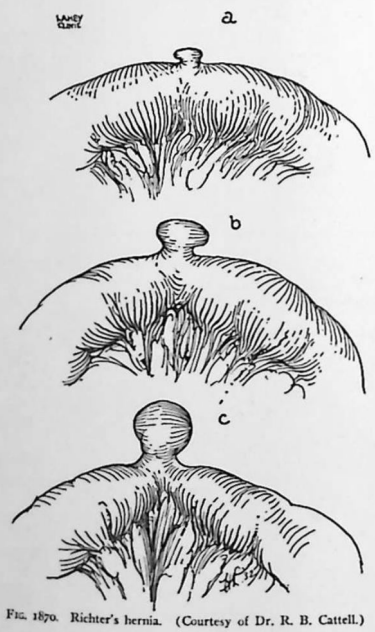


Fig. 1870. Richter's hernia. (Courtesy of Dr. R. B. Cattell.)

cases. The first complete scientific description of this type of hernia was made by Richter in 1778. He described this form of hernia as a "small rupture." He recognized that the wall of the involved bowel was made up of the same layers and structure as were present in the intestinal wall, a condition not present in the diverticulum later described by Meckel. In considering treatment, he recommended, if gangrene had not appeared, reduction aided by dilatation of the ring with a hook, but if gangrene was present he believed that reduction was dangerous and that resection should then be done. Treves suggested that this type of hernia be called Richter's hernia in order definitely to identify it and to differentiate it from the

hernia of Littré and other forms. The earliest report Treves was able to find was that of Guilielmus Fabricius Hildanus in 1606.

The treatment of Richter's hernia is surgical. Operation should be done as soon as possible in order to avoid gangrene.

In the cases collected by Treves there was a mortality of 62.2 per cent in those not operated upon. With rare exception all those recovering spontaneously developed persistent fecal fistulae.

Cattell reported two patients with Richter's hernias.[1] Both occurred in the femoral region and in each instance the terminal ileum was involved. In one, the appendix was incarcerated in the femoral sac beneath the engaged intestine.

The majority of these patients do not have complete intestinal obstruction so that strangulation may not be evident. Diagnosis is rarely made before operation. In all cases with symptoms suggestive of partial intestinal obstruction it is important to examine all possible hernia sites.

There are about 60 cases of **pericecal hernia** reported in the literature.[2] By an internal hernia Applo Meucci means one developed exclusively intra-abdominally. Two such cases have been observed in Meucci's clinic and another case was found during an autopsy.

Robert L. Rhodes reported three cases of partial enterocele; Richter-Littré's Hernia.[3] These cases confirm Scarpa's observation that complete obstruction results from a two-thirds constriction of the bowel (two of Rhodes' cases) while one-third constriction gives only partial obstruction.

VOLUMINOUS HERNIAS

Voluminous hernias are often difficult to diagnose, especially if associated with pregnancy. It would be very unwise to operate in such cases before labor is completed. If the hernia is not too large relief may be expected at the hands of a competent surgeon.

The case depicted on p. 1708 is one which precluded any surgical intervention. The chances are it would be impossible to force the herniated mass back into the abdomen and even if such were the case, the operative shock would be likely to kill the patient.

The condition followed shortly after the patient was discharged from the hospital where she had been operated upon for suppurative appendicitis and the wound had not healed readily; evidently, the layers of the abdominal wall failed to consolidate, or the nerve supply was injured.

About six months after the operation, the patient noticed a lump on the site of the scar. It gradually enlarged until it reached the size shown in Fig. 1871.

The principal factors involved in avoiding the occurrence of voluminous hernias are proper primary closure of the abdominal surgical wounds, and respecting the nerve supply.

Garlock has reported that a large series of postoperative hernias following appendicectomies have been avoided by leaving the wound open, that is, only a few plain catgut sutures placed in the parietal peritoneum to prevent prolapse of the bowel or omentum; no sutures were placed in the muscle, fascia or skin.

Postoperative hernias are not the only type which offer difficulties in the

[1] Surg., Gynec., and Obstet., 1933.
[2] Prat. Chirurg. e delle Discipl. Affini. Vol. III, No. 2.
[3] Transactions Southern Surg. Assoc., 1928, Vol. xli, p. 175.

voluminous variety; inguinal, femoral and others frequently perplex the surgeon especially those in which a large portion of the intestine, stomach, uterus or other organs have descended into the inguinal hernial sac rendering it partially or completely irreducible because of the apparent inability of the abdomen to retain the herniated organs. (Figs. 1872-1873.)

Patients carrying these voluminous hernias have become accustomed to them through their long existence, and while generally there is no great tendency to

Fig. 1871. Enormous ventral hernia.

acute symptoms due to strangulation, nevertheless, on occasion, perplexing problems present themselves.

Careful examination of this type of hernia suggests the impossibility of replacing the hernial contents in the abdomen. Great force would have to be exerted which would doubtless cause injury to the intestines and other viscera, or there might be a very decided retraction of the diaphragm caused by replacing the organs which would interfere with the functions of the heart and lungs or even resulting in asphyxiation.

It would seem, from the cases reported in the literature, that the best method

for dealing with hernias of this type surgically is to resect a portion of the small intestine, which varies in length in different individuals from 4.5 to over 9 meters; from 2.5 to 3 meters may be removed in most cases without threatening the patient's life. Of course, the general physical state of the patient should be considered, as well as the length of bowel to be resected.

When confronted with voluminous hernias, Kocher's aphorism comes to my mind, "Wer seinen Bruch zu solchen Dimensionen anwachsen lässt mag ihn auch ferner behalten" meaning "He who permits a hernia to assume such dimensions should retain it." While many surgeons feel the justification of Kocher's admonition, there are instances in which even very large hernias can be remedied by proper operative intervention. Figure 1874 depicts an enormous ventral hernia complicated by intestinal obstruction in a patient who came under my attention at the Cook County Hospital. In Fig. 1875 a lateral view of the hernia is shown on the apex of which a large excoriated area is seen. Not to submit this patient to operation would mean to permit her to die without surgical aid. Exploration was decided upon. The abdomen was opened through a transverse incision and it was discovered that most of the large bowel and about two-thirds of the small intestine were found in the hernial sac. Reposition was a difficult task but was eventually accomplished without the necessity of resecting segments of the bowel for purposes of diminishing the volume of the hernial mass. The patient made a complete recovery. (Fig. 1876.)

Fig. 1872. Massive irreducible double inguinal hernia (Hernia Magna). A considerable portion of the contents of the sac had been reduced when the photograph was taken. The patient was operated on the left side four days after admission to the hospital. Ileum and omentum were firmly united, greatly thickening the sac. It was found impossible to separate these without first excising the testicle and cord after which a large opening in the abdominal cavity was closed. Recovery. No recurrence. Right side not operated on "because we could not promise to repair it without a possible removal of the testicle." (Courtesy of Dr. A. I. Ludlow, Seoul, Korea. From the Severance Union Medical College.)

This experience emphasizes the necessity of heroic measures when the occasion arises. Not always, however, are such efforts crowned with success and conditions arise where the herniated mass cannot be forced back into the abdomen.

In 1923, Becker reported a case of inguinal hernia which descended to the knee in a man 50 years of age; it could not be held by a truss and was only partially reducible. He performed a herniolaparotomy, resecting two meters of the small intestine (ileum) including the over-fat mesentery; he then removed the testicle and cord and joined the ends of the intestine by means of a side-to-side anastomosis. The wall of the hernia was reconstructed in accordance with Bassini's principles. The resection was done because Becker felt that the ab-

domen was no longer able to hold the herniated mass and a forced reduction would be likely to result in asphyxiation, due to the pressure on the diaphragm.

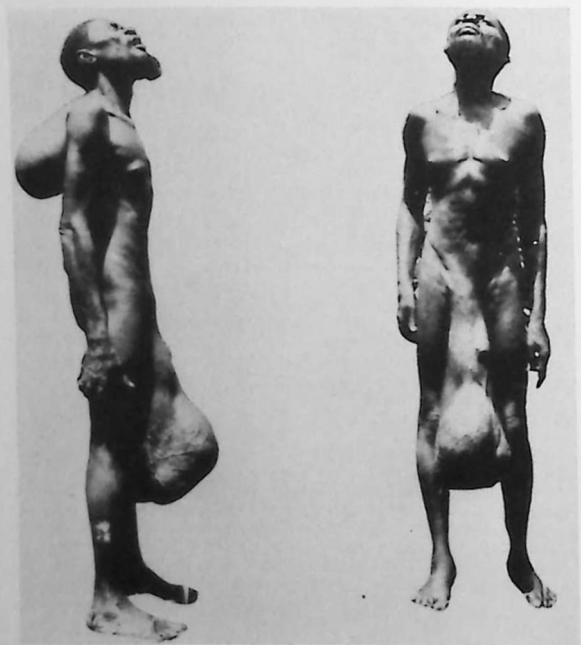


Fig. 1873. Enormous right inguinal hernia reaching to the middle of the leg; lipoma of the shoulder. Man about 55 years of age of Ntum tribe of Spanish Guinea (lateral and front view). Contents of hernial sac: about half of the urinary bladder and about 14 feet of small intestine. Three feet of the latter were resected; the cut ends exteriorized and a Bloch-Paul-Mikulicz procedure resorted to (described in the chapter on Intestinal Surgery) resulted in recovery. (Case communicated to the author by Dr. G. Davies, Central Hospital, Ebolowa, French Cameroon, West Africa.)

This method was first used by Monprofit in 1899; Madelung, Julliard, Pauchet and Denk later used it successfully.

The case of an obese patient aged 53 is reported by Pototschnig. The patient, who had a right inguinal hernia the size of an adult's head and who was also afflicted with emphysema, was operated upon under spinal anesthesia. The sac revealed numerous loops of small intestine, the cecum, a portion of the as-

cending colon and a much adiposed mesentery. About 2 meters of the herniated small intestine were resected and the ends were united by means of a termino-terminal anastomosis. The walls of the hernia were reconstructed in accordance with Bassini's principles; the patient made a good recovery.

Fig. 1874. Enormous ventral hernia complicated by intestinal obstruction.

Dreesen reported the case of a patient 62 years of age who had a left inguinal hernia of 9 years' duration, which was about the size of a child's head. The patient suffered no pain and did not wear a truss. After a time he suffered from

Fig. 1875

Fig. 1876

Fig. 1875. Same patient in lateral decubitus.
Fig. 1876. Same patient five weeks after operation. Complete recovery.

gastric disturbances and the hernia enlarged after drinking much fluid and a gurgling sound could be heard. Roentgenologic examination revealed a much ptosed stomach, elongated and bilocular, with a lower pouch corresponding to the

pyloric antrum situated in the hernial sac and joined with the remainder of the stomach by a strictured part which coursed through the inguinal canal. A radical operation resulted in the elimination of the gastric disturbances. Before operation, only slight reduction could be effected.

A case is reported by Bianchetti concerning a woman 21 years of age where the uterus and adnexa which were in the sac of an inguinal hernia were returned to their normal position and the sac removed.

Lenormant recommends the resection of a large portion of the intestine and mesentery in cases of hernia. He states that he encountered a voluminous hernia in a patient where the viscera seemed to have left the abdominal cavity; he replaced them easily and the patient recovered satisfactorily.

It may be well to remark here that the small intestine varies in length in many, from about four and five-tenths to more than nine meters and that from two and five-tenths to three meters can be removed without serious physiologic phenomena which threaten the life of the patient. If resection seems to be indicated, the general state of the patient and the length of bowel to be removed should be considered.

Nash reports the case of a man 84 years of age who suffered from an enormous inguinal hernia for 50 years. The scrotal coverings extended down over the inner third of the right thigh and the inner two-thirds of the left thigh; the hernial protrusion measured 25 inches in circumference at its widest part, contained omentum and a large mass of bowel and extended down to the left patella; the kidney, spleen and liver were prolapsed. Nash considered surgery inadvisable here because: (a) it would be necessary to draw the ligaments and mesenteries away from the abdominal wall; (b) it would be impossible to replace the ptosed and herniated viscera within the shrunken abdomen; (c) on account of the long-standing of the hernia and (d) because of the advanced age of the patient.

In this instance the contraindication for operation was justifiable; however, this would not hold true in all cases of hernia where resection of part of the hernial contents is advisable.

ABDOMINAL HERNIA

HERNIA OF THE LINEA ALBA

As the name implies, these hernias occur in the midline of the abdomen but do not involve the umbilicus (Fig. 1877). As a rule, these protrusions are usually encountered above the umbilicus. Hence these hernias are often referred to as "epigastric hernias"; these may vary in size from that of a pea to a fist. The larger types are situated near the umbilicus. As a rule, most of these protrusions are very small in size, however.

Anatomically, the linea alba lies in the midline of the abdomen between the two recti abdomini muscles and is an aponeurotic structure made up of the fusion of the sheaths of the recti muscles on both sides. It is narrower below the umbilical pit than above it. It is connected with the peritoneum posteriorly but separated from it by the transversalis fascia. (Fig. 1878-A.)

The blood vessels run between the peritoneum and transversalis fascia, the same as in the rest of the abdomen. Blood vessels pierce the portion of the linea alba lying above the umbilicus as well as the transversalis fascia causing them to be prolonged outward (Fig. 1878-B).

A very narrow space exists between the posterior sheath of the rectus muscle and the transversalis fascia; this space is so extremely narrow that, if there were an outward prolongation of the transversalis fascia at the point where the blood vessels penetrate it, the linea alba and transversalis fascia would be joined, obliterating the space entirely. In fact, Moschcowitz speaks of this space as hypothetical.

The opening in the transversalis fascia through which a blood vessel emerges to the surface is a locus minoris resistentiae which during increased intra-abdominal pressure yields and a hernial protrusion results.

The falciform ligament of the liver is attached in the middle of the abdomen, slightly to the right of the linea alba. This consists of two layers of peritoneum enveloping a quantity of fatty tissue. In front, this adipose tissue is close to the transversalis fascia at the linea alba.

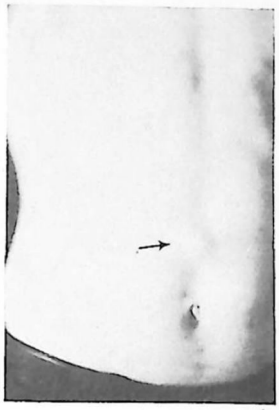


Fig. 1877. Hernia in the linea alba.

Figure 1878-C depicts a diagrammatic horizontal cross-section of the linea alba where it is penetrated by a blood vessel. Therefore, if an opening results in the transversalis fascia by reason of piercing by a blood vessel, the peritoneal fat of the falciform ligament would naturally be the first tissue to emerge through such an opening. Figure 1878-D depicts a cross-section of an ordinary epigastric hernia.

The reason why these hernias are usually of small size is because the openings in the transversalis fascia are very small while the fascia and other constituents of the linea alba are firm and resistant.

A hernial sac is usually not present in this class of cases. The peritoneal cavity will, therefore, not be entered during the repair of such hernia. Frequently wrong diagnoses are made in these cases because the dragging down of the fat and peritoneum of the falciform ligament causes symptoms referable to the stomach and a diagnosis of gastric disease rather than hernia is made.

Treatment. Make an incision in the linea alba over the hernial protrusion. The surgeon observes the adipose tissue alluded to above and usually mistakes it for peritoneum. After he incises and examines it, he recognizes he is dealing with omentum. The opening of the peritoneal cavity then offers a great deal of difficulty.

A better method is Moschcowitz's operation which is performed as follows:

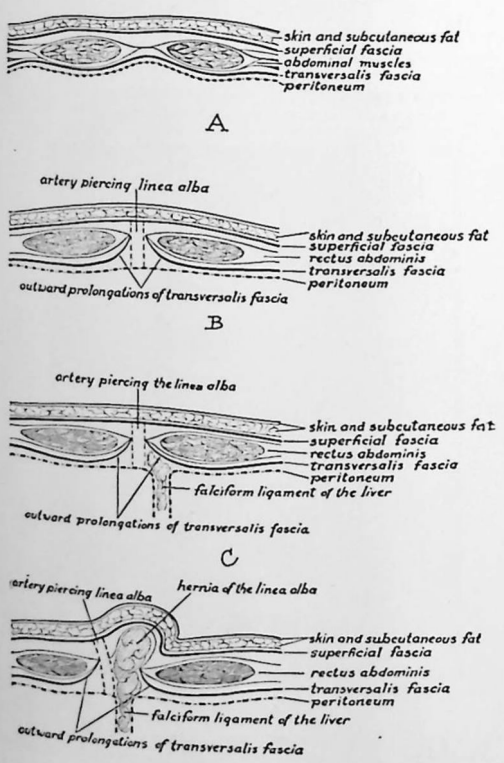


Fig. 1878. Topographic anatomy of the linea alba and its relation to hernia in this situation. (After Moschcowitz.)

Step 1. Make a small vertical incision over the middle of the hernia.

Step 2. Incise and retract the skin and subcutaneous fat, thus exposing the fat nodule.

Step 3. Grasp the blood vessel, which is usually situated on the left side of the protrusion, and ligate it. The fat is carefully dissected apart convincing the surgeon that he is not dealing with a true sac. Ligate the shreds of fat to preclude secondary hemorrhage.

Step 4. Push the ligated stumps back into the opening which is then closed with one or two sutures. Place the ligatures close to the bottom of the opening in the transversalis fascia. Close the skin as usual.

Comment: While strangulation of epigastric hernias is very rare, it is, nevertheless, occasionally encountered.

OBTURATOR HERNIA

This hernia egresses through the obturator canal which is situated in the upper, external portion of the obturator membrane occupying the entire obturator

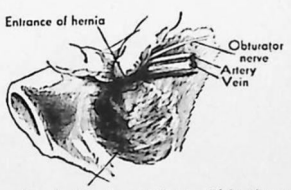


Fig. 1879. Hernia seen through obturator membrane. Right obturator hernia seen from within. (Piersol.)

foramen. (Fig. 1879.) It usually occurs in elderly women. It is difficult to diagnose and is usually recognized at operation for intestinal obstruction.

Normally, the obturator canal is occupied by the obturator vessels which are enveloped in the sheath resulting from the prolongation of the pelvic fascia, a small amount of adipose tissue, the obturator nerve and at times a small lymph node. The canal is lined with peritoneum and is covered by the pectineus muscle. The blood vessels course through an interspace in the obturator internus muscle.

The origin and development of an obturator hernia is the same as that of other hernias. In order to reach the thigh, the obturator vessels which run between the peritoneum and transversalis fascia of the pelvis pierce the transversalis fascia, forming an opening; through this opening the hernia emerges in the following sequence. Anatomically, the obturator vessels, after penetrating the transversalis fascia, are enveloped in a fascial sheath. A small cul-de-sac of pelvic peritoneum is pushed into the obturator canal alongside of the vessels and herniation results if a portion of an intra-abdominal viscus finds its way into the hernial sac. Besides bowel these hernias often contain, perchance, parts of the female genital organs (ovary, tube) or bladder.

The obturator nerve does not accompany the obturator vessels; it is separated from them by the pelvic fascia. Nevertheless, it is sufficiently contiguous so that the hernia may press against the nerve causing pains along its course (inner surface of the thigh) and extending to the knee joint. The phenomenon is spoken of as the **Howship-Rombert symptom.**

These hernias are usually small but on occasion they may become large and are covered by the pectineus muscle which may become stretched.

Treatment. Because the neck of the sac is situated so deeply in the abdomen, it is extremely difficult to ligate the neck of the sac, even after

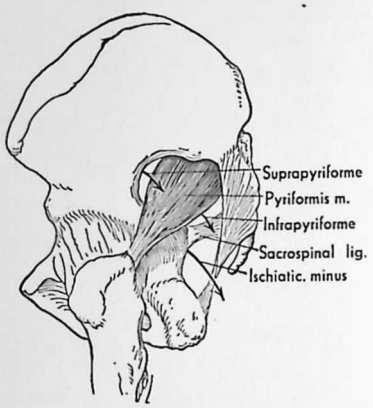


FIG. 1880. Lateral view of the pelvis showing openings through which sciatic hernia may develop.

incising the pectineus muscle. If the hernia is a strangulated one, close proximity of the obturator vessels renders the division of the strangulating ring very difficult.

Step 1. Place the patient in Trendelenburg's position. Open the abdomen.
Step 2. Bring out the afferent and efferent loops of the strangulated contents of the hernia. Avoid injury to the nerve and blood vessels. Manipulation of the contents of the hernial sac should be done with extreme gentleness.
Step 3. Withdraw the hernial sac and divide its peritoneum exposing the opening in the transversalis fascia.
Step 4. Close the opening with Pagenstecher linen or chromicized catgut.
Step 5. Obliterate the sac and close the peritoneum.

Comment: It should be recalled in dealing with a strangulated obturator hernia that the obturator vessels are branches of the internal iliac vessels, consequently lie slightly behind the neck of the sac. Not infrequently, the obturator artery is a branch of the deep epigastric or the external iliac artery and is likely to lie in front of it.

A. Rendle Short states (personal communication): "In these cases the hernia cannot be closed successfully by suturing from within the abdomen, and recurrence is common. In recurrent cases, I fill the hernia cavity by inserting a piece of costal cartilage, and then close the peritoneum over it. After this there was no recurrence."

SCIATIC HERNIA

This variety is also called gluteal hernia; it is exceedingly rare. The different sites where it occurs are: at the gluteal artery above the pyriformis muscle; at the sciatic, internal pudic and inferior gluteal vessels below the pyriformis muscles (Fig. 1880); the hernia may appear as a large pendulous tumor passing through the lesser sacrosciatic notch, accompanying the internal pudic vessels as they reenter the pelvis and may be mistaken for a perineal tumor (Fig. 1881).

FIG. 1881. Sciatic hernia. (Surgical Service, Cook County Hospital.)

The first two types are so small and deeply imbedded that diagnosis is almost impossible. If these hernias become strangulated, the preoperative diagnosis is usually intestinal obstruction; the correct diagnosis is made after the abdomen is opened. Treatment is the same as that described for obturator hernia.

LUMBAR HERNIA

This variety is rarely encountered. At one time it was believed that the only site for this hernia was the triangle of Petit which occurs over the crest of the ilium, bounded anteriorly by the external oblique and posteriorly by the latissimus dorsi muscle; the internal oblique, the transversalis muscles and transversalis fascia making up its base. However, later observations have prompted the belief that this hernia emerges through another part of the lumbar region.

The course followed by the lumbar and circumflex iliac arteries is still controversial. They are covered with peritoneum, are branches of the aorta and lie upon the transversalis fascia, which they must penetrate to reach the surface; the resulting hiatus may thus mark the beginning of a hernia; these vessels penetrate the walls of the abdomen posteriorly and laterally. Blood vessels may pierce the triangle of Petit rendering a hernia here possible. Openings in the tendon of the latissimus dorsi, trigonum lumbale superius, etc., have been described. Guy van Alstyne (personal communication) recently operated on such a case. While exceedingly rare, it must be remembered that hernia in this situation does occur.

Treatment

No definite steps of procedure can be outlined in surgically attacking lumbar hernias because each operation will depend upon the anatomic structures involved and the peculiarities of the hernial protrusion.

INCISIONAL HERNIA

This type of hernia occurs in the scar of a wound of an antecedent abdominal operation. (Figs. 1882-1883.) Among factors contributing to the occurrence of incisional (postoperative) hernias may be recalled:

(a) Faulty suturing, unsuitable suture material, sutures which have been tied too tightly causing tissue strangulation.

(b) Infected wounds followed by sloughing of the fascial and muscular structures resulting in the weakening of the abdominal support.

(c) Wounds demanding drainage.

FIG. 1882

FIG. 1883

FIG. 1882. Recurrent incisional hernia. Patient has been operated on 18 times.
FIG. 1883. Hernia in an operation scar. (Incisional hernia.)

(d) Where closure of the abdominal wound is imperfect or impossible. For example, in cases where a portion of the abdominal wall must be sacrificed because of malignant tumors. It must be recalled here that in instances where the motor nerves to a single muscle or group of muscles have been accidentally severed during an operation and are not immediately repaired are often referred to as incisional hernias; when, as a matter of fact, these are not really hernias; the muscles become paretic and atrophy; the transversalis fascia bulges; however, a true hernia does not result.

Treatment

Step 1. Expose thoroughly the opening through which the hernial contents escape.
Step 2. Make an adequate incision exposing fully the normal structures adjacent to the hernial opening.
Step 3. Open the peritoneum and separate all adhesions.
Step 4. Reduce the hernial contents and close the peritoneum as usual.

Step 5. Unite the superimposed freshened abdominal layers with chromic catgut. Meticulous suturing and strict asepsis are essential.

DIAPHRAGMATIC HERNIA

Cases of diaphragmatic hernia may be divided into two classes, that is, true and false.

True diaphragmatic hernia is one which has a complete peritoneal sac, forces the overlying pleura upward as it grows so that it is covered with two serous

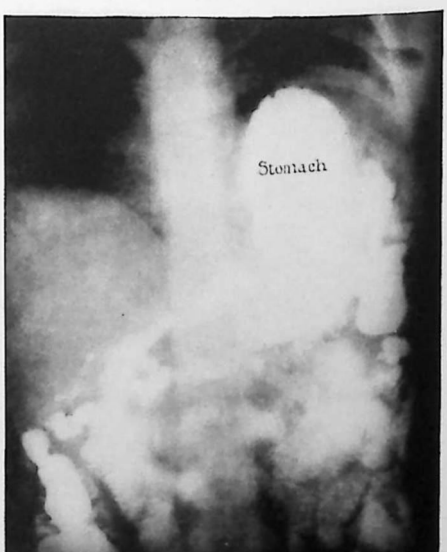


FIG. 1884. Diaphragmatic hernia. Observe greater portion of stomach contained in the left thoracic cavity.

layers; false diaphragmatic hernia is caused by trauma and has no peritoneal sac. The difference between the two is readily noted in recent cases but in those of long standing, the prolapsed hernial contents which are characteristic of the "false" variety become covered by a pseudoperitoneal sac. (Fig. 1884.)

Diaphragmatic hernias are divided according to their origin as (1) congenital and (2) acquired. The congenital type is very rare. The acquired type may be either "true" or "false." The true type is one in which there is a protrusion of intra-abdominal contents into an acquired sac. The false (acquired)

diaphragmatic hernia may be the result of a wound penetrating the thorax, diaphragm, pleura and peritoneum; or of a crushing force against the thorax.

The more frequently encountered form is explained on the following basis: peritoneum covers the entire diaphragm; immediately under the peritoneum is the diaphragmatic fascia. Careful examination reveals perforations in the diaphragm and diaphragmatic fascia allowing the passage of certain structures from the abdomen to the thorax and vice versa. These perforations are frequently the beginning of an acquired diaphragmatic hernia.

The apertures in the diaphragm are:

(a) Between the sternal and costal portions of the diaphragm where the superior epigastric artery penetrates.

(b) Where the musculophrenic artery pierces it.

(c) The opening of the esophagus.

(d) The opening of the aorta.

(e) The opening for the vena cava.

(f) The foramen of Bochdalek.

The size and quantity of the contents of a diaphragmatic hernia vary. The stomach, transverse colon and omentum are often embraced in the hernial mass; this accounts for the frequently complained of gastric distress. The heart and pericardium are frequently displaced to the opposite side. Tympany may be elicited in the thorax. When the stomach is extended, dyspnea may be complained of.

Treatment

In attacking, surgically, cases of diaphragmatic hernia in which the defects in the diaphragm are accompanied by considerable prolapse of a large portion of intestine, the undertaking is beset with many dangers.

The two methods of surgical approach are: **(a) transpleural; (b) transperitoneal.**

The advocates of the transpleural method point out that it is preferable because it permits freer handling of the hernial contents and affords better opportunity for the union of the hernial openings in the diaphragm and thoracic wall.

Transpleural Operation

Make a long incision in the intercostal space overlying the hernia. A rib spreader correctly used will give sufficient exposure without the necessity of resorting to rib resection. If such procedure is insufficient, do not hesitate to resect one or two ribs. A pneumothorax should be avoided. This may be accomplished by a promptly controlled intratracheal insufflation anesthesia or pressure cabinet.

In true diaphragmatic hernia incise first the diaphragmatic pleura, then the diaphragmatic peritoneum; in the false variety, the hernial contents are exposed. Liberate all adhesions and reposit all contents into the abdomen. Trim away the redundant portions of the sac. Suture the hernial opening in the diaphragm, each suture grasping in its bite pleura, endothoracic fascia, diaphragm, diaphragmatic fascia and peritoneum. Expand the lung by means of intratracheal insufflation anesthesia or with the pressure cabinet and close the aperture in the

thorax. A temporary resection of the costal arch, after the procedure of Marwedel is often very helpful.

Charles Harrison Arnold of Lincoln, Nebraska, suggests that when operating on a diaphragmatic hernia, using the thoracic approach, that one week before operation the patient have an artificial pneumothorax on successive days, until the lung is completely collapsed on the affected side. He finds that by so doing, all shock is obviated when the chest is opened at operation time.

He also suggests that after making the skin horse-shoe incision down to the ribs, that the soft tissues be dissected backward for one inch around this entire incision, and with an electric drill, holes be made through the ribs one inch distant

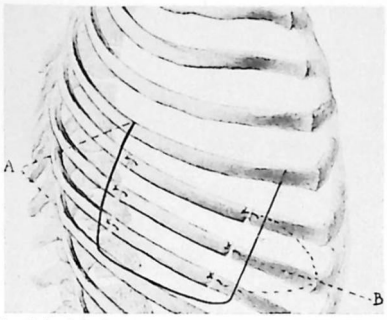


FIG. 1885. Ribs of the right side in their natural position; seen from right. A. Horse-shoe incision. B. Drill holes in ribs. Wires in place.

from each other so that the ribs can be united by placing a rustless steel wire through these openings and approximating the cut ends of the ribs, thus eliminating pain and stabilizing the entire chest wall. (Fig. 1885.)

P. E. Truesdale[1] describes his procedure as follows:

In determining the method of approach, many factors must be considered. Laparotomy is more direct, requires less time and produces less shock. However, it has limitations. An extensively adherent viscus within the sac, coexistent with adhesions between the sac, lung and pericardium, may add much to the difficulties encountered. In traumatic cases and in congenital cases in children, adhesions and distended hollow viscera sometimes prevent reduction of the hernia from below. Olmstead regretted that he had not used the thoracic route in a fatal case. Gibson pointed out the fact that when the stomach is markedly dilated, it cannot be pulled through a narrow aperture in the diaphragm from below.

The x-ray film is of assistance in determining the method of approach. When the cardiac end of the stomach, which is visible by x-ray above the diaphragm with the patient in the Trendelenburg position, does not descend when the position is changed to the upright posture, one concludes that adhesions have formed

[1] Am. Jour. Surg., Vol. 32, No. 2, May, 1936.

between the stomach and the sac and one employs the thoracic route. It is not maintained that adhesions of the stomach within the sac cannot be severed from below. With the cardia drawn down into the abdomen, adhesions within the sac are put on tension and their division, though somewhat difficult, can be accomplished. However, adhesions of the sac to the esophagus, pericardium and pleura are shut off from the abdomen and their division becomes difficult if not impossible.

Whichever method of approach is employed, operation is predicated upon the knowledge that acquired hiatus hernia in the adult presumably is caused by a loss of tone in the diaphragmatic musculature partially encircling the esophagus. A loss of tone and an abnormal spreading of the muscle structure forming

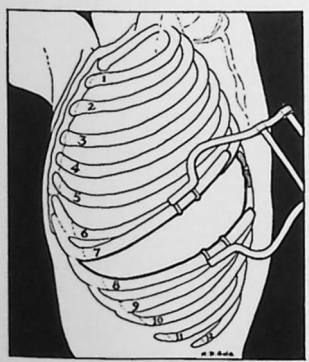


FIG. 1886. Seventh and eighth ribs severed posteriorly according to the method of Roberts. (Courtesy of Dr. P. E. Truesdale.)

the hiatus result in what might be termed a "weak milking hand" with retardation of the food column before it enters the stomach.

Truesdale Technic for Diaphragmatic Hernia by the Thoracic Route

Step 1. Truesdale believes that the approach described by Roberts of London generally gives satisfactory results. Make the usual incision of the soft tissues dividing one or more ribs (usually the seventh and eighth posterior to the tubercle).

Step 2. Divide the intercostal pleura along the entire length of the incision. Use a self-retaining retractor with or without illumination. The former gives adequate approach and light to expose those "parts of the diaphragm ordinarily considered inaccessible." (Fig. 1886.)

Truesdale admonishes that despite the possibility of saving ribs he found that under certain conditions such as the repair of a very extensive aperture,

it is of unquestionable help to excise one or more ribs particularly when the hernia occurs at the foramen of Bochdalek.

Step 3. If there is no sac, sever adhesions and reduce the herniated organs. If a sac is present dissect it free from adhesions and free it from the diaphragm. The opening at the hiatus of the diaphragm appears as shown in Fig. 1887.

Step 4. Grasp the outer extremity of this opening with a pair of intestinal forceps and draw it laterally so the borders are made taut (Fig. 1888).

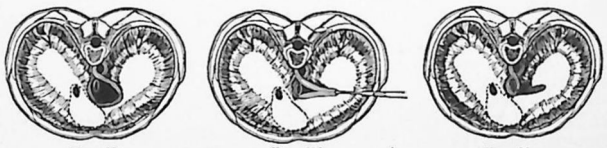


FIG. 1887 FIG. 1888 FIG. 1889

FIG. 1887. Appearance of hernial aperture.
FIG. 1888. Margin of hernia ring drawn to the left for suturing.
FIG. 1889. Hernial aperture after suturing.
(Courtesy of Dr. P. E. Truesdale.)

Step 5. Approximate these edges with a running suture of silk reinforcing the suture line with interrupted silk sutures. (Fig. 1889.)

Step 6. After the hiatus has been repaired, close the thoracic wall with interrupted sutures of silkworm-gut. Truesdale finds a Reverdin needle useful and timesaving in placing sutures.

Repair of Diaphragmatic Hernia by the Abdominal Route

Truesdale Technic

Step 1. Make an abdominal incision and expose the hernial orifice from below after the stomach has been drawn down and the margins of the opening identified. (Fig. 1890.)

Step 2. Grasp the relaxed crura which appear in the form of a rounded muscle bundle, with intestinal forceps, and draw them into the field of operation. Bear in mind the fact that the normal hiatus permits the introduction of one or two fingers. It is therefore essential that care be exercised not to suture the musculature too closely about the esophagus. While the sutures are being placed, a metal depressor about 1 inch in width is used to guard against injury to the esophagus (Fig. 1891). If the muscle on the weak side is but slightly relaxed, the two sides may be evenly apposed by placing sutures vertically, anterior to the esophagus, thus the hiatus is reduced in size to approximately normal. Truesdale points out that such method of repair has one objectionable feature and that is that the intended closure of the hiatus consists of actually uniting the two halves of the diaphragm and, while the diaphragm contracts and relaxes, the powerful traction on the suture line may result in a recurrence of the hernia. (Fig. 1892.) It is for that reason that the undesirable resort to phrenicotomy is a routine procedure of some surgeons. Again, in a typical left sided hiatal hernia, the relation of the two sides of the hiatus appears in the form of a triangle having the

right muscle bundle at its base. In order to suture this triangle vertically, the sutures must be placed at greater intervals at the two left sides which results in a shirring on the left side. However, if both sides of the triangle are brought horizontally or laterally at a tangent as shown in Fig. 1893, the closure of the hiatus is limited to an operation on one leaf of the diaphragm resulting in lessened tension of the suture and a decrease in the liability to recurrence.

Step 3. Close the anterior angle vertically with two or three interrupted sutures as shown in Fig. 1894. This will add somewhat to the strength or retention capacity of the horizontal sutures as shown in Fig. 1895.

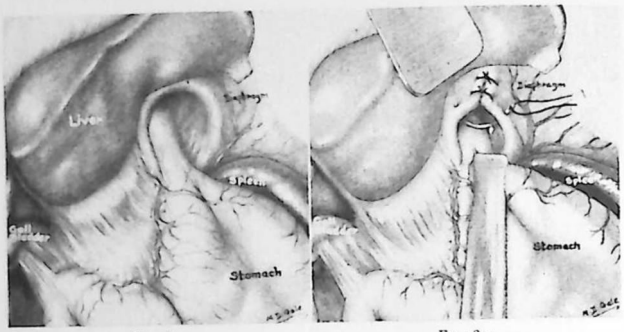


Fig. 1890 Fig. 1891

Fig. 1890. Diaphragmatic hernia. Relaxed crura outlining the hernia.
Fig. 1891. Metal depressor to guard against trauma to the esophagus while inserting sutures. (Courtesy of Dr. P. E. Truesdale.)

Comment: Truesdale points out that this operation of approximating the pillars of the diaphragm is similar to that used in joining the levator ani to strengthen the pelvic diaphragm. He also draws a convincing analogy between the anatomy of the central portion of the diaphragm and the muscle structure of the floor of the pelvis which supports and controls the rectum. (Fig. 1896.) The crura of the diaphragm are tendinous here. They pass forward and inward converging to form an arch beneath which pass the aorta and thoracic duct. It is from this arch that muscle fibers diverge so as to encompass the esophagus. A study of the origin and disposition of the levatores ani muscles reveals a similar arrangement.

Dealing with the Hernial Sac

This is a difficult process by either method. The approach to it was found more accessible by Sauerbruch and Lake when dealt with from above; it may be separated readily from adhesions and disposed of in a manner practiced in umbilical hernia. While complete removal of the sac is desirable, plication as practiced by Hinz has been resorted to; when the sac is approached from below it is drawn down to a level where it is most accessible, is dissected free and

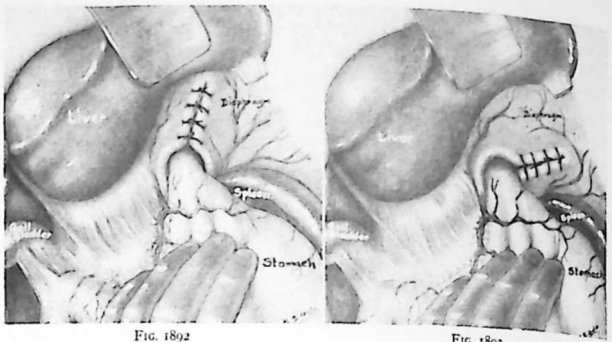


Fig. 1892 Fig. 1893

Fig. 1892. Vertical apposition of the crura.
Fig. 1893. Lateral closure of the crura.

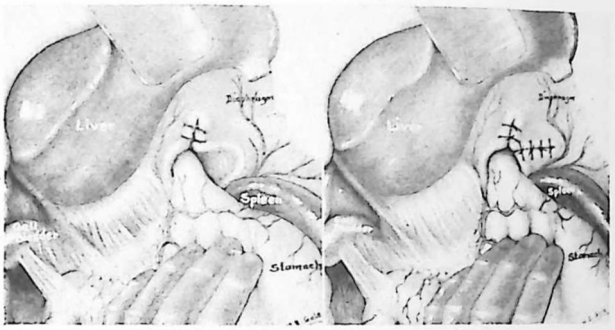


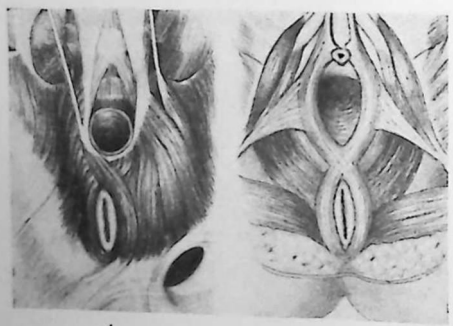
Fig. 1894 Fig. 1895

Fig. 1894. Vertical closure of anterior angle.
Fig. 1895. Closure completed.
(Courtesy of Dr. P. E. Truesdale.)

removed. Truesdale questions the wisdom of phrenic avulsion in these operations. Atrophy of the diaphragm has been shown to result in cases where the surgeon resorts to paralysis of the phrenic nerve in order to facilitate surgical repair of the hernia; crushing of the phrenic nerve should be resorted to to assure temporary paralysis instead of permanent. Injection of the phrenic nerve with 70 per cent alcohol may be done.

PERINEAL HERNIA

This name applies to hernias occurring at the pelvic outlet, emerging from the true pelvis either through or between the fibers of the levator ani and other muscles forming the "pelvic diaphragm." It may occur either behind the rectum or in front of the bladder.



A B

Fig. 1896. A structural comparison of the diaphragm with the pelvic floor. A. Posterior view. B. Anterior view of inverted diaphragm pelvic floor. (Courtesy of Dr. P. E. Truesdale.)

INTERNAL HERNIA

(See Intestinal Surgery, p. 1458)

In this variety of hernia the sac is formed from normal physiologic protrusions of the peritoneum. It may find its way (a) through the foramen of Winslow into the lesser peritoneal cavity; (b) where the duodenum joins the jejunum; (c) in the fossae around the cecum; (d) at the mesosigmoid fossa which occurs on the left side of the root of the mesosigmoid and (e) occasionally in blind fossae near the top of the bladder.

The majority of these cases are diagnosed preoperatively as intestinal obstruction, their true nature being disclosed at operation. Therefore, the procedure is the usual emergency operation. Two loops of bowel, one distended and one collapsed, show the way to the affected zone. The loop which is collapsed is much more easily followed.

In instances where the hernia is strangulated, manipulation may be effective in obtaining reduction. If this fails, open the neck of the sac; carefully avoid injuring the surrounding vessels; this should be particularly observed in the case

of left-sided duodenojejunal hernia where the inferior mesenteric vessels may easily be injured. After the intestines have been reduced, the sac may be dealt with in different ways. Obliteration of the sac may be out of the question on account of its size, because it is surrounded by large vessels or because a part of its wall is made up of intestine. Suturing of the sac or its neck may be dangerous on account of the size of the sac and the presence of large blood vessels; such a closed sac is liable to become infected and cause peritonitis. It seems better under such circumstances to leave the sac alone regardless of the chance of a possible recurrence.

THE USE OF AUTOPLASTIC SUTURES IN HERNIA

Comment: W. E. Gallie endeavors to overcome the drawbacks in surgical operations for hernia by using autoplastic sutures of fascia lata. The results, in experienced hands, are satisfactory. Gallie states[1] that a thoughtful analysis of the results of the operative treatment of hernia in adults will convince the most sanguine that there is much room for improvement. The percentage of recurrences varies greatly with the experience and skill of the operator, but even in the hands of the most skillful, recurrences after the closure of large ventral hernias are very frequent. Gallie's researches on the causes of failures with fascial transplants caused him to evolve this method. The blame for the recurrence of the hernia must be laid to the character of the healing between the transplant and the surrounding tissues, and because surgeons rarely take the precaution to remove the areolar membranes from the surface of the transplant and the edges of the defect. The adhesion, therefore, can have only the strength of these areolar membranes, and can be of no importance whatever in preventing the separation of the hernial ring. He also states that the surgeon must place his whole trust in the character of the healing which occurs, the strength of which is very uncertain. The light scar-tissue which develops between overlapped aponeurotic surfaces is not equal to the strain which must be resisted in large ventral hernias.

Ventral hernia seems to be ideal for closure with living sutures. The whole responsibility for a curé is placed upon the sutures themselves. There is practically no limit to the number of sutures that may be inserted, so that it becomes simply a matter of the judgment of the surgeon as to how many layers of sutures are necessary to restore the abdominal wall to its normal strength. The chief precautions which must be observed are to see that the sutures are woven securely into the tissues surrounding the opening, and that these tissues, wherever possible include aponeurosis. It is preferable to make no preliminary dissection of the edges of the hernial ring into their various layers as the grip of the sutures is most secure when they are undisturbed. If the edges of the ring can be drawn together without too great tension, so much the better; but if they cannot, the gap which is left may be closed by weaving the sutures across the opening as in the darning of a sock.

Save time by having an assistant secure and prepare the sutures. A long incision is made on the lateral aspect of the thigh; expose the fascia

[1] British Journal of Surgery, 1924.

lata. Remove the fat and areolar tissues over the whole area from which the sutures are to be taken. Make a small longitudinal incision through the fascia through which it is enlarged to the required length. A second incision in the fascia is made a quarter of an inch lateral to the first, and one end of the suture is passed through the eye of a large curved needle, and tied securely after transfixion with fine silk. Cut the terminal end of

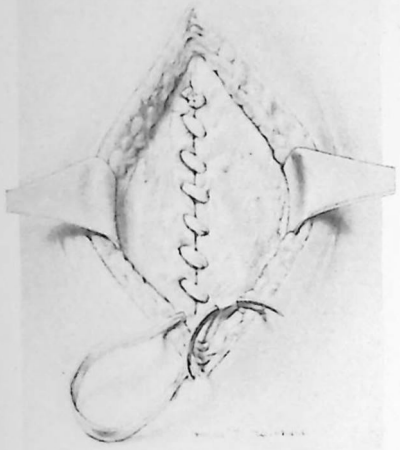


FIG. 1897. Drawing of the repair of ventral hernia with sutures of fascia lata. Insertion of the first row of sutures which brings the edges of the defect together or as nearly together as they will come without great tension. (Courtesy of Dr. W. E. Gallie.)

the suture free and tie a fine linen ligature around it to prevent splitting. In taking the first stitch the needle is passed through a tough portion of the edge of the gap to be closed and then through the terminal end of the suture. In this way a slip-knot is produced which forms an excellent anchor. (Fig. 1897.) The suture is woven strongly into the edges with as many bites as seem necessary, and passed backward and forward across the opening until its whole length is used up. Owing to the slippery character of the fascia it will be found useful to anchor the sutures at every second or third stitch by some form of knot. When the first suture has been used up a second may be attached to it in the same way as pieces of tennis gut are fastened together, and the sewing continued. In this way

one suture after another may be inserted until the opening is completely closed. The suture is finally ended by splitting its terminal portion into two strands which are tied together about the suture in a triple knot. This knot should be made secure by transfixing it with a catgut ligature which will hold its loops in contact until they become firmly healed together.

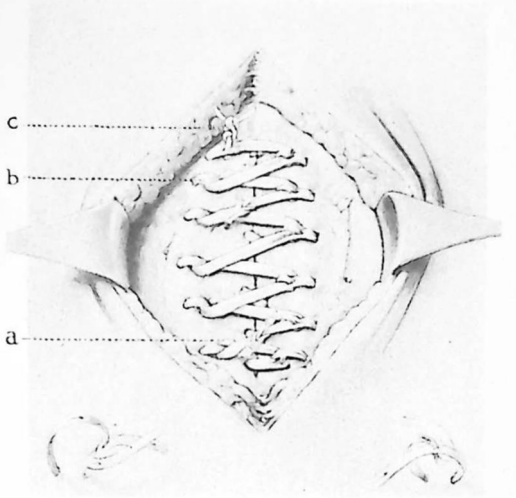


FIG. 1898. Drawing of the repair of ventral hernia. Insertion of second row of sutures. The needle takes deep bites of the aponeurosis at some distance back from the edges of the opening. a. A join between two sutures; b. lock-stitch inserted to prevent slipping; c. triple knot which terminates the suture. It is transfixed with a ligature of fine silk or catgut. The inserts in the lower corners show methods of making the lock-stitch. (Courtesy of Dr. W. E. Gallie.)

(Fig. 1898.) Close the gap in the thigh if not too large; otherwise leave it alone. Care should be taken that each loop of the suture passes through strong aponeurotic tissue, well back from the edges of the opening, so that all possibility of cutting out is avoided.

When the healing process is complete the abdominal defect is filled with an aponeurotic structure which is comparable with the linea alba.

Whatever the cause of the recurrence, the indications are that in operations for inguinal hernia in adults definite precautions must be taken to leave the abdominal wall medial to the internal ring as strong as it normally should be, and if there is any possibility of the posterior wall of the canal

being weaker than normal, it must be supported by some form of plastic operation which is more certain than the ordinary methods of suture.

It is very problematical whether the structures which are sewn to Poupart's ligament really do stay in this position for any length of time. In not one instance, despite the fact that the records showed that the conjoined tendon and the sheath of the rectus had been sewn to Poupart's ligament with kangaroo tendon or catgut, did Gallie find these structures together at the time of the second operation. This observation I can substantiate.

These findings have produced a doubt as to whether the sewing of the muscles and conjoined tendon to Poupart's ligament with ordinary sutures is ever a factor in preventing recurrence of the hernia. If, before inserting the sutures, all areolar membranes were removed from the surfaces which were placed in contact, and particularly if these surfaces were scraped and scarified, the amount of adhesion was greater; but if the normal action of the muscle tended to produce definite strain on the line of suture, the scar-tissue soon became stretched and the intention of the operation defeated. "These results demonstrate the folly of dragging structures such as the abdominal aponeurosis, the conjoined tendon, and the sheath of the rectus out of their normal positions to suture them to Poupart's ligament in the hope of permanently strengthening the abdominal wall," says Gallie.

In the case of direct inguinal hernia the defect in the ordinary Bassini operation has frequently been recognized, and many attempts have been made to improve on this operation by filling the defect in the abdominal wall with muscular or aponeurotic structures which might be able to withstand the strain. These operations all have the defect that they depend for their success on the healing together of fibrous or muscular structures, a factor which unfortunately cannot be depended upon.

The structures about the inguinal canal are peculiarly suitable for the use of living sutures. With a sufficient number of strips of fascia lata, the weak spot in the abdominal wall can be filled up completely without any disturbance of the normal anatomical relations and without any dependence on the uncertain process of healing.

The incision is made so as to allow perfect exposure of the spine of the os pubis and the insertion of the conjoined tendon and the rectus sheath. After splitting the external oblique, the upper leaf is reflected until a good view is obtained of the internal oblique aponeurosis. The sac is dealt with in the usual manner, although occasionally Gallie has done nothing more than to push it backward out of the way. The first suture of fascia lata, a quarter of an inch wide, is then anchored securely into the rectus sheath close to its attachment to the pubic bone. The needle is now passed behind the spermatic cord to pierce Poupart's ligament at its insertion into the pubic spine. If possible it should be made to pick up the periosteum to make the security of its fixation more certain. When the suture is drawn taut, the weakest spot in the abdominal wall, namely, that which lies behind the external abdominal ring, is filled with a tough aponeurotic tissue which effectively prevents any bulging through the ring. (Fig. 1899.) The sewing is continued in an outward direction, drawing the internal oblique muscle to the reflected portion of Poupart's ligament behind

the cord, until the position of the internal ring is reached. Here the suture is locked and then carried to the outer side of the ring, where a supporting stitch is inserted. In this way the cord, at the point where it disappears through the abdominal wall, is surrounded by a fibrous ring which will effectively prevent the development of a hernia at this point. By locking

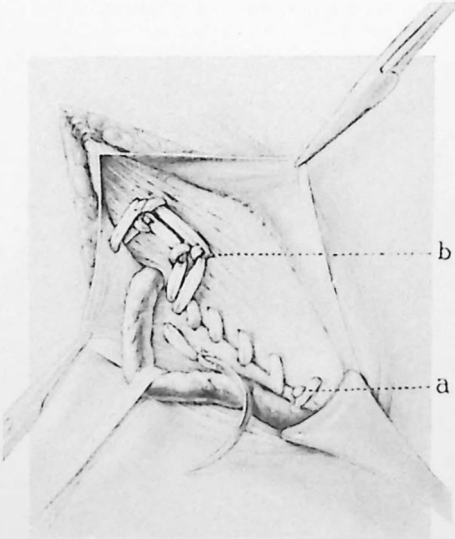


FIG. 1899. Repair of inguinal hernia. Drawing of the repair of an inguinal hernia with sutures of fascia lata. Insertion of first row of sutures which brings the internal oblique and conjoined tendon into contact with Poupart's ligament and reinforces the internal ring. a. Slip-knot anchoring stitch; b. lock-stitch. (Courtesy of Dr. W. E. Gallie.)

each stitch at this stage the possibility of undue constriction of the cord is prevented. It is of value to permanently cover the peritoneum with a thick layer of muscle which will prevent the protrusion of peritoneum through the chinks of the next layer of sutures, which is the important one in the prevention of recurrence. This layer commences as a continuation of the first, at the outer side of the internal ring. The needle takes a solid bite of the oblique aponeurosis at its point of fusion with the external oblique and is then passed behind the cord to pick up Poupart's ligament. The

suture is carried backward and forward across the space, with frequent lock-stitches, until the sheath of the rectus is reached, and this also is woven to Poupart's ligament until the whole space is filled with fascia down to the pubic spine. (Fig. 1900.) No attempt is made with the second row of sutures to drag the abdominal aponeurosis and the rectus sheath out

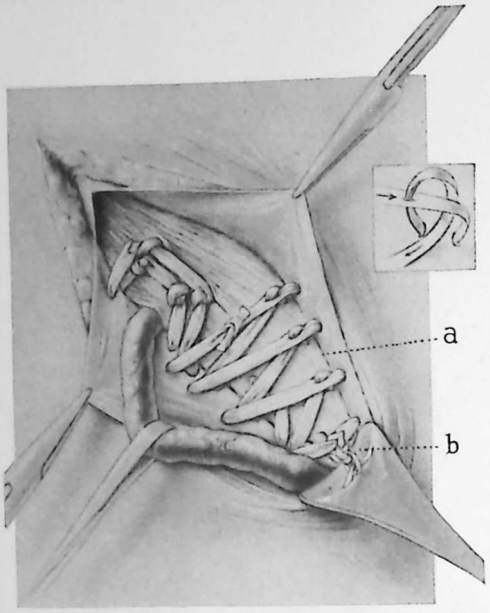


Fig. 1900. Repair of inguinal hernia. Drawing of the repair of an inguinal hernia. Insertion of second row of sutures between the external aponeurosis and Poupart's ligament. These structures are not drawn together, but the interval between them is filled in with a filigree formed by the fascial suture. a. Line of junction of the aponeuroses of the internal and external oblique muscles in the abdominal aponeurosis. b. Termination of suture. Insert shows most useful form of lock-stitch. (Courtesy of Dr. W. E. Gallie.)

of their normal positions. No greater tension is exerted on the sutures than is sufficient to make them lie flat. The whole idea of the operation is to fill the weak spot in the abdominal wall with what may be called a filigree of living aponeurosis. What one does with the external oblique is of relatively little importance. Usually in direct hernia it is too weak to be of any value to the surgeon.

In many oblique hernias, however, the posterior wall of the canal is not normal. The simple removal of the sac in these cases, therefore, leaves

the posterior wall of the canal very weak and quite unfit to withstand unusual intra-abdominal pressure. These are the cases which call for some form of repair of the abdominal wall.

The operation for oblique hernia consists of supporting the weak spot by a permanent meshwork of fascia lata which is sufficient to withstand all variations of abdominal strain.

W. H. Ogilvie points out[1] that Poupart's ligament is composed entirely of strips with a long arrangement having very full connecting fibers. The passage of a double row of sutures about one-quarter of an inch in width and threaded with very coarse needles is necessary to carry them, which tends to split up the ligament into a leash of disconnected fibers. This

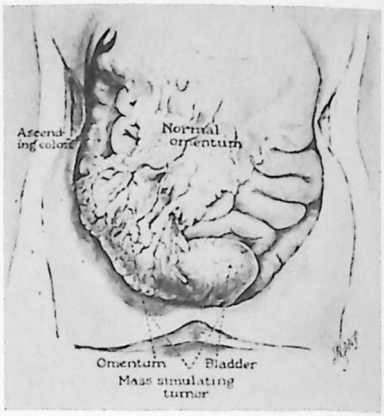


Fig. 1901. Epiploitis.

laceration of the main tie is a possible reason for recurrences which have been reported from time to time following Gallie's operation for inguinal hernia. Ogilvie has seen only one such recurrence which happened in the case of a physician on whom he operated a year previously, for direct hernia, by the fascial suture technic. He states: "I have, however, been so distressed by the irregular appearance of Poupart's ligament at the end of the operation that I have abandoned the fascial strips for silk threads." Ogilvie further points out that silk is very much stronger than any living suture material of considerable size and, while it is, of course, a foreign substance, it is not absorbed. It is not resented by the tissues, remaining permanently incorporated in fibrous tissue as a harmless foreign material. Silk repair is carried out in a very similar manner to fascial suture, the point being that the silk is not used to draw the structures together but to form a lattice work, bridging the deficient posterior wall of the inguinal

[1] Operations of Surgery, Rowlands and Turner, 1937.

canal and extending to Poupart's ligament below, and the outer border of the rectus abdominis sheath above and medially. It holds in its meshes the conjoined tendon and cremaster muscle, all of which blend to form a pliable and tough fibromuscular sheath. No. 4 silk, about 22 inches long, threaded on a small Mayo needle is used. The method is a modification of W. Sampson Hadley's "Darn-Staylace method" described in 1918.

POSTOPERATIVE EPIPLOITIS

The author and Phil Thorek[1] observed such cases. (Fig. 1901.) The presence of inflammatory and suppurative lesions in the omentum is by no means rare. Vigyázo found less than 100 cases reported in the literature. Abdominal operations may or may not be the origin of this condition. It may result from the presence of a foreign body or from an inflammation extending from some adjoining organ. In the cases following abdominal operations, their cause has been attributed to ligatures which nurtured microorganisms or to ligating inflamed tissues of the omentum during a herniorrhaphy, appendicectomy or any procedure involving the omentum, especially if it has been resected.

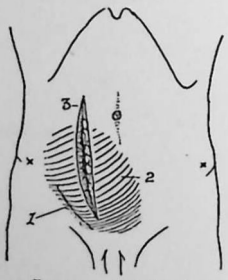


Fig. 1902. 1. Healed hernial scar. 2. Tumor mass. 3. Incision for exploration and biopsy.

Epiploitis is of two types: (1) the chronic or Schnitzler-Brown type which manifests itself from a few weeks to a year following operation and (2) the acute or Küttner-Schmieden type which seems to originate from an embolus or thrombosis and may be characterized by symptoms very much like acute appendicitis or some other abdominal condition.

Emerson reported recently three cases of inflamed and hypertrophied omentum in obese patients which followed subumbilical celiotomy. The omentum had not been resected in any case. Two cases which followed pelvic and abdominal operations were reported by Arnold. The omentum had not been touched during either procedure but in each instance the patient had left the hospital feeling not quite normal and the symptoms of abscess manifested themselves a few weeks later. In one of the author's cases epiploitis followed herniotomy. (Fig. 1902.)

Another case was recently operated on by the author at Cook County Hospital. It concerned a middle-aged man suffering from a left indirect scrotal hernia. During operation the sac was found filled with serosanguineous fluid but no hernial contents could be discovered. The small bowel was pulled down through the opened inguinal canal but no explanation could be found for the existing bloody effusion. The thought that a strangulated loop of bowel had been reduced and escaped our attention caused me to excise the sac, repair the inguinal canal and open the abdomen through a left transrectus incision. This disclosed that a large portion of the omentum showing all macroscopic evidences of a chronic epiploitis had been contained in the hernial sac when it became

[1] Jour. A.M.A., April 30, 1932, Vol. 98, pp. 1548 and 1549.

incarcerated and the bloody effusion was thus explained. It is possible that the reduction into the abdominal cavity took place during anesthesia, hence could

Fig. 1903

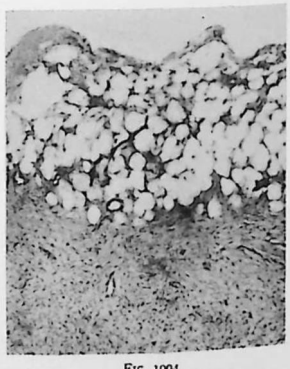


Fig. 1904

Fig. 1903. Chronic epiploitis forming the contents of hernial sac.
Fig. 1904. Postoperative epiploitis. Magnified 70 diameters. Omentum shows marked inflammatory changes.

not be discovered during operation. The affected portion of the omentum was resected and the abdomen closed (Figs. 1903-1904).

THE INJECTION TREATMENT OF HERNIA

C. Jennings Marshall (Med. Press and Circular, Oct. 19, 1938) reminds us that the injection treatment for hernia is a century old, originated by Velpeau and recently revised with the "usual éclat of the plagiarist." A variety of formulas are used.

Proliferation and obliteration of the sac and fibrosis of the deep parts of the inguinal is the aim; the former a rather speculative probability. Fatalities and complications are not rare. Frequent injections are required (not infrequently 20 or over). A truss must be worn during the treatment and for some time afterward. "In general the treatment is reasonably successful according to its exponents' figures in the type of case in which surgery is most uniformly effective; whereas on the same basis it is quite undependable in the degenerative cases in which intelligent surgery will secure still "high proportion of good results" (Marshall). The author has seen one case of gangrene of the spermatic cord and testicle following an injection of a sclerozing substance for the "cure" of an inguinal hernia by a "rupture specialist." Harris and White (J.A.M.A., Vol. III, Nr. 22, p. 2013, 1935) point out among their conclusions that this method of treatment "is not simple and necessitates detailed care over a considerable

period. The most important single factor in the technic is the selection and application of a truss." They conclude by pointing out that in general, the end results of the treatment of hernia by injection are not comparable to those obtained by operation. These results, however, are sufficiently good to recommend this treatment when operation cannot be considered because of economic, personal or physical reasons, while Robert Slater (New England Journal of Surgery, Vol. 221, Nr. 23, p. 895) points out that twenty patients with hernias were treated by the injection method and carefully followed. At the end of four years two patients were cured. Slater believes that the injection treatment of hernias is not satisfactory and should be used only when the patient must not be operated on and then only after the method of treatment and its potentialities for cure have been fully explained to the patient.

Ignatz Mayer of Detroit reintroduced the injection treatment and claimed 98 per cent of cures. The irritants used for injection are varied: tannic or gallic acid, zinc sulfate, carbolic acid, thyol, pinus canadensis, a soap solution derived from psyllium seeds, etc. The truss must be worn night and day for a prolonged period. Early tissue reactions cause more or less thickening which may temporarily prevent the hernial contents from descending, masking the true state of affairs and cures claimed where not justified. Leonard Erdman recalls that Frank A. Kelly of Detroit who worked with Mayer and subsequent to the latter's death followed many of Mayer's patients, states "We are not sure that we have cured anyone" and that he believes that about 12 per cent of hernias may be cured. Reliable statistics indicate that one may expect one cure in every six patients suffering from hernia. Coley (New York) reported 81.03 per cent relapses following the injection treatment.

Mayer's solution consists of

Zinc sulfate	3.9
Phenol (cryst)	23.3
Glycerin	15.
Aqua cinnamomi	30.
Ex. fl. pinus canadensis (dark)	18.5
Aqua Dest. (sterile)	59.2

Of this solution 0.1-0.5 cc. are injected.

Place the patient on his back; elevate his hips slightly. An ordinary hypodermic syringe with a needle of about 22 gauge is used. Prepare the field of operation as usual. Local anesthesia with a 1 per cent solution of novocain is satisfactory.

The aim is to inject the musculo-fascial structures about the rings and along the inguinal canals. Place a gauze pad over the puncture after withdrawing the needle. Keep the patient recumbent for about 20 minutes or so, having him compress the site of the injection during that time.

Injections are made at three-day intervals for about two weeks. Only the smallest dose of the preparation should be injected at first, in order to ascertain reactions; when no untoward manifestations are observed the dose is gradually increased. The truss is worn for about two months.

Part VI

SURGERY OF THE PELVIC REGION

CHAPTER	PAGE
39. Gynecologic Operations	1739
40. Surgery of the Genitourinary Organs	1858

ORIENTATION

Many a general surgeon not infrequently recalls that he has built his reputation on the success he has attained in surgery of some urologic operation (Chapter XL), or in performing some noteworthy gynecologic procedure (Chapter XXXIX). Both of these sections of the work have been thoroughly entered into and every form of operation in both chapters described as fully as possible.

The successes of today are built on the sacrifices and researches of the masters of the days gone by. Abroad, Sir Astley Cooper, John Hunter, Sir Henry Thompson, Jean Civiale, Félix Guyon, Joaquin Albarran, Bottini, Légue, Max Nitze, James Israel, Thiersch, Proust, and in our own country, Samuel Gross, J. H. Bigelow, Hugh H. Young, Coffee, Braasch, Keyes, Van Buren, Belfield, Hinman and others made urologic history.

Operative gynecology started with Jacob Hufer, a sow-gelder, who in 1500 performed a successful Caesarian section upon his own wife. She lived to be seventy-seven years of age and bore other children. Through the centuries, to our own time notable contributions were made in gynecologic surgery by pioneers to mention only Marion Sims, McDowell, Emmett, Tait, Martin, Doyen, Wertheim, Howard Kelly, Sampson, König, Alexander, Schauta, Koeberlé and others.

The general surgeon must always keep in mind that the term "minor surgery" is a misnomer. A distinguished colleague and myself were observing an individual struggling, while performing a circumcision. The details need not be described. I ventured the question: "Is there such a thing as minor surgery?" "No," replied my colleague, "there is not, but there are 'minor surgeons.'" Harold Burrows describes a startling disaster in an operation for varicocele. After the surgeon had made the usual incision he grasped what he thought was the spermatic cord. He applied two ligatures and divided the tissues between. He then permitted the two ends of the ligated tissues to retract and he sutured the wound. He was later called to see the patient who could not urinate. Catheterization proved of no avail. The house staff could not introduce a catheter. Examination revealed that instead of ligating the spermatic veins the surgeon had ligated and severed the penis. Burrows concludes this narrative by stating that while this case is almost too gross an error to be printed but "since it happened once" he thought "it might happen again." If such mishaps are recorded in modern times, how cautious must the surgeon be in approaching the intricate problems presented in surgery of the kidneys, ureter, prostate, seminal vesicles, etc., or in operations on the female genital organs? Yes, of all operations performed, circumcision tops the list for poor technic. Whether in simple catheterization of the bladder, or the repair of a difficult hypospadias, or a ruptured urethra, the removal of an obtrusive median bar of the prostate or in renal surgery, the simple dilatation of the cervix uteri or an extended hysterectomy, all must be approached by the surgeon armed with sound surgical judgment, a full knowledge of the problems involved and he must be free, at all times, from overconfidence and of inflexible conviction of "superior" ability.

CHAPTER 39

GYNECOLOGIC OPERATIONS

Anatomic Considerations. (Fig. 1905.) The pelvic outlet is closed by two muscles, the levator ani and coccygeus. The former, together with the strong fasciae covering its external and internal surfaces, are important constituents of the pelvic diaphragm. The levator ani supports and retains the abdominal and

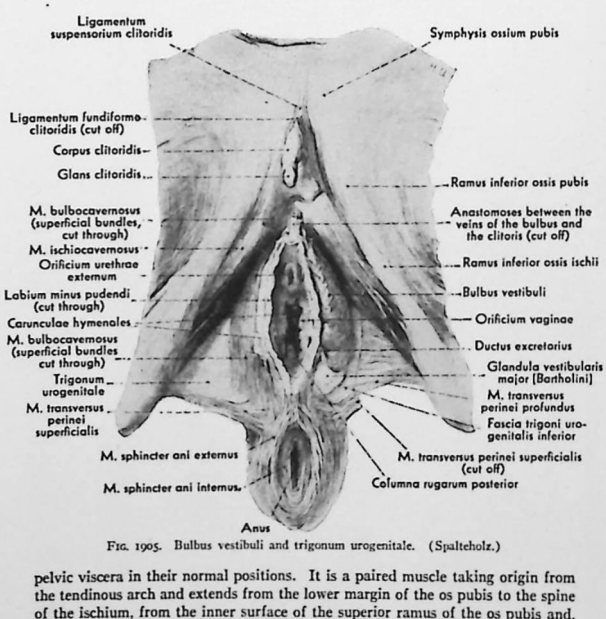


FIG. 1905. Bulbus vestibuli and trigonum urogenitale. (Spalteholz.)

pelvic viscera in their normal positions. It is a paired muscle taking origin from the tendinous arch and extends from the lower margin of the os pubis to the spine of the ischium, from the inner surface of the superior ramus of the os pubis and, from the pubes parallel to the symphysis, then from the pubococcygeus muscle. The pubococcygeus muscle is a smaller structure. The relation of the levator ani to the external sphincter muscle of the rectum is of great importance. The transversus perinei and deep pelvic fasciae also play an important part in the repair of the soft tissues composing the pelvic floor (Figs. 1906-1907).

COLPOSCOPY

The colposcope devised by Harry O. Maryan[1] is used to magnify and detect lesions of the cervix uteri and the vaginal fornices, not visible to the naked eye.

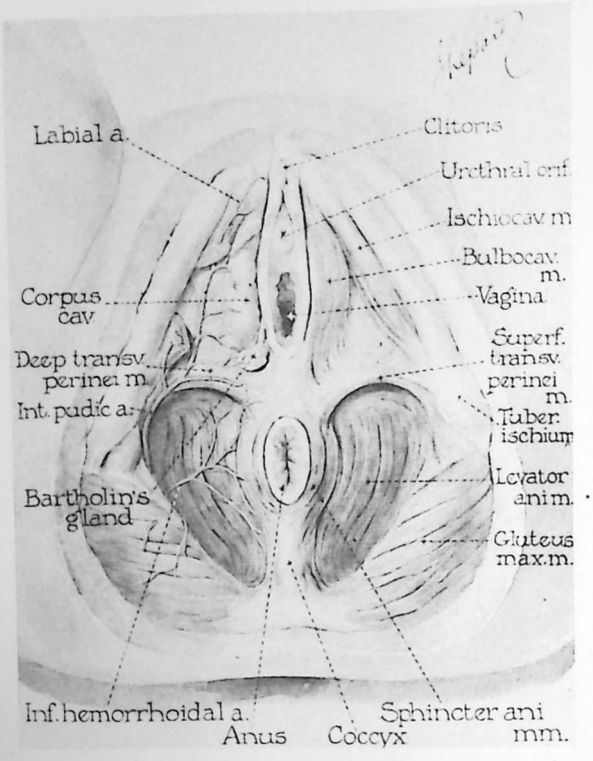


Fig. 1906. Anatomy of female perineum.

The colposcope is of especial value in detecting pin-point leukoplakias, suspicious lesions along the margins of erosions (the base of which is known as the matrix)

[1] Am. Jour. Obst. & Gynec., 30: 148, July, 1935.

and also small early carcinomatous lesions. It also acquaints one with the surface of the erosion, the healed area of which is known as the transformation zone, and the granular red unhealed area as the base, or matrix. (Fig. 1908.)

Fig. 1907. Draping of patient in gynoplastic surgery. Note instrument shelf conveniently attached to the operating table.

The transformation zone and base of the erosions with its margins are the areas where leukoplakias and early carcinomas can be detected.

This colposcope may be used in conjunction with Schiller's test. With an ap-

plicator, paint the cervix with Gram's solution, consisting of one part iodine to two parts of potassium iodide and 300 parts of water.

A positive Schiller's test is characterized by a definite area which does not take the stain. It was discovered by Lahm that the glycogen present in large quantities in the normal epithelium of the portio vaginalis of the cervix disappears with the change of the epithelium into carcinoma. After a few minutes the

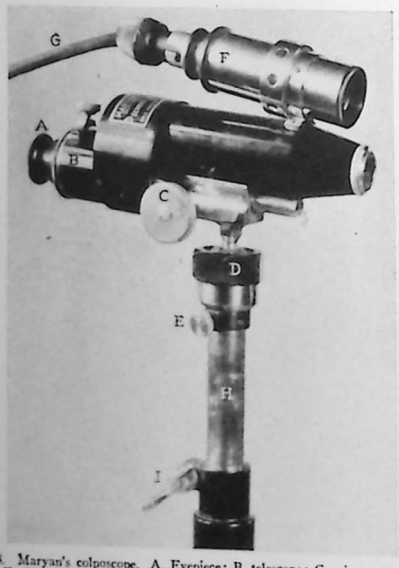


Fig. 1908. Maryan's colposcope. A. Eyepiece; B. telescope; C. micrometer; D. universal swivel joint; E. clamp of extension rod for telescope; F. lamp attachment; G. rheostatic cord; H. extension rod; I. clamp of stand.

Gram's solution fades away. Therefore one should make the observation immediately. Leukoplakias and early carcinomas do not take the stain and are brought out with the aid of the colposcope.

This colposcope is a monocular achromatic prismatic telescope giving magnifications of 6, 10, 13, 18, 25 and 30 diameters, at a focal distance of 6¾ inches from the cervix to the front lens. It gives an erect image and has a fixed focus. It can be used on a circuit of 110 V. 60 Cy. A.C. or D.C. current, as it contains a rheostatic cord attached to the lamp.

The magnification can be increased by interchanging the eyepieces as they are numerically marked. The free working distance from the cervix to the front

lens is 6¾ inches. The distance from the introitus to the front lens is 2¾ inches, leaving adequate room to perform direct biopsies, electrical cauterization, or coagulation, and to perform any manipulation which may be necessary, including the Schiller's test. We have found for preliminary study that the six-power magnification acquaints the observer with the general picture. After this preliminary study the ten-power eyepiece is used to locate carefully the suspicious lesion or area. The ten-power magnification is universally accepted by most observers. The higher the magnification the greater is the distortion and the smaller becomes the visual field.

The next important step is to obtain adequate exposure and to have the field as dry as possible. For this, Maryan uses sand-blasted Grave's specula and Guttman's operative speculum. In this way unnecessary glare and reflections will be done away with, and will prevent fogging of the colposcopic picture. The vagina, fornices and the cervix should be carefully wiped clean with a one per cent solution of lysol on a cotton sponge and dried. The heavy mucoid discharge from the cervical canal may be dissolved with "caroid powder" on a cotton applicator. It may be necessary to repeat this procedure several times to secure a dry field and avoid the fogging of the colposcopic picture. The observer can now visualize through the colposcope the cervix, the fornices, and the cervical canal and detect conditions that he was not able to see with the naked eye.

Colposcopic findings should always be checked by multiple or serial tissue sections; in this manner mistaken tissue biopsies will be greatly reduced.

OPERATIONS ON THE EXTERNAL GENITALIA

VAGINISMUS

Operation for vaginismus calls for (a) Excision of the hymen or (b) Enlargement of the vaginal entrance (Fenton's operation).

Step 1. Small, sensitive hymenal carunculae myrtiformes about the introitus vaginae are excised and the entrance to the vagina thoroughly dilated. Check oozing by means of packs or a suture of catgut.

Step 2. If the hymen is intact, excise its base of attachment around the introitus. Always remove the entire hymen. Stretch the introitus with the thumbs, introducing first one, then the other.

PERINEOPLASTY (PERINEORRHAPHY)

Local infiltration anesthesia may be used as depicted in Fig. 1909, which depicts the initial wheal of ½ per cent novocaine solution creating an area of bloc extending from one caruncula myrtiformes to the other. Figure 1910 shows the method of anesthetizing the lateral triangles to be denuded within the vagina while Fig. 1911 depicts the completion of the anesthesia.

Step 1. Planning the Flap. Study the direction and extent of the laceration. Find the carunculae myrtiformes on either side of the hymenal circle. Grasp these with a vulsellum forceps or transfixion sutures; place another vulsellum at the highest point of the laceration—the "crown" (Fig. 1912 a). In placing the vulsella at the carunculae estimate their distance as related to the external urethral orifice in order to avoid the formation of too small an introitus.

Step 2. Opening the Pelvic Floor (Fig. 1912 a). Make a curved incision with its convexity upward extending from one caruncula (vulsellum) to its opposite fellow. Dissect or divide the vaginal mucous membrane for a short distance with a sharp scalpel, the cutting edge of which is directed toward the vagina in order to avoid injury to the underlying rectum. Extend the dissection upward to the vulsellum holding the "crown"—the highest point of the laceration; remove the dissected flap of vaginal mucosa with scissors. Once the line of cleavage between the vaginal wall and the underlying structures is entered the detachment of the vaginal flap proceeds with facility by continuing the dissection with a gauze covered right index finger. There is a layer of veins between the rectum and the vaginal wall; avoid them.

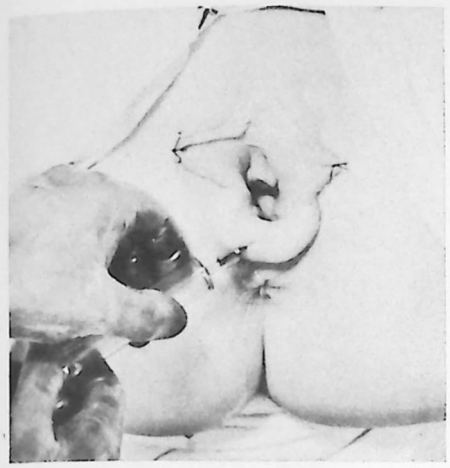


FIG. 1909. Local anesthesia in perineoplasty. Formation of initial wheal. Labia minora kept out of field of operation with sutures attaching them to the adjacent inner surface of the thighs.

Step 3. Isolation of the Levator Ani Muscle Fascia ("Musculofibrous sling"). The anterior margin of each levator ani muscle is now located by exploration with the finger and dissected free for about 2 or 3 cm. By freely separating the vaginal flap laterally toward the pelvic floor the fascia and levator ani will be made more accessible. (Fig. 1912 b.)

Step 4. Uniting the Levators and Fascia (Figs. 1912 c-d). With catgut of sufficient tensile strength and durability (No. 1 or 2 chromic) carried on a curved Mayo needle, unite the levators and fascia by interrupted sutures in

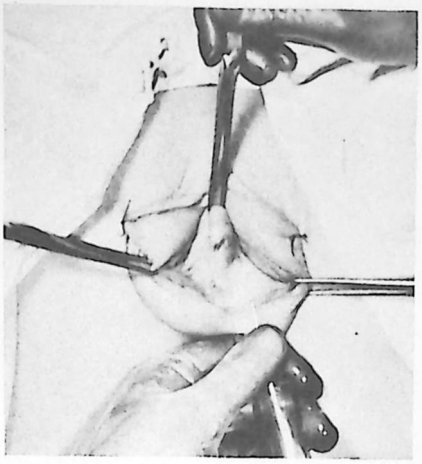


FIG. 1910. Anesthesia of vaginal triangles

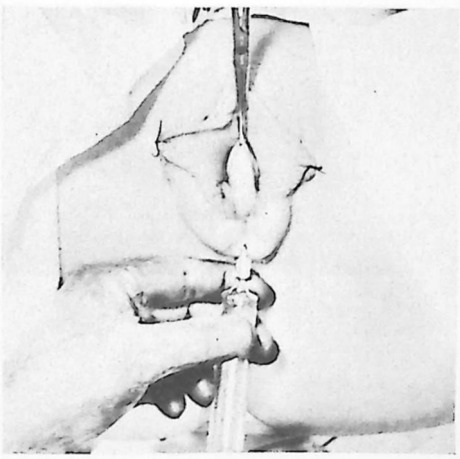


FIG. 1911. Anesthesia completed.

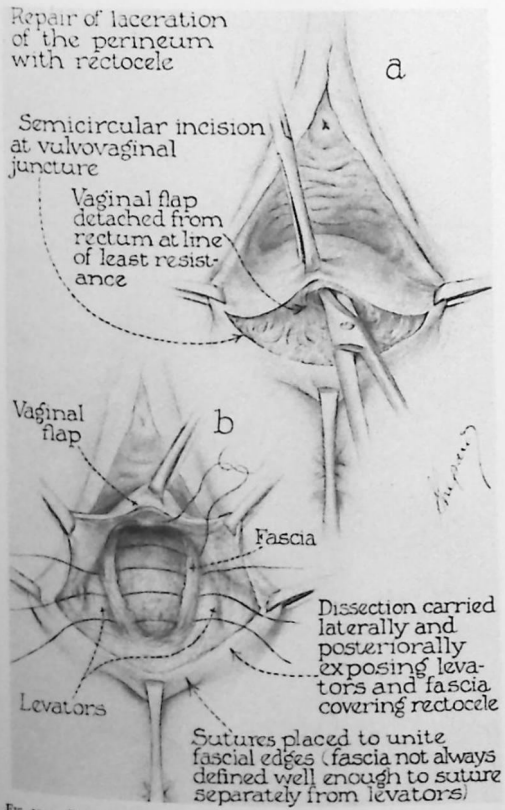


FIG. 1912. Perineoplasty: repair of perineum with rectocele. a. Caruncular myrtiformes and highest point of the laceration. "Crown" grasped with vulsella forceps. Opening the pelvic floor. Finding line of cleavage. b. Isolation of the levator ani muscle (musculo-fibrous sling). Uniting the levatores ani and fascia.

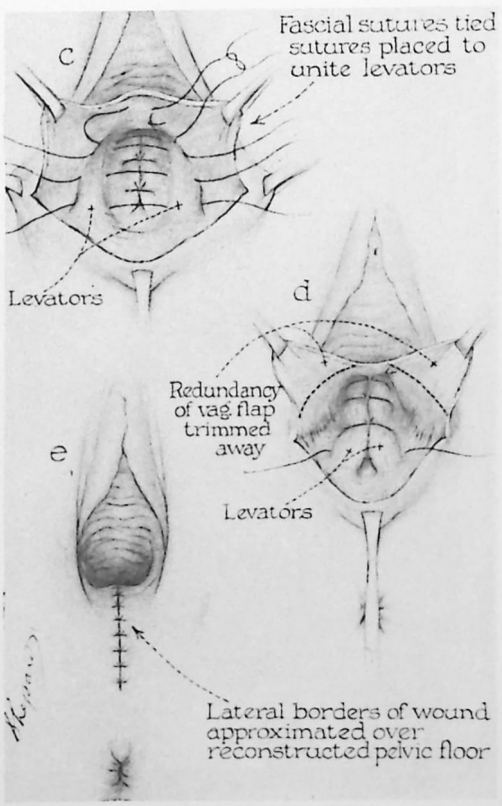


FIG 1912. Perineoplasty (continued). c. Suturing musculo-fibrous sling. d. Redundancy of the dissected vaginal flap may be ablated earlier in the operation or now. After testing size of vaginal outlet (Fig. 1913) the perineal wound is closed (e).

such a manner that when the sutures are brought together and tied an outlet of proper proportions results. As many sutures as are necessary to thoroughly unite the structures should be used (about 3 or 4). Include in the upper sutures the connective tissues at the base of the vaginal flaps. Bleeding may now be encountered; arrest it now instead of waiting until later. Ascertain the size of the introitus by introducing three fingers into it. At the conclusion of the operation it should admit two fingers easily (Fig. 1913). After the first suture is tied it is easy to ascertain the size of the introitus vaginae. If too large, take up the slack; if too small, readjust the sutures. We recall that a renowned French gynecologist was killed by the husband of a patient who believed that his wife's vagina was rendered too narrow following a perineal repair.

Step 5. Closing the Cutaneous Structures (Fig. 1912 e). This is accomplished with interrupted sutures of Pagenstecher linen.

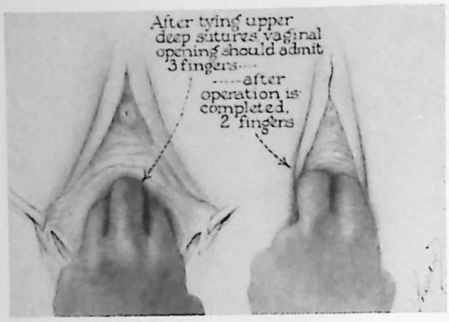


FIG. 1913. Perineoplasty. Method of testing the size of the vaginal opening after application of upper sling sutures and at completion of the operation.

Comment: In cases where the separation of the vaginal flap from the subjacent structures is beset with difficulties denudation should be practiced. This consists in first outlining the area to be denuded with a scalpel and then snipping off the mucosa of the entire area embraced in the outlined region.

Complete Laceration of the Perineum

In cases of complete severance of the sphincter ani muscle, the ends retract gradually and after some time become widely separated. The muscle gradually becomes atrophic.

The two important factors from the standpoint of success in the repair of completely torn perinei are:

(a) To accomplish direct union of the divided ends of the sphincter muscles.

(b) To avoid the passage of sutures on the mucous surface of the bowel by turning down an apron of tissue from the torn septum.

Step 1. Stretching of the torn and separated sphincter muscle. The torn muscle is stretched with the fingers permitting the disabled sphincter to regain its function by operatively recreating its circular form. This can be accomplished with persistent and dextrous endeavor.

Step 2. Flap formation or Denudation. Figure 1914 a depicts the line and extent of the flap formation. A flap, fairly thick, to prevent ischemia and consequent sloughing, should be made. Note that after the denudation, an apron of tissue (A) and (B) is left which will be dissected free and turned down. After this has been done pick up the tissues in the sphincter pit; carefully dissect around the point elevated with tissue forceps (Fig. 1914 b) using pointed curved scissors for the dissection. First one, then the other side is dissected free and pulled out. The dissection of the apron coupled with the lateral incisions will usually effect the necessary exposure of the torn ends of the sphincter muscle.

Step 3. Suturing the Sphincter Ani. The approximated ends of the torn sphincter are united with 40-day, fine, interrupted chromic catgut sutures (Fig. 1914 c). Splint the united sphincter muscle with silkworm-gut tension sutures passed as shown in Fig. 1914 d.

Step 4. Repair the pelvic floor as described above. The sides of the apron are united with Pagenstecher linen sutures. The formation of an apron was first suggested by C. Warren of Boston.

Comment: Control of the sphincter should not be expected promptly after the operation. It takes a number of weeks or even months before the tone of the sphincter is restored, depending upon the time elapsed since the injury was inflicted as well as the degree of damage done.

PROLAPSE OF THE URETHRA

Step 1. Grasp the anterior and posterior portions of the prolapsed mucosa with Allis forceps. Bring the mucosa completely down.

Step 2. Insert a trocar-pointed needle threaded with a No. 1 chromic catgut (20-day) suture through the urethra above the prolapsed part. (Fig. 1915 a.)

Step 3. Ablate the projecting mucosa below the transfixion suture which is pulled out in a long loop as it crosses the urethral canal; it is then divided and each half tied and held. (Fig. 1915 b, c.)

Step 4. Unite the divided edges with a series of fine interrupted sutures to the skin of the vulvar vestibule. (Fig. 1915 d.) Insert a sound into the bladder to insure patency of the urethral passage.

Comment: If too wide an area of surrounding mucosa has been removed or the wound heals by secondary intention, stricture of the urethra may result. This is treated by urethral dilatation or by a plastic procedure which consists of dividing the constriction and suturing the raw area so that the opening is enlarged.

URETHRAL CARUNCLE

Step 1. Insert a sound into the bladder and dilate the urethra to about a 12 Hegar. Cautiously pull the caruncle downwards. Insert a suture from side

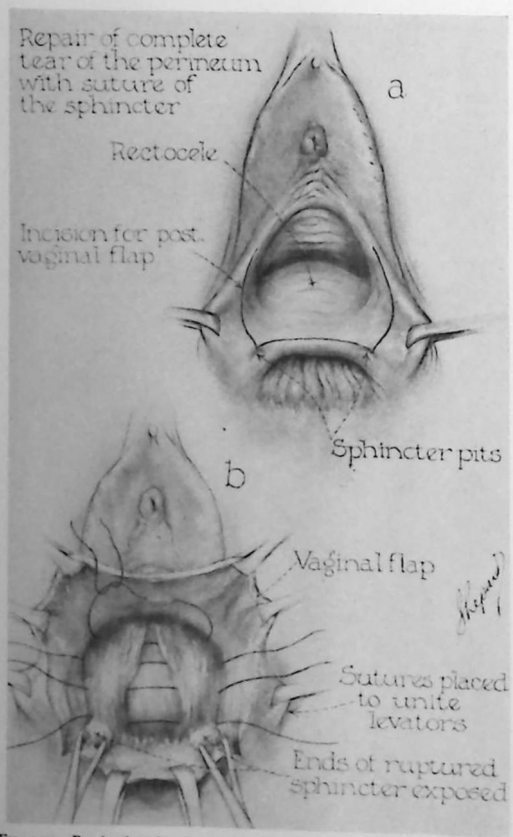


FIG. 1914. Repair of total perineal laceration. a. Incision, flap formation or denudation. b. Isolation of anatomic structures to be reconstructed. Dissection of sphincter pit and exposure of ends of ruptured sphincter ani.

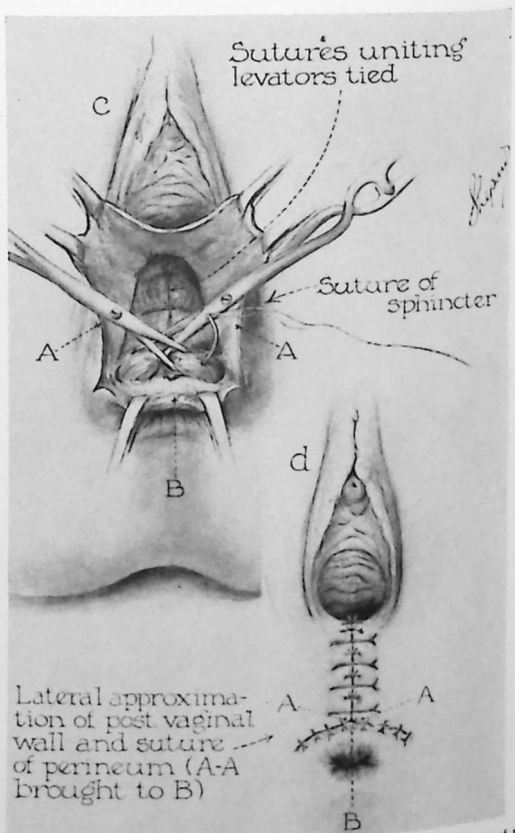


FIG. 1914 (continued). Repair of total perineal laceration. c. Suturing the torn ends of the sphincter ani and of the levators and fascia. d. Repair of the superficial perineal structures.

to side through the floor of the urethra about one-quarter inch above the caruncle; this suture is used as a traction suture to bring down the urethral mucosa after the caruncle has been removed. (Fig. 1915.)

Step 2. With a forceps, elevate the caruncle; in so doing handle the delicate caruncular structure gently lest it tear off. Make an incision around the base of the caruncle leaving a narrow margin of mucous membrane between the cut edge and base which is undercut about one-eighth of an inch.

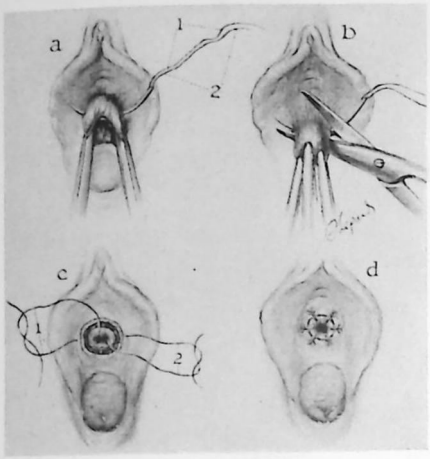


FIG. 1915. Operation for prolapsed urethra. a. Redundant meatus transfixed at base with needle carrying double ligature. b. Mucosa amputated distal to needle. c. Ligature drawn through and cut at needle, providing sutures to approximate lateral edges of mucous membrane. d. Additional sutures placed. This technic is applicable to cases of urethral caruncle which has resisted the usual conservative treatments and careful electrocoagulation.

Step 3. Check bleeding with hot compresses.

Step 4. Exert traction on the stitch through the floor of the urethra exposing the upper divided edge. Insert three or four interrupted catgut sutures to unite the edges and check oozing. Insert a sound into the bladder to insure patency of the urethral lumen.

Swab the parts with an antiseptic solution and apply an aseptic pad. Apply to the suture line a 5 per cent chloretone solution to relieve pain. Encourage the patient to empty the bladder naturally; catheterization may be necessary.

FIG. 1917. Vulvectomy. 1. Outlining the incisions: around the entrance into the vagina and above the urethra; an incision beginning above the clitoris and extending downward along the labia majora on each side, meeting in the midline of the perineum posteriorly. 2. Ablation of the tegumentary and subcutaneous tissues between the two outline incisions previously made. The dissection extends to the deep fascia. 3. Approximation of the upper part of the denuded area by suturing the supraurethral angles to the opposite healthy skin, as shown in the illustration. 4. Union of the rest of the denuded surface by means of interrupted sutures of Pagenstecher linen or dermal suture. 5. Removal of involved inguinal lymph nodes.

FIG. 1918. Removal of Bartholin cyst. 1. Dotted line indicates the incision. The cyst is picked up between the thumb and index finger, which render the overlying skin tense. 2. The cyst is being dissected out with a scalpel. 3. The bed from which the cyst has been removed, is united with interrupted catgut sutures. 4. The operation is completed by uniting with stitches the overlying teguments.

Comment: Urethral caruncles tend to recur frequently; this may be largely prevented by deep excision of the base of the growth. Difficulty is often experienced in approximating the upper and lower divided edges of the raw area because of the oozing. The diathermy knife when used in place of a scalpel checks the oozing.

CLITORIDECTOMY

This operation is indicated in carcinoma or hypertrophy of the clitoris.

Carcinoma not infrequently develops on the clitoris; the growth invades the labia majora and minora at an early stage. The treatment is radical operation which is similar to vulvectomy. The lymph nodes in both groins may be removed later or at the same time. The skin incisions are made wide of the involved area and the entire clitoris is removed down to the attachment of its crura to the pubic rami. Some cases of marked hypertrophy of the clitoris may cause dyspareunia, calling for operative removal.

Step 1. Make a curved incision around the base of the clitoris. (Fig. 1916[1].)

Step 2. Retract the lateral skin edges with Allis forceps; draw the clitoris upward and divide its base of attachment to the symphysis pubis with a scalpel. (Fig. 1916[2-3].)

Step 3. Check bleeding of the dorsal vessels of the clitoris and its corpora cavernosa with properly placed catgut ligatures. (Fig. 1916[4].)

Step 4. Approximate the edges of the incision with interrupted silk or Pagenstecher linen sutures including the subcutaneous tissues. (Fig. 1916[5-6].)

VULVECTOMY

Indications: Carcinoma, tuberculosis, leukoplakic vulvitis, elephantiasis, hypertrophy, and intractable pruritus.

Step 1. (Fig. 1917.) Make an incision around the vaginal entrance and in front of the urethra. Make a second incision starting above the glans clitoris, proceeding around the vulva including the labium majus on each side and the fourchette posteriorly. In carcinoma, leave a wide margin of uninvolved skin between the growth and the divided border. (Fig. 1917[1].)

Step 2. Remove the tissues lying between the two incisions down to the deep fascia. (Fig. 1917[2].)

Step 3. Unite the cut edges around the vaginal entrance with interrupted sutures. Insert the first two stitches on each side uniting the skin to the cut edge surrounding the urethra; bring the skin edges in front of the urethra together from side to side. If difficulty is encountered in joining the outer skin edge with that around the vaginal entrance, mobilize it for about an inch. (Fig. 1917[3-4-5].) Unite the skin edges carefully. Remove the inguinal lymphnodes on both sides.

Step 4. Dress with dry gauze; apply a T-bandage with bismuth ointment. Give morphine for two or three days following the operation to relieve pain.

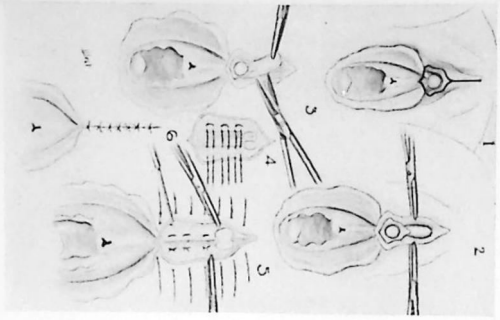


FIG. 1916. Clitoridectomy. 1. Outline of incision around clitoris. 2. The tissues around the clitoris have been dissected free. 3. Clitoris removed with scissors. 4. Mattress sutures of catgut closing bed from which clitoris has been removed. 5. Interrupted silk sutures for approximation of raw surfaces. 6. Interrupted sutures closing skin defect.

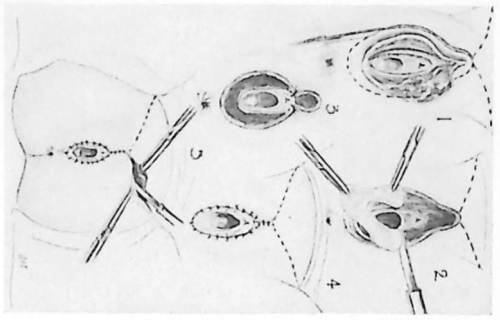


FIG. 1917

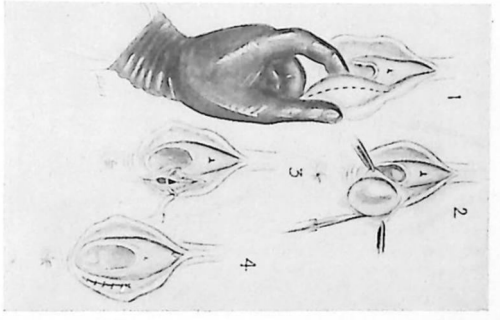


FIG. 1918

Swab the parts with an antiseptic solution and apply an aseptic pad. Apply to the suture line a 5 per cent chloretone solution to relieve pain. Encourage the patient to empty the bladder naturally; catheterization may be necessary.

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Step 4. Dress with dry gauze; apply a T-bandage with bismuth ointment. Give morphine for two or three days following the operation to relieve pain.

Catheterization may be necessary. Where a septic growth has been removed, secure an indwelling catheter into the bladder; leave it there for a few days.

OPERATIONS ON BARTHOLIN'S GLANDS

1. Drainage of Bartholin abscess.
2. Excision (chronic suppuration; cyst; malignancy).

Drainage of a Bartholin's Gland Abscess

While some counsel complete removal of the Bartholin gland, in cases of acute suppuration, it is safer to drain the abscess first and remove the gland later, if need be. Drainage alone will frequently not cure suppuration because the gland is of the compound racemose type; infected acini perpetuate the infection causing either recurrent abscesses or a continuous discharge.

Step 1. Make an incision over the most prominent portion of the swelling in the long axis of the labium majus at its junction with the vaginal mucous membrane. (Fig. 1918, 1.)

Step 2. Evacuate the pus; pack cavity with gauze saturated with glycerine.

Apply hot fomentations and repack the cavity daily until all symptoms disappear. Electrosurgical destruction of the lining of the sac may be done.

Excision of Bartholin's Gland

Step 1. Make a double incision in the long axis of the labium majus extending the full length of the affected area including the sinus and a narrow ellipse of skin.

Step 2. Retract the skin edges thoroughly while the indurated tissues are completely dissected. (Fig. 1918, 2.)

Step 3. Check oozing, dry the wound and swab it with tincture of iodine. Insert a small drainage-tube into the depths of the cavity which is obliterated with catgut. Approximate the skin edges with Pagenstecher linen or silk. (Fig. 1918, 3-4.)

In cases of carcinoma of the Bartholin gland, thorough dissection of the affected gland as well as the lymph nodes draining it is essential.

Excision of Bartholin Cyst

Step 1. Tense the skin over the cyst between the thumb and index finger of the left hand. Make an incision over the most prominent portion of the cyst.

Step 2. Retract the edges of the wound and remove the cyst by means of sharp dissection.

Since the cyst is often fastened to the labium minus on the inner side, it is desirable to dissect the outer side and the deep aspect of the cyst first, liberating the inner side last.

Step 3. Obliterate the resulting cavity, from the bottom upwards, with interrupted sutures of fine catgut. Close the skin with Pagenstecher linen.

OPERATIONS ON THE VAGINA

ATRESIA OF THE VAGINA

There are two varieties of vaginal atresia (a) congenital and (b) acquired. Congenital atresia occurs more frequently than the acquired variety. It is

caused by the partial canalization of the vaginal cords which project downwards from the Müllerian ducts. As a result of the atresia, hematometra, hematocolpos and hematosalpinx may eventuate. Coition is, of course, impossible.

Treatment

Divide the septum and evacuate the thick, black fluid contents of the vagina. Observe rigid asepsis. Infection may end fatally. This is especially true in the

Fig. 1919. Fig. 1920

Fig. 1919. Double uterus with double (septate) vagina. a. Septum.
Fig. 1920. Double uterus with double (septate) vagina. a. Septum, b. uterus bilateralis.

presence of hematometra (distention of the uterus with menstrual blood) and hematocolpos (distention of the vagina).

Comment: Imperforate hymen is sometimes encountered. The symptoms are the same as those of complete atresia. Acquired atresia is very similar in characteristics to the congenital type.

SEPTATE VAGINA

If the two downgrowths from the Müllerian ducts fail to fuse completely, the result is a septate vagina. One part may be smaller than the other and thus escape notice. In the case of a double uterus (Figs. 1919-1920-1921) both parts of which are sufficiently developed, the two sides may function during parturition. Occlusion of one side of the lower end may persist, causing hematocolpos, hematometra or even hematosalpinx on the involved side.

In case of dyspareunia, the septum must be excised. Treatment for the retention of menses in the obstructed portion of the vagina is the same as for atresia.

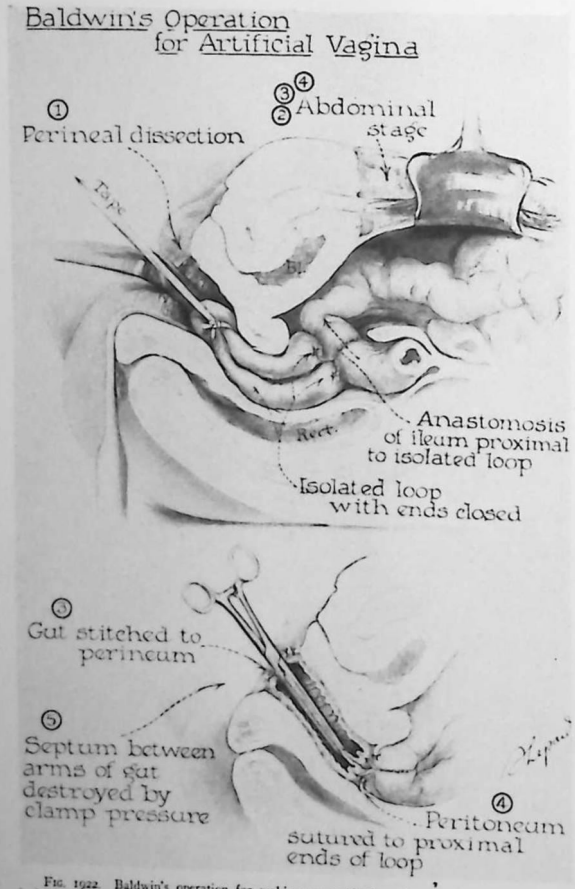


Fig. 1922. Baldwin's operation for making an artificial vagina. 1. Transverse perineal incision between meatus urinarius and rectum. Dissection of perineum (blunt) up to the peritoneum. 2. 3. 4. (upper illustration). Loop of ileum is isolated, ends closed, and pulled down into perineal wound after opening the peritoneum. Divided ends of intestine anastomosed. Lower illustration. 3. 4. 5. Peritoneum over ends of bowel closed. Opened bowel sutured to skin margin of perineum. Septum crushed, as shown, at a later date.

ABSENCE OF THE VAGINA

Construction of a Vagina by Transplantation of a Loop of Intestine

BALDWIN'S OPERATION

Historical Notes. In 1907, Baldwin devised a method which gave a permanently useful vagina. It consists of using a loop of small intestine for the formation of the vagina. This operation has now been used successfully in a number of cases and by different surgeons and has proved exceedingly satisfactory. It is carried out as follows.

Step 1. Place the patient in the lithotomy position after preparation is made for both perineal and abdominal operation. Make a transverse incision where the vaginal opening should be, between the meatus urinarius and the

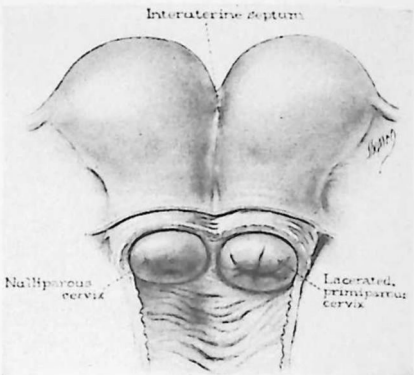


Fig. 1921. Double uterus with single vagina. Appearance of uteri in situ.

rectum. Dissect carefully, bluntly from this incision between the bladder and rectum up to the peritoneum. Be careful not to enter the bladder or rectum. Widen the space in all directions, press a long artery forceps against the peritoneum which is still unopened and pack the canal thus made with gauze, about the forceps. (Fig. 1922[1].)

Step 2. Place the patient in the horizontal position and make a median incision in the abdomen. (Fig. 1922[2-3-4].) Select a loop of ileum about a foot long for making the vagina. The loop must be long enough so as to be drawn into the connective tissue canal already made, without undue tension. A loop ending four or five inches from the ileocecal valve is satisfactory. Press the intestinal contents out of the loop and resect it, being careful to preserve its mesentery. The continuity of the bowel is restored by means of a Murphy button.* Invert the ends of the resected loop with purse-string sutures.

Step 3. The peritoneum over the point of the forceps in the vagina is opened and the opening enlarged to permit the loop of resected intestine to be drawn

* Wherever possible suture anastomosis is preferable.

through. An assistant grasps the middle of the loop of intestine, drawing it into the newly made canal between the bladder and rectum.

Step 4. Close the peritoneum over the ends of the loop. Do not constrict the mesentery.

Step 5. Close the abdomen.

Step 6. Place the patient in the lithotomy position. Open the loop of bowel where it is caught with the forceps and suture the opening all around to the skin margin. (Fig. 1922[5].)

Step 7. Clean the loop of all mucus and lightly pack it with gauze to press the peritoneal surface of the bowel against the surrounding raw surfaces so that union will readily take place.

Comment: When the patient is fully recovered, divide the septum between the two arms of the loop by means of pressure necrosis. Introduce a long clamp, one blade in the upper and one in the lower arm of the loop. Close the clamp firmly and leave in place until it cuts through; this takes about five days. A sedative may be required.

Baldwin comments: "While studying the technic of this operation from a theoretical point of view I took pains to examine the ileum and sigmoid in a large number of patients on whom I was making ordinary abdominal operations. Several hundred patients were thus examined and in all I found that there would be no difficulty in drawing down such a loop of ileum into the vagina or a loop of sigmoid if for any reason the ileum should not be found satisfactory. With either there would be plenty of slack of the mesentery so that the circulation would not be interfered with. I have always used, however, a loop of ileum, because resection of the ileum is safer than resection of the sigmoid. In all of my cases operative recovery was absolutely smooth and the new vagina seems to take the place very satisfactorily of the natural organ. I was induced to use the bowel for this purpose because after a very extended study of the vagina, other methods resulted in almost complete failure, although full of promise in many cases when the patient left the operating table. The favorite method of operating had been by transplantation of pieces of skin, to line the artificial canal. In all of these cases, however, to which I had access, the ultimate results had been very unsatisfactory owing to cicatricial contraction. By the use of the bowel a normal mucous membrane is provided, surrounded by normal connective and muscular tissue and with an ample blood supply. Theoretically and practically, therefore, such a vagina would seem to fulfill to the highest degree all the requirements.

"The dangers of operation are simply those inherent in any other deliberate resection and anastomosis of intestine, but the operation is one which should certainly not be undertaken by a tyro in surgery. My first operation took over two hours, the last one about half that time, and I think in an uncomplicated case the operation should be done in one hour. There is, of course, no hemorrhage to amount to anything and if the field of operation is carefully protected there should be no shock. The danger, therefore, would be merely the danger of a possible infection from the intestine, and that danger in the hands of an expert is very slight. Never-

theless, the danger should be fully explained to the patient, who would then decide whether the operation would be worth while."

GENITAL FISTULAS

The principal varieties of these are the following: (a) vesico-vaginal, (b) vesico-utero-vaginal, (c) urethro-vaginal, (d) recto-vaginal and (e) intestino-vaginal fistulas.

Historical Notes. Gailard Thomas (1878) made a thorough study of the history of the development of the operative procedure of this distressing condition. Ambroise Paré outlined a plan of treatment (closure by a retinaculum) for its relief. Roonhuysen of Amsterdam in 1660 exposed the fistula through a speculum, pared its edges and united them by a needle. In 1720 Vaelter of Württemberg counseled the use of a needle, needle-holder, suture of hemp or silk and a catheter. Johann Fatio of Basle used the lithotomy position and employed a tensile suture in 1792. A vaginal plug and catheter in the bladder were used by Dessault in 1804. Naegele of Württemberg in 1812 scarified the edges of the fistula with scissors, approximated them with needles and interrupted sutures. Schreger (Germany) in 1817 placed the patient on the abdomen, scarified the edges of the fistula and united them with interrupted sutures. In 1825 Lallemand (France) applied silver nitrate to the edges of the fistula and approximated them by a *sonde e rigue* introduced through the bladder. Four cases out of fifteen were cured by this method. In 1829 Roux (France) used twisted suture, metallic bars and ordinary thread. In 1834 Gosset of London used the knee-elbow position, levator perinei speculum, metallic sutures and a permanent catheter in the bladder. A clamp suture was used by Beaumont in 1836. Jobert de Lamballe in 1837 used autoplasty by transplanting a piece of labia or tissue from the thigh or buttocks to cover the defect. Wutzer of Bonn (1838) placed his patients on the abdomen, freshened the edges of the fistula and approximated them with small needles and figure-of-eight sutures. Chelnis in 1884, Metzler in 1846 and Mettauer of Virginia made advances in operations for vesicovaginal fistula, the latter being particularly successful. In 1852 Jobert de Lamballe used a method which he called "reunion autoplastique par glissement" which consists of mobilizing flaps. In 1852 Marion Sims (America) achieved much success by the combined use of speculum, suture and catheter. He claimed credit for the following: (a) a method for the distention and exploration of the vagina; (b) a suture not liable to excite inflammation and ulceration; (c) a method of keeping the bladder empty during the process of cure. Simon (Germany) did much in systematizing the operation.

Vesicovaginal Fistula

For types of fistula, see Fig. 1923.

Instruments: Sims' speculum, lateral retractors, tissue forceps, fistula knife, fistula scissors, needles, needle holder and suture material (fine silkworm-gut, silk, catgut).

METHOD A. DENUDATION PROCEDURE (SIMS')

Step 1. Retract the vaginal wall and expose the fistula; aid the exposure by engaging the cervix in a vulsellum forceps and pulling it down.

Step 2. Freshen the edges of the fistula with a special scissors designed for the purpose or with a scalpel. Trim the tissues down to but not into the vesical mucous membrane and extend the dissection outward into healthy tissue. (Fig. 1924.)

Step 3. The sutures (fine silkworm-gut or chromic catgut) are placed as outlined in the illustrations. (Fig. 1925.) The needle enters the vaginal mucosa about 3 mm. from the margin of the denuded area emerging just under the vesical mucosa; it is made to re-enter the opposite side and to emerge on the vaginal surface at a point corresponding to its opposite fellow. The other sutures are placed similarly and about one-half a centimeter apart. The defect is closed by as many sutures as are deemed necessary. Approximate snugly but do not strangulate the tissues as shown by blanching of the mucous membrane.

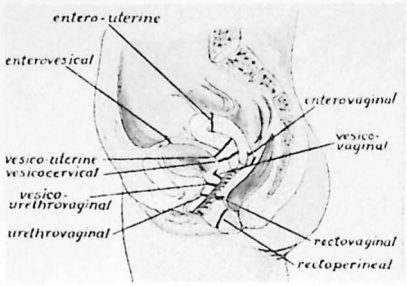


Fig. 1923. Different types of genital fistulae. a. Entero-uterine; b. enterovesical; c. vesico-uterine; d. vesicocervical; e. vesicourethrovaginal; f. urethrovaginal; g. rectoperineal; h. recto-vaginal; i. vesicovaginal; j. enterovaginal.

Fig. 1924

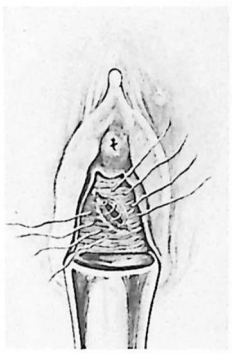


Fig. 1925

Fig. 1924. Sims' operation for vesicovaginal fistula. a. A sharp scalpel circumscribes the area of mucous membrane to be removed down to the mucosa of the bladder. Fig. 1925. Placement of sutures.

Step 4. Introduce a retention catheter for a few days.

METHOD B. MOBILIZATION OF THE BLADDER WALL

A. Mackenrodt (1894) popularized this method; it is an excellent procedure.

Step 1. Expose the fistula as in the previous procedure.

Step 2. Make an incision down the median line, across the fistula, through the vaginal wall down to the bladder, exposing the entire vesical base, as in operations for a cystocele. (Fig. 1926.)

Step 3. Split the edges of the fistula and dissect the bladder freely from its surroundings on all sides. (Figs. 1927-1928.)

Step 4. Close the opening in the loosened bladder by suturing its raw edges together with a fine continuous chromic catgut suture. As many rows of sutures as are deemed advisable are introduced (usually 2-3) to accomplish broad surface approximation. (Figs. 1929-1930.)

Step 5. Close the wound in the vagina. Let the line of sutures come to lie as distant from the suture line in the bladder as possible. (Fig. 1929.) Kelly uses urethral catheters in situ for three days to relieve the bladder and encourage prompt healing.

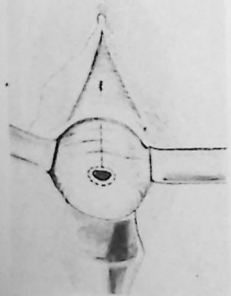


Fig. 1926. Vesicovaginal fistula situated close to the cervix. Dotted line indicates the incision.

METHOD C. OPENING THE VAGINAL VAULT

In cases of fistula resulting from accidental opening of the bladder during hysterectomy the operation consists of the following steps:

Step 1. Dissect the scar in the back of the fistulous opening at the vault of the vagina, cautiously. Avoid injury to the rectum by placing the finger in the rectum during the dissection.

Step 2. Isolate and enter the peritoneal cavity. Enlarge the opening by introducing the index fingers and spreading them laterally.

Step 3. Pull the fistula down into the vagina; dissect it out and freshen its edges.

Step 4. Close the fistula with one or two layers of fine chromic catgut sutures.

Step 5. Close the peritoneum partially. Insert a cigarette drain for a day or two.

METHOD D. CLOSING THE FISTULA THROUGH THE BLADDER

Occasionally, it seems desirable to close a fistulous tract by entering the bladder suprapubically (extraperitoneally); the margins of the fistula are denuded and united. If the fistula is inaccessible the peritoneum may be entered, the bladder pulled up and detached from the uterus, and if necessary from the vagina. The fistula is exposed, its margins freshened and united with catgut sutures. The peritoneum may be drained through the vagina.

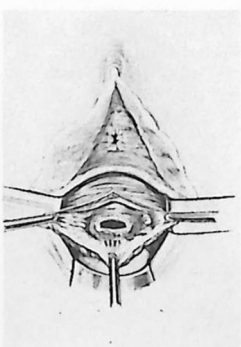


Fig. 1927

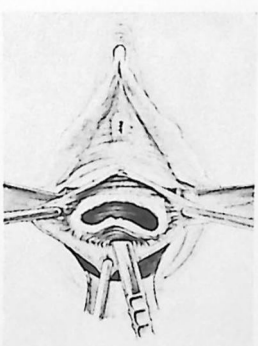


Fig. 1928

Fig. 1927. Vesicovaginal fistula situated close to the cervix uteri. Illustrating the separation of the vagina and the cervix from the urinary bladder by sharp dissection.
Fig. 1928. Vesicovaginal fistula situated close to the cervix uteri. Method of mobilizing the bladder from the cervix uteri.

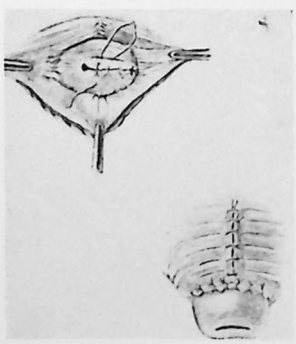


Fig. 1929

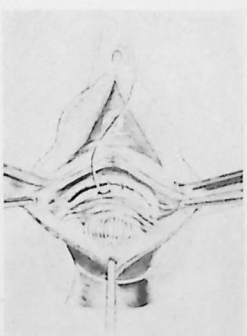


Fig. 1930

Fig. 1929. Vesicovaginal fistula situated close to the cervix uteri. Above: method of closing the bladder with continuous chromic catgut sutures. Below: closure of the vaginal mucous membrane with interrupted sutures.
Fig. 1930. Vesicovaginal fistula near the cervix. Closure of the bladder.

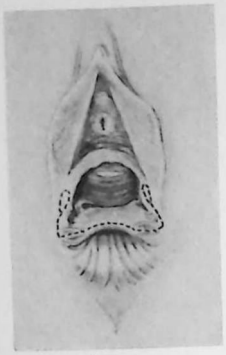


FIG. 1931

FIG. 1932

FIG. 1931. Repair of rectovaginal fistula. Dotted line indicates the course of the incision for raising the vaginal flaps. The rectovaginal septum below the fistula is removed.

FIG. 1932. Repair of rectovaginal fistula. A finger introduced into the vagina presses the rectal wall downward and brings the fistulous opening to the anal canal; it is there sutured as shown in the illustration.

FIG. 1933

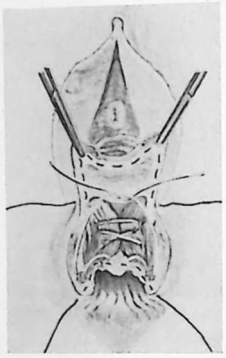


FIG. 1934

FIG. 1933. Repair of rectovaginal fistula. The fistula is situated about the mid-portion of the posterior vaginal wall. The dotted lines indicate the segment of vaginal septum between the rectum and vagina to be removed.

FIG. 1934. Repair of rectovaginal fistula. The levator ani muscle has been sutured beneath the vaginal flaps with interrupted catgut sutures. Note carefully the placement of the sutures.

METHOD E. RECTOVAGINAL FISTULA

Figures 1931-1932-1933-1934-1935 depict the steps of the operation.

METHOD F. OTHER METHODS

Von Rosthorns' operation. The body of uterus is brought down into the vagina as in Watkin's interposition operation for prolapsus (which see); the margin of the large fistula is freshened and sutured to the posterior wall of the uterus.

CLIFFORD U. COLLINS' TECHNIC FOR THE REPAIR OF VESICOVAGINAL FISTULAS[1]

Comment: This is a modification of C. H. Mayo's operation.

Step 1. A large vulvar dilator is used such as that of J. F. Percy. If necessary a Schuchardt incision may be made in the side of the vulva.

Step 2. Make a transverse incision in the vaginal mucous membrane. Make an elliptical incision running transversely around the edge of the fistula. Collins believes that the direction of the incision is of little importance whether it be transverse, longitudinal or crucial.

Step 3. Pass a curved sound or forceps into the bladder through the urethra. An effort should be made to determine the thickness of the partition between the bladder and vagina. The vaginal flaps should be as thin as possible so as to leave the greater thickness of the partition on the bladder wall.

Step 4. Separate the vaginal flaps from the bladder as far as possible in order to expose and mobilize the bladder.

Step 5. The problem here is to get the fistulous opening to project into the vagina as far as possible, to facilitate the placing of the sutures.

Step 6. A needle threaded with catgut is passed through the edges of the fistula. Traction on this brings a cone-shaped portion of the bladder into the vagina with the fistula on the apex of the cone (Fig. 1936).

FIG. 1935. Repair of rectovaginal fistula. The operation shows placement of sutures closing the skin; these are either silkworm gut or black silk.

Step 7. Pass one or more purse-string sutures around the cone thus produced.

Step 8. Pass a curved forceps through the urethra and on through into the vagina.

Step 9. Grasp the ends of the suture through the edge of the fistula by means of the forceps and draw it up into the bladder and out through the urethra (Fig. 1937). Traction on this suture produces a cone with the fistula on the apex.

Step 10. Tie the purse string sutures in the vagina firmly. This will fix the cone and bring the raw under surfaces of the bladder together. If the fistulous opening is rectangular instead of round, use continuous sutures.

[1] Western Jour. of Surg., Obst. and Gyn., Apr., 1937.

These push the edge of the fistula up into the bladder. After the fistula is closed, a few interrupted sutures may be passed in the bladder wall to support the sutures already placed.

Step 11. Bring the base of the vaginal flaps together with mattress sutures so as to push the edges of the flaps down into the vagina, the object being to get the external opening of the fistula as far from the internal opening as possible.

FIG. 1936. Repair of vesicovaginal fistula. A catgut suture is passed through the edges of the fistula. Traction on this suture brings a cone-shaped portion of the bladder down into the vagina with the fistula on the apex of the cone. One or more purse-string sutures are passed around the cone. A curved forceps is passed through the urethra and through the fistula into the vagina. The two ends of the suture through the edges of the fistula are grasped by the forceps and drawn back through the fistula, bladder and urethra. (Courtesy of Dr. C. U. Collins.)

Comment: The sutures closing the fistula should not be tied too snugly or they will defeat the purpose for which they are used. Approximation and not strangulation should be the rule. The suture material should be chromic or tanned catgut. Perfect hemostasis is essential. Nonabsorbable sutures may be used. A self-retaining catheter should remain in the bladder for about 12 days. The bladder should be irrigated twice a day with some bland solution such as boric acid. Only one or two ounces should be used at a time in irrigating the bladder. The patient should be encouraged to lie on her abdomen as much as possible. Some patients do this with ease; in others it causes great discomfort.

Where failure threatens, the introduction of ureteral catheters and allowing them to remain about two weeks or until they cause irritation is a good plan to follow. It has been successful when other methods failed.

Vesicouterovaginal Fistula

HOWARD KELLY'S PROCEDURE

Step 1. Engage the cervix in a vulsellum forceps and pull it down. Detach the vaginal vault from the front, dissecting well above the point of the fistula.

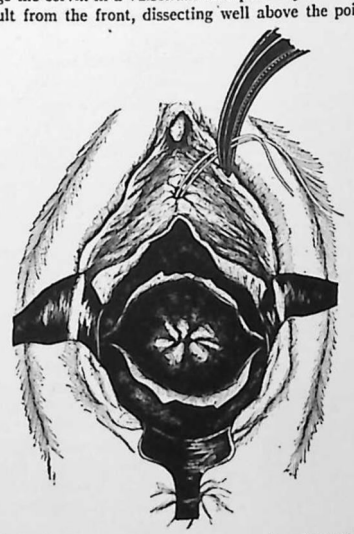


FIG. 1937. Repair of vesicovaginal fistula. Traction on the suture producing a cone on the floor of the bladder. The tying of the purse-string sutures in the vagina closes the fistula and brings the raw under surface of the bladder in apposition for healing union. (Courtesy of Dr. C. U. Collins.)

Step 2. Detach the bladder from the supravaginal cervix and from the vagina on all sides.

Step 3. Closure is effected by fine interrupted sutures of linen, silk or chromic catgut, the bladder wall being united with two or three layers of sutures.

Step 4. The cervix may or may not be reattached with two or three chromic catgut sutures at the vault of the vagina.

O'CONOR'S MODIFICATION OF KELLY'S OPERATION FOR INCONTINENCE OF URINE IN WOMEN

Vincent J. O'Conor modified the Kelly procedure as follows:

Step 1. Spinal Anesthesia. Lithotomy position with hips elevated by a wide sand bag.

Step 2. Retract the posterior vaginal wall. Engage the posterior lip of the cervix with a vulsellum forceps and exert traction upon it downward and forward to bring the vesicovaginal septum into a good view.

Step 3. (Fig. 1938 a.) Introduce a straight Young prostatic tractor into the bladder; open its blades and pull them out in such a manner that they impinge upon the vesical orifice. The tractor pushes the floor of the bladder downward and forward. This maneuver is more easily accomplished by the prostate tractor than by pulling the tissues with tenacula or forceps from below—thus obviating injury to the tissues when pulled upon. The position

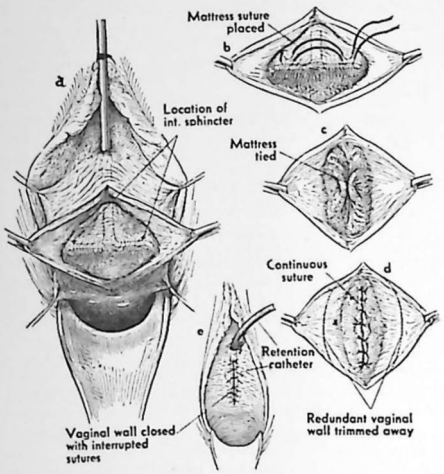


Fig. 1938. O'Conor's modification of Kelly's operation for incontinence of urine in women.

of the blades of the tractor affords an easy method of determining the exact location of the sphincter vesicae and facilitates the proper introduction of the overlapping sutures to be described.

Step 4. Incise the anterior vaginal wall for about 5 cm. in such a position that the neck of the bladder occupies the center of the incision. Dissect the flaps carefully, meticulously avoiding opening the urethra or bladder. This can be easily accomplished by carefully noting (palpation) the position of the tractor. Flaps of vaginal mucosa are widely detached on both sides by gauze dissection thus exposing the neck of the bladder and upper half of the urethra. By carefully adhering to the line of cleavage little bleeding is encountered. The detachment is carried furthest along the palpable blades of the tractor which outline the neck of the bladder.

Step 5. Introduce three mattress sutures of No. 2 chromic catgut, gathering up the relaxed tissues adjacent to the tractor blades; bring the tissues together (Fig. 1938 b). Pressure on the tractor from above presently greatly aids in the ease of application of these sutures.

Step 6. The tractor is removed before the sutures are tied (Fig. 1938 c). The firmer tissues on either side of the urethra are then brought together by two mattress sutures or a continuous suture of the same material. This fortifies the posterior urethral wall (Fig. 1938 d).

Step 7. Trim away the redundant vaginal wall on either side and unite its edges with interrupted, fine chromic catgut sutures.

Step 8. Introduce a small special de Pezzer with a stylet in the catheter into the bladder which is kept in situ for about a week, thus affording rest to the bladder, by keeping it empty.

Comment: The hips of the patient are kept elevated until the effects of the anesthetic have subsided (about two hours). O'Conor's modification of the Kelly procedure consists mainly in substituting a prostatic tractor instead of a mushroom catheter, as a guide; and the elimination of sharp instruments, thus avoiding trauma and affording better exposure; and the use of an indwelling catheter following the operation. The results of the operation are gratifying; patients pass their urine normally following the removal of the catheter.

Vesicouterine and Enterovesical Fistulas

These are treated by meticulous separation of the organs concerned, isolating and freshening the openings in the respective viscera, and their careful closure by appropriate suturing.

CYSTOCELE

Hadra (1889) and Sänger (1896) did pioneer work in this operation.

Step 1. **Incision through the anterior vaginal wall.** Steady the vaginal wall with two vulsella forceps, the latter just in front of the cervix. Outline the area to be denuded. An incision is carried from the introitus vaginae backward to the cervix uteri.

Step 2. **Flap formation.** The flaps are dissected free with a knife or scalpel (Fig. 1939 a) for a short distance, to be continued by dissection with the gauze-covered index finger. Keep close to the vaginal flap thus avoiding injury to the fascia attached to the bladder. When sufficient separation has been accomplished, remove the excess of vaginal wall with scissors.*

Step 3. **Transverse plication of the utero-pubic plane** (Fig. 1939 b, c). Chromic catgut on a curved needle is used to accomplish this step. Two or three rows of sutures are used depending upon the depth of the prolapsus of the bladder wall. No bulge should be visible after this step of the operation is concluded.

* When the dissected flap of vaginal mucous membrane is trimmed off and the edges united by sutures, we speak of a *colporrhaphy*: either on the bladder surface (*anterior colporrhaphy*), or on the rectal side (*posterior colporrhaphy*).

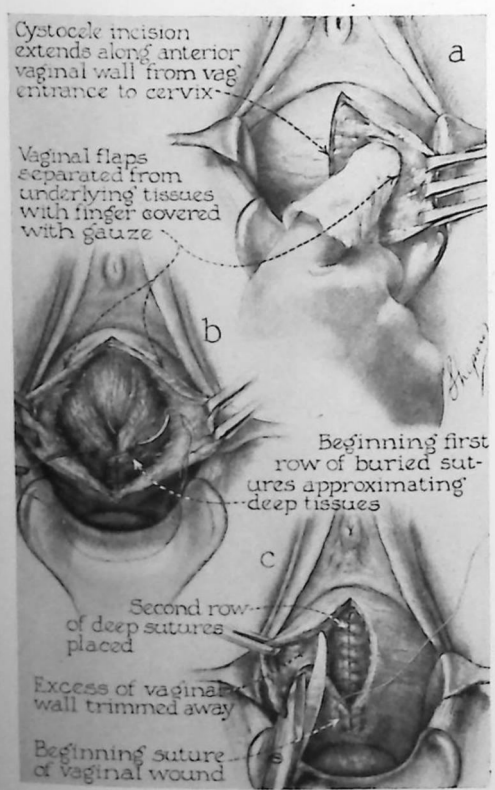


Fig. 1939. Operation for cystocele. a. Incision and flap formation. b. Suturing of the deep structures composing the utero-pubic plane. c. Closure of the vaginal wound.

Step 4. **Closure of the vaginal wound.** Interrupted or continuous Pagenstecher or 40-day catgut sutures are used to accurately approximate the free edges of the vaginal wall. Hemostasis.

OPERATIONS ON THE CERVIX

DILATATION OF THE CERVIX

Step 1. Retract the perineum by means of an Auvard speculum. Draw the anterior lip of the cervix downward by means of a vulsellum forceps.

Step 2. Wipe dry the external os and the cervix with cotton pledgets. Swab with iodine.

Step 3. Introduce a uterine sound. The entrance and direction of the canal is usually ascertained by sounding in various directions. In case of retroversion the concavity of the bend in the sound is directed backward and in anteflexion forward; the former is the most common.

Step 4. Ascertain the length of the uterus, the presence of submucous fibroid, septum or bicornuate uterus, etc.

Step 5. Dilate the cervix with Hegar's dilators dipped in glycerin until the desired size is reached (about 12 to 14 Hegar). Make countertraction with the vulsellum on the engaged cervical lip while the dilators are being inserted.

The Dangers Connected with Cervical Dilatation Are: (a) Cervical lacerations; (b) perforation of the uterus.

The former is likely to take place when the cervix is dilated too rapidly or excessively, particularly in the presence of inflammation or in an infantile cervix. Laceration usually occurs in the region of the external os; suspect it if the dilator suddenly slips forward where it hitherto resisted, if the succeeding dilators seem to enter too easily or if the grip on the dilator by the cervix is lost.

Perforation of the uterus may take place where the uterus is acutely anteor retroflexed, in which case the dilator penetrates the anterior or posterior uterine wall.

TRACHELOPLASTY OR TRACHELORRHAPHY

Step 1. The patient is placed in the lithotomy position. The external genitalia and vagina should be thoroughly prepared. Grasp the anterior lip of the cervix with a vulsellum forceps and steady it. Dilate the cervical canal thoroughly with Hegar's graded dilators. Curet the uterus; paint its interior with iodine carried on intra-uterine applicators. Grasp the posterior lip of the cervix with a vulsellum forceps and approximate the edges of the cervical lips. Estimate the extent of the lacerations and decide whether a simple trachelorrhaphy will suffice or an amputation of the cervix seems preferable.

Step 2. (Fig. 1940 a.) Outline with a sharp scalpel the edges of the laceration of the mucous membrane of the cervical canal and the areas to be denuded, leaving in the center of each lip a strip about a third of an inch in width to form the new cervical canal. Denude as shown in the illustration (Fig. 1940 b). If Nabothian cysts abound, it is better to do a partial amputation or Sturmdorf conical resection of the cervix.

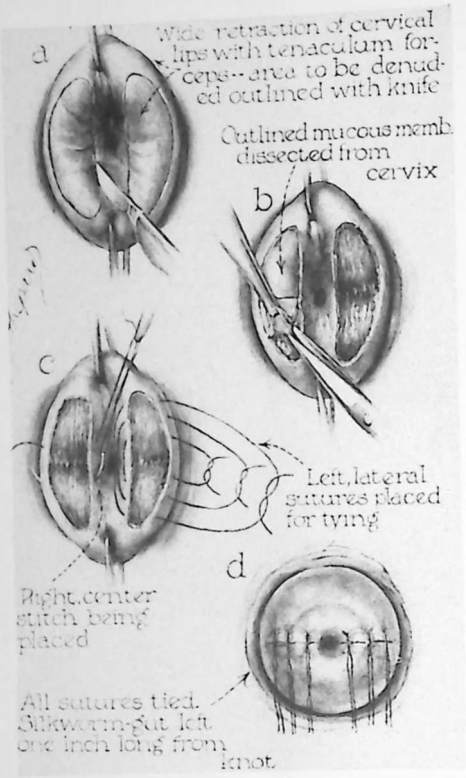


FIG. 1940. Repair of lacerations of cervix uteri. a. Outlining area to be denuded. b. Method of denudation. c. Manner of introduction and placement of sutures. d. Completion of operation.

Step 3. Introduction of the sutures takes place after denudation is complete and after cleansing the operative area. The first suture is introduced just below the angle of the laceration beginning on the vaginal mucous membrane of the cervix extending through the muscular tissue and emerging just at the edge of the mucous membrane of the cervical canal and then through the edge of the mucous membrane of the canal on the opposite lip, through the muscular tissue and emerging on the vaginal mucous membrane of the cervix opposite the point of introduction of the needle (Fig. 1940 c).

Introduce as many additional sutures, about one-eighth of an inch apart, as are necessary to neatly complete the suture line until the internal os is reached. The sutures on the opposite side of the cervix are introduced in a similar manner. Special cervical needles, and silkworm-gut or 40-day chromic catgut are used in the operation; the former are tied long, the latter cut short. The sutures should not be tied too snugly to avoid strangulation. (Fig. 1940 d.)

Step 4. Pass a sound through the cervical canal to assure patency. Remove the retractors. Replace the uterus. Pack the vagina lightly (iodoform gauze).

Comment: If nonabsorbable sutures are used remove them after about 2 to 3 weeks. If the cervix is long, the inflammation marked or the laceration stellate or markedly irregular

Sturmdorf's Operation

is to be preferred. This operation consists of a conical excision of the cervix. This procedure does away with the cystic areas in the cervix and the Sturmdorf stitch draws the vaginal mucosa over the raw surfaces and covers them in a highly satisfactory manner. The important features to be observed here are:

1. Proper conization of the cervical tissue to be removed.
2. Thorough hemostasis during the operation.
3. Adequate covering of raw surfaces with the Sturmdorf stitch.
4. Measures to avoid subsequent stenosis of the os.

Step 1. Outline the area to be excised with a sharp scalpel (Fig. 1941 a). Avoid too much tissue sacrifice. No more cervical tissue should be removed than is necessary to insure the removal of the chronic inflammatory foci (H. S. Crossen). Excise the deeper portion of the cervical cone with sharp, curved, pointed scissors.

Step 2. A large, raw bleeding surface results. Grasp the spurting points with pointed artery forceps (Kelly or Ochsner type). These are left in situ for a minute or two, and the bleeding stopped either by torsion or hot packs applied to the raw surface.

Step 3. The Sturmdorf stitch is next introduced and tied on the anterior surface of the cervix (Figs. 1941 b, c, d). Follow this by a similar suture below, after first releasing the artery forceps which were permitted to remain in the lower segment of the cervix while the upper suture was being introduced (Fig. 1941 e). Lateral sutures of catgut are next introduced (Fig. 1941 f and g) on both sides. A catheter is introduced into the lumen of the cervicouterine passage and retained in place during the time of healing. This is to

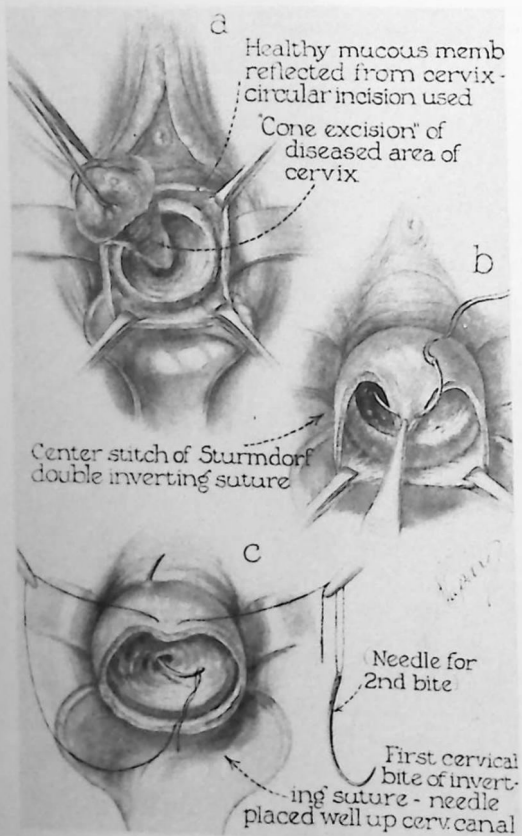


FIG. 1941. Sturmdorf's operation. a. "Cone excision" of affected cervix. b, c. Method of placing Sturmdorf stitch in the upper part.

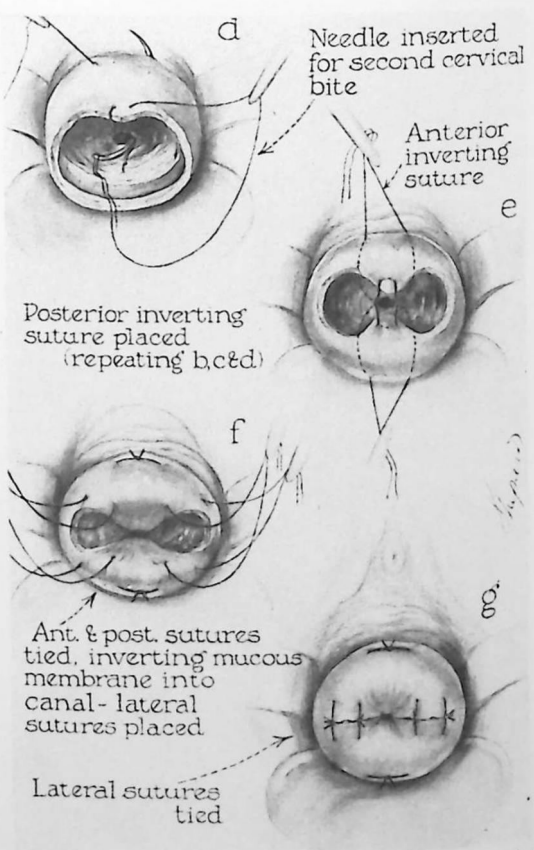


FIG. 1941 (continued). Sturmdorf's operation. d. Completing anterior Sturmdorf suture. e. Repeating a, b, c, and d, in placing a similar stitch below. f. Placing lateral sutures on both sides. g. Operation completed.

avoid stricture formation. Place a light iodoform tampon in the vagina. Dress.

TREATMENT OF CHRONIC CERVICITIS BY ELECTROSURGERY

Chronic cervicitis is one of the most frequent gynecologic diseases and has long been one of the hardest to cure. The treatment has gone through many phases since Emmet's first report in 1862 on lacerations and their surgical repair. The treatment of chronic cervicitis depends upon the proper selection of cases, and the proper understanding of the histopathology. Medicinal therapy is limited in scope and is rather unsatisfactory. H. O. Maryan[1] advocates treating chronic cervicitis by electrocoagulation. He prefers the crucial incision or stripping method.

The terms erosion, ulceration or endocervicitis are a bit confusing, but easily understood if the genesis of chronic cervicitis is understood. Normally the vaginal portion of the cervix (the portio vaginalis) is covered by stratified squamous epithelium and contains no glands, while the cervical canal or endocervix is lined by high cylindrical compound racemose glands which are 3 to 4 mm. deep, and extend from the external os to the internal os, just below the isthmus of the uterus. Just within the external os, where the squamous epithelium meets the cylindrical epithelium of the compound racemose glands there is a definite line of demarcation.

The cervix is prone to infection because of its situation in the vagina, and because it is lacerated during labor. Crypts and lacunae of the mucous membrane afford a protection for the invading organisms and in these areas the gonococcus and other bacteria may be dormant for long periods of time.

It is accepted among gynecologists that chronic cervicitis is due to a persistent deep infection of the compound racemose glands (extending from the internal os to the external os) and which is characterized by a periglandular and perivascular lymphocytic infiltration and a downward proliferation to the stroma and to the cervical lips of the compound racemose glands. This extension of the proliferation is referred to in the literature as an erosion, which is a misnomer. Maryan believes that with its associated inflammation and regeneration it should be called chronic pancervicitis or chronic cervicitis because the entire cervix is invaded. Our understanding of the pathologic genesis of chronic cervicitis will help to differentiate between apparently normal and doubtful tissue, and to treat cervical lesions adequately. Macroscopically, an erosion or chronic cervicitis, is evidenced by redness of varying degrees of the cervical lips surrounding the patulous external os, together with an abundance of mucopurulent secretion from the cervical canal.

The treatment required for chronic cervicitis varies with the extent of the lesion. Treatment depends upon the invasion of the cervical lips. If the extent of the lesion extends about one-third the radius of the external os, or if there exists a slight eversion, a mild tear, or a localized bulging of the Nabothian cysts, we recognize a mild type of cervicitis. If the lesion extends to two-thirds of the cervical lips we are confronted with a moderately advanced type of cervicitis, and if the lesion extends throughout both lips an advanced type of cervicitis is at hand. In this last class may also be included the hypertrophic bilaterally

[1] Surg., Gynec. & Obst., 1936, 62, 85.

lacerated cervicitides and the large smooth boggy incompletely healed form of cervicitis. The first two types are amenable to ambulatory treatment. The third class of cases is surgical. Other lesions of the cervix should be ruled out before coagulation is resorted to (syphilis, tuberculosis, early carcinoma and pinpoint leukoplakias). Because of the rich supply of lymphatics capable of producing such associated lesions as metritis, parametritis, and uterosacral cellulitis, it is advisable to rule out chronic pelvic inflammatory residual pathology. Coagulation of the cervix should never be done in the presence of an acute or subacute inflammatory lesion of the internal or external generative organs. If the paracervical tissues are tender (digital examination per rectum) or, if the uterus is retroverted, or if the sacro-uterine ligaments are tender or boggy, coagulation or cauterization should never be done.

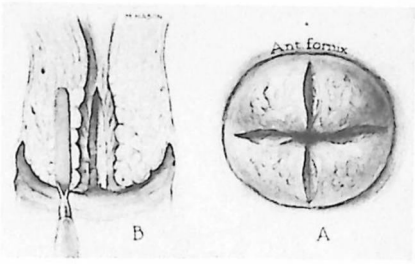


FIG. 1942. Electrosurgical treatment of infections of the cervix. A. Linear crucial incisions with exposure of the cervical canal. B. The tip of the spatula in situ. Observe that contact is made against the edge of the blade at right angles to the crucial incision. (Courtesy, Dr. H. O. Maryan.)

Rectal examination is indispensable in selecting cases for this form of treatment (Maryan). Smears give valuable information as to the type of bacterial flora, and rule out the hemolytic streptococcus of the apparently innocent case.

Where the cervix has an edematous and acutely inflamed appearance associated with marked lacerations, it is best to treat it first by topical applications of 10 per cent tannic acid and glycerin into the cervical canal, supplemented by daily hot douches. This will shrink the cervix materially and reduce the activity of the chronic inflammatory disease.

Step 1. Place the patient in the lithotomy position. Introduce a vaginal speculum. Dissolve the heavy mucoid discharge from the cervix with caroid powder. Usually, no local anesthesia is necessary. If desired, however, one can use 35 per cent cocaine or a crystal of cocaine introduced into the cervix. A vulsellum is not necessary to hold the cervix in place if proper exposure is obtained with the ordinary vaginal speculum or Guttman's operative speculum.

Step 2. Biterminal diathermy coagulation is used with the indifferent tin plate electrode under the sacrum and buttocks of the patient. The spatula tip

(3 mm. long by 3 mm. wide) positive electrode is used for coagulation of the cervix. The proper dosage is dependent upon the type of high frequency diathermy apparatus used. Routinely, the radical crucial incision or linear striping is used at 12, 9, 6 and 3 o'clock (Fig. 1942 A), commencing on the outer margin of the upper cervical lip at 12 o'clock, and extending to the external os. This is then repeated at 9 o'clock, 6 o'clock and at 3 o'clock, either in one sitting or, preferably, in four separate sittings, which may be done every other day. In this way the cervical canal is laid wide open and one can visualize the extent of the pathology and also carry on linear coagulation of the cervical canal. The linear or vertical striping of the cervical canal commences at right angles from the crucial incisions at the external os and extends to just beyond the internal os.* The edge of the spatula tip is

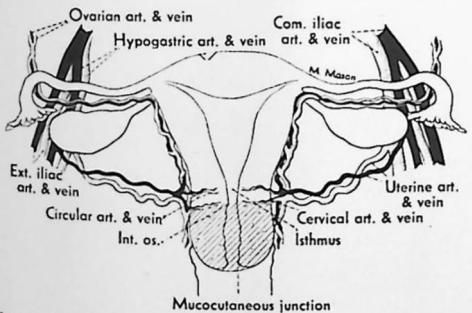


FIG. 1943. Electrosurgical treatment of infections of the cervix. Notice close proximity of the cervical artery and vein and the circular artery and vein to the internal os, isthmus and to the cervical canal. One should keep in mind the relationship of the vascular supply to the general architecture of the cervix in order to avoid severe secondary hemorrhage. (Courtesy of Dr. H. O. Maryan.)

most suitable for the purpose. (Fig. 1942 B.) The tip is first placed firmly against the cervical tissue, and then slow coagulation is begun. The amount of coagulation should be sufficient to reach beyond the gland-bearing tissue and into the adjacent stroma. In this way sufficient destruction of the infected gland-bearing tissue will be produced and adequate drainage provided. A conical-shaped area analogous to that which is removed by the classical Sturmdorf operation is the desired coagulation. The apparatus is operated by foot-switch control. Do not remove the electrode from the cervix unless the foot-switch is off, because undesirable fulguration will result. Should bleeding occur, apply the tip of the spatula to the bleeding point; sparking will seal the bleeding stoma. The desired amount of coagulation is characterized by a grayish white color. The extent of coagulation differs with the degree of pathology encountered.

In some instances, with marked hypertrophy of the upper cervical lip, addi-

* Danger in this area on account of vessels.

tional linear striping is done at 11, and 1 o'clock. Further coagulation, if necessary, is done after three weeks, since the height of the tissue reaction has subsided by this time. It is then advisable to wait about 3 months before repeating treatment again. Fractional coagulation is preferable for chronic gonorrheal infections. Short-wave apparatus may be used to advantage.*

Comment: Failures following coagulation or cervical plastics are usually due, as shown by Koster and Wolfe, to remnants of the uppermost infected gland-bearing tissue near the internal os. Patients should abstain from the use of douches during the postcoagulation period, and also from sexual relationship. Epithelization is usually complete between 4 to 6 weeks.

Complications which may follow coagulation of the cervix are: (1) hemorrhage, (2) stenosis, and (3) pelvic infection. Bleeding during the days immediately following coagulation of the cervix is usually of no moment and is due to oozing of the sloughing surface. Very frequently severe secondary hemorrhage is encountered about the 12th or 14th day; this is the result of too extensive coagulation. In such instances, severe secondary hemorrhages may occur from sloughing of the cervical branch of the uterine artery in the region of the internal os (Fig. 1943).

Stenosis is avoided by follow-up dilatation of the cervical canal by graduated special uterine sounds (Hegar's) and topical applications of silver nitrate (about 3 per cent). Maryan stresses that with this type of prophylactic treatment of cervical disease the mortality incidence should be greatly reduced from possible malignant metamorphosis.

AMPUTATION OF THE CERVIX

This classical procedure is divided into two types: (a) Low and (b) High cervical amputation.

Low Amputation of the Cervix

In the low operation the cervix is divided laterally with sharp scissors or scalpel. A curved incision extending between the lateral incisions is made. This is followed by freeing of the vaginal mucous membrane. The anterior lip of the cervix is now amputated with the scalpel. A cervical needle (Fig. 1944) carrying chromic catgut unites the reflected portion of the vaginal mucous membrane with the raw surface of the cervix. As many interrupted sutures as are needed are introduced in such fashion as to leave no raw cervical tissue uncovered. The posterior lip of the cervix is treated in the same manner, viz.: excision of the lip after incising the posterior vaginal mucous membrane from side to side and dissecting it backward, finally covering the resulting raw surface of the cervix with vaginal mucous membrane as was done with the anterior segment. Additional sutures are introduced at the angles of the wound.

FIG. 1944. Cervix needles. (Emmett.)

Pack the vagina lightly with a strip of iodoform gauze.

* The reference to time represents the relative position of the electrode to the dial on a clock.

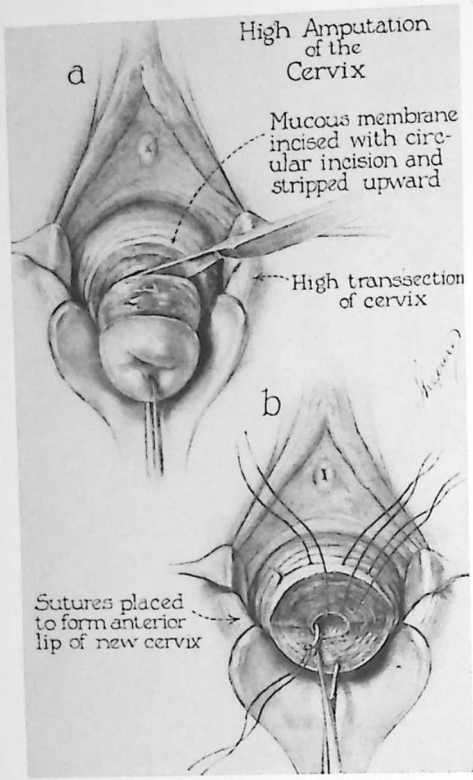


FIG. 1945. High amputation of the cervix. a. Circumincision of vaginal mucous membrane and transection of the cervical tissue. b. Placement of sutures to form new anterior lip of cervix.

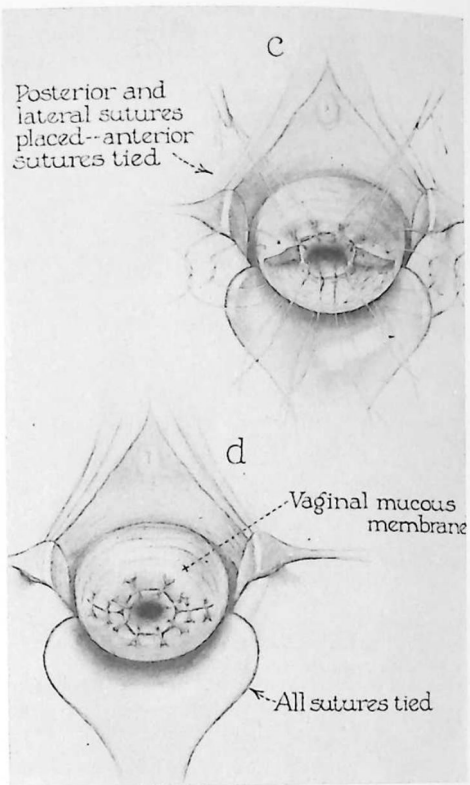


FIG. 1945 (continued). High amputation of the cervix. c. Placement of posterior and lateral sutures. d. Operation completed.

High Amputation of the Cervix

Step 1. Expose the cervix by appropriate retractors. Pull it forward with vulsellum forceps.

Step 2. Circumincise the cervix at the cervico-vaginal junction (Fig. 1945 a).

Step 3. Catch bleeding vessels and ligate them with chromic catgut.

Step 4. Expose as much of the cervix as is desired to amputate by further dissection. Amputate the cervix at the desired level.

Step 5. Cover the raw surfaces resulting from the ablation of the cervix with the detached vaginal mucous membrane (Fig. 1945 b, c, d).

Comment: If the cervix is amputated high the uterine arteries will have to be secured and ligated. To accomplish this expose the parts thoroughly. Place an Auvard speculum in the posterior vaginal wall. The lateral walls must be thoroughly separated by retractors in the hands of assistants. Meticulous ligation of the cervical vessels is essential.

OPERATIONS ON THE NONPREGNANT UTERUS

CURETTAGE

Curetting the uterus is done for the purpose of emptying it of pathologic products and abrading its mucous membrane in part or "in toto."

Historical Notes. Curettage was introduced by Recamier in 1846. Afterward it was abandoned and later restored in the treatment of malignant tumors by Simon in 1872, and in cases of endometritis by Hegar, Kaltenbach and Olshausen in Germany, and by Doleris in France. Its renaissance was followed for many years by much abuse in its use.

The dangers likely to result from curettage are: (a) perforation of the uterus, (b) hemorrhage, and (c) sepsis.

Perforation of the Uterus

This is of frequent occurrence. It happens more often during dilatation than curettage; the curet may enlarge a rent made by the dilator. Such trauma frequently occurs in the lateral cervical or uterine wall and extends into the corresponding broad ligament. If you suspect that the uterus has been perforated, STOP! Pack the vagina lightly with iodoform gauze. Get the patient back to bed; put her in the Fowler position. Apply an ice bag to the abdomen and observe vigilant expectancy. If all is well (pulse rate, respirations, abdominal signs) leave well enough alone. Do not become panicky. If the surgeon "loses his head" he often loses his patient. If perforation results in hemorrhage into the peritoneal cavity or broad ligament, prolapse of the intestine or peritonitis, operate. In case of severe hemorrhage into the peritoneal cavity, open the abdomen and suture the rent in the uterus. If the laceration is extensive, a hysterectomy may have to be resorted to. Hemorrhage into the broad ligament is usually the result of tearing the internal os. When this occurs the uterine artery is frequently injured causing severe hemorrhage. In such cases locate the laceration; expose the vault by dividing the vaginal part of the cervix. Stop the bleeding by deep sutures of substantial catgut carried on curved sturdy needles. The bleeding

vessel must be secured at any cost; if unsuccessful, open the base of the broad ligament from below and secure the bleeding vessel. Should this fail, pack the vagina tightly, open the abdomen and ligate the uterine artery from above. Combat shock by appropriate measures.

Prolapse of the intestine through a laceration while rare, does nevertheless occur. Do not try to replace the prolapsed bowel into the abdominal cavity or pack the uterus! Open the abdomen, examine the bowel for possible injuries which are repaired if found, cleanse the bowel and reposit it. Close the wound in the uterus with catgut sutures.

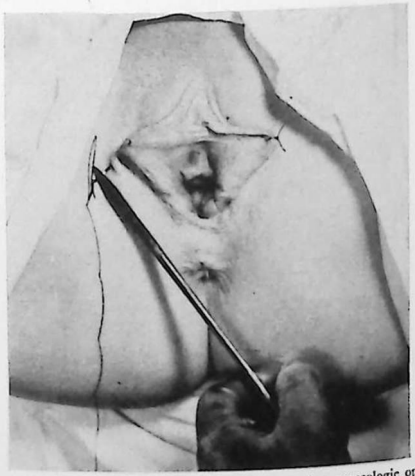


FIG. 1946. Labia stitched out of way for curettage or other gynecologic operation.

Peritonitis usually follows sepsis of the uterus. Local peritonitis is treated conservatively. In progressive peritonitis, drain the pouch of Douglas promptly through a large drainage tube.

In uterine hemorrhage, the bleeding is occasionally perpetuated by retained secundines.

In septic conditions of the uterus, curettage is usually contra-indicated. Do not empty the uterus until the temperature has been normal for some time. Sepsis caused by curettage may result in acute salpingitis, pelvic peritonitis which may become general, pelvic cellulitis, thrombophlebitis and septicemia.

Operate preferably five or six days after menstruation. Use general anesthesia.

Step 1. Place the patient in the dorsosacral position with the buttocks ex-

tending over the edge of the table. Place the legs in supports; flex and abduct the thighs. Shave and cleanse the operative field thoroughly.

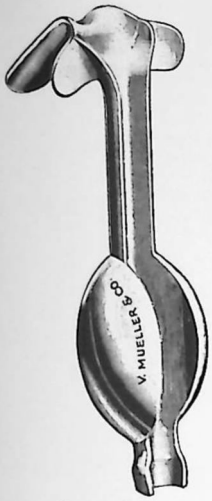


Fig. 1947. Auvard's speculum.

Step 2. Stitch the labia out of the way (Fig. 1946).

Step 3. Depress the posterior vaginal wall with an Auvard speculum; locate the cervix (Fig. 1947). Grasp the cervix with a vulsellum forceps (Fig. 1948) engaging its posterior lip generally about 1 or 2 cm. from its free border, in order to avoid tearing it. Draw the cervix gently and gradually down to the vulva. Introduce lateral retractors into the vagina (Fig. 1949). A second vulsellum is placed on the anterior lip. Drawing down the cervix has the advantage of straightening the uterine canal.

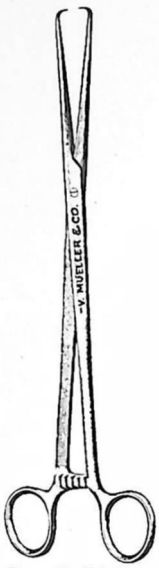


Fig. 1948. Vulsellum forceps. (Pozzi.)

Step 4. Ascertain the direction and depth of the uterine cavity by means of a uterine sound.

Step 5. With the aid of Hegar's dilators (Figs. 1950-1951) dilate the cervix sufficiently to permit the introduction of the curet (Fig. 1952). There are a great number of models of curets. Specially useful are those of moderately sharpened edge. It is well to have two or three different calibers. In order to reach the uterine cornua, a small ring curet is useful. Curettage should be done methodically. Project the instrument gently until it comes into contact with the fundus (Fig. 1953[1],[2]). Proceed to curet both walls of the uterine cavity from above downward. Repeat the manipulation on the same wall several times until you feel a special grating sensation described by the French under the name of "cri uterin," a sensation which is that of touch rather than of hearing. Support the wall being curetted with the aid of the index finger of the left hand introduced into the fornix corresponding to the respective anterior or posterior wall of the uterus.

The curet should be brought out to the external os with each sweep of the curet in order to bring out of the cavity the clots and mucous membrane débris.

From time to time rinse the curet in sterilized water or an antiseptic solution in order to dislodge the scrapings clinging to the instrument.

Curettage should be more energetic at the level of the cervix because here the epithelial crypts are deeper and the lesions more pronounced than elsewhere. Be particular to carefully curet the angles of the uterine cavity.

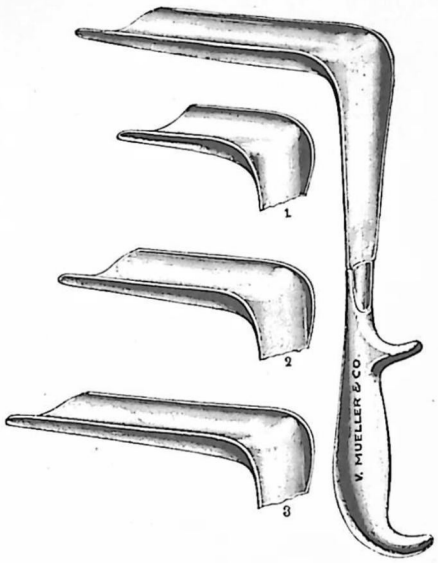


Fig. 1949. Vaginal retractors. (Doyen.)

During curettage the uterus usually contracts; on occasion its cavity increases in size and the curet misses the resistance felt a moment before and one is led to think of uterine perforation. If this be so, withdraw the curet at once and compress the uterus through the abdominal wall; expel clots and when the organ contracts again continue the curettage. I am in the habit of giving an ampule of pituitrin subcutaneously. Immediately after the operation is concluded, resort to an intrauterine irrigation (Fig. 1953[3]) or intrauterine application of an antiseptic (Fig. 1593[4]).

Step 6. Tampon the vagina lightly with iodoform gauze. Remove the gauze

tampon on the second day. Confinement to bed should generally be about a week.

Hemorrhage. If a serious hemorrhage occurs during curettage, it may result from too superficial curetting and may be dealt with by completing the scraping of the diseased and bleeding mucosa. If hemorrhage persists, it may be necessary to resort to intrauterine tamponing.

Infections result from faulty technic.

Sterility, Stricture and Obliteration of the Uterine Cavity. Sterility has been known to result following curettage. This is often caused from atresia or a partial or complete obliteration of the uterine cavity. The uterine mucous membrane rapidly regenerates after curetting, by the multiplication of the cellular

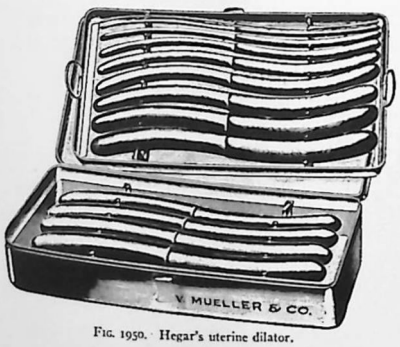


Fig. 1950. Hegar's uterine dilator.

elements lining the recesses of the crypts of the mucous membrane which are ordinarily spared by the curet. If curetting has been too violent, these cellular regenerative centers may be destroyed. In such instances a cicatrix is produced or even a complete fusion of the uterine walls may take place, leading to stenosis or obliteration. Gradual dilatation should be resorted to in such instances. If the stricture is situated near the external os a plastic procedure is indicated. In case of extensive strictures or almost complete obliteration of the uterine cavity with the existence of very painful complicating dysmenorrhea, hysterectomy offers the only chance for relief.

HYSTERECTOMY

Vaginal

Historical Notes. Andreas of Cruce is given credit for having performed the first vaginal hysterectomy in 1560. Marchall (1783) and Langenbeck in 1813 performed incomplete hysterectomies for uterine prolapses. Sauter in 1822, Blundell in 1828 and Récamier in 1829 used ligatures in the broad ligaments. Kiexter in 1848, and Henning in 1878, removed the adnexae during the vaginal ablation of the uterus.

To Czerny belongs the credit of systematizing the procedure in 1879. He employed Récamier's method of applying ligatures in the broad ligaments. Czerny's successors to popularize vaginal hysterectomies were Billroth, Schroeder, Martin, Wölfler (1880), Mikulicz, Teuffel, Kocher and Müller (1881). In 1881 Hailden reported 52 total vaginal hysterectomies with a mortality of 32 per cent. Martin (1866) collected from the literature 311 cases with a mortality of 15 per cent. Doyen in 1892 reported 112 cases with a mortality of 5.3 per cent. Spencer Wells was the first to suggest the use of the forcipressure principle on the clamped broad ligament. His pupil E. Jenning was successful with this technic in 1885. Doyen devised the elastic-jawed forceps in 1887. (Figs. 1954-1955.)

Fig. 1951. Goodell's dilator.

Step 1.* The patient is placed in the lithotomy position with legs and hips elevated. Asepticize the cervical canal by swabbing it with iodine carried on a uterine applicator. Close the external uterine opening with stout silk or silk-worm gut sutures; these are tied and left long to serve as tractors. Do not fail to catheterize the bladder.

Step 2. Circumincise the vaginal mucosa at its junction with the cervix uteri. The anterior vaginal cuff is separated from the bladder by sharp and blunt (gauze) dissection. This is continued until the bladder is somewhat free on the lateral sides exposing the broad ligaments on both sides.

Step 3. Identify the vesico-uterine reflection. This is best reached by extending the gauze dissection upward and retracting the bladder (upward) out of the way. Its whitish color will aid in recognizing the peritoneal fold; its identification is enhanced by having the index finger glide over its surface thus gaining the digital impression of the two peritoneal surfaces gliding over one another. Open the peritoneal fold. Introduce both indices and spread them laterally as if dilating a rectal sphincter. Through this opening introduce a warm lap sponge, of appropriate size, into the pelvis to keep the bowels out of the way. It is important to separate the bladder sufficiently laterally

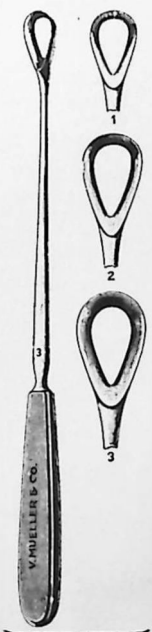


Fig. 1952. Uterine curette.

* Study Fig. 1956 in conjunction with this text as well as that describing the next (Doyen's) type of vaginal hysterectomy.

from each broad ligament in order to displace the ureters upward and out of harm's reach.

Step 4. Separation of the rectum from the uterus. Forcibly pull the cervix upward. Before doing so place an artery forceps on the tape of the lap

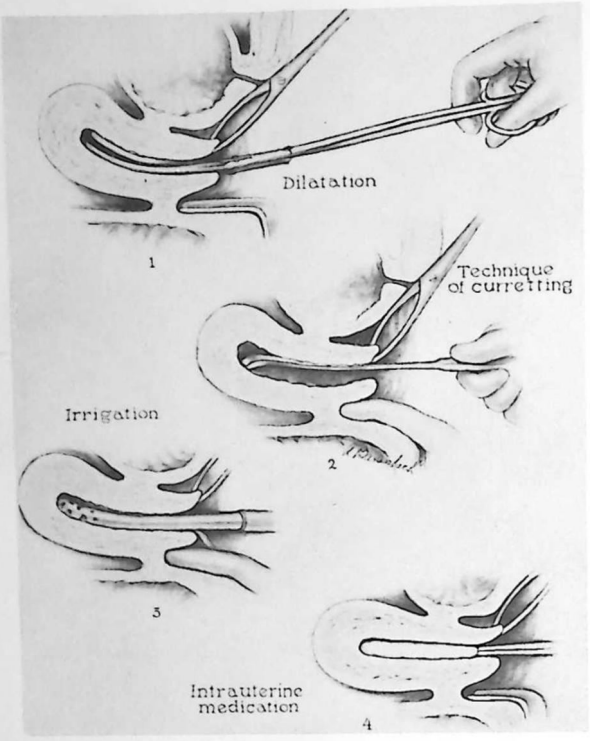


Fig. 1953. Technic of curettage.

pack introduced between the bladder and uterus. Treat, in principle, the posterior vaginal cuff similarly to the anterior one, viz.: dissect it away from the uterus up to the posterior peritoneal pouch. Open the culdesac of Douglas. Isolate the broad ligaments. The uterus is now held suspended

in the pelvis by the broad, uterosacral, infundibulopelvic and round ligaments.

Step 5. Ligation and division of the broad ligaments. A curved Mayo needle carrying a No. 1 or 2 chromic catgut suture engages the lower edge of the broad ligament, which is ligated, tied and left long, to be used temporarily as a traction-suture. Divide this portion of the broad ligament close to the uterus. Treat another segment of tissue above the first ligature similarly. Introduce the needle under the guidance of the finger and suture as large a segment of broad ligament as is consistent with safety. The higher the separation of broad ligament from the uterus proceeds, the greater the mobility of the uterus becomes. Treat the broad ligament on the other side

Fig. 1954 Fig. 1955

Fig. 1954. Prolapsus of the uterus (second degree).
Fig. 1955. Complete prolapsus of the uterus.

similarly. Hook a finger over the top of the broad ligament on one side. Place safety ligatures and sever the ligament from the uterus. If a salpingectomy or salpingo-oophorectomy is to be done simultaneously, the ligatures are placed where indicated (infundibulopelvic ligament). Repeat the procedure on the opposite side. Keep in mind at all times the importance of thorough hemostasis and the avoidance of injury to the ureter and the adjacent viscera (rectum, prolapsed small bowel, bladder). Inspect the pedicles of the ligamentous structures held by the traction sutures. Put in additional sutures where hemostasis seems incomplete.

Step 6. Remove the gauze-pack from the anterior culdesac. Isolate the divided edge of the bladder peritoneum. Unite the broad ligaments by bringing the sutures which were left long into apposition. Additional sutures are used to unite the divided ligaments. The order of uniting the severed ligaments is as follows: Bladder peritoneum and round ligaments; broad ligaments and finally the vaginal vault. Provide for drainage (tube or cigarette drain) in the posterior opening leading into the pelvis.

Step 7. Close the vaginal vault. If cystocele and rectocele are present, repair these. Pack the vagina lightly.

Doyen's Vaginal Hysterectomy

This is undoubtedly the most rapid method of performing vaginal hysterectomy.

Step 1. Opening and exploring of the culdesac of Douglas. Retract the posterior vaginal wall (weighted speculum). Engage the posterior lip of the cervix in a vulsellum forceps; displace it upward. Do a posterior vaginal colpotomy. Enter Douglas' pouch. Introduce both index fingers, divulse the opening thus created, transversely. Explore the posterior surface of the uterus and adnexae through the opening thus made.

Step 2. Opening of the anterior vaginal culdesac and detachment of the bladder. Introduce a flat vaginal retractor and exert traction toward the pubes. Grasp the anterior lip of the cervix with a vulsellum forceps and pull it downward. Enter the anterior vaginal culdesac. The circular incision of the vaginal attachments of the cervix is then completed. To avoid injury to the bladder, direct the point of the scissors toward the cervix. A gauze covered finger aids in separating the bladder from the supravaginal portion of the cervix. This must be done thoroughly and the bladder cleared high up lest injury to it and the ureters results.

Step 3. Median anterior hemisection of the cervix. Entering the anterior peritoneal space. Median anterior hemisection of the body of the uterus and its delivery. Retract the bladder anteriorly. Grasp the cervix with two strong-toothed vulsella forceps. Divide the anterior cervical lip between the two vulsella with a pair of straight scissors (Fig. 1956 a, b). If not already opened, the vesico-uterine peritoneal culdesac is now entered. Apply another pair of vulsella above those already placed and extend the incision into the anterior uterine wall higher up (Fig. 1956 c). In large uteri the anterior retractor is removed, the index finger of the right hand is introduced between the bladder and uterus and the vulsella are placed above the second pair and the incision extended further up. Traction on the highest vulsellum forceps will now bring the fundus of the uterus into view. If difficulty is encountered at this stage of the operation by reason of narrowing of the vagino-peritoneal aperture in nonparous women, two fingers in the anterior culdesac deliver the fundus; or, aid is obtained by grasping the top of the fundus uteri with a strong pair of vulsellum forceps and dragging it into the field of operation (Fig. 1956 d). The adnexae may also be brought down in this manner. The ligamentous structures are taken care of by ligation as described above, or by crushing forceps.* The uterus is cut away between the ligatured ligamentous structures and the forceps which have been placed proximal to the uterus (Fig. 1956 e, f, g).

If pressure forceps are used instead of ligatures, the surgeon may elect (in certain contingencies) to apply the forceps from above downward. The treatment of the stumps proceeds as outlined above. (Steps 5-7, p. 1789.)

In relaxation and descensus cases union of the broad ligament is very efficacious. G. L. Hunner advises passing a chromic catgut suture just beneath the urethral sphincter, then through the stumps of the upper third of

* Read Steps 5, 6 and 7 on page 1789.

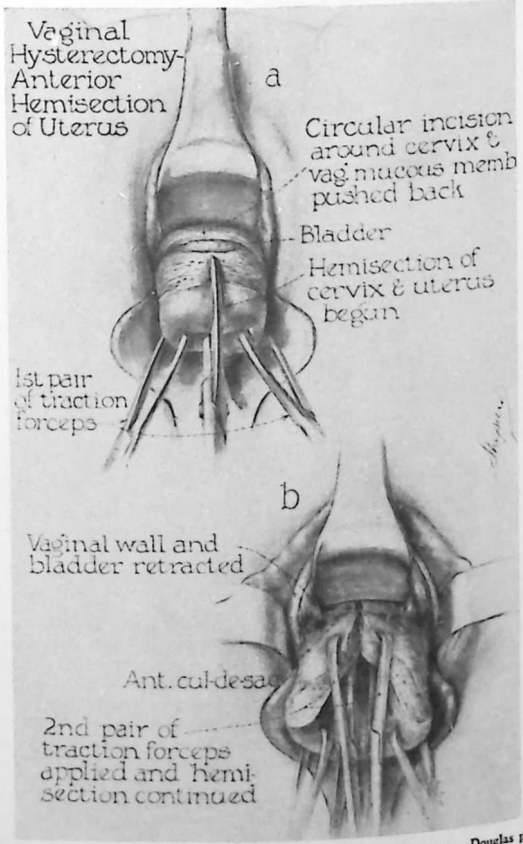


Fig. 1956. Doyen's vaginal hysterectomy. a. Posterior vaginal colpotomy. Douglas pouch entered. Anterior culdesac opened, bladder detached. Median anterior hemisection of the uterus with straight scissors. b. Hemisection of uterus continued between vulsella placed higher up.

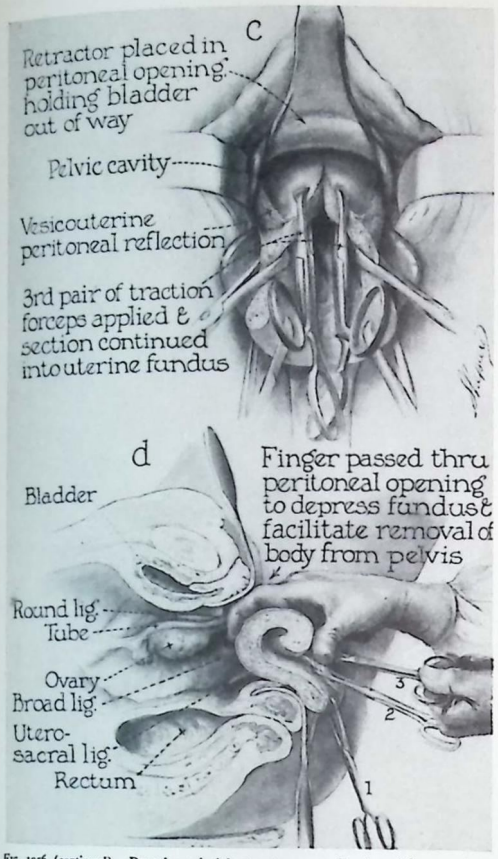


FIG. 1956 (continued). Doyen's vaginal hysterectomy. c. Further delivery and anterior hemisection of the uterus. d. Delivery of fundus uteri with fingers. Adnexae may also be brought through this opening if desired.

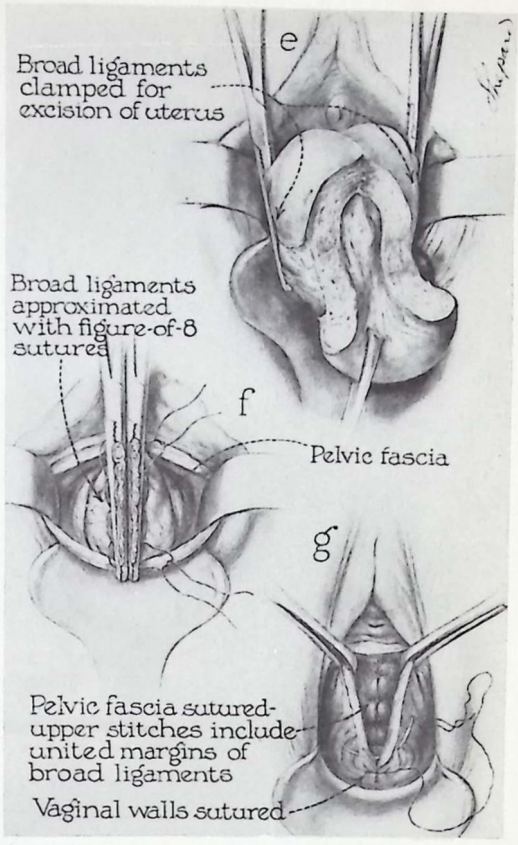


FIG. 1956 (continued). Doyen's vaginal hysterectomy. Clamping. e. Clamping and division of broad ligaments. f. Approximation of broad ligaments with catgut sutures. g. Final steps of the operation (cf. steps 5, 6, 7, p. 1789).

the broad ligaments, the round and the uterosacral ligaments, crossing over to the opposite side picking up the ligaments in inverse order, emerging finally through the vaginal edge opposite to the point of entrance. This gathering suture is tied around a cigarette drain for a few days. Close the vaginal incision. Pack lightly.

ABDOMINAL HYSTERECTOMY

Historical Notes. The names of Péan and Koeberlé are prominently connected with the history of supravaginal amputations of the uterus and with the extraperitoneal treatment of the pedicle. They employed the metal ligature with Cintrat's serre-noëd and steel pins. In obstetrical practice Porro used supravaginal amputation of the uterus on May 21, 1876. Kleeberg of Odessa first used the temporary elastic ligature in 1875. Its use was urged by Martin in 1878. Hegar in 1879 substituted the elastic for the metal ligature to secure hemostasis for the pedicle. Reduction of the cervical stump was proposed by Schroeder in 1878, and independently without the knowledge of the latter's work, by Spencer Wells in 1880. A buried elastic ligature was used by Czerny in 1879 and by Kaltenbach in 1881. Accidents observed after the reduction of the pedicle by the methods in vogue caused Memert (Odessa) in 1885 to pass the pedicle via the vagina by opening Douglas' culdesac. His innovation proved a failure. Wölfler and von Hacker advocated attaching of the pedicle by a suture to the abdominal wall and protecting the parts with iodoform gauze and drains. In 1866 Max Sänger proposed to isolate the pedicle by suturing the parietal peritoneum over it. It is to Sänger's credit that he advocated sero-serous suture of the uterus. Total abdominal hysterectomy was proposed by Delpech in 1830, and was designed anew by Freund in 1878. The operation, despite its advocacy by Rypier, Schroeder and MacCormac, fell into abysmal discredit. The reason is evident. Hegar and Kaltenbach showed a mortality of 72 per cent in a series of 119 cases thus operated on. Later some surgeons attempted total hysterectomy by a combined abdominovaginal method (Péan, Lister, Bouilly, Doyen) with disappointing results.

Abdominal, Supravaginal (Supracervical) Hysterectomy

A thorough knowledge of the vascular supply of the tissues in question is essential. In supravaginal (supracervical) subtotal hysterectomy the body of the uterus is removed leaving more or less of the cervix behind (Fig. 1957).

Step 1. The patient is placed in the Trendelenburg position (Fig. 1958). Make a suprapubic paramedian abdominal incision, a little to the right or left, as preferred. Thorough exposure and exploration are indispensable essentials. Pack the intestines out of the way. See if complicating conditions are present. Decide what procedure will suit best.

Step 2. Engage the fundus of the uterus in a strong vulsellum forceps and pull it upward, exposing and putting on the stretch the side to be attacked first. In cases where the ovaries are to be preserved, hemostats are applied between the ovary, uterus and tube; if they are to be removed, the artery forceps engages the ovarian vessels in the infundibulopelvic ligament (on the right or left side depending on the side from which the operation is chosen to proceed). Ligate and sever the infundibulopelvic ligament. Secure the round ligament in a hemostat; ligate it doubly and divide it a short distance from the uterus (Fig. 1959 a).

Step 3. Clamp and divide the broad ligament toward the cervix; expose, clamp

and ligate the uterine artery. Avoid the ureter. Incise the vesico-uterine peritoneum along its entire extent. In freeing the vesico-uterine peritoneum avoid injury to the bladder. Fashion a similar flap from the posterior wall of the uterus.

Step 4. Amputate the uterus low down, at its cervical portion, thus exposing the uterine vessels on the opposite side. These are clamped, ligated and divided well above the level of the amputation stump (Fig. 1959 b).

Step 5. Draw the uterus upward. Touch the cervical opening with iodine carried on an applicator; the round ligament and its vascular supply and

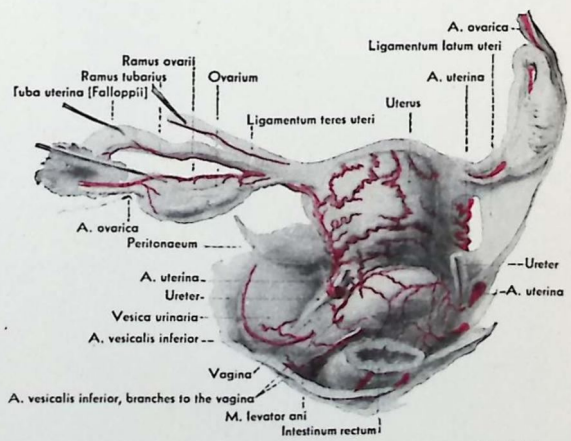


FIG. 1957. Arteries of the uterus and the surrounding structures. (Spalteholz.)

the infundibulopelvic ligament carrying the ovarian vessels are clamped and ligated, and the uterus with or without its adnexae is severed from its attachments.

Step 6. Cone out the cervical stump with an appropriate scalpel. Close the cervical stump with interrupted chromic catgut sutures. Implant the round ligaments into the angles of the stump of the cervix (Fig. 1959 c, d, e).

Step 7. Peritonealize thoroughly. This is accomplished by bringing the broad ligaments together in such a manner that no raw surfaces are left exposed. The vesico-uterine reflection is made to cover the suture line uniting the roof of the cervix.

Step 8. Free the peritoneal cavity of blood clots. Replace the viscera; pull down the great omentum. Close the abdominal wound in layers.

Kelly's Sagittal Bisection of the Uterus

This operation offers many advantages, viz.:
(a) Preliminary control of the uterine vessels;
(b) Additional room for thorough work;
(c) Better avenues of approach in difficult cases.

FIG. 1958. Trendelenburg position.

(d) In instances where the lateral masses are adherent, they may be removed with safety with scalpel or scissors, or they may be morcellated with forceps, in situ.

(e) Injury to contiguous organs (rectum, ureters, great vessels) may be avoided.

Step 1. Grasp the fundus and pull it upward with Museux vulsellum forceps. Divide the body of the uterus in the median line with strong scissors, to a point below its peritoneal reflection (Fig. 1960 a).

Step 2. As the operation progresses the Museux vulsellum forceps are released and reapplied on the cut surface, not unlike the procedure in Doyen's vaginal hysterectomy (p. 1790).

Step 3. One-half of the bisected cervical part of the uterus is next cut horizontally toward the broad ligament. While this is being done, the Museux vulsellum forceps grasp the horizontal surface of the divided uterus pulling it upward thus exposing the uterine vessels.

Step 4. Ligation of the uterine vessels is next done (Fig. 1960 b). Repeat the procedure on the opposite side. The further steps of the operation are essentially those of the classical supravaginal hysterectomy. After the removal of the uterus the adherent adnexae may be dealt with by dissection proceeding from within outward (Fig. 1960 c, d).

The operation may be extended and the cervix also removed (panhysterectomy). In those cases where the adnexae on both sides are much involved, and the uterus is so plastered down with adhesions that it cannot be bisected as described, Kelly advises horizontal bisection which consists of dividing the bladder peritoneum from side to side, pushing the bladder toward the cervix and bisecting the exposed cervix horizontally.

Total Hysterectomy (Panhysterectomy)

In this operation the cervix is also removed.

The same steps are carried out as in the supravaginal operation with the following steps added:

(a) The bladder is pushed down in front of the cervix.
(b) Be oriented on the relative lateral position of the ureters.
(c) Clamping, dividing and ligature of the lateral cervical tissues (parametrial).
(d) Opening the vagina.
(e) Removal of the cervix.
(f) Closure of the vaginal vault with or without drainage.

Comment: Separate the bladder first in the median line and then laterally. Without identifying the ureter on either side of the cervix, the surgeon can never be sure that it is out of harm's way. The vagina is incised longitudinally. Immediately after it has been opened it is grasped with artery forceps and a strip of iodoform gauze is pushed into it, to be removed later. In cases where, during the preparation of the vagina, a strip of iodoform gauze has been placed there, as is often done, it is pulled up through the open vaginal vault to be used as a drain after the operation. In excising the cervix, shortening of the vagina should be avoided by cutting the vaginal tissues quite close to its cervical attachments. The vagina is closed about a cigarette or rubber tube drain.

DOYEN'S PANHYSTERECTOMY

Step 1. Introduce a long sturdy curved forceps into the vagina; it is pushed up forcibly behind the cervix by an assistant, causing the posterior vaginal culdesac to bulge as high as possible.

Step 2. Incise the tensed tissues longitudinally with a sharp scalpel, permitting the vaginal forceps to enter the abdomen through the opening thus made (Fig. 1961 a).

Step 3. Enlarge the opening in the vault of the vagina by divulsion.

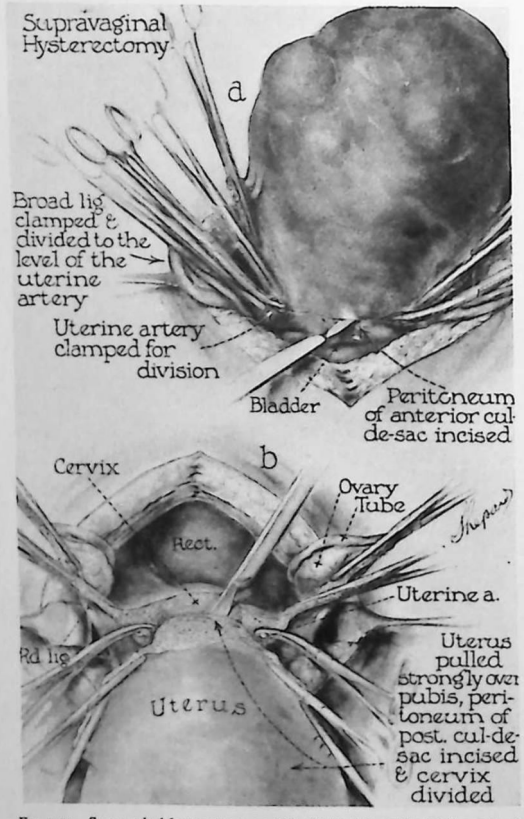


FIG. 1959. Supravaginal hysterectomy. a. Infundibulopelvic and broad ligaments clamped and ligated to the level of the uterine artery which is doubly clamped, ligated and divided. b. Anterior uterine incision.

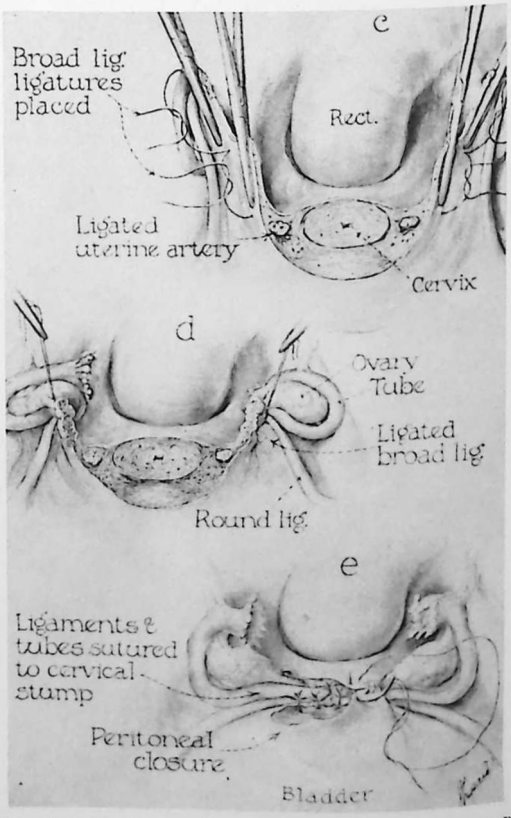


FIG. 1959 (continued). Supravaginal hysterectomy. c. Uterus has been removed. Placement of ligatures on infundibulopelvic, round and broad ligaments. d. The cervix cored out. e. Cervical stump closed with interrupted sutures. Round ligaments implanted into corners of cervical stump. Peritoneal closure.

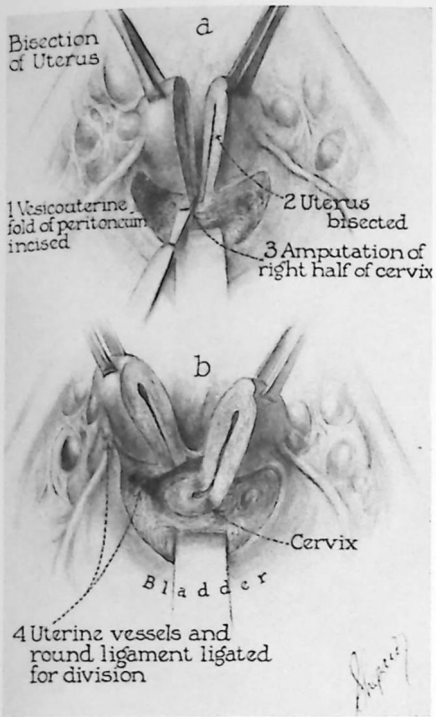


FIG. 1960. Kelly's method of hysterectomy (bisection of the uterus). a. Incision of vesicouterine fold of peritoneum. Bisection of uterus. Amputation of right half of cervix. b. Exposure and ligation of uterine vessels.

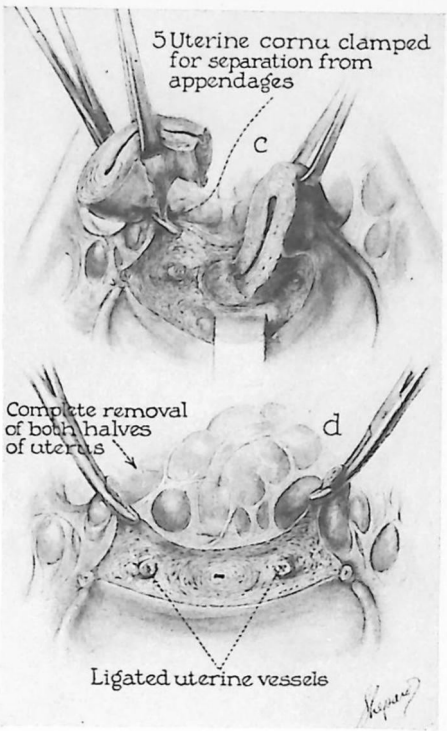


FIG. 1960 (continued). Kelly's method of hysterectomy (bisection of uterus). c. Uterus completely detached from adnexae. d. Removal of bisected uterus completed; bloodvessels ligated. Closure and peritonization as previously described and illustrated.

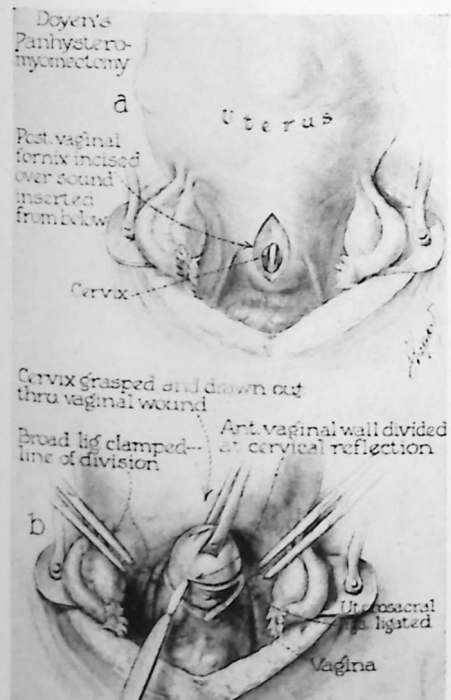


FIG. 1961. Doyen's panhysterectomy. a. Incision of posterior vaginal fornix over sound, opening enlarged by divulsion. b. Cervix delivered from vagina by Museux vulsella forceps. Vaginal attachments severed from cervix. Opening of anterior culdesac.

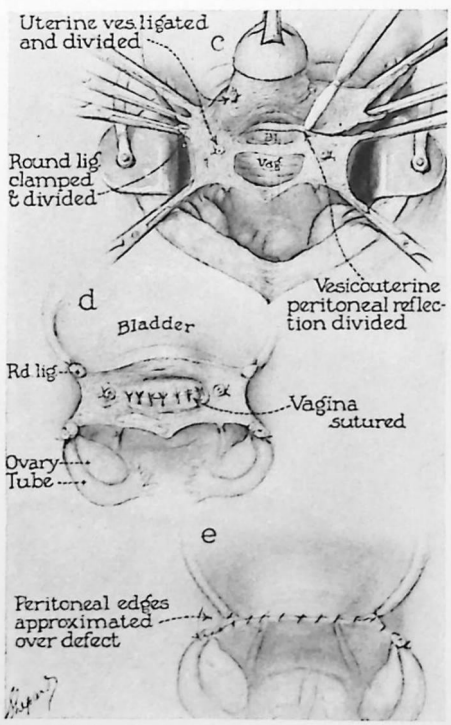


FIG. 1961 (continued). Doyen's panhysterectomy. c. Cervix being freed from attachments; uterine vessels clamped and ligated. d, e. Closure of vagina. Peritonization.

Step 4. Introduce the index finger into the vagina, locate the cervix, grasp it with a Museux forceps and deliver it into the abdominal wound (Fig. 1961 b).

Step 5. While traction is applied to the fundus of the uterus, the vaginal attachments are severed with curved scissors from the cervix and the anterior culdesac is entered.

Step 6. Free the anterior portion of the cervix from its attachments. The operative steps are now continued as described above (Fig. 1961 c, d, e).

Comment: Genital Prolapse following Total Hysterectomy. R. L. Payne[1] discussing the subject of genital prolapse following removal of the uterus points out that:

After any type of vaginal hysterectomy a marked genital prolapse often happens in which the vagina becomes completely everted and the bladder partially or completely protrudes. With the cervix and its attached supports entirely wanting in these cases, the problem of returning the bladder to the abdomen and fixing it there through any type of vaginal operation, is, practically speaking, impossible.

In all the literature and textbooks on this question of genital prolapse after total removal of the uterus, the only procedure offered to relieve this trouble is colpocleisis. Simon, in 1885, originally recommended and described colpocleisis for the cure of intractable vesicovaginal fistula, but for the past twenty-five years or more, colpocleisis has been undertaken repeatedly for the cure of genital prolapse after total removal of the uterus. Needless to say, not only is this operation a poor surgical procedure, which is rather difficult to accomplish properly and gives a poor result in many instances, but it is definitely deforming.

Payne devised the technic depicted in the accompanying illustrations and legends (Fig. 1962). He has done this operation only four times, the last one two years ago and the first one more than ten years ago. In these four cases, the result has been entirely satisfactory.

Payne does not claim this to be a new operation; all the steps or principles have been utilized for years in other gynecologic problems. The technic merely covers the application of wellknown principles which, as far as he can discover, have not been described in the literature or applied to the handling of this particular problem of prolapse after total hysterectomy.

Hysterectomy for Carcinoma of the Uterus

(Ries-Wertheim's Operation)

In this country Emil Ries, Werder, Sampson and Clark, and in other countries Wertheim, Freund and others contributed much to the development of the extended operation for uterine carcinoma. Its performance requires one to be a good anatomist, with an ample knowledge of pathology and to command a good technic; coupled with these a careful selection of cases will tend much to lower the operative mortality in this class of cases.

[1] Archives of Surgery, Vol. XX, 1930.

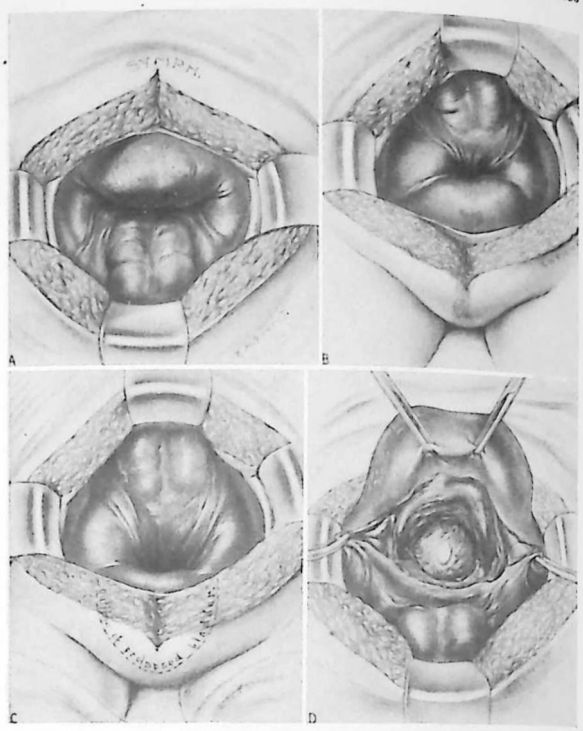


FIG. 1962. Payne's operation for genital prolapse following total hysterectomy. A. The relationship of the pelvic structures, with the patient in the Trendelenburg position. It will be noted that the bladder is rolled upward and completely covers the apical attachments of the broad ligaments to the upper end of the vagina. B. The same relation of the broad ligaments, but the vagina and bladder have been returned to the normal position. C. A diagrammatic sketch showing the funnel-shaped appearance of the pelvis when the abdomen is opened and before the bladder and vaginal prolapse have been reduced. It will be noted that the two broad ligaments, consisting of the round and infundibulopelvic ligaments, together with the fibrous structures between, are drawn down and attached to the apex of the funnel the smaller end of which coincides with the upper end of the vagina where the cervix was originally located. D. The first step is the introduction of the Cameron light through the vulva to the upper end of the vagina. This acts as a mechanical guide; the glow of the light readily facilitates the identification of structures. The dissection provides for the complete freeing of the bladder anteriorly, the broad ligaments laterally and the rectum posteriorly from the vagina. In the average case the vagina will then represent a raw cone from 1½ to 2½ inches (3.8 to 6.3 cm.) long.

Step 1. This consists of disinfection of the vagina, preceded by a thorough electrocoagulation of the accessible carcinomatous tissue and thorough packing of the vagina with iodoform gauze. It is good insurance to catheterize the ureters to avoid injuries during the operative manipulations.

Step 2. High Trendelenburg position. Ample subumbilico-paramedian incision. Thorough protection of the bowels away from the field of operation. The pelvis must be free to afford facility of operative manipulations.

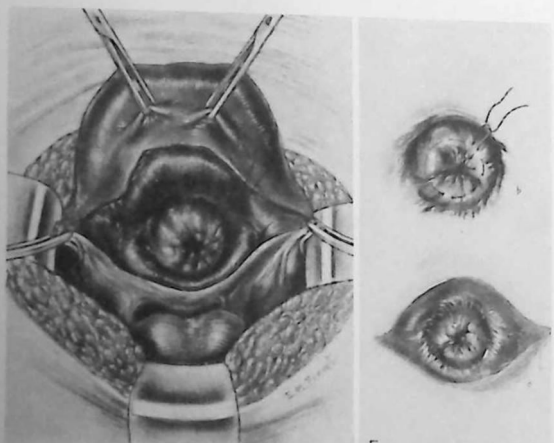


FIG. 1962 (continued). Payne's operation for genital prolapse following total hysterectomy: E. With the pelvic portion of the vagina completely freed on all sides, the next step consists of the introduction of three purse string sutures of silk, a, b, c. Each purse string is tied before the next one is put in; this results in an infolding mass of the upper end of the vagina which provides a kind of plug for the outlet and at the same time shortens the normal depth of the vagina, depending on its individual length. The average reduction in length is about half.

Step 3. Engage the fundus of the uterus in a strong vulsellum forceps; draw it strongly upward and forward. Divide the infundibulopelvic ligament (Fig. 1963 a) on the side the operation is begun. Incise the peritoneum toward the round ligament. Doubly ligate the round ligament and divide it. Repeat the same procedure on the other side. The body of the uterus is now practically free on both sides.

Step 4. Incise the peritoneum. Free the urinary bladder by blunt gauze dissection aided, by scissors dissection where deemed advisable, from the whole anterior surface of the uterus to a little below the vault of the vagina (Fig. 1963 b). Place a retractor in front, to hold the separated bladder out of the way. Ligate and divide the uterosacral ligament posteriorly, joining the

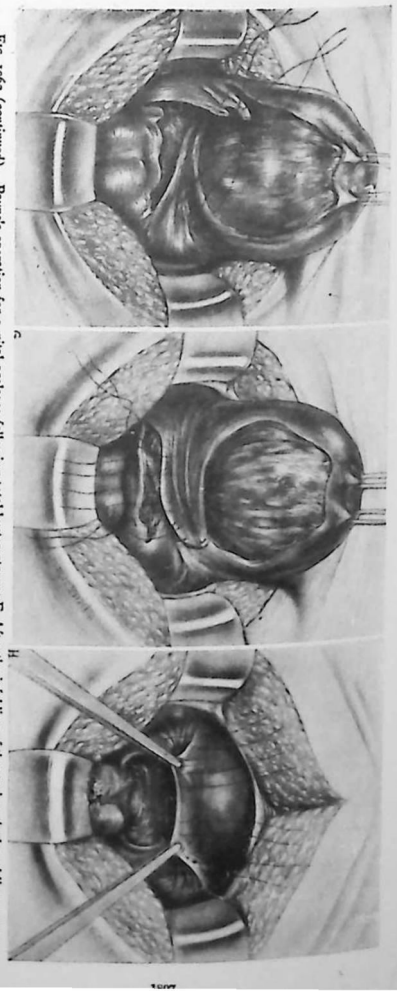


FIG. 1962 (continued). Payne's operation for genital prolapse following total hysterectomy: F. After the infolding of the vagina, the broad ligaments are brought obliquely across the vaginal ball and sutured snugly to the fibrous structures on each side of the vaginal stump. G. Both broad ligaments are overlapped and snugly sutured behind the bladder and as near to the apex or trigone as is possible, thus providing an additional sling or hammock on which the bladder can be supported. H. The final step, in which the bladder is brought backward over the constructed supports and sutured to the posterior pelvic area in a manner that will cover up all raw surfaces. Following the closure of the abdomen, a snug, high perineal repair is always done according to the technic previously described. (Payne: A Technic for the Repair of Relaxed or Lacerated Perineum, Arch. Surg. 20:638-641.)

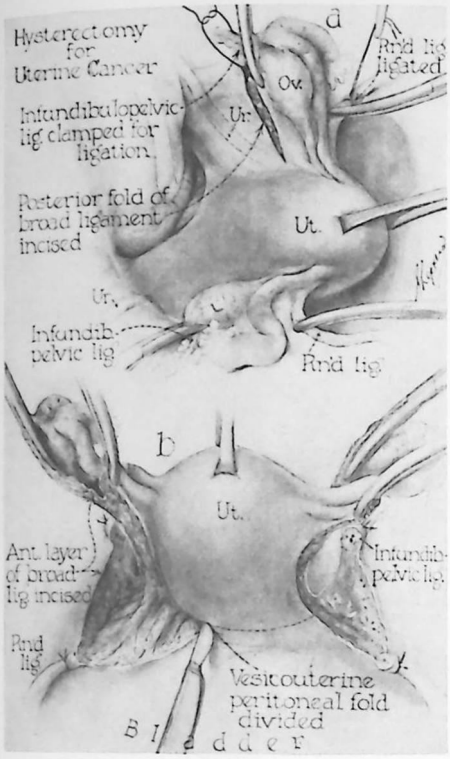


FIG. 1963. Ries-Wertheim operation for carcinoma of the uterus. a. Division of the infundibulopelvic and round and broad ligaments. b. Freeing of bladder and rectum.

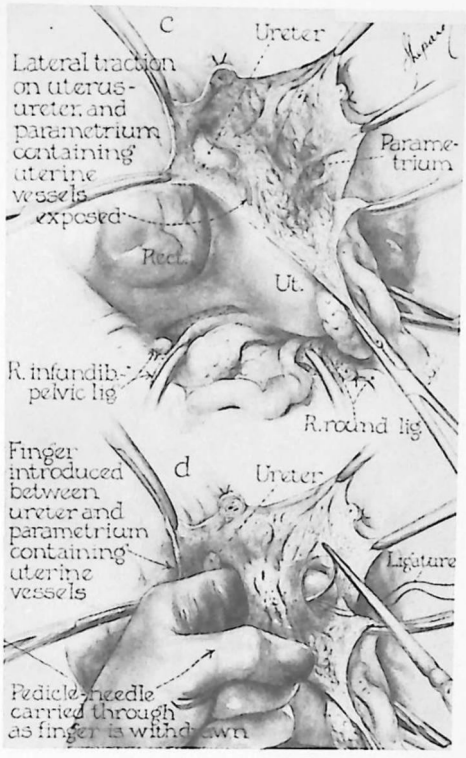


FIG. 1963. (Continued) Ries-Wertheim operation for carcinoma of the uterus. c. Locating the ureter and dissection of the parametria. d. Ligating the uterine vessels while avoiding the ureter.

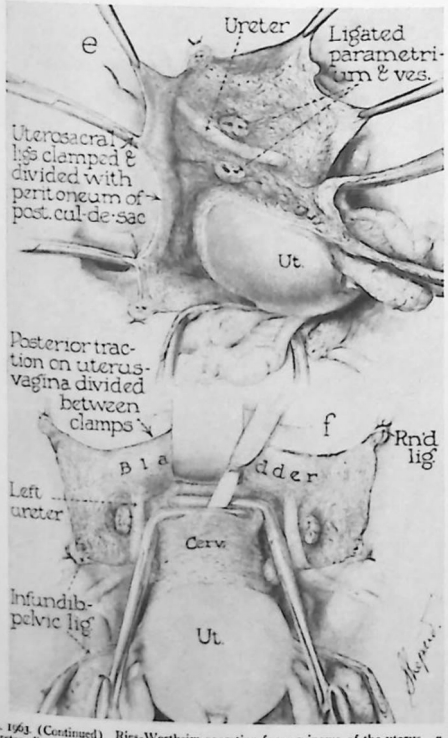


FIG. 1963. (Continued) Ries-Wertheim operation for carcinoma of the uterus. e. Exposure of the ureter, dissection of the parametria; care of blood vessels. f. Separation of base of bladder in front of cervix, vagina and its lateral attachments to paramedial and paravaginal tissues. Freeing, clamping and division of vagina.

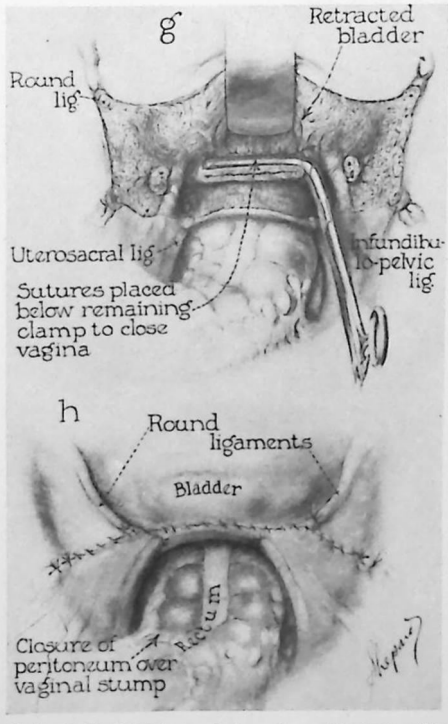


FIG. 1963. (Continued) Ries-Wertheim operation for carcinoma of the uterus. g. Closure of the vagina over vaginal clamp. Peritonization.

posterior with the anterior incision. Separate the rectum from the upper part of the vagina.

Step 5. Locate the ureter (Fig. 1963 c). This is one of the very important steps of the operation. Draw the uterus to one side; locate the uterine artery close to the uterus, ligate it doubly and divide it. The ureter lies in the parametrium immediately below the uterine vessels. It may be picked up between the fingers at the base of the broad ligament on the pelvic floor and identified by the characteristic firm sensation it imparts to the palpating fingers. If not recognized by this maneuver, it should be located at the pelvic brim, tracing it down to the apertures in the lower part of the broad ligament through which it passes beneath the uterine artery. A boring movement of the index finger from beneath forward enlarges the canal through which the finger passes having above it the parametrium and vessels (Fig. 1963 d) and below it the ureter. The illustration shows the method of securing the uterine artery and safeguarding the ureter. Do not dissect the ureter from its surrounding structures; rather displace it by pushing it off the tissues. In many cases the freeing of the ureter may prove extremely difficult (Fig. 1963 e). Cancer tissue seldom if ever invades the ureteral structures; if that should happen a resection of the involved portion may become imperative (which see) followed by a uretero-ureteral or uretero-vesical anastomosis. When both ureters have been liberated the cervix remains attached only by the upper part of the vagina.

Step 6. Complete the separation of the base of the bladder in front of the cervix and vagina as far down as is deemed necessary for thorough work, as well as from its lateral attachments to the parametrial and paravaginal tissues. The parametria should be thoroughly dissected out with the lymph nodes contained in them. In some instances this is accomplished with facility while in others, marked infiltration will render this step extremely difficult. Wertheim's parametrial clamps act admirably to grasp the parametrial tissues preliminary to ligation and division.

Step 7. An assistant removes the vaginal pack. Readjust the lap packs and either

(a) Open the vaginal vault in front by continuing the incision around the vagina which is held by artery forceps as its division continues or

(b) The vagina is freed all around and palpated in order to make sure that it is freed beyond the infiltrated area; two vaginal clamps (Fig. 1963 f, g) are made to grasp the vagina which is severed between the clamps. Immediately after the removal of the cancerous uterus, disinfect the stump of vaginal cuff with tincture of iodine. The vagina may now be closed completely in cases reasonably free from contamination. As a rule, I prefer providing drainage in these extensive cases by suturing the vagina around one or two substantial cigarette drains and covering its vault with peritoneum. Or, the vaginal vault may be closed by first suturing its margins to their respective peritoneal folds (Fig. 1963 h) after which the vesico-uterine peritoneum is joined to the rectal peritoneum.

Step 8. A thorough survey of the operative field is now made. Peritonization

must be meticulous by careful covering of raw surfaces and the exposed ureters.

Step 9. Change gloves and substitute fresh instruments for those used. Close the abdomen in layers.

Comment: Every precaution should be taken to avoid contamination. The ureters should be handled with utmost care. Postoperative cystitis is not unusual. If present, treat it systematically. Avoid urinary retention. Occasionally, ligation of both internal iliac vessels is practiced.

Since the advent of radium and deep x-ray therapy the extensive Ries-Wertheim procedure has yielded much ground to hysterectomy with removal of only a moderate amount of the parametrial tissues followed by x-ray and radium therapy.

ARTERIAL LIGATION AND LYMPHATIC BLOCK FOR IRREMOVABLE CARCINOMA OF PELVIC ORGANS

Historical Notes. The application of a ligature to blood vessels is said to have been practiced at least eighteen hundred years before the vascular system itself was understood. It is not known who first employed the method, but ligation of bleeding vessels for the control of hemorrhage is mentioned in the writings of Celsus (30 B.C. to 50 A.D.) and of Galen (131-211 A.D.), Aetius (502-575 A.D.), Avicenna (980-1037 A.D.), and others of the early authorities on surgery. The ligature was used for the control of hemorrhage and in the treatment of aneurysm.

When Ambroise Paré, the great French surgeon, revived interest in the ligature in 1522, he improved the method of its application, and extended its field of usefulness. Paré besought the surgeons of his day to abandon the "old and too too cruel way of healing" by the use of the "red-hot iron," and to embrace the new method of controlling hemorrhage by binding the vessels "toward their roots."

The beginning of the eighteenth century found the surgeons of the world still using the actual cautery for the control of hemorrhage.

Thus it will be seen that while the ligation of arteries was practiced for centuries before Harvey discovered the circulation of the blood (1616-19), its use was limited to the control of hemorrhage and the treatment of aneurysm.

With Harvey's discovery of the circulation of the blood and the development of the knowledge of the part played by the blood in the nourishment of tissue, abnormal as well as normal, the method of ligating arteries increased in scope. It is now applied for the purpose of causing atrophy of organs and other parts of the body, and of lessening the nutrition of inoperable and irremovable new growths, thus retarding their further development.

This particular use of the ligature has given rise to the term "starvation ligature," and the procedure has been applied to the uterus, ovaries, testes, spleen, thyroid, tongue brain (epilepsy), and other parts of the body.

The discoverer of the circulation of the blood is himself credited with originating this newer application of the ligature in surgery, and for a long time the method was known as "Harvey's method." In 1651 he is said to have successfully treated a case of elephantiasis of the scrotum and testicle by ligating the spermatic artery. So far as is known no further application was made by Harvey of this procedure.

The next recorded application of the starvation ligature is that of Lange, who, in 1707, employed the method in the treatment of goiter.

So far as Bainbridge has been able to ascertain from the literature, a hundred years elapsed before the method was revived with any definiteness.

Travers, in 1809, tied the common carotid artery in the treatment of a tumor of the orbit, said by some writers to be a fungous growth and by others to be an aneurysm.

From this time on the method was employed in a more or less desultory manner for various purposes, particularly in the carotid region. In 1878 the history of this special application of the ligature was traced by John A. Wyeth, and his own original work detailed.

Interest in the procedure was again aroused, in 1903, when Dawbarn reviewed the history of the subject briefly, and explained his own modification of the method; viz. the exsection of the external carotid arteries; paraffin injection of the terminal branches; injection of its main branches with liquid paraffin, after the suggestion of Wyeth.

Starvation Ligature in the Treatment of Malignant Pelvic Tumors

Historical Notes. The application of the starvation ligature to the pelvic organs was first recorded by Fritsch, who, in 1885, advised and practiced ligation of the uterine arteries in a case of fibroma of the uterus. He was followed by a number of surgeons.

To Baumgartner seems to belong the credit for having first tied arterial blood vessels in the treatment of irremovable cancer of the uterus, the report of which was published in 1888. The uterine arteries were ligated by way of the vagina when this was possible, or if not, the ligature was applied to the anterior trunk of the internal iliac, at the origin of the uterine artery. Unfortunately, no details are given concerning the technic which he employed.

Kelly, in 1893, ligated the internal iliac arteries in the treatment of a case of cancer of the uterus, the procedure in this instance being one of emergency rather than of selection, for the purpose of checking unexpected and otherwise uncontrollable hemorrhage. In the course of abdominal hysterectomy for squamous-cell carcinoma of the cervix, with extension to both broad ligaments, the ligatures cut through and free hemorrhage ensued. Both internal iliac arteries were ligated, the hemorrhage was controlled and the operation was completed. The patient's condition was such, however, that it was impossible to remove all the diseased tissue. When, six months later, the patient was readmitted to the hospital to be treated for a vesicovaginal fistula, careful examination failed to reveal the slightest evidence of the carcinoma. The patient died ten months after the operation, presumably from the result of the extension of the growth.

In 1896 Dr. W. R. Pryor of New York ligated the internal iliac arteries with the avowed purpose not only of controlling hemorrhage, but for the "starvation of tissue which cannot safely be removed." "In all cases," he said, "of cervical cancer where the infection has extended to the pelvic glands, in all cases of recurrence after hysterectomy, and in so-called inoperable cases I advocate the ligation of both internal iliac arteries as a step preliminary to any other. My object," he further stated, "is to remove all the tissue I can, and what I cannot remove I want to starve. I do not expect a radical cure is ever possible where once the glands are affected but I believe that at least a retardation is possible."

Pryor ligated, through a median abdominal incision, the ovarian, the internal iliac and the obturator arteries. He simultaneously ligated both internal iliacs for malignant disease of the uterus in thirty-four cases, with one fatality. In his experience, life was much prolonged and suffering diminished.

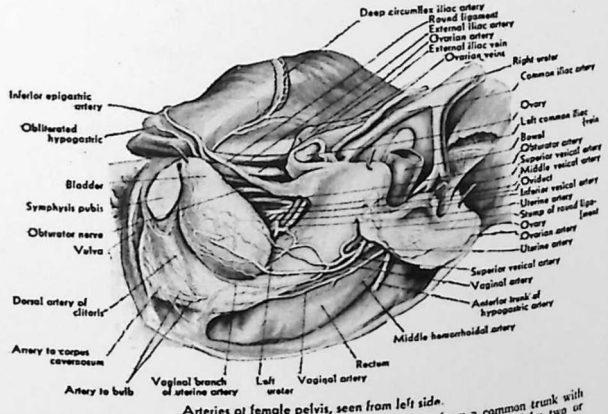
Polk, in 1896, Hartmann and Fredet, from 1897 to 1900, de Rouville, in 1904, Cantier, in 1907, and a number of others have added to the literature of arterial ligation in the treatment of neoplasms of the pelvic organs.

Anatomic Considerations (Fig. 1964). Ligation of the uterine arteries alone is not always sufficient to control hemorrhage, nor is it so effective in the retardation of the malignant growth, as is ligation of the anterior trunk or of the internal iliac itself. Nor is ligation of the utero-ovarian arteries sufficient in all cases, a fair blood supply to the parts being maintained through the anastomosis of other branches of the internal iliac, or possibly through the establishment of a recurrent circulation. In Bainbridge's early experience the ovarian and uterine arteries alone were ligated; or, if the uterine could not be reached, its nearest branches were tied off, or the anterior

division of the internal iliac was ligated on the side of the most extensive involvement, the uterine and ovarian of the opposite side being ligated at the same time.

Ligation of the internal iliac artery of each side close to the bifurcation of the common iliac, thus shutting off all the branches of the posterior and anterior trunks of the internal iliac arteries, eliminates the chief blood supply of the uterus, vagina and pelvic fasciae. If these are accessible without cutting into cancerous tissue, and if it is deemed necessary or advisable, the obturator, superior vesical, or other branches of the internal iliac may be ligated individually, as practiced by a number of surgeons, in addition to the main ligature of the internal iliac.

If, in addition to the internal iliacs, the ovarians and the sacra media (if developed large enough to warrant it) are ligated, the blood supply is sufficiently lessened to



Arteries of female pelvis, seen from left side.

FIG. 1964. Variations. The vaginal artery occasionally arises from a common trunk with the uterine. Frequently, as a result of its precocious division, it is represented by two or more vessels.

control immediate and, usually, all subsequent hemorrhage of any severity, and to offer a reasonable hope of checking the growth of the neoplasm.

From the above it may be fairly assumed that in many instances failure may be attributable to the fact that the ligation was not sufficiently extensive to control the blood supply to the pelvic organs, thus proving ineffectual in either of the purposes for which it is mainly applied, namely, the control of hemorrhage and the retardation of the growth. Bainbridge found this to be the case, and gradually extended the method accordingly.

BAINBRIDGE'S OPERATION

Bainbridge's amplified method, which has proved efficacious in a number of cases, extending over a period of twenty-five years, is that of arterial ligation, with the additional safeguard of lymphatic block to prevent, as far as possible, the extension of the disease through the lymphatics. It is definitely a procedure for advanced cancer of the pelvic organs where complete removal seems im-

possible. However, for a number of years he has utilized it in some earlier cases with very satisfactory results.

The operation is one that could well be used in certain cases of advanced malignancy as a preliminary to other methods of treatment or following their use. The contraction of the growth through lack of blood supply, and the limiting of absorption and extension by way of the lymphatics through the removal of the nodes, may definitely result in a more beneficial reaction to additional other procedures, than otherwise would be possible.

Step 1. Make an incision a little to the right or left of the median line; enter the abdominal cavity. With the patient in the Trendelenburg position, the intestines are displaced with large packs toward the diaphragm. A full view of the entire pelvic cavity is absolutely essential.

Step 2. Ligate the ovarian arteries just above the pelvic brim with Pagenstecher thread or strong silk.

Step 3. Open the peritoneum on the posterior wall of the abdomen by a curved incision extending from one internal iliac artery to the other, with its convexity upward. As a rule this incision gives free access to all the retroperitoneal structures in the pelvis. Occasionally, however, the mesosigmoid is so short, or the adhesions are so extensive, that it is difficult to accomplish all that is necessary through the transverse incision. In such cases the ends of the incision in the peritoneum may be prolonged downward over the iliac vessels.

Step 4. Ligate each internal iliac artery in turn. The artery is carefully separated from its vein and ligated in two places. The first ligature is placed just below the bifurcation of the common iliac, and the second is placed half an inch below the first. With a large plain clamp the artery is crushed; the ligature is tied in the groove.

In atheromatous conditions it may be necessary to tie the common iliac in order to obviate the danger of rupture following erosion of this vessel by cancerous nodes at the bifurcation.

If it is possible to go below, without getting into cancerous tissue, the uterine and the obturator arteries may be ligated individually, in addition.

Step 5. The sacra media, if large enough to warrant it, is next ligated, one ligature sufficing for this.

Step 6. The nodes along the iliacs are removed *en masse*, if possible, from the receptaculum chyli above to the obturator foramina below. Thus all the nodes situated within and around the obturator foramina and in the pelvis, are removed. In the course of the operation, lymphatic block may be performed before or after the starvation ligature procedure. (Lymphatic block is applicable to fields other than the pelvis and Bainbridge has so employed it to advantage.)

Step 7. The ligation operation being completed, the posterior layer of peritoneum is closed, the intestines and omentum are replaced, and the anterior layer of peritoneum is brought together with a few sutures.

Step 8. The abdominal wall is then closed with through-and-through sutures of silkworm-gut or silk thread.

Step 9. After the abdomen is closed the patient may be placed in the lithotomy position and thorough curettage, by the Byrne method or otherwise, may be done, where such procedure is advisable. With the arteries ligated as above described, the uterus may be curetted to a shell without danger of hemorrhage. Zinc chloride or acetone may now be applied to the interior of the uterine cavity, or radiation may be employed.

Comment: Wherever possible the ovaries are removed. This is done for three reasons: (1) In accordance with Beatson's theory of the presumptive influence of ovarian irritation upon the malignant process. (2) An otherwise normal ovary may be subjected to a degenerative process as a result of pressure irritation by the carcinoma, or by adhesions later in the course of the disease, giving rise to additional and preventable discomfort. (3) By cutting away the upper part of the broad ligament, in the removal of the ovary, a certain amount of collateral circulation is shut off.

In considering the technic, the following points should be especially borne in mind:

(1) That adhesions of a cancerous nature must not be broken up in order to reach and ligate the vessels. The differentiation, therefore, must be made between malignant and nonmalignant adhesions.

(2) That cicatricial contraction in the diseased tissue frequently causes pressure upon the ureter, which may itself not be involved in the malignant process. In such event, the ureter may be stripped free, without breaking the cancerous adhesions, thus relieving the pressure in the neighborhood. This is accomplished by inserting the finger or an instrument between the ureter and the connective tissue which lies over or under the cancerous tissue, carefully working the ureter free. If the ureter itself is involved in the cancer, this procedure is not applicable; the case is then too far advanced for the operation.

(3) That should there be oozing from distant veins; this may be controlled with pads dipped in hot saline solution and left in place while attending to the other side.

(4) That in dealing with suspicious lymph nodes situated directly in contact with large blood vessels, one must be careful to ascertain whether they are softened underneath, while apparently normal on the surface. Failure to note such a condition may lead to the rupture of an underlying or contiguous blood vessel, or to the soiling of the peritoneum by the breaking of such softened lymph nodes.

(5) That care must be taken not to injure the internal iliac vein, which lies just to the mesial side of and behind the artery.

(6) That the ureters should be carefully identified as they cross into the pelvis, and retracted outward, thus avoiding injury to them.

(7) That the enlarged ligation clamp of Dawbarn is an admirable substitute for the blunt aneurysm needle generally employed. There is less danger of injury to the large vessels with the clamp than with the needle.

(8) That the crushing of the arteries and the use of permanent ligature material are necessary to secure adequate occlusion.

The method is not applicable:

(1) If the condition is too advanced or the patient markedly septic.

(2) If there is carcinomatous dissemination in the abdomen as well as the pelvis.

(3) If the bladder and rectum are already extensively involved.

(4) If cancerous adhesions are so extensive that it is impossible to reach the vessels for the purpose of ligation.

(5) If there is no hemorrhage, if the patient is as comfortable as can be expected under the circumstances, if there are no urgent symptoms warranting some more radical attempts at relief than are usually employed in the treatment of irremovable cancer of the pelvic organs, and if the disease is of very slow growth.

The method is applicable:

(1) When hemorrhage, which threatens death, cannot be controlled by other means.

(2) When hemorrhage has been sufficiently severe or frequent to warrant the fear of fatal return at any time.

(3) When hemorrhage is sufficient to cause a constant drain on the patient's vitality.

(4) When the disease is so extensive as to render curettage dangerous because of hemorrhage.

(5) When there is reason to believe that, by controlling, to a certain extent, the progress of the disease, the pain, fetor, and discharge may be lessened.

(6) When it is possible, by this means, to relieve various pressure symptoms.

(7) When, in the presence of advanced cancer of the pelvic organs, other conditions, which may not be due to the cancer, call for exploratory laparotomy.

(8) When, in cases seemingly too far advanced for total extirpation with hope of permanent cure, there is yet a possibility that life may be prolonged and suffering relieved, and in some cases radical cure effected.

(9) When all other measures have failed to give relief from the symptoms in the given case, when the patient demands that something more be done, and when there is any hope of mitigating suffering or prolonging life.

(10) When there is any hope of bringing a seemingly inoperable cancer within the scope of the operable by the contraction of the growth following the enforced anemia of the part.

The beneficial effects of radiation should be kept in mind in this connection. The combination of a number of methods may be indicated.

OPERATIONS FOR THE REPAIR OF INJURIES TO THE URETERS DURING HYSTERECTOMY

When no prophylactic catheterization of the ureters has been done prior to hysterectomy, the possibility of accidental ligation, crushing or cutting of one or both ureters is always to be kept in mind. The surgeon must be prepared to act promptly and command a number of methods to suit the condition present. If, during the operation, it is discovered that the ureter has been accidentally ligated, the ligature should be promptly released. When the ureter is divided or severely crushed (a) ureterovesical or (b) uretero-ureteral anastomosis should be done. Small injuries may be repaired by suturing the opening.

Historical Notes. Ureterovesical Anastomosis. Pozzi, Paoli and Busacchi have experimentally shown the feasibility of this method. It was Novarro who performed the operation successfully first on the human in 1893. His operation was a retroperitoneal one. Bary and Monari performed the operation intraperitoneally.

In injuries of the ureter during operations the following methods may be resorted to:

1. Ureterocysto-anastomosis.
2. End-to-end anastomosis.
3. End-to-side anastomosis (Van Hook's Operation).
4. Nephrostomy.
5. Implantation of the ureter into the skin.
6. Nephrectomy.

Fedor Krause's Operation of Ureterocystostomy

Step 1. Isolate the ureter with its surrounding connective tissue down to the vault of the vagina. The procedure is to be used only when the lower end of the ureter can be brought in contact with the bladder, without tension. If only a little too short, the bladder may be loosened sufficiently from its pubic attachments and approximated to the ureteral end.

Step 2. Remove the mucous membrane of the distal end of the ureter and close it by suture. The central segment is, in order to avoid stricture formation, split at its anterior and posterior wall. About one and a half centimeters from its free margin a long silk suture is introduced.

Step 3. Pass a long curved forceps through the urethra and press it against the fundus of the bladder; incise the bladder and with the forceps thus introduced, grasp the sutures, pulling them down, and with them the ureter. The sutures are brought out through the external urethral orifice where they are secured. About one centimeter of the ureter projects into the bladder.

Step 4. Suture the mucosa, muscularis and serosa of the bladder around the ureter, with fine catgut. Drain Retzius' space.

Comment: In making the opening in the bladder it is important not to divide all of the coats of the bladder in a straight line. The serosa and muscularis should be cut to the mucosa which is divided about half an inch from the opening in the former. Gruber called attention to the importance of the function of the normal ureterovesical valve in preventing hydroureter and hydronephrosis. The flap of mucosa resulting from incision of the bladder as outlined, functions as a valve. A catheter introduced into the ureter and led out of the bladder and left in situ for a few days is an excellent prophylactic (avoidance of retention due to postoperative swelling, etc.). I have used Krause's operation with modifications to be described.

Sampson's Ureterocystostomy Operation

offers advantages over Krause's procedure. It is simple and efficacious.

Step 1. Expose and isolate the ureter and close its distal end as above. Split the proximal end 4-6 mm.

Step 2. Introduce a curved U-suture of very fine chromic catgut carried on fine curved needles through the right and left wall of the ureter in a manner depicted in the illustration (Fig. 1965 d, e).

Step 3. Open the bladder as described above, holding the edges of the wound in Allis or tissue forceps. Introduce the needles about one-half centimeter from the margin of the incision, from within outward and emerging on the

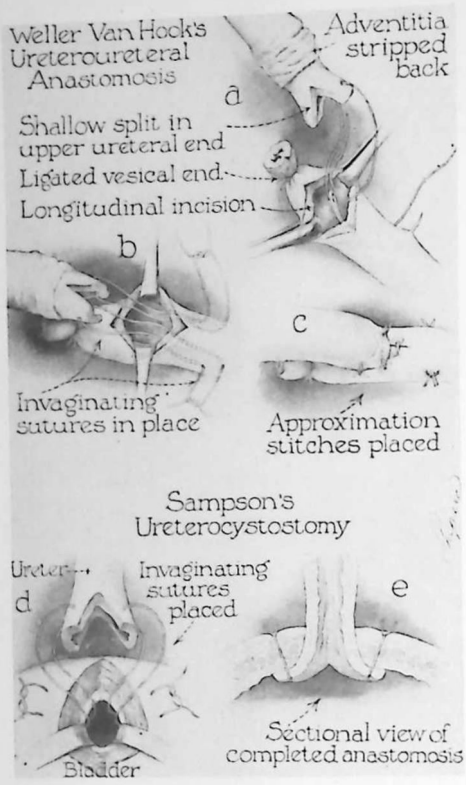


FIG. 1965. The Weller Van Hook uretero-ureteral anastomosis. a. The bladder or distal end of the divided ureter is ligated and incised longitudinally sufficiently to admit the kidney end. b. The invagination is accomplished by using two loop sutures. c. The implantation is made secure by stitching the approximated portions of the ureter with linen or silk. The Sampson ureterocystic implantation operation is similar in its main feature to the Van Hook procedure. d, e. The bladder is incised and the divided ureter drawn within it with two loop sutures. Additional approximation stitches are necessary to make the anastomosis secure.

surface of the bladder; both needles are directed in the same course. The loop of both sutures when gently dragged upon bring the ureter into the bladder when the sutures are tied.

Step 4. Anchor the bladder wall about the ureter as described above.

KRÖNIG'S MODIFICATION OF SAMPSON'S OPERATION

This consists of omitting one U-suture.

Comment: When the Sampson or Sampson-Krönig operation has been done, leave an indwelling catheter in the bladder for a few days.

End-to-Side Uretero-ureteral Anastomosis

WELLER VAN HOOK'S OPERATION

Step 1. Ligate the distal end of the ureter. About 5 mm. below the ligated point make a longitudinal incision approximately twice the diameter of the ureter.

Step 2. Split the proximal end of the ureter for about 6 mm. On the wall opposite this, introduce a U-chromic catgut suture as shown in the illustration (Fig. 1965 a, b, c) bringing the proximal ureteral end into the split distal segment and there secure it.

Step 3. Secure the slit to the invaginated ureteral part by interrupted fine linen or silk sutures. Catgut sutures may be used.

End-to-End Uretero-ureteral Anastomosis

When the ureter has been divided too high for the junction of the proximal end with the bladder, it may be implanted in the distal portion of the ureter, beyond the area of ligation. The difficulties here are:

(a) the difficulties presented in joining the ends of the divided ureter and

(b) postoperative blocking of the outflow of urine by reason of operative edema. The best way to overcome this difficulty is by:

1. End-to-end union over a ureteral catheter;
2. Introduction of a second catheter into the proximal portion of the ureter to drain off the urine (Bump and Crowe).

(See also chapter on Surgery of the Genito-Urinary Organs, p. 1901)

Step 1. Make a longitudinal slit in the proximal portion of the ureter. Insert a No. 6 or 8 ureteral catheter distally toward the bladder, bridging the gap between the divided ureteral ends.

Step 2. Unite the ureteral ends with fine chromic catgut. The sutures pass through all the layers of the ureteral wall except the mucous membrane which should be avoided.

Step 3. Pass now a No. 8 ureteral catheter through the longitudinal slit made in the upper segment of the ureter, pass it upward toward the pelvis of the kidney. This catheter diverts the urine, thus avoiding leakage at the site of anastomosis.

Step 4. The ends of both ureteral catheters are brought out through a stab wound in the lumbar region.

Comment: The catheters are removed in about a fortnight. The urinary fistula usually closes within a few days.

Treatment of Ureteral Injuries Discovered After Operation

According to Caulk and Fischer about 25 per cent of unilateral ligation of the ureter show no symptoms. A ureter ligated with catgut will open sufficiently to allow sufficient drainage in six to eight weeks. They urge that as soon as ligation of a ureter is discovered nephrostomy should be performed. These authors have the following to say on the question at issue:

"Consider the difficulties of deligating a ureter, such as re-opening an abdominal wound and searching for a small tie in a pelvis imbedded with exudate, and the ureter incorporated in the ligature with the uterine vessels, with consequent danger of hemorrhage and the possibility of cutting the ureter with resulting fistula. This is certainly a more serious operation than a nephrostomy. The same may be said concerning uretero-ureteral anastomosis with the exception of the hemorrhage. We are of the firm belief that the safest method of protecting the individual when a ligated ureter has been discovered is immediate nephrostomy.

"We are impressed that dealing with a single ligation such as we propose may not have as large a field as it merits. In the first place, the diagnosis of single ligation may prove difficult, as the symptoms may be slight. However, if a woman who has undergone a pelvic operation complains of pain in the kidney area about the third day, and this is found to be large and palpable, not having been so beforehand, such symptoms are highly suggestive of ureteral ligation. If the patient's condition should warrant it, a ureteral catheterization would clinch the diagnosis. It is then up to the surgeon to decide whether it is better for the patient to let the kidney die or to try to protect it. It seems certain that no reputable surgeon would hesitate to make this situation known and provide the good chance of saving the kidney. The danger of a unilateral nephrostomy should be extremely slight, as it can be done under local anesthesia or quickly under gas.

"With such a fair chance of the ureter opening and the kidney healing in good condition, we believe that this should be the procedure. Granting that it may not be successful, even then the patient's ultimate condition is as good as it would have been had the attempt not been made, and we would have filled our chief urological duty, namely, to attempt to conserve the renal parenchyma."

When both ureters have been ligated, the sooner the diagnosis is made the better. Institute under such conditions the following:

1. **Bilateral nephrostomy.**
2. **Deligation.**
3. **Ureterovesical, uretero-ureteral anastomosis or**
4. **Transplantation of the ureters into the bowel.**

The first is the method of choice (Caulk).

Nephrostomy

(See under Operations on the Kidney, p. 1875)

DISPLACEMENT OF THE UTERUS

Historical Notes. Alquie of Montpellier, announced the first definite plan for the surgical correction of retro-displacement of the uterus (experimental studies of shortening of the round ligaments through the inguinal canals on animals and cadavers). Alquie's report was referred to a committee composed of Baudelocque, Berand and Villeueve; these kept their findings in abeyance for four years and then submitted them to the academy with a report of condemnation of Alquie! Amussat in 1850 endeavored to cause adhesions between the posterior vaginal wall and cervix by cauterizing these areas with caustic potash and the actual cautery, the object being to have the contracting adhesions pull the uterus into place. Aran in 1858 pondered Alquie's proposal of shortening the round ligaments and finally abandoned the procedure considering its execution next to impossible. Marion Sims in 1859 conceived the idea of fastening the fundus uteri to the abdominal wall by means of a silver wire thread carried in a hollow needle. He soon abandoned the plan. Deneffe of Ghent (Belgium) attempted to shorten the round ligaments on the living. He failed to find the ligaments and was severely criticized. In 1869 Koeberlé sutured an ovarian pedicle to the lower angle of the abdominal incision thus suspending the uterus. Schroeder in 1879 used practically the same procedure. Lawson Tait in 1880 suspended the uterus by including it in the suture for closing the abdominal wall. The same procedure was used by Henning in 1887. The credit of performing the first successful shortening of the round ligaments in 1881 belongs to William Alexander of Liverpool. He published his case in 1883. A year later James H. Adams of Glasgow performed the same operation; failure resulted in this case, the uterus being bound down by posterior adhesions. Herrick in 1883 sutured the cervix to the posterior vaginal wall, endeavoring thereby to relieve a retrodisplacement of the uterus. Ventral fixation was conceived and worked out independently in 1885 by Howard E. Kelly of Baltimore and Olshausen of Berlin. The latter published his case in 1886 and although Kelly did his first operation in 1885, he did not publish it until 1887. Intraperitoneal folding of the round ligaments was performed and worked out independently by Wylie in 1886 and Bode in 1888. Vaginal shortening of the uterosacral ligaments was done by Kelly in 1888. In the same year Byford published two cases treated in the same manner. Vaginal fixation (fastening the uterus forward by means of a suture passed through the anterior vaginal wall) was suggested by Sänger in 1888; this was actually carried out by Schucking a little later. The operation was abandoned because it carried with it the danger of injury to the bladder. In 1892 Mackenrodt obviated the danger by an incision into the vaginal wall and separation of the bladder from the uterus. Dührssen described in the same year a similar operation; in his procedure the fixation sutures were passed somewhat higher. In 1893 Winter modified the Mackenrodt operation by doing an anterior colporrhaphy in every case, to secure better fixation. In 1894 Küstner further modified the Mackenrodt operation by opening, as a routine measure, the peritoneal cavity at the vesico-uterine pouch.

Shortening the round ligaments by anterior vaginal section was worked out independently in 1896 by Vineberg, Bode and Wertheim. In 1897 Goldspohn of Chicago amplified the Alexander operation by opening the internal inguinal ring on one or both sides permitting the introduction of a finger to break up any adhesions present. Gilliam in 1900 described the method of drawing the proximal portion of each round ligament through the peritoneum, rectus muscle and aponeurosis on each side near the median incision. J. Clarence Webster in 1901 described his operation, to which the name of Baldy (1902) is also attached, this consists of shortening the round ligament on each side by drawing it back of the uterus through a small opening in the broad ligament just below the utero-ovarian ligament. In 1902 Bové described an operation of shortening the uterosacral ligaments, through a transabdominal incision. In 1903 Alexandroff described a method of coaptation of the broad ligaments in front of the cervix through a vaginal incision. Figueroa of Mexico (1913) described extraperitoneal transplantation of the round ligaments. A. D. Dudley, 1900, Latzko in 1908 and numerous others described modifications of greater or lesser importance which appeared in the literature from time to time.

Extraperitoneal Shortening of the Round Ligaments

ALEXANDER-ADAMS OPERATION

Step 1. Make an incision two or three inches in length as for an operation for inguinal hernia. Expose the external inguinal ring. Identify it by the

external and internal pillars and arcuate fibers. Open the inguinal canal on a grooved (Kocher) director by dividing the external abdominal oblique fascia to about the level of the internal inguinal ring.

Step 2. Isolate and deliver the round ligament by hooking it up en masse on

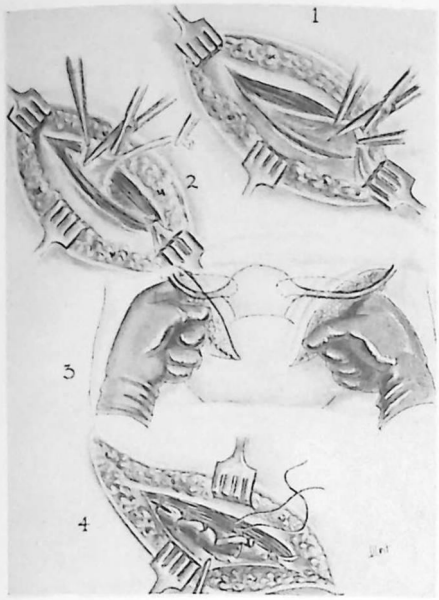


Fig. 1966. Alexander-Adams operation. (Goldspohn's modification.) 1. The inguinal canal has been opened, the round ligament caught high up between two artery forceps and is being divided by a pair of scissors. 2. The round ligament has been divided and its upper end has been ligated. The peritoneal cuff has been made tense and is being opened. 3. The peritoneum has been opened, the index fingers of the surgeon have been introduced into the peritoneal cavity for purposes of palpating the uterus and adnexae. 4. The round ligament is fastened with interrupted sutures to the under surface of the fascia of the external abdominal oblique muscle.

the left index finger. The ligament appears as a round cord of reddish hue in the vicinity of the internal inguinal ring, which becomes thicker in diameter as it is pulled outward. Do not attempt to isolate the ligament at the external inguinal ring, lest failure result, because in this locality the ligament consists of attenuated fibrous strands of greater or lesser dimen-

sions. Careful upward dissection will usually lead to its isolation. The ligament is then pulled out by means of forceps as far as desired to bring the uterus in proper position.

Step 3. Fold the ligament on itself or excise the excessive portion; suture it in place to the fascia of the external abdominal oblique muscle with interrupted (chromic) catgut sutures. Repeat the same procedure on the opposite side.

Step 4. Restore the inguinal canal to avoid the occurrence of hernia. Close the skin; dress the wound.

GOLDSPOHN'S MODIFICATION (Fig. 1966)

Open the peritoneal cavity by opening the peritoneal cuff. Introduce the index fingers and explore for existing complications of the uterus or adnexae. Bring the uterus into the proper position.

Comment: The Alexander-Adams operation should be performed only when the uterus is freely movable and other pelvic pathology can be excluded with reasonable certainty.

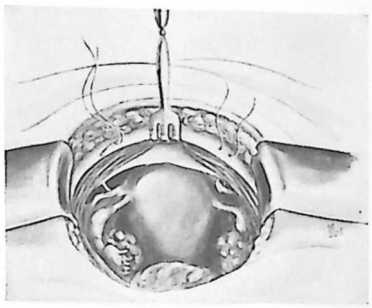


Fig. 1967. Olshausen's operation of ventrofixation of the uterus. The abdomen is opened through a Pfannenstiel incision. The round ligaments are transfixed with silk or chromic catgut sutures which embrace the parietal peritoneum of the anterior abdominal wall, the muscle and fascia. When the sutures are tied on the fascia the uterus is fixed to the anterior abdominal wall. On right, beginning of suture; on left, completion of same.

VENTROSUSPENSION AND VENTROFIXATION

It is deplorable that some surgeons even today use these terms interchangeably. Ventrosuspension aims to suspend the uterus (ligamentous or uterine surface to peritoneum only), while ventrofixation aims at fixity (firm union of the uterus to the abdominal wall with sutures which are made more or less to embrace the entire thickness of the abdominal wall). Suspensions are resorted to in the child-bearing period; fixations must needs be confined to individuals in whom conception is out of the question. In ventrosuspension (Kelly's operation) the posterior surface of the fundus of the uterus is united to the parietal peri-

toneum by two or three sutures of silk. It is not much used nowadays having given way to other procedures to be described later.

Ventrofixation of the Uterus

OLSHAUSEN'S OPERATION

Step 1. Open the abdomen with the patient in the Trendelenburg position. Engage the edges of the peritoneum and fascia in artery forceps.

Step 2. Pick up each round ligament near its uterine attachment with a pair of curved artery forceps. Pass a No. 2 chromic catgut suture on a curved round needle through the fascia, muscle and parietal peritoneum; pass the needle now through the round ligament and return the sutures to the surface in reverse order. Tie the suture. Repeat the procedure on the opposite side. (Fig. 1967.)

Step 3. Close the abdomen in layers.

Comment: This operation fixes the fundus of the uterus securely to the anterior abdominal wall about two inches above the pubes. Kelly's modification consists of using the utero-ovarian instead of the round ligament. Leopold's modification consists of having the sutures pass directly through the uterine tissue. Vineberg's method makes use of a combination of Olshausen's and Leopold's technic.

Transperitoneal Transplantation of the Round Ligaments

GILLIAM'S OPERATION

Step 1. Place a temporary ligature on the round ligament about 1½ inches from the uterus. Catch the ends of this ligature with a pair of curved, long artery forceps. Repeat the procedure on the opposite side.

Step 2. Retract the structures overlying the aponeurosis of the external abdominal oblique muscle. Make an opening with a sharp pointed scalpel through the entire thickness of the abdominal wall from the aponeurosis inward about an inch external to the abdominal incision and about 1½ inches above the pubes. Avoid injuring the vessels coursing in this vicinity.

Step 3. Pass through the stab wound thus made a pointed artery forceps. Pick up the ligature placed around each round ligament and by pulling on it, deliver the ligament onto the anterior surface of the aponeurosis. Release the suture. Fasten the loop of the round ligament on either side to the aponeurosis with interrupted chromic catgut sutures. (Fig. 1968 a, b.)

Step 4. Close the abdominal wound in layers.

Comment: This is an excellent procedure which has withstood the test of time. The uterus is held secure in an anteverted position. The portion of broad ligaments necessarily pulled out with the round ligaments raises the tubes and ovaries into a higher position. Avoid too small an opening through which the ligaments are pulled. Postoperative swelling and constrictions may cause necrosis of the ligament.

ABELL'S MODIFICATION OF THE GILLIAM OPERATION

Irvin Abell modified the Gilliam operation as follows:

Step 1. The patient is placed in the Trendelenburg position.

Step 2. A four-inch midline suprapubic incision is used.

Step 3. Guy sutures of catgut are placed through or under each round ligament

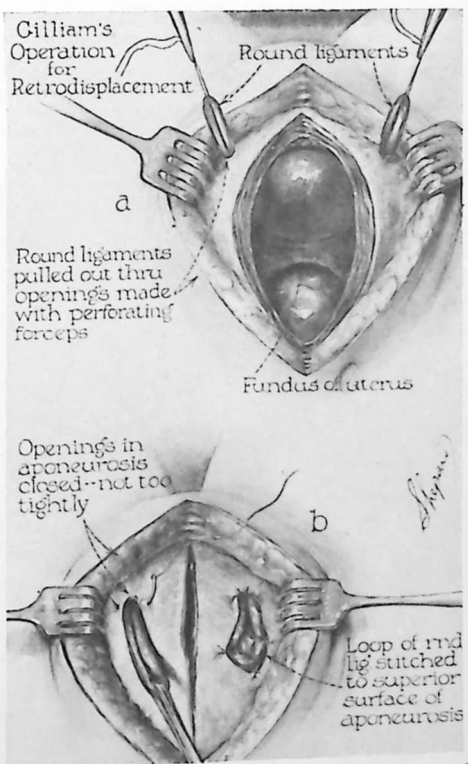


Fig. 1968. Transperitoneal transplantation of the round ligaments. Through a midline incision the round ligament is caught up with a temporary ligature strand about 4 cm. from the uterus. This strand is grasped by a perforating forceps which has been forced through the aponeurosis, muscle and peritoneum 4 cm. above the symphysis pubis and about 2 cm. lateral to the midline. The loop of round ligament is now drawn out through the perforation to its new position on the anterior abdominal wall. a. Both ligaments having been brought out, they are stitched to the surface of the abdominal aponeurosis. b. (The author places the ligaments parallel to each other across the midline stitching them together and to the aponeurosis.)

midway between their origin and exit through the internal abdominal rings, and each suture is held by an artery forceps.

Step 4. The sheath of the rectus is opened on each side of the midline incision and by blunt dissection the rectus abdominis is gently separated from the under surface of the anterior rectus sheath.

Step 5. A blunt-pointed, curved artery forceps is passed out under the fascia, above the rectus muscle, through the posterior termination of the sheath of the rectus to the outer aspect of the internal ring; with the abdominal wall of the corresponding side elevated, the inner aspect of the internal ring is made prominent by traction on the guy sutures in the round ligament and the artery forceps is forced in through the internal ring under the peritoneum and on the upper surface of the round ligament, penetrating the peritoneum when well within the limits of the parietal peritoneum. The blades of the artery forceps are separated, the guy suture in the round ligament is grasped and drawn through the internal ring into the midline incision; further traction brings the elongated round ligament doubled on itself through the internal ring over the upper surface of the rectus and along the under surface of the fascia to the midline incision.

Step 6. The double fold of round ligament is spread out in the shape of a triangle and anchored to the under surface of the fascia with three catgut sutures, the apex at the cut edge of the fascia in the midline incision, the base looking outward toward the outer border of the rectus.

Step 7. The same steps are carried out with the opposite round ligament.

Step 8. The midline incision is closed in tiers, the apex of each round ligament being sewed together as the fascia is closed. No. 1 chromic catgut is used to suture the round ligament; No. 1 or No. 2 chromic catgut for the peritoneum and fascia; dermal sutures are used for skin or stay sutures of silkworm-gut if desired. Care should be exercised to avoid tying the round ligament sutures too tightly; otherwise necrosis will result and permit of the round ligament being drawn back into the abdomen.

Postoperative care is the same as that in case of ordinary closed abdominal section, with rest in bed for two weeks following operation and the avoidance of severe physical exertion for a period of six weeks thereafter.

Posterior Implantation of the Round Ligaments

WEBSTER (1901) BALDY (1902) OPERATION

Step 1. Place the patient in the Trendelenburg position. Perforate the broad ligament on the right side with an artery forceps at a point close to the uterus under the ovarian ligament. (Fig. 1969 a.)

Step 2. Grasp the round ligament with an anatomic forceps at a point about one-third of the length of the ligament from the uterine end, whence it is carried to the open jaws of the perforating artery forceps which seizes the ligament and draws it through the opening in the broad ligament to the posterior wall of the uterus. (Fig. 1969 b, c.) The round ligament on the left side is treated in a similar manner.

Step 3. Suture the loops of the round ligaments together and then attach them with interrupted catgut sutures to the posterior surface of the uterus.

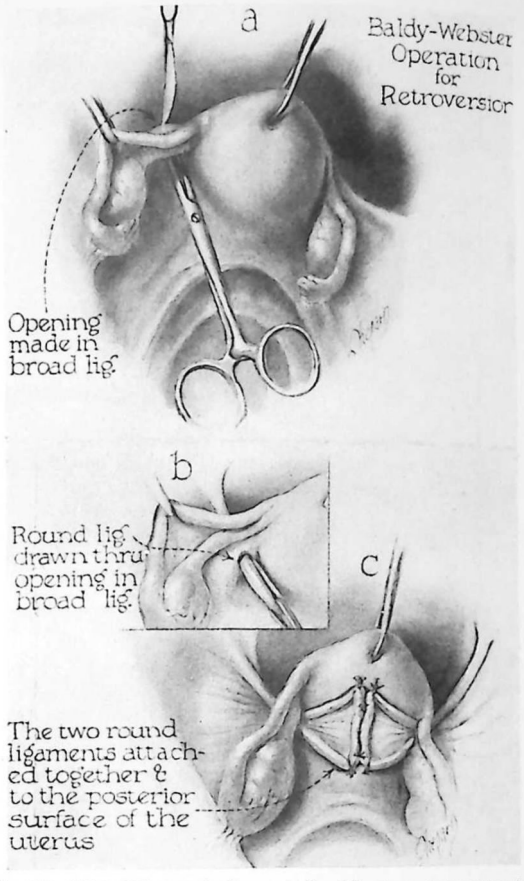


FIG. 1969. Webster-Baldy operation for retroversion of the uterus. a. A small opening is made in the broad ligament and the round ligament is drawn through. b. Method of drawing round ligament through the opening in the broad ligament. c. Attaching the round ligaments to the posterior surface of the uterus. The approximation suture should not compromise the entire blood supply of the round ligaments.

Comment: The ligaments should be attached at the proper positions on the posterior surface of the uterus. If attached too low, the uterus may become retroflexed over the ligaments; if too high, anteflexion of the uterus may result. As little trauma as possible should be done to the peritoneum during the perforation of the broad ligament and suture of the round ligaments to the posterior surface of the uterus. If this precaution is neglected adhesion of contiguous structures (ovaries, bowel, etc.) may result.

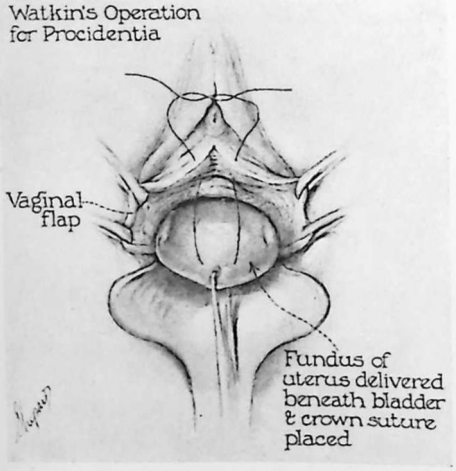


FIG. 1970. Watkins' interposition operation.

Interposition Operation

(SCHAUTA, FREUND, FRITSCH, WERTHEIM, WATKINS)

The principle of this procedure is based on separating the bladder from the anterior surface of the uterus and transposing its attachments to the posterior uterine wall. The uterus is thus placed in a position to support the bladder. Excess of vaginal wall is trimmed off and the vaginal wound closed. Follow with a perineoplasty.

Step 1. Separate the anterior vaginal wall from the bladder. Grasp the cervix with a vulsellum forceps. Make a small incision in front of the cervix. Introduce a pair of blunt scissors and separate the vaginal wall from its attachments to the bladder; or proceed as in anterior colporrhaphy (p. 1769). Gauze dissection completes the separation of the vaginal wall. Avoid injury to the bladder during this detachment.

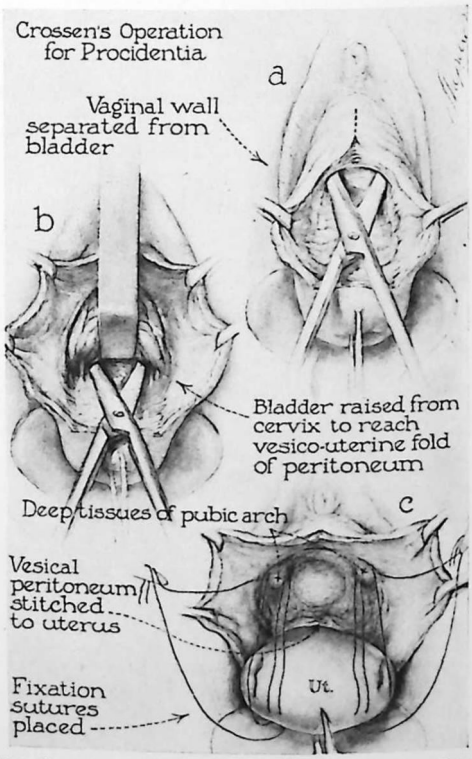


FIG. 1971. Crossen's operation for procidentia uteri. a. vaginal wall separated from bladder. Bladder raised from cervix to reach vesico-uterine fold of peritoneum. c. Method of attaching uterus by fixation sutures to the deep tissues of the pubic arch.

Step 2. Separate the bladder from its uterine attachment (uterovesical ligament). Avoid separating the bladder too much laterally; separate it just sufficiently to permit the fundus of the uterus to be brought down after

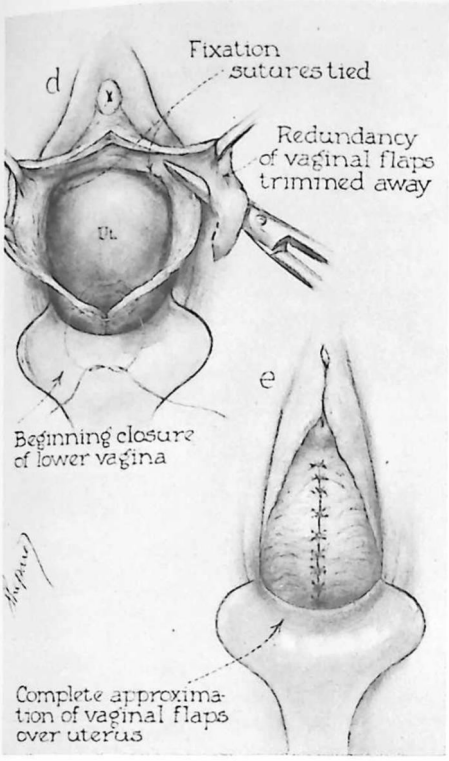


Fig. 1971 (continued). Crossen's operation for procidentia.

opening the anterior culdesac, through the vesico-uterine reflection. (Fig. 1970.) Occasionally identification of this peritoneal fold is beset with some difficulties (adhesions). Once the peritoneum has been entered, the opening is enlarged laterally with the index fingers exerting lateral pressure.

Step 3. This consists of delivering the fundus uteri. Introduce an appropriate retractor between the bladder and uterus displacing the former upward, out of the way. Engage the fundus uteri in vulsella forceps; pull it downward and forward; in so doing the cervix rises upward and is carried backward. The fundus is delivered through the wound.

Step 4. Place the retaining sutures as shown in Fig. 1970. The vesical peritoneum is sutured to the posterior surface of the uterus. This shuts off the peritoneal cavity and the operation is now completed in an extraperitoneal manner.

Step 5. Simple attachment of the fundus to the vaginal mucous membrane gave rise to recurrences (prolapsus of the interposed uterus; return of the fundus to its usual position). To obviate these drawbacks Crossen uses two special buried sutures (Fig. 1971 c). "These sutures fasten the fundus to tissues which have a dependable attachment to the pubic arch. These tissues are identified by traction with forceps. Different tissues are caught and pulled upon until some are found which have the required attachment and then the special sutures are placed. These sutures are entirely buried when the vaginal flaps are brought over. They fasten the fundus uteri that resists both upward and downward displacement."

While it is important to superimpose the entire bladder on the uterus, the latter must not be placed so firmly against the urethra as to interfere with urination.

Step 6. Closure of the vaginal wall is now completed by uniting the edges of the vaginal incision over the anterior surface of the uterus with interrupted sutures. Before doing this, redundant vaginal mucous membrane is trimmed off.

Step 7. Complete the operation by a well executed perineoplasty (p. 1743).

Comment: The operation should never be done in the child-bearing period; when indicated during that time, the patient should be sterilized during the operation (partial salpingectomy, etc.). Some surgeons excise the anterior lip of the cervix on general principles. A very large uterus should not be transposed without removing a portion of the fundus. Hypertrophy of the cervix should be remedied by amputation of the cervix. Transposition of the uterus is well adapted to instances after the menopause accompanied by marked cystocele without much prolapse or enlargement of the uterus.*

MYOMECTOMY

Vaginal Myomectomy

Historical Notes. Amussat performed this operation in 1840. Hysterotomy (simple incision of the uterus) was proposed and described by Péan. Myoma enucle-

* Plastic operations on the broad ligaments may be done when pregnancy is still desired by vaginal shortening of the broad ligaments and elevation and repair of the uteropubic supporting plane (*Donald, Fothergill* or *Manchester operation*, Am. Journ. Obst. & Gyn., Vol. 26, p. 667, 1933). This, in the main, consists of excision of the vaginal wall extending well laterally to the vault, and in most cases, excision of the cervix, inclusion of broad ligaments and properly shortening these by simple coaptation in front of the cervix (Aleksandroff, Russk. Vrsatch., Vol. 11, 1903); or, by division and overlapping in front of the cervix (Hertzler, Jour. Am. Med. Ass., Vol. 48, 1907; Dudley, J. A. M. A., Vol. 47, 1906). These surgeons worked independently and developed practically the same operation at the same time.

ation was practiced in England and America by Attlee and Hutchinson in 1857. Langenbeck advocated it in Germany.

Step 1. Lithotomy position; general or spinal anesthesia. Seek the pedicle of the tumor with the finger; if attached high up it may be engaged in a long curved forceps.

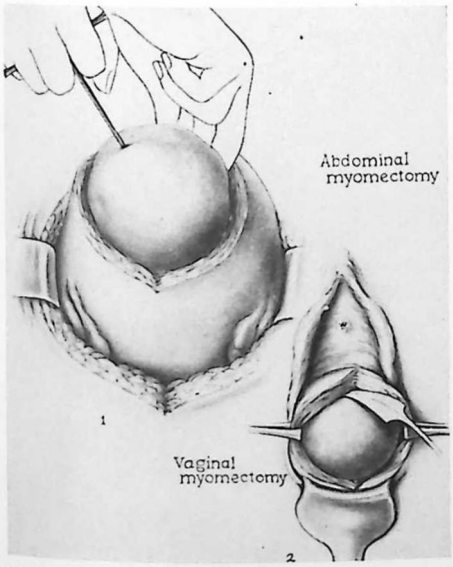


Fig. 1972. 1. Abdominal myomectomy. 2. Vaginal myomectomy. The uterus is delivered through the vaginal opening. The tumor, which is seen in the illustration is dissected with a knife designed for the purpose.

Step 2. The pedicle is divided and the clamp is left on for about 48 hours after which it is cautiously removed. This procedure is applied in submucous pedunculated myomata projecting from the cervix. The myoma may be better exposed by hysterotomy through anterior division of the cervix, removing the pedicled tumor and suturing the pedicle. (Fig. 1972[2].)

Comment: Myomas of the fundus may be extirpated as illustrated in Fig. 1972[2].

Abdominal Myomectomy

Step 1. Expose the uterus through a liberal abdominal incision.

Step 2. Engage the uterus in vulsella forceps.

Step 3. Incise the wall of the uterus parallel to its axis and over the most prominent part of the tumor. Carry the incision down to the tumor.

Step 4. Insert a myoma screw into the tumor mass which is pulled out of the wound made in the uterus.

Step 5. Blunt dissection aided by sharp snips here and there usually enables enucleation of the tumor. Avoid injury and crushing of the uterine wall. (Fig. 1972[1].) If the base of the tumor is broad, accomplish its separation from the uterine wall by sharp dissection. Thorough hemostasis at the base of the tumor, which usually bleeds freely, is essential (ligatures properly placed).

Step 6. Obliterate dead spaces. Close the wound in the uterus.

Step 7. Cover the line of suture with an omental graft.

Step 8. Close the abdomen in the usual manner.

OPERATIONS ON THE UTERINE ADNEXAE

SALPINGOSTOMY—STOMATOPLASTY

The object of this operation is to make an artificial ostium in the Fallopian tube. (Fig. 1973, Martin.)

Step 1. Free the tube from adhesions. Hemostasis must be perfect; this is of utmost importance for if blood is permitted to remain in the neighborhood of the fimbria, adhesions will form again and thus frustrate the very object of the operation.

Step 2. Pick up the mesosalpinx with a pair of forceps and put the tube on the stretch. Incise its occluded end.

Step 3. Pass a probe along the lumen of the tube toward the ostium tubae uterinae, making sure that no strictures are present; if present, dilate them.

Step 4. Insert a pair of fine pointed scissors and split open the upper border of the fimbriated end of the tube for about an inch and a half.

Step 5. Insert a suture at each end of the incision to be used as tractors while the mucous membrane of the opened end is united to the muscular wall of the tube with fine catgut sutures. The operation may be performed on both sides.

Comment: Skutsch was first to do a salpingostomy.[1] Others followed.[2, 3, 4, 5]

Such operation may be lateral or terminal. In the lateral salpingostomy (Skutsch) an oval excision of the tubal sac is done and the mucous membrane of the tube sutured to the peritoneum. (Fig. 1973, 3 and 4.)

The terminal salpingostomy described above was first introduced by Martin. (Fig. 1973, 1. 2.)

Clado[4, 5] devised an operation which he called "salpingo-ovaro-syndesis." This consists of resecting a portion of the ovary and then fixing the fimbria of the tube to the resected ovary as shown in the illustration. (Fig.

[1] Skutsch, Verh. d. deutsch. Ges. f. Geb. und Gyn., 1889, T. III, p. 376.
[2] Jarsaillon, De la salpingostomie et autres operations conservatrices des trompes uterines. Th. de Lyon, 1899-1900, No. 19.
[3] Kahn, some conservative operations on the tubes. Th. de Paris, 1901.
[4] Clado, Semaine Gynecologique, Paris, 24 Jan., 1894.
[5] Ayroles, Salpingo-ovaro-syndesis. Th. de Paris, 1898-1899, No. 256.

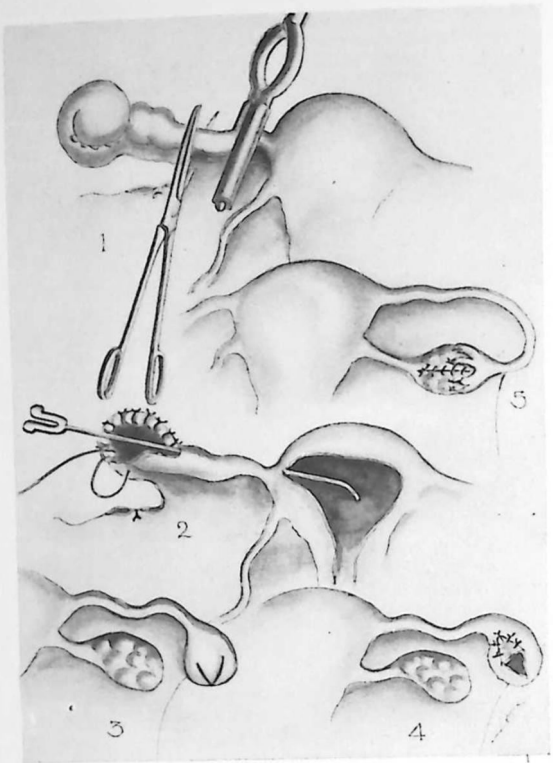


FIG. 1973. Salpingostomy-stomatoplasty. 1. and 2. illustrate Martin's operation. 1. A rubber-covered intestinal clamp is placed near the uterine end of the tube. The blood vessels in the broad ligament are ligated, the broad ligament is incised and the portion of the tube to be removed is resected with a pair of scissors. 2. A probe is seen passing through the reconstructed end of the tube, into the uterine cavity, to assure its patency. The mucous membrane of the tube is united with interrupted catgut sutures to the peritoneum of the tube. 3. and 4. Skutsch's operation of lateral salpingostomy; 3. outlines the incision, while 4. depicts the turnback of the flap and the junction of the serous surface to serous surface. 5. Clado's operation of salpingo-ovaro-syndesis (fixation of the fimbriae of the tube to the ovary after a portion of the ovary has been resected).

1973, 5.) Gersung, Delbet, Martin and others have reported pregnancies following these operations.

For completeness' sake, it must be mentioned that Vidal[6] devised a salpingoplasty on the stenosed tube which is comparable in principles to pyloroplasty.

SALPINGECTOMY

Removal of the Fallopian tube leaving the ovary behind.

Step 1. With an artery forceps grasp the mesosalpinx between the fimbriated end of the tube and the ovary.

Step 2. Another appropriate forceps engages the uterine end of the tube proximal to the tubal isthmus.

Step 3. Remove the tube by cutting through the mesosalpinx with scissors or sharp scalpel. (Fig. 1974 a.)

Step 4. A deep wedge of uterine tissue carrying the uterine extremity of the tube is removed.

Step 5. Hemostasis. Often salpingitis isthmica nodosa is encountered. In order to frustrate its effects the isthmus of the tube must be removed. Catgut sutures (interrupted or continuous) close the wound. (Fig. 1974 b.) Perfect peritonization should be the aim.

SALPINGO-OÖPHORECTOMY

Removal of the Fallopian tube and ovary.

Step 1. Clamp the infundibulopelvic ligament.

Step 2. Apply another clamp to the uterine end of the tube, as in the previous procedure; here the first clamp is applied underneath the ovary.

Step 3. Both tube and ovary are ablated with curved scissors. (Fig. 1975 A.)

Step 4. Ligate doubly the ovarian vessels in the infundibulopelvic ligament.

Step 5. Cut off the blood supply to the round ligament by ligating it; doubly ligate the uterine supply in the adjacent broad ligament. Make sure that hemostasis is perfect. Many a patient has paid with her life from neglect of ligating all vascular bundles. Leave nothing to chance. Look and make sure!

Step 6. Peritonize the raw area left by the removal of the adnexae. An inversion suture tends to obliterate raw surfaces. A through-and-through suture embracing the entire thickness of the broad ligament and approximating the stump of the infundibulopelvic ligament to the raw surface at the uterine tubal ostium is very effective (Fig. 1975 B).

Step 7. Close the abdomen in the usual manner.

Comment: It is advisable after salpingo-oöphorectomy to suspend the uterus by one of the round ligament operations described above; this will avoid retroversion which frequently results following the operation. An Olshausen suspension serves the purpose well.

CONSERVATIVE OPERATIONS ON THE OVARIES

Resection of the Ovary

This operation is indicated only in cases when one follicle seems to be growing at the expense of the "rest of the ovarian tissue" threatening to become a large

[6] Vidal, Rev. de Gyn. et de Chir. abdomen, Paris, 1900, T. IV. p. 81.

retention cyst. The so-called "cystic degeneration of the ovaries" being considered a physiological process, resection of the ovary does not hold the important place in gynecologic operations as it did years ago.

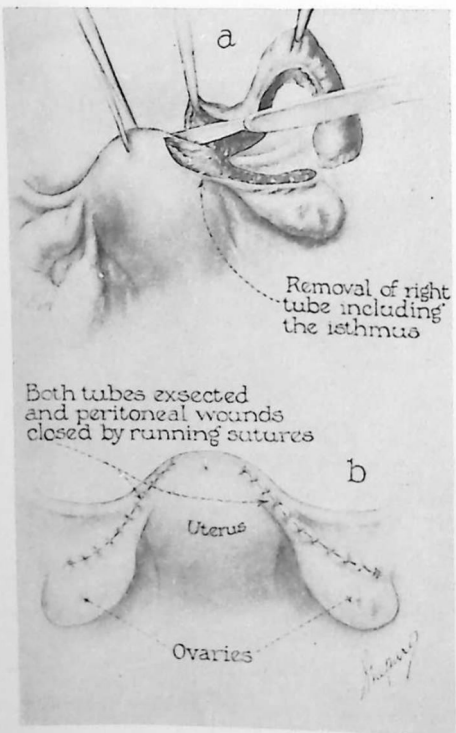


FIG. 1974. Salpingectomy. a. Removal of right Fallopian tube and isthmus. b. Bilateral salpingectomy, leaving ovaries intact.

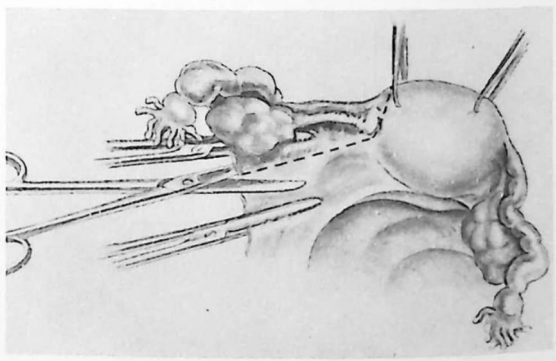
Step 1. Expose the ovary.

Step 2. Place a noncrushing clamp on the mesovarium. Tighten it only sufficiently to cut off the circulation during the operative procedure.

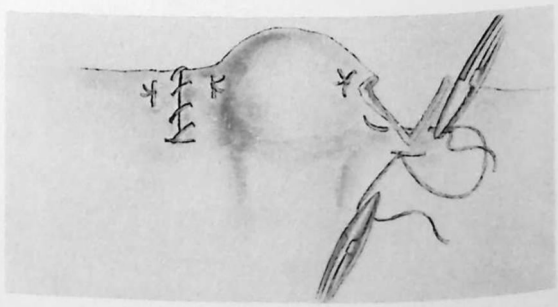
Step 3. Circumscribe the cyst with the point of a sharp scalpel.

Step 4. Shell out the cyst.

Step 5. Attend to hemostasis in the hilum of the ovary (fine catgut).



A



B

FIG. 1975. A. Unilateral Salpingo-oöphorectomy. Clamps applied to the infundibulopelvic ligament which is divided with scissors along the dotted line which embraces portions of the uterine ostium of the tube. B. Bilateral Salpingo-oöphorectomy. The ovarian vessels have been ligated with interrupted catgut sutures after ablation of the tubes and ovaries. The gap in the broad ligament, between the ligature on the ovarian vessels and that of the uterine ostium, is approximated with a continuous catgut suture which, when tied, effaces the raw surfaces and steadies the uterus.

Step 6. Remove the clamp. Close the wound in the ovary with fine catgut sutures (interrupted or continuous). Safeguard against adhesion formation by careful coaptation of the edges of the ovarian tissue without tension.

Transplantation of Ovarian Tissue for Sterility and Endocrine Deficiency

Ovarian tissue has been transplanted to relieve vasomotor disturbances following the artificial onset of the menopause resulting from loss of ovarian tissue. In many cases of physiologic menopause accompanied by serious disturbances, homotransplantation has, as I have shown elsewhere,[1] distinct value. Following pelvic inflammatory processes sterility often results. In such instances the following procedure may prove of value. It has also been used in selected cases in sterility.[2, 3]

Step 1. Do a classical salpingectomy.

Step 2. Close the wound in the mesosalpinx with the exception of the wedge-shaped opening left in exsecting the isthmus of the tube. Make sure that there is an opening from the tube into the uterine cavity; it must not be too large, it should admit only the point of the sound.

Step 3. Remove a slice of ovarian tissue about one-quarter of an inch thick and about the size of a thumbnail from one of the ovaries and put it into the opening at the uterine cornu. The implant should consist of the epithelial covering, cortex and medulla of the ovary. (Fig. 1976 a.)

Step 4. Cover the ovarian transplant with the superimposed structures. Do not strangulate the tissues. Use fine catgut interrupted sutures.

Step 5. Close the wound in the ovary with fine catgut.

Step 6. Repeat the same procedure on the other side. If only one ovary is present, the transplant is taken from it for both sides.

ESTES' OPERATION FOR OVARIAN TRANSPLANTATION

When both tubes have to be removed and one or both ovaries remain, an attempt to transplant one of these may be undertaken.

Do a salpingectomy. Prepare the isthmic area as in the previous procedure. Remove a slice from the ovary as shown in the previous illustration. Keep in mind not to interfere with the blood supply of the ovary. Fold the ovary toward the isthmic denudation approaching it with its denuded surface. (Fig. 1976 b, c.) Cover the area over with peritoneum, round ligament, etc.

Comment: The practicability of ovarian (auto-, homo- and hetero-) transplantation:

Historical Notes. Knauer in 1895 first successfully transplanted ovarian tissue from one site to another in the same animal. Such transplantation has been shown time and again to have definite indications and is a practical procedure in well selected cases. Following Knauer, Grigorieff, Uffreduzzi, Benesch, Kohler, Long and Evans performed successful autografts. Successful transplantations have also been reported by Foá, Pettinari, Sand, Marshall, Athias, Lipschütz and others. Heterografts in animals were, as a general rule, failures. Morris in 1895 first successfully transplanted a piece of ovary into the stump of one tube. The author reported on the results of 44 cases of human ovarian transplantation.[1] Morris and Behney reported on 31 auto-transplants. The majority took but probably did not survive more than two or three years.

Comment: From a technical point of view, the site of implantation is

[1] Thorek, Max, Practicability of Ovarian Auto-, Homo- and Heterotransplantation with Histologic Proof, Endocrinology, July-August, 1930, pp. 265-281.
[2] Von Graff, Iowa St. J. Med., Jan., 1936.
[3] Estes, Surg., Gynec., and Obstet., 38:394, 1924.

of importance. Thorough asepsis is essential on the part of both donor and recipient. Human ovarian tissue may be kept at a temperature varying from 0° to 12° and after 5 days be successfully implanted (Zondek-

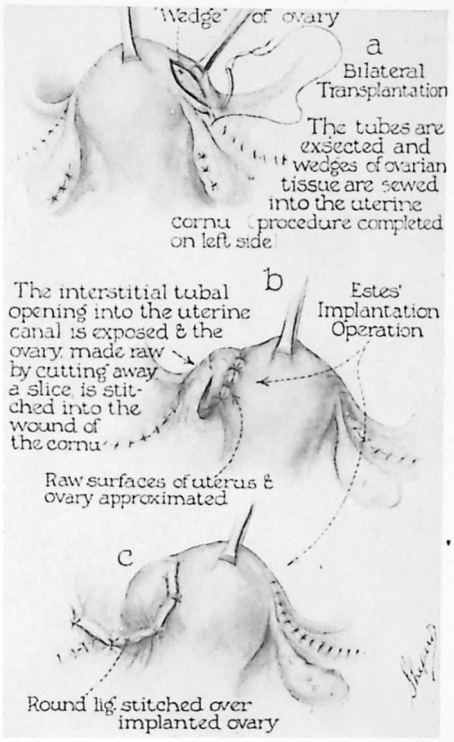


FIG. 1976. a. Transplantation of ovarian tissue into the horns of the uterus. b., c. Estes' implantation of the ovary into the uterus. The tube is exsected laying open the cornu. The ovary is freshened and the raw surfaces of ovary and uterus stitched together.

Wolff). Lipschütz and others believe that freezing injures ovarian tissue. My experimental work showed that after 96 hours' refrigeration the im-

plant is of no value. As to the site, the labia majora, the broad ligament, supraperitoneal space, the rectus abdominis muscle just behind the sheath have all been made use of. My best results were obtained in menopausal conditions and in various forms of ovarian dysfunction and following surgical castration. (Figs. 1977-1978.)

Suspension of Prolapsed Ovary

Historical Notes. The surgical treatment for this condition was first discussed seriously by F. Imlach, a pupil of L. Tait, in 1886, who called this operation oöphorraphy. Numerous operations have been devised for this procedure. Howard Kelly has on numerous occasions puckered and tightened the uterosacral ligaments as a means of forming a fossa ovarica in which the ovary reposes naturally. An operation recommended by C. C. Barrows of New York, and adopted by Ward is performed as follows:

FIG. 1977. Human ovary transplanted into *Macacus rhesus* (neck). Refrigerated twenty-four hours. Eleven months after implantation. Van Gieson stain. Atretic follicles.

Step 1. Perforate the broad ligament of the mesosalpinx with an artery forceps, avoiding the blood vessels.

Step 2. Draw the ovary through the buttonhole opening thus created.

Step 3. Stitch it in place with a catgut suture at each end.

Comment: Barrow and Ward point out that no disadvantages result from this procedure and that it

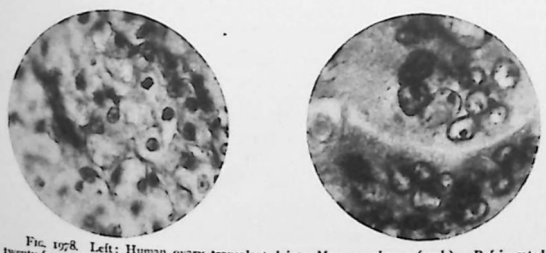


FIG. 1978. Left: Human ovary transplanted into *Macacus rhesus* (neck). Refrigerated twenty-four hours. Eleven months after implantation. Van Gieson stain. Follicular cells simulating multinuclear giant cells. Right: Human ovary transplanted into *Macacus rhesus* (neck). Refrigerated twenty-four hours. Eleven months after implantation. Van Gieson stain. Lutein cells or lipoid-containing cells in hyaline degenerated areas.

relieves the discomfort incident to the prolapsed ovary. It does not prevent pregnancy.

ACROHYSTEROSALPINGECTOMY

Blair-Bell-Beuttner Operation

DEFUNDATION OPERATION

The treatment of periuterine inflammation offers some interesting

Historical Notes. Propagation of inflammation via the uterus to the Fallopian tubes was studied by Astruc and Lieuland in 1770 and 1776. Phlebitis was described by Hunter in 1773; lymphangitis by Asselun in 1787 and Soemmering in 1795. Phlegmasia alba dolens was shown to be an extension from the uterine venous sinuses to the lower extremities, Davis (1823), Guthrie (1825), Lee (1826). Extended studies of lymphatics were made by Allard (1824), Audrel (1825), Gendrin (1829), Cruveilhier (1830), Velpeau (1834). In 1832 Nonat showed the presence of pus in the uterine lymphatics after labor. This was confirmed by Velpeau and Duplay in 1836. Baudelocque in 1830 showed the relation between sterility and postpartum infections. Mercier in 1838 showed the relation of gonorrhea to sterility. Lucas Championnière in 1870 stressed the rôle played by the lymphatics in periuterine inflammations. Ovariotomy was first done by MacDowel of Kentucky in 1809. Hegar in July, 1872, and Battey in August of the same year, removed the first normal ovaries for the purpose of creating an artificial menopause to cure dysmenorrhea and ovarian neuralgia. Hegar's patient died. He performed this same operation in 1876; by that time Battey's method had been popularized for a long period of time. In February, 1872, Lawson Tait performed a unilateral oöphorectomy for pelvic pain and later in the same year (August) he did his first oöphorectomy for fibromyoma of the uterus. He insisted on the importance of removal of both tubes and ovaries.

Acrohysterosalpingectomy aims at removal of both Fallopian tubes, the fundus of the uterus and one ovary. The object of the operation in Blair-Bell's own phraseology is "to temper surgical justice with physiologic mercy." In view of the fact that in pelvic inflammatory disease the fundus of the uterus is always infected and is responsible for metrorrhagia and persistent annoying leukorrhea when only the tubes are removed, the rationale of the procedure becomes apparent. The conservation of one ovary and part of the uterus permits menstruation to continue.

Step 1. Place the patient in the Trendelenburg position. Open the abdomen.

Step 2. Free the tubes from adhesions. Pack off the intestines. Ample exposure is essential.

Step 3. Do a salpingo-oöphorectomy on one side and a salpingectomy on the other, with the difference that instead of excising only wedge-shaped portions of the cornua of the uterus, a defundation of the uterus through anterior and posterior incisions as shown in the illustration is done. (Fig. 1979 a.)

Step 4. A wedge-shaped space with anterior and posterior flaps results. These are brought together with two rows of interrupted or continuous chromic catgut sutures. (Fig. 1979 b.) It is important to leave behind sufficient endometrial tissue to carry on the menstrual function.

Step 5. Unite the mesosalpinx and the other raw surfaces as indicated in describing salpingectomy and salpingo-oöphorectomy. Bring the surfaces of the broad ligaments neatly together.

Step 6. Implant the round ligaments on the newly formed uterine top.

Step 7. Suspend the ovary to prevent its prolapse into the space of Douglas.

Step 8. Close the abdomen.

VAGINAL DRAINAGE OF AN ABSCESS OF THE CULDESAC OF DOUGLAS

The important factors to be considered in vaginal drainage are: (a) To avoid injury to the structures surrounding the abscess cavity and (b) to effect thorough drainage.

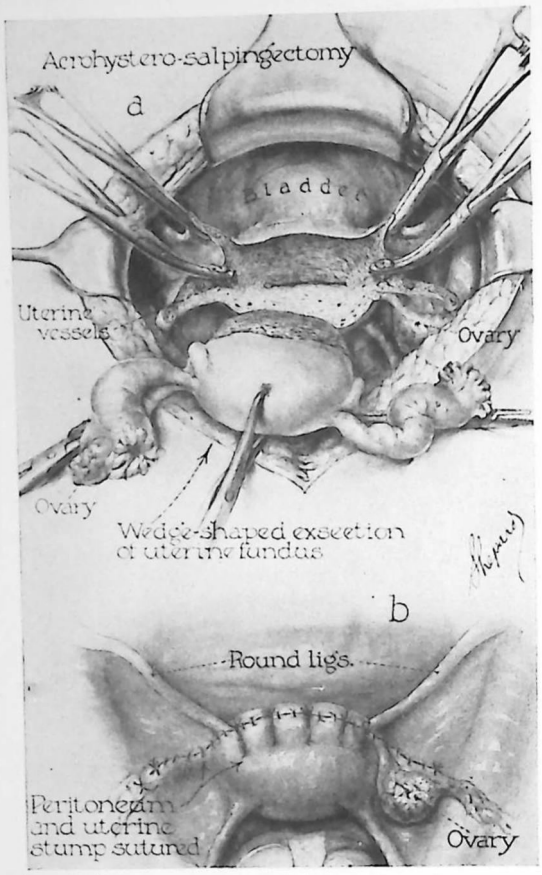


FIG. 1979. Acrohysterosalpingectomy. Defundation operation. a. Salpingo-oöphorectomy on one side, salpingectomy on the other. Method of defundation of uterus and its cornua is shown. b. The anterior and posterior flaps are united, obliterating the wedge-shaped space resulting from the defundation.

Step 1. Determine, with the patient anesthetized, by means of a bimanual examination, the size and position of the purulent accumulation and particularly its point of fluctuation, if any.

Step 2. Introduce an Auvard or other form of vaginal retractor to keep the posterior vaginal wall taut. Grasp the posterior lip of the cervix with a vulsellum forceps and pull it forcibly upward, thus exposing the posterior vaginal vault. Introduce the left index finger as high up in the vagina as possible, the back of the index finger holding the rectal wall out of harm's way, while the right hand introduces a curved, closed pair of scissors along the palmar surface of the fingers, between it and the posterior surface of the cervix; it is made to enter bluntly; or, sharply divide the vaginal mucous membrane with a scalpel.

Step 3. Remove the perineal retractor and introduce one or both index fingers into the opening thus made and enlarge it. The dissecting finger separates the connective tissue upward keeping close to the posterior cervical wall. The closed scissors are an aid in locating and entering the abscess cavity.

Step 4. Enter the abscess cavity, bluntly if possible, by perforating its wall; if too dense, sharp scissors dissection may be used. Avoid entering the rectum. A fecal mass must not be mistaken for the abscess. If in doubt leave the dissecting scissors in situ and have an assistant control the advance of the instrument with his finger in the rectum. Once the scissors have entered the abscess cavity open and withdraw the instrument with its blades opened. (Fig. 1980 a.) Introduce a finger into the abscess cavity and explore for secondary pus pockets. Do not mistake a knuckle of bowel for such pocket. Be gentle in the exploration. Do not perforate the roof of the granulating tissue limiting the abscess cavity.

Step 5. Introduce a large size drainage tube into the cavity. (Fig. 1980 b.) Pack the vagina lightly with iodoform gauze. A large size de Pezzer catheter may be used to advantage here. The tube is permitted to remain for from two to six weeks or until the abscess cavity is practically obliterated. It is better to leave a tube longer than depicted in the illustration.

Comment: Never irrigate a retro-uterine abscess cavity. It is unnecessary and may produce a great deal of harm. If the tube slips out it should be reintroduced.

ARTIFICIAL INSEMINATION

Indications: Where it is impossible for the semen to be deposited in the vagina (hypospadias, urethral fistula and impotentia coeundi).

The technic is simple. The necessary instruments consist of a special syringe with a long nozzle about the size of a uterine sound, a good speculum and vulsellum. A fresh specimen of semen in a rubber condom should be at hand.

Step 1. Place the patient in the lithotomy position; introduce the speculum; grasp the cervix with a vulsellum forceps.

Step 2. Render the vagina and cervix dry with aseptic cotton pledgets.

Step 3. Insert the nozzle of the syringe filled with semen through the os and into the uterus. Avoid touching the vaginal walls. Inject the semen slowly and withdraw the syringe carefully. Let the patient remain in bed for a day with hips elevated.

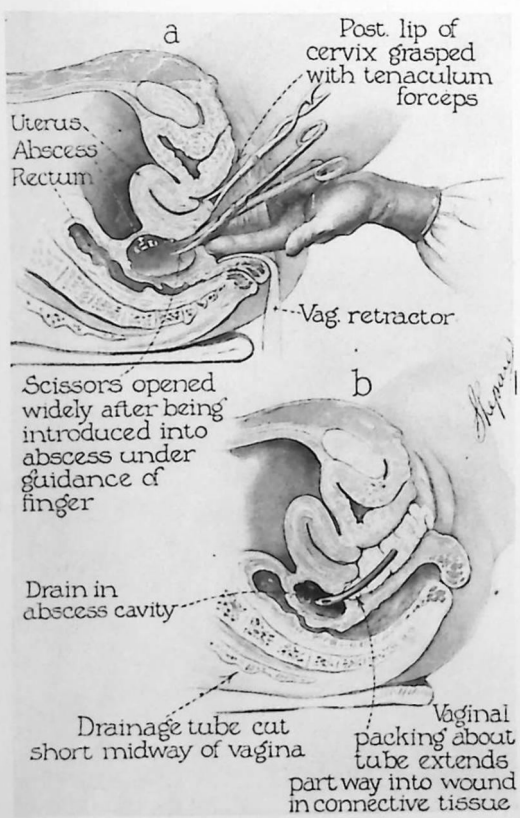


FIG. 1980. Draining of abscess in culdesac of Douglas. a. Manner of displacing cervix protecting rectum and opening abscess cavity. b. Method of draining abscess cavity, and packing of vagina.

Comment: Insemination should be practiced according to Ogino-Knaus during the so-called fertile period. This can be determined in terms of the preceding menstruation only if the menstrual period is absolutely regular. Inasmuch as the onset of the next menstruation cannot be determined in irregular periods, a formula has been devised which takes into account the irregularity and permits the date of the last period to be used.

Fertile period lies between 10 + minimum days of cycle − 28
17 + maximum days of cycle − 28

For example—the period is regular each 29 days.

10 + 29 − 28 = 11
17 + 29 − 28 = 18

That is, the fertile period lies between the 11th and the 18th days after the first day of the preceding menstrual period. If the period started on Sept. 3, the fertile period would start on Sept. 14, and end on Sept. 21.

If the periods are irregular, a definite knowledge of the variations is needed (for purposes of conception control, variations of more than 10 days in the length of the cycles render the method too uncertain to be of use). Suppose the shortest period is 26 days, the longest 32 days.

10 + 26 − 28 = 8
17 + 32 − 28 = 21

The fertile period lies between the 8th and the 21st days after the previous menstruation—or, using the same date as above, from Sept. 11 to Sept. 24.

This does not mean that all these days are fertile—but that investigation has proved that the ovary may discharge its ovum at any time within 2 days after and up to two days before the end of the fertile period. The two days which are added before and after the actual possibilities of ovulation are added because of the known possibility of the spermatozoa living 48 hours within the genital tract, i.e., a lapse of 48 hours between coitus and ovulation might still result in impregnation.

STERILIZATION

Sterilization in the female may be produced either by the means of x-ray or surgery. After thorough dilatation and curettage, the ostia of the Fallopian tubes may be electrocoagulated. Occlusion by chemical means may be resorted to by using escharotics such as zinc chloride which results in atresia of the interior of the uterus. Surgical means employed for sterilization are the following:

(a) Picking up the mid-portion of each Fallopian tube, ligating the tube in two places and dissecting the central portion. P. Brooke Bland stresses the importance of using absorbable sutures in ligating the tube.

(b) The following operative procedure may also be resorted to:

Step 1. Make an incision about ½ inch long through the anterior layer of the broad ligament.

Step 2. Insinuate a curved forceps through this opening and separate the cellular tissue in the broad ligament for a short distance.

Step 3. Cut off the fimbriated end of the tube. Ligate the stump.

Step 4. Pass a ligature through the ligated stump and tie the ligature about its middle.

Step 5. Pass the needle through the opening made in the broad ligament and pull with it the tube. The other half of the catgut suture is left long and armed with a needle. Pass this half of the suture similarly and ligate the two ends of the catgut, thus obliterating securely the opening of the tube.

Step 6. Close the opening in the broad ligament with a few fine catgut sutures.

OPERATIONS ON THE PREGNANT UTERUS

CESAREAN SECTION

Classical, Conservative Operation

A hypodermic injection of a preparation of ergot is given into the muscles of the thigh about ten minutes before the operation is begun; this will aid the contractions of the uterus thus minimizing the danger of hemorrhage.

One ampule of pituitary extract is injected into the uterus immediately after the child is delivered. A second ampule of ergot may be administered just before the patient is returned to bed.

Where the patient is in labor at the time of operation, the ergot is administered only with the idea of limiting postpartum hemorrhage and may be postponed until the abdomen is opened.

Some surgeons recommend the injection of pituitary extract alone into the uterine muscle immediately before incising it.

Care should be exercised while the incision is being made not to injure the intestines or the bladder which lie in close proximity to the uterus. To cut the infant while the incision is being made is a reflection on the surgeon's temperament and skill.

Step 1. The incision may be made either above or below the umbilicus unless an extraperitoneal operation is planned when a low incision is made. The long incision, practiced long ago, which extends from the ensiform cartilage to the pubes and which permits of the free delivery of the uterus from the abdominal cavity after which it is incised, has been discontinued by the majority of surgeons. At the present time the incision is made just long enough for delivering the infant easily, the uterus being opened in situ. If infection is present, the uterus is delivered before it is incised and the abdominal cavity is protected by gauze packing. The uterus should then be amputated to prevent the infection from spreading throughout the peritoneal cavity (Porro operation).

Surgeons who recommend the high incision claim that it prevents the formation of adhesions between the uterine and abdominal incisions and also avoids incisional hernia. Its chief objection seems to lie in the fact that if it becomes necessary to deliver the uterus before it is incised, the abdominal incision must be enlarged considerably. It is, however, quite desirable, in obese patients, to resort to a liberal incision. The low incision has many advocates; however, I fail to see any particular point of superiority in its use.

An incision to the right of and falling about midpoint of the umbilicus will serve its purpose well; it should be about six inches long. (Fig. 1981[1].) In the majority of cases the uterus is twisted somewhat to the right, thus the incision falls over the site of the uterus to be incised.

As often seen practiced, Cesarean section is responsible for more hurried motions in the operating room than any other procedure; yet it is quite unnecessary to work any faster here than in any other laparotomy with the exception of the period from the incision into the uterus to the delivery of the child, the purpose being to avoid the loss of much blood.

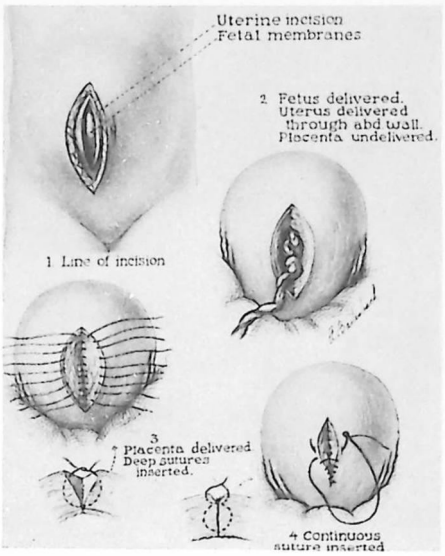


FIG. 1981. Classical (conservative) cesarean section.

Step 2. Ascertain the position of the uterus and child by palpation and if twisted considerably to the side, attempt to return it manually to the normal position.

Step 3. If a Porro operation is contemplated, protect the abdominal cavity with gauze packs wrung out of normal salt solution and proceed as described under Porro Cesarean Section, p. 1854. If the case is clean, protect the peritoneum from escaping amniotic fluid and blood by pressing the walls of the abdomen against the uterus.

Step 4. Incise the wall of the uterus longitudinally exactly in the midline down to the placenta if this is located on the front. The incision should be of sufficient length to permit easy delivery of the child. Do not become alarmed

if bleeding is free from the uterine sinuses; it will stop as soon as the uterus begins to contract. If the placenta is right under the incision in the uterine wall: (a) either push it aside, if that can be accomplished with ease, or (b) proceed right through it with firm pressure of the right index finger. Open the membranes.

Because the placenta is immediately beneath the incision need not cause concern. Go right through it. Of course, the bleeding will be more profuse than otherwise but that is of no moment. Once the membranes have been perforated, simply pass the hand into the uterine cavity, search for a foot of the child; deliver it to the surface; deliver the other foot. Deliver the arms, extract the body and deliver the head of the child.

Step 5. Clamp the cord in two places and cut it between the clamps. Give the baby to an assistant who waits with a warm blanket and will take further care of the newborn.

Step 6. Deliver the uterus through the incision in the abdomen; protect the peritoneal cavity from contamination with lap sponges or sterile towels. Remove the placenta and all of the membranes, especially those in the lower uterine segment which if left behind will obstruct the cervical canal. (Fig. 1981[2].)

Step 7. Close the incision in the uterine muscle with interrupted sutures of chromic catgut embracing all the layers except the mucosa, being careful not to tie them too tightly (Fig. 1981[3, 4]). Secure proper approximation by coaptation sutures placed superficially. Interrupted linen sutures have served me well.

Step 8. Remove the lap sponges from the abdominal cavity; mop up any amniotic fluid or blood which may have escaped into it and close the abdominal wound in layers.

Comment: The only time the child is in danger during Cesarean section is during the interval between the incision of the uterus and the delivery of the infant, particularly in instances where the placenta must be detached from the wall of the uterus before the hand can be inserted into the uterine cavity. This is the only step in the operation where unusual speed is justified.

Forty years ago Fritsch advocated the adoption of a transverse fundal incision based on the idea that since the vessels of that area run mostly transversely, the large ones are less likely to be injured. The results following this procedure were very satisfactory but seem no better than those obtained by the present-day method. The classical method offers more protection against adhesions and infections than this method.

In cases that have been a long time in labor, vaginal preparation should be made before the abdominal operation is done. This is accomplished by thoroughly scrubbing the parts with sterile soap and water while the patient is under anesthesia. Antiseptic douches are not sufficient. Before closing the abdominal incision, any clots remaining in the uterus should be pressed out.

Compression of the broad ligaments, while the incision is being made, is advocated and still practiced by some, although it is wholly unnecessary

except on rare occasions. It has been observed that pressure exerted on the lower uterine segment, either by tourniquet or hands, seems to partially paralyze the uterine musculature, temporarily diminishing its contractility thus interfering with normal contraction and retraction.

No matter what method of suturing of the uterine wound is resorted to, the important factor is to accomplish this step of the operation thoroughly, safeguarding the suture line against leakage.

Two-flap, Low-incision Cesarean Section

Alfred C. Beck uses two-flap, low-incision cesarean section which is a modification of the Krönig technic. Beck maintains that the usual source of peritonitis is through the uterine wound and the clinical course is that of a puerperal infection followed by a sudden development of peritonitis due to leakage into the peritoneal cavity. Placing the incision in the lower uterine segment and doubly sealing it with bladder and flaps of peritoneum offers a two-fold barrier against the usual mode of extension of infection from the uterus to the peritoneum. Within a short time after operation, these flaps become adherent and make the wound extraperitoneal. Should infection supervene the flaps are sufficiently united now so as to protect the peritoneal cavity from contamination. Beck states: Infection is thus limited to the subperitoneal tissues from which drainage occurs spontaneously, either through the lower angle of the abdominal wound or through the separated edges of the uterine wound into the cervix and vagina.

Although the low, cervical Cesarean section is somewhat more difficult than the classical operation, it gives excellent results, and is the procedure of choice whenever Cesarean section is performed six or more hours after the onset of labor. If, however, the patient shows signs of actual infection, as indicated by elevation of temperature and rapid pulse, much better maternal results are obtained if the body of the uterus is amputated by a Porro operation.

Step 1. Place the patient in the Trendelenburg position. Catheterize. Make a midline incision beginning immediately below the umbilicus; extend it to the symphysis pubis (Fig. 1982[1]).

Step 2. Expose by adequate retraction of the wound edges, the lower uterine segment, the bladder and its uterine reflection, about 2 cm. above the bladder. Cut the peritoneum transversely for about 7 cm. If the single incision or laparotrachelotomy technic is followed, dissect away the upper margin of the uterovesical peritoneum sufficiently for adequate exposure of the lower uterine segment and proceed with the subsequent steps (Fig. 1982[2]). If the two-flap operation is followed, the peritoneum is picked up about 4 cm. above the lower transverse incision and is freed about 3 cm. on each side of the midline. The dissection of this upper flap is carried out like the dissection of the lower flap; this is a little more difficult. The object is to dissect this flap far enough to expose the upper part of the lower uterine segment. If the patient is in labor, all the dissection should be below the gray line of firm attachment between the peritoneum and uterine wall, but if not in labor, it is better to make the upper flap above this line of attachment.

Step 3. Traction sutures are introduced at the apices of the denuded areas.

Exposure of the lower uterine segment shows the lower and upper flaps between which is a 4 cm. bridge of undisturbed peritoneum. A DeLee retractor is placed under the bladder flap to protect it from injury. The abdominal cavity is well walled off with lap sponges. The lower uterine segment is opened by a longitudinal incision which is started below the retractor in the midline and is continued upward toward the upper retraction suture. If blood and amniotic fluid obscure the field, the incision is continued by touch. Suction should be used for the removal of the blood and amniotic fluid (Fig. 1982[3]).

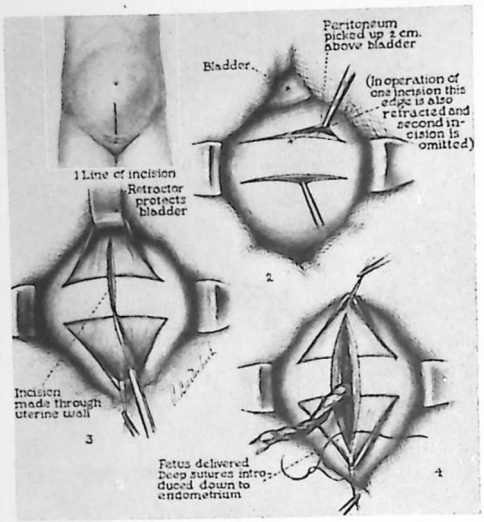


Fig. 1982. Low cesarean section. (Alfred C. Beck, two-flap technic)

Step 4. By means of a finger in the mouth, the head of the child is rotated until the face comes to occupy the uterine incision, when the delivery is effected by means of a short pair of forceps with the concavity of its blades facing the pubis, or by passing the hand under the occipital region, aided by pressure upon the fundus of the uterus. The cord is severed and the child is handed to an assistant. The nurse injects a full cubic centimeter of obstetrical pituitrin into the deltoid muscle just before the child is born, and after its delivery the placenta is expressed or removed manually. Then another full cubic centimeter of pituitrin is again injected into the same place. Some surgeons inject the pituitrin into the uterine muscle. While waiting for the placenta to separate, deep interrupted chromic catgut, No. 1,

single strand sutures may be introduced down to the endometrium. These sutures are placed about 1 cm. apart (Fig. 1982[4]).

Step 5. Pull on the two traction sutures lifting the uterus against the abdominal wall and facilitating the introduction of the interrupted chromic catgut sutures. Immediately after the placenta is removed the uterus is closed by pulling on the clamps which hold the deep sutures (Fig. 1982[5]).

Step 6. The deep sutures are tied and the wound is made more secure by inserting a second series of interrupted chromic No. 1 single strand catgut sutures. These are introduced midway between the deep ones and pass

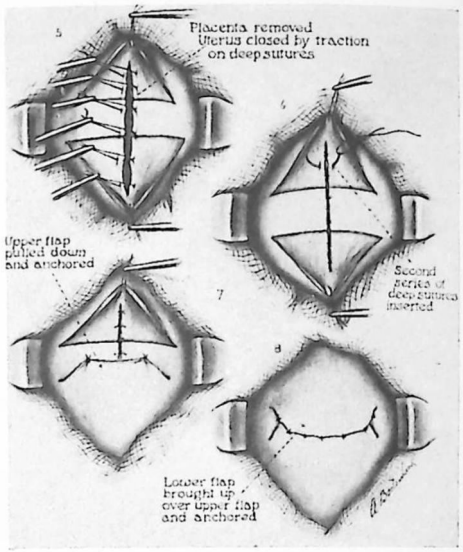


Fig. 1982 (continued). Low cesarean section.

through the tough surface connective tissue and most of the thickness of the uterine wall (Fig. 1982[6]).

Step 7. The lower flap is now pulled up over the bridge of undisturbed peritoneum and is anchored by two chromic No. 1 single strand sutures (Fig. 1982[7]).

Step 8. The lower flap is brought up over the upper one and is attached by a few chromic No. 1 single strand interrupted sutures, after which a continuous suture reinforces this attachment and turns in the cut edges of peritoneum. After a short time the uterine wound becomes extraperitoneal as a result of adhesion of these flaps (Fig. 1982[8]).

Porro Cesarean Sections Under Local (Infiltration) Anesthesia
J. P. GREENHILL'S TECHNIC

J. B. DeLee pointed out, in 1925, the feasibility and advantage of performing cervical Cesarean section under local (infiltration) anesthesia. However, as far as Greenhill could trace, no one has described Porro Cesarean section (supravaginal hysterectomy after Cesarean section) under direct infiltration anesthesia.

Although 6 to 8 ounces of the anesthetizing solution is the usual amount used in administering a local anesthetic for a Porro Cesarean section, 12 ounces of mixture is generally prepared—0.5 per cent procaine hydrochloride, to which, after sterilization, 2 drops of 1:1000 epinephrine are added for each ounce of procaine solution.

In a series of 42 operations performed by Greenhill, the average amount of anesthetic solution used was about 6 ounces and for the average Porro approximately 8 ounces.[1]

Step 1. While the skin is being injected, the patient is given ¼ grain of morphine sulphate and 1/200 grain of scopolamine. A low midline incision is made; injection of procaine hydrochloride solution is begun at the upper point of the planned incision. A fine needle is used to form the first wheal as it is less painful; after that a larger needle is inserted into the puncture point made by the first one. Injections of procaine hydrochloride are made into and under the skin down to the symphysis pubis. Besides being injected in the midline, injections of the solution are made for a distance of about 3 cm. on either side of the midline down to the pubis. Procaine hydrochloride is used generously here to overcome the natural sensitiveness of the tissues. Keeping the needle constantly in motion while injecting the solution prevents it from entering the blood vessels.

Step 2. Wait four or five minutes for the anesthetic to act. Make an incision through the skin and adipose tissue with a sharp knife. Anesthetize the anterior rectus fascia as well as the rectus muscle, using another needle. After the anesthetic has had time to become effective, incise the fascia with a new knife and divide the rectus muscles in the midline.

Step 3. Desensitize the posterior rectus fascia and the parietal peritoneum for about 4 cm. on each side of the midline. Generous injections are made over the bladder and into the space of Retzius. Open the peritoneal cavity. Expose the reflection of the bladder peritoneum over the lower uterine segment and raise it up with tissue forceps. Inject about 1½ or 2 ounces of procaine hydrochloride under the loose peritoneum (Fig. 1983); spread the solution with the finger under the bladder and into the broad ligaments (Fig. 1984). Plenty of solution should be used so that it can be pressed into the broad ligaments in an outward, upward and downward direction. No more anesthetic is administered until after delivery.

Step 4. Make a transverse incision in the bladder peritoneum as if a cervical Cesarean section is being done. Strip the bladder as far down as is deemed necessary. Make a vertical or transverse incision, preferably the former, in the lower uterine segment. Deliver the child either manually or by means of forceps. Remove the placenta; close the uterus.

[1] *JAMA*, March, 1928.

Step 5. If a Porro operation is being performed, make a transverse incision in the peritoneum of the bladder; strip it down a short distance. A transverse incision in the lower uterine segment is preferable here to a vertical incision and it is made close to where the body of the uterus joins the lower uterine segment (Fig. 1985). Point the ends of the incision upward toward the round ligaments. The transverse incision is chosen here because it renders extensive stripping of the bladder unnecessary; and because the amputation

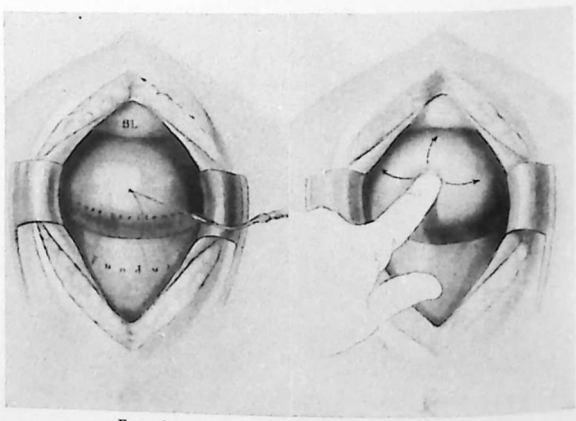


Fig. 1983 Fig. 1984

Fig. 1983. Exposure of field for Porro cesarean section under infiltration anesthesia. The solution of procaine hydrochloride is injected at one spot beneath the peritoneum which is loosely attached to the lower uterine segment. A catheter is left in the bladder to prevent distention.

Fig. 1984. With a finger, the procaine hydrochloride solution under the loose peritoneum is gently pushed down under the bladder and well out into the broad ligaments, upward and downward. (Courtesy, Dr. J. P. Greenhill.)

can be done by continuing this transverse incision to the posterior wall of the lower uterine segment; and also because it makes unnecessary the suturing of a vertical incision in the cervical stump along with the transverse circular one.

Step 6. After delivering the baby, clamp the cut edges of the uterus temporarily (Fig. 1986). Leave the placenta, cord and membranes in the uterine cavity. Carefully lift the uterus out of the abdominal cavity. Inject a little procaine hydrochloride solution subperitoneally on the posterior wall of the uterus along the line of amputation from one broad ligament to the other. Ligate the round ligaments distally, clamp them proximally and divide between the clamp and ligature. Apply long clamps to the broad ligaments close to the uterus (Fig. 1986). Leave the adnexae unless their removal seems especially indicated.

Fig. 1985

Fig. 1986

Fig. 1985. The loose peritoneum has been cut transversely, near its firm attachment to the fundus, and the bladder is retracted to expose the lower uterine segment. Part of the transverse, arched incision in the lower uterine segment has been made near the junction with the fundus and the remainder of the incision is indicated by the dotted line. Bandage scissors are used for incising the uterus. The spill of liquor amnii is taken up by means of an electric suction pump.

Fig. 1986. After the baby has been delivered, the placenta and cord are left in the uterus, clamps are applied to the edges of the incision, and the uterus is brought out of the abdominal cavity. This must be done gently or pain will result from pulling on the peritoneum. The ligatures and clamps shown here are applied to the round and broad ligaments. The adnexa are not removed. (Courtesy, Dr. J. P. Greenhill.)

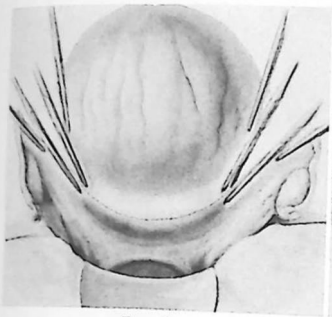


Fig. 1987

Fig. 1988

Fig. 1987. Posterior view of uterus. Clamps have been applied to the broad ligaments down to and including the uterine arteries. The dotted line represents the line of incision on the posterior wall of the lower uterine segment and the peritoneum covering it. The elevation of the peritoneum resulting from the injection of procaine hydrochloride solution is easily seen. Likewise the edema due to the procaine hydrochloride in the broad ligaments is distinct in the region of the clamps.

Fig. 1988. Appearance of field of operation after the lower uterine segment has been sutured, the round and broad ligaments sewed to it, and the entire mass covered with the peritoneal flap of the bladder. (Courtesy, Dr. J. P. Greenhill.)

Step 7. Incise the broad ligaments between the clamps down to the level of the transverse incision in the lower uterine segment (Fig. 1987). After checking to see that the uterine arteries are clamped, continue the original transverse incision in the lower uterine segment all around the uterus, completely amputating it. Doubly ligate the uterine arteries; ligate the broad ligaments with figure-of-eight sutures. It is permissible to ligate the broad ligaments and uterine arteries without previously clamping them.

Step 8. Suture the edges of the lower uterine segment; stitch the round and broad ligaments to it; the liberated peritoneal flap of the bladder is sutured over the entire mass (Fig. 1988). Proceed to close the abdominal wall as in any laparotomy.

All pulling and tugging should be avoided while performing this operation under local anesthesia. If abdominal pads are deemed necessary they may be placed without discomfort to the patient.

CHAPTER 40

SURGERY OF THE GENITO-URINARY ORGANS

OPERATIONS ON THE KIDNEYS

Anatomic Considerations. The kidneys are situated one on either side of the spine. They are retroperitoneal, being located in the lumbar fossae (iliocostal space; costovertebral angle). They are about four inches in length, two and one-half inches in width and from one and one-quarter to one and one-half inches in thickness.

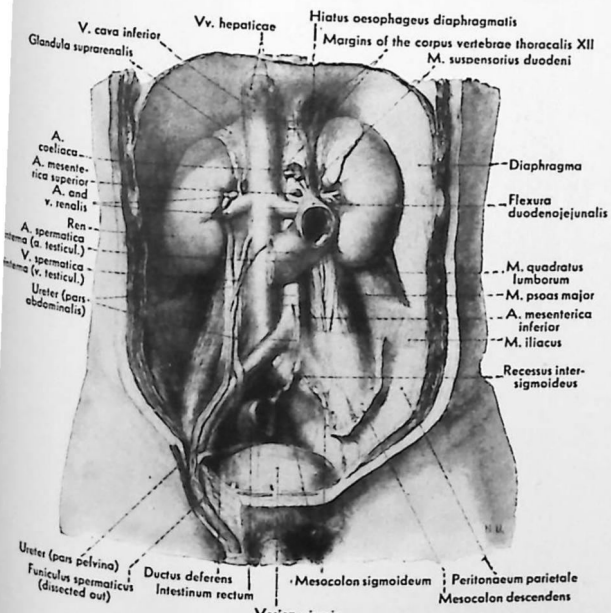


Fig. 1989. Urinary organs. (Spalteholz.)

The right kidney usually lies opposite the last dorsal and the first three lumbar vertebrae. The left kidney is situated at a slightly higher level. The hilum of each kidney lies approximately opposite the first lumbar vertebra. Its position may be marked on the surface by a point one and one-half inches from the midline in the transpyloric plane. (Fig. 1989.)

Relations of the Kidney.

	Right Kidney	Left Kidney
Anterior—	Below: hepatic flexure of colon.	Below: splenic flexure.
	Medial: second part of duodenum.	Crossing the middle: Pancreas and splenic vessels. Below pancreas is jejunum. Above pancreas is stomach and spleen.
Medial—	Above: suprarenal, liver. Inferior vena cava, ureter.	Above: suprarenal. Duodenojejunal flexure, inferior mesenteric vein, suprarenal, ureter.
Lateral—	Below: ascending colon. Above: liver.	Below: descending colon. Above: spleen.
Posterior—	Same in both kidneys. Each kidney rests upon four muscles: psoas, transversus abdominis, quadratus lumborum, diaphragm. The lumbocostal arches, last thoracic, iliohypogastric and ilio-inguinal nerves, and subcostal vessels are between the kidney and the quadratus, the anterior layer of the lumbodorsal fascia intervening.	

Fascial Investments of the Kidneys. The fibrous capsule invests the exterior of the kidneys; in health it can readily be stripped from the kidney. Next is the adipose capsule of the kidney and it also completely invests the organ; it is most marked about the lower pole and is not developed until the tenth year. Approaching the surface, the extraperitoneal fat becomes condensed forming the fascia renalis or Gerotas capsule. The fascia splits at the outer border of the organ into two lamellae, which embrace the adipose capsule and the kidney. The anterior lamella passes over the renal vessels to blend with the corresponding lamella of the opposite side; the posterior layer passes behind the renal vessels and fuses with the prevertebral connective tissue. Bands of connective tissue pass through the adipose tissue uniting the fibrous capsule to the fascia renalis.

The Hilum of the Kidney and Its Structures. The Renal Vessels: The renal arteries (Fig. 1990) arise from the aorta opposite the first lumbar vertebra. The right renal artery lies a little below the left and reaches the hilum of the kidney by passing behind the inferior vena cava and the right renal vein, the head of the pancreas and the second part of the duodenum. The left renal artery lies behind the left renal vein and the body of the pancreas. The renal artery divides within the hilum of the kidney into an anterior and posterior branch; these embrace the renal pelvis and give off four or five small vessels which enter the respective anterior and posterior surfaces of the hilum to pursue a parallel course within the kidney toward its outer border. Between the vertebral and dorsal aspects of the kidney there is a relatively avascular zone known as the "exsanguinated zone of Hyrtl" or as "Brödel's line" which lies slightly behind the outer border of the kidney and may be recognized by being somewhat lighter in color. In about 40 per cent of cases the renal arteries present variations in number, in point of entry and in relation to the surrounding structures. Frequently an extra-aortic branch passes either to the hilum or the lower pole of the kidney, a point to be remembered in ligating its pedicle. The renal veins empty into the inferior vena cava and usually lie in front of their respective arteries. The left renal vein receives the left spermatic vein. Owing to the proximity of the inferior vena cava to the pelvis of the ureter on the right side, the vein here is very short and requires particularly careful manipulation in doing a right-sided nephrectomy. The vein has frequently been torn in careless handling. In the pedicle of the kidney, the renal vein lies in front, the renal artery between, and the ureter and pelvis of the kidney behind and somewhat below. In addition, there are a number of lymphatics, an abundance of connective tissue and the nerves derived from the renal plexus, which

in turn is derived from the aortic and solar plexuses and the lesser splanchnic nerve The renal plexus is closely associated with the spermatic plexus in the male, with the sympathetic ganglia supplying the intestines and bladder, and with the upper lumbar nerves, which accounts for the intense testicular pain, the intestinal and vesical tenesmus and the lumbar radiations, so frequently observed in affections of the kidney.

The Ureters and Pelvis of the Kidney. The ureter (Fig. 1991) is about 10 inches in length and begins in the hilum of the kidney in a dilation known as the pelvis of the kidney. It passes downward on the posterior surface of the abdominal wall and entering the pelvis terminates in the posterolateral angle of the urinary bladder. The pelvis of the kidney is pyramidal in shape; its base is directed

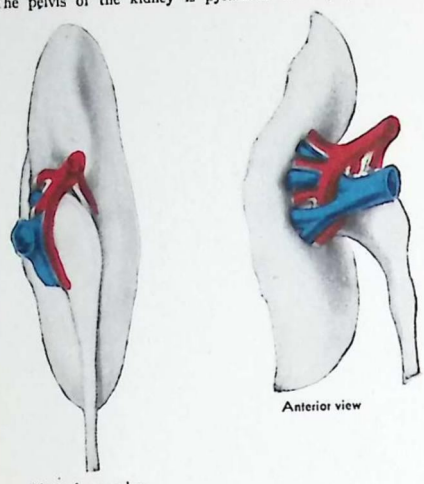


Fig. 1990. The right kidney, showing the relations of the pelvis and blood vessels. (Applied Anatomy, Davis.)

toward the renal sinus; its apex pointing downward. Its base is divided into major and minor calyces; the former are usually three in number; occasionally a fourth calyx is present; the minor calyces vary in number. The capacity of the renal pelvis varies but is usually from 8 to 10 cc. In hydronephrosis the capacity is greatly augmented. The abdominal portion of the ureter is extraperitoneal and lies on the psoas muscle; it courses downward toward the sacro-iliac joint and crosses the common iliac vessels just above the origin of the external and internal iliac arteries. Near the midline the ureter crosses the genitocrural (genitofemoral) nerve; the spermatic or ovarian vessels cross it about the same point. The left ureter lies behind the left colic and sigmoid vessels and the parietal attachment of the pelvic mesocolon. The pelvic portion of the ureter lies against the lateral wall of the pelvis in the retroperitoneal tissue. It passes downward and forward, lying on the obturator internus muscle, the obturator vessels and nerves, the inferior vesical and middle hemorrhoidal arteries; while posteriorly to it lie the hypogastric artery and the sacral plexus. It courses from the spine of the ischium to the posterior surface of the bladder being crossed above, before its termination, by the vas deferens. In the female, after crossing the common iliac ves-

sels, it courses downward and forward, passing beneath the base of the broad ligament; at this point it is crossed above by the uterine artery. Before entering the bladder it is in close relation above and laterally with the walls of the vault of the vagina.

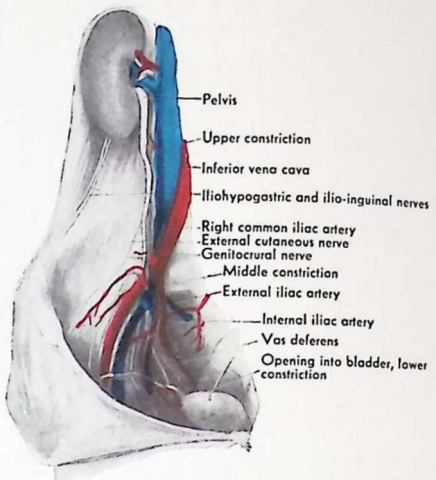


Fig. 1991. Course and relations of the ureter. (Davis, Applied Anatomy.)

METHODS OF EXPOSING THE KIDNEY

GENERAL CONSIDERATIONS

1. Lumbar, retroperitoneal route.
2. Paraperitoneal route.
3. Abdominal, transperitoneal route.

Lumbar Route

Position of the Patient (Fig. 1992). The patient may be placed in the prone, lateral or semiprone position. If in the prone position, a large pillow, air cushion or sandbag covered with a small cushion should be placed beneath the abdomen. No matter what position is used the following conditions must be met in order to successfully expose the kidney:

1. The iliocostal space must be made as wide as possible.
2. Respiration must not be permitted to become impeded.
3. The proper position of the patient must be maintained throughout the entire operative procedure without the aid of an assistant.

Body elevators on modern operating tables must be so constructed as to

exert pressure on the front of the abdomen, to push the kidney up into the lumbar wound. The adjustable kidney elevator when in operation with the patient on the sound side, exerts pressure between the costal margin and the ilium and will cause a marked lateral flexion and a correspondingly increased costo-iliac space in which the incision is to be made. It must be kept in mind that when the wound is about to be sutured the elevator must be lowered.

Anesthesia may be local or general (Fig. 1993).

Fig. 1992

Fig. 1993

Fig. 1992. Position for kidney operation.

Fig. 1993. Block anesthesia in operations on the kidney and ureter. Infiltration of the intercostal nerves and infiltration block of the border of the quadratus lumborum muscle. Vertical subdermal infiltration and the passage of the needle for deep infiltration. Transverse subdermal infiltration along the proposed line of incision. A. Infiltration line for operation on the kidney. B. Extension from line (A) where the ureter is to be exposed. (After Farr.)

Varieties of Incisions (Fig. 1994). 1. Vertical incision (Simon). 2. Transverse incision (Péan). 3. Oblique incision (Bergman-Israel). 4. Trap-door incision (Bardenheuer).

The most popular and widely used is the Bergman-Israel oblique incision or some modification of the same. It is carried out as follows:

Begin the incision on a level with the twelfth rib at the outer edge of the erector spinae muscle; continue it downward and forward to a point about a finger's breadth above the highest point of the iliac crest. The incision may terminate here or, if need be, it may be extended forward toward the junction of the outer and middle thirds of Poupart's ligament (Fig. 1995). The length of the incision depends, of course, upon the nature of the operation to be performed and the size of the surgeon's hand. For ordinary exploration, an incision of 4 to 5 inches is sufficient. If necessary, the incision is enlarged through the first muscle plane, viz.: the latissimus dorsi above and the external oblique below, then through the second muscular plane—the internal oblique. Incise then the aponeurosis of the transversus muscle and the muscle itself beneath which the

transversalis fascia is found. A small opening is made into this fascia through which a finger is introduced as a guide and the fascia incised along the entire length of the wound. The quadratus lumborum now presents. Hold the ilio-inguinal and iliohypogastric nerves out of the way with the group of sectioned muscles and the twelfth intercostal nerve with the anterior group. The quadratus lumborum may be either retracted toward the spine or incised, as needs be. After the

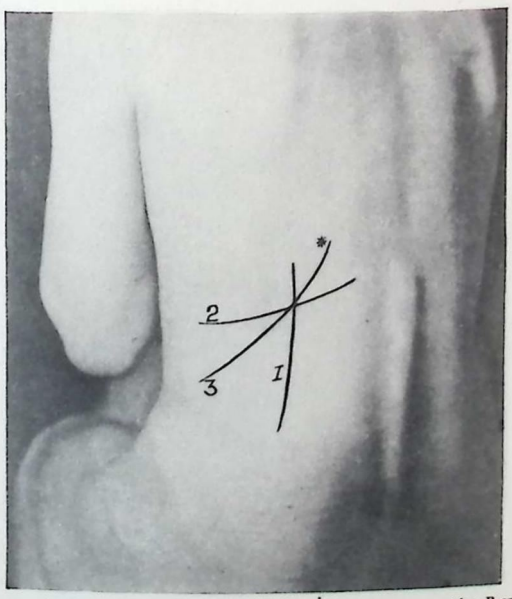


Fig. 1994. Incisions to expose kidney. 1. After Simon. 2. After Pean. 3. After Bergman-Israel. (*) Position of twelfth rib.

transversalis fascia is incised the perirenal fat presents; this is torn through with the finger until the kidney is reached. Avoid, during the deeper dissection, injury to the pleura, should it descend below the twelfth rib.

In the presence of certain difficulties such as: (a) firm adhesions; (b) very short pedicle of the kidney; (c) large kidney (tumor, etc.), W. J. Mayo suggested freeing the twelfth rib in order to gain additional exposure space. The posterior portion of the rib is turned upward and backward nearly to the articulation of the rib with the transverse process of the twelfth dorsal vertebra. Should

this also prove insufficient, the last rib should be resected, keeping in mind the pleural reflections.

Comment: The difficulties encountered in exposing the kidney by the lumbar route may be due to: (a) obesity, with thickly set trunk; (b) a narrow iliocostal space; (c) inflammatory adhesions about the kidney; (d) high position of the kidney (above the level of the twelfth rib).

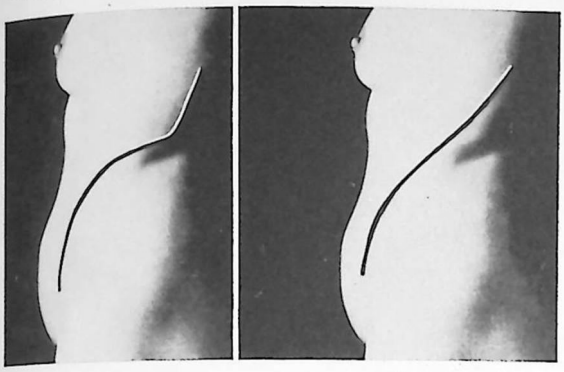


Fig. 1995. Type of incisions for exposure of the kidney and ureter. (Monod and Vanwerts.) The outlines are exaggerated.

The Paraperitoneal Route
(TRÉLAT, ANTONA, KRÖNLEIN)

The advantages of this procedure are: (a) the operation is performed with the patient in the dorsal position; (b) the kidney is exposed through the anterior abdominal wall without opening the abdomen.

Incision. Begin the incision anteriorly at the costal margin and carry it nearly to the anterior superior spinous process of the ilium—just a little outside the linea semilunaris. Divide the tissues down to but not through the peritoneum. Detach the peritoneum along the line of incision and as far out as its reflection from the lateral aspect of the abdomen (Fig. 1996). Retract it medially and retain it there with large, warm lap sponges (the peritoneum, colon and small bowels are drawn toward the median line and there retained by lap packs). Isolate and expose the kidney. If even more space is needed, a second incision perpendicular to the first is made (Fig. 1996).

Transperitoneal Abdominal Route
LANGENBUCH'S METHOD

Incision. Begin the incision immediately below the costal margin about three inches from the midline. Extend the incision downward for about four inches. Identify the linea semilunaris (outer edge of rectus abdominis muscle).

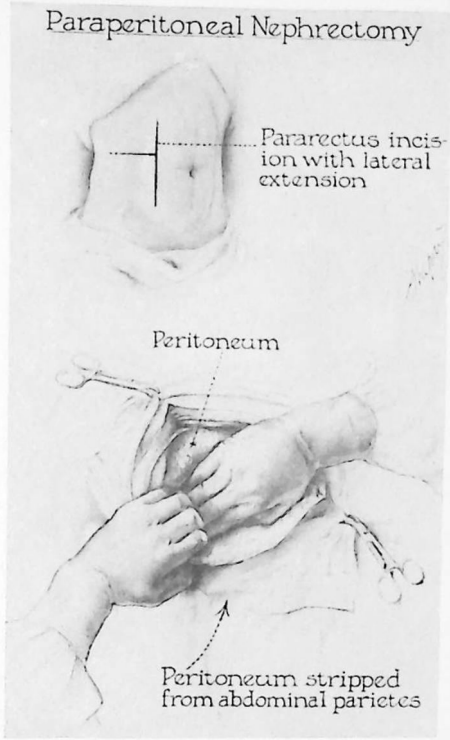


Fig. 1996. Paraperitoneal nephrectomy.

Extend the incision along the semilunar line down to the peritoneum. Explore. Make sure of the condition of the other kidney. Such opportunity is not offered by the lumbar route. Pack the intestines out of the way. Expose the outer surface of the mesocolon (Fig. 1997); make a small opening into it. It must be remembered that the blood vessels supplying the colon enter it through the inner half of the mesocolon; hence the incision must be made through the outer leaf of that membrane. In close approximation of the two leaves the vessels may be wounded in dividing the outer leaf. The incision into the mesocolon may be made parallel to the direction of the colon or at right angles to it. The former affords more room, but endangers the vessels; the contrary is true with the latter.

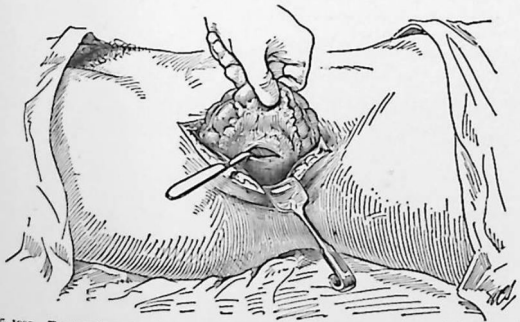


Fig. 1997. Transperitoneal nephrectomy. Note incision through the outer leaf of the mesocolon. Never incise through the inner leaf.

OPERATIONS ON THE KIDNEY

NEPHROPEXY—FIXATION OR SUSPENSION OF THE KIDNEY

Historical Notes. This operation was first introduced in 1881 by Hahn (sutures were passed through the fatty capsule of the kidney and the edges of the outer wound). In 1882 Bassini passed sutures through the fibrous capsule of the kidney and the edges of the outer wound. In the same year the operation was performed by Weir in America; by Esmarch, Delhaes and Keister in Germany; Newman introduced it in 1883. Bazy performed it first in France in 1885. A bilateral nephropexy at one sitting was done by Keister in 1883. Since that time to the present time a variety of procedures designed to suspend the kidney have been devised.

Indications:

1. Uncomplicated movable kidney with repeated attacks of neuralgia, crises and neurosis, explicable only by the presence of the displacement.
2. Torsion of the ureter owing to the abnormal mobility of the kidney (intermittent hydronephrosis).
3. Gastrointestinal disturbances while the patient is active and which are relieved when he is at rest.

4. Cases causing introspection and various neurotic states not relievable by other measures.

Contraindications:

1. General splanchnoptosis.
2. Ren mobilis causing no symptoms.

The aim of the classical operation is to create adhesions between the kidney and the posterior abdominal wall (partial decortication).

Principles Underlying Nephropexy Operations

The essential features embodied in the multitude of operations devised for this procedure are as follows:

1. Suspension of the kidney without incision or decortication of any part of the kidney.
2. Or, with incision and partial decortication of the kidney.
3. Passage of sutures through the renal capsule only.
4. Sutures should not be applied to the lower pole only; for if so, a forward displacement of the upper pole will result and predispose to torsion of the ureter.
5. No suspension should be done by utilizing the parenchyma of the kidney alone—the capsule and fascial investments must always be mustered into service.

EDEBOHL'S OPERATION OF NEPHROPEXY AND DECAPSULATION OF THE KIDNEY

Step 1. Expose the kidney by either of the two methods described above with the patient in the proper position.

Step 2. Deliver the kidney into the lumbar wound. Incise the fatty capsule. If the lumbar wound is too small to allow the ready delivery of the kidney, slightly incise the outer border of the quadratus lumborum muscle, transversely.

Step 3. Make a small opening in the fibrous capsule, through which pass a grooved director between the capsule and the parenchyma as shown in Fig. 1998 a. The incision is made to extend the entire length of the convex border of the kidney and over each pole. Strip the capsule from the surface of the kidney on either side of the central incision detaching it from the surface to about halfway between the convex border and the hilum on either side. See Fig. 1998 b.

Step 4. Pass four suspension sutures of forty-day chromic catgut, as shown in the illustration (Fig. 1999 a) through the fibrous capsule close to the junction of the reflected to the unreflected portions of the capsule. Two of these suspension sutures are placed on either pole of the kidney capsule, one near the upper, the other near the lower pole of the kidney (Fig. 1999 b). The kidney parenchyma is not penetrated by the sutures.

Step 5. Replace the kidney and pass the sutures from within outward through the whole thickness of the abdominal wall except the skin. The upper strands emerge just above the upper border of the twelfth rib, occasionally the tenth or eleventh rib. The perirenal fascia is utilized by passing a purse-

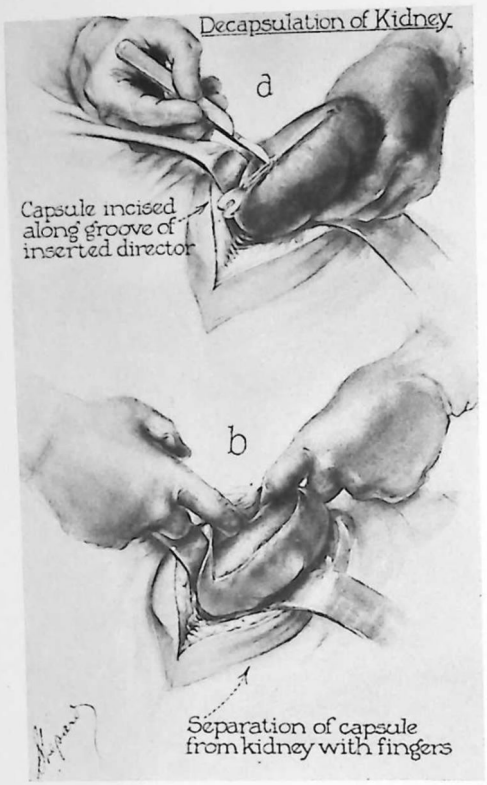


FIG. 1998. Edebohl's operation of decapsulation and suspension of the kidney. a Incision of the capsule of the kidney over a grooved director. b. Decapsulation effected by stripping the capsule from the kidney substance.

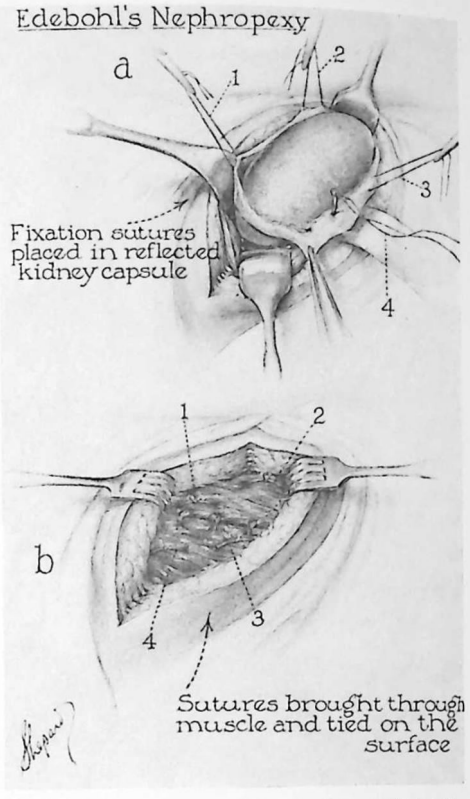


FIG. 1999. Edebohl's nephropexy and decapsulation operation. a. Method placing the fixation sutures. b. Manner of passing sutures through the superimposed structures.

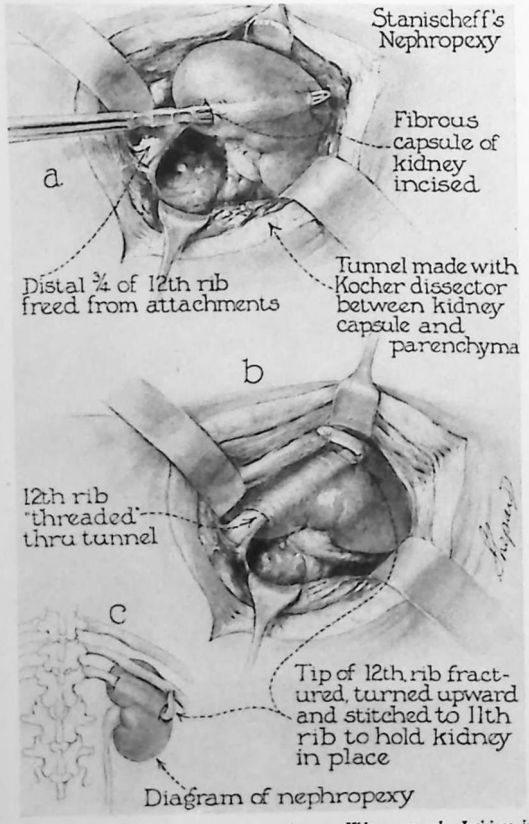


FIG. 2000. Stanischeff's nephropexy operation. a. Kidney exposed. Incisions in the fibrous capsule of the kidney to create a tunnel between the capsule and parenchyma. b. Twelfth rib "threaded" through tunnel, attaching kidney to periosteum of the rib. c. Tip of twelfth rib fractured, reflected upward and stitched to eleventh rib.

string suture about it and causing the formation of a hammock to support the lower pole of the kidney. The muscle and fascia are now closed by interrupted sutures. The previously placed sutures, outside the closed lumbar muscles, are now gently pulled upon thus bringing the denuded surfaces of the kidney in contact with the quadratus lumborum; the sutures are now tied.

Step 6. Close the skin. Dress the wound.

Comment: Avoid kinking the ureter during the operation. The main principle of the operation is to bring a large area of decorticated kidney into contact with a corresponding area of quadratus lumborum.

Albarran's method consists of suspending the kidney to the last rib after its decapsulation and converting the capsule into flaps which are sutured to the rib.

Israel's method takes sutures through the parenchyma of the kidney; suspension is accomplished by attaching the kidney to the last rib, subperiosteally.

In Vogel and Narath's method the twelfth rib is made use of as a direct support to the kidney by passing around the rib, flaps of the fibrous capsule.

STANISCHEFF'S NEPHROPEXY

In Stanischeff's clinic, among 25,000 operations between 1922 and 1934, there were 163 operations on the kidneys, and of those only 11 suspensions of the kidneys—7 per cent of all kidney operations. All other cases of floating kidney were treated conservatively (dietetic-orthopedic régime). The operation is performed as follows:

Step 1. Bergman-Israel incision. Open and retract the fatty capsule.

Step 2. Make an oblique incision about 1.5 cm. long, parallel to the long axis of the kidney on its posterior surface in the region of the upper pole, somewhat mesially, penetrating the fibrous capsule to the parenchyma of the organ. Make a similar incision through the fibrous capsule to the parenchyma, running parallel to, about midway and near the lateral border of the kidney as shown in the illustration (Fig. 2000 a).

Step 3. With a Kocher director create a tunnel between these two incisions between the fibrous capsule and the parenchyma of the kidney.

Step 4. Insinuate the twelfth rib through this tunnel of the mobile kidney; a few sutures attach the kidney to the periosteum of the rib (Fig. 2000 b).

Step 5. In order to avoid the suspended organ slipping off (coughing, muscular contractions, etc.), the tip of the twelfth rib is fractured about 4 cm. from its termination; it is reflected upward and attached to the periosteum of the contiguous rib with catgut sutures. This effectively prevents the kidney slipping off (Fig. 2000 c).

Step 6. Resuture the fatty capsule over the kidney and fractured rib. Attach the adipose capsule with a few sutures to the lumbar musculature.

Step 7. Close the wound without drainage.

Comment: Stanischeff emphasizes the following advantages of this method:

(a) Complicated incisions and flap formations of the fibrous capsule are not necessary—a simple tunnel between capsule and parenchyma of the kidney is all that is necessary.

(b) The kidney is not simply suspended but securely fixed to the twelfth rib; torsion of the kidney becomes impossible.

(c) The direction of the tunnel corresponds to that of the last rib, thus assuming a normal position of the kidney.

(d) The hooklike displacement of the rib assures impossibility of the suspended organ slipping.

(e) The results were highly satisfactory (Fig. 2001).

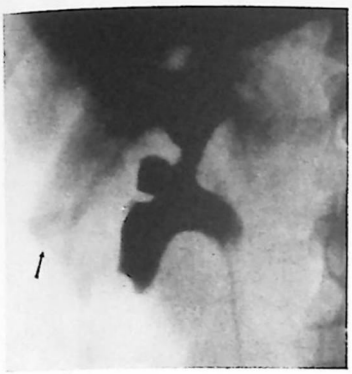


Fig. 2001. Stanischeff's nephropexy. Pyelogram two months after operation. Normal position of the suspended kidney. Arrow points to fractured, healed point of twelfth rib. (Courtesy of Prof. Alexander Stanischeff.)

Nephropexy Combined with Nephrolysis and Ureterolysis

O'CONOR'S OPERATION

Vincent J. O'Conor pointed out that important data obtained from a careful study of a series of cases (roentgenograms, ureteropyelograms, history, etc.) establish definite indications and contraindications to the use of renal suspension. Comparing his personal experiences with those of others (Rovsing, Kolischer), O'Conor is partisan to nephrolysis and ureterolysis combined with nephropexy, which he performed in a series of selected cases with gratifying results.

O'Conor admonishes that to be successful, the operation "not only must include a proper replacement of the kidney in as nearly normal position as possible, but must also provide for a complete freeing of the kidney, kidney pelvis and ureter from surrounding attachments before the restoration of position is attempted."

Step 1. An incision (Figs. 2002-2003-2004) is made which begins just below and parallel with the anterior half of the twelfth rib, from whence it is carried downward and forward for about five inches (Fig. 2003).

Step 2. Free the kidney in the usual manner; incise its adipose capsule and clear the fossa renalis. Isolate the pelvis and ureter and carefully separate these from all surrounding attachments; the ureter is separated down to the bifurcation of the iliac vessels (Fig. 2003).

Step 3. Liberate the kidney and its pedicle freely from its attachments.

Step 4. Incise the true capsule of the kidney at its upper pole both anteriorly and posteriorly and reflect it carefully down to the region of the hilum. This should be done gently lest some cortical tissue be torn off with the capsule. In a similar fashion the capsule is incised at its lower pole and reflected upward. A ribbon of true capsule about two inches in diameter is thus left attached at its original site surrounding the middle third of the kidney. The capsular layers are now overlapped so that three thicknesses of capsular tissue are available to receive the suspension sutures (Fig. 2002 a).

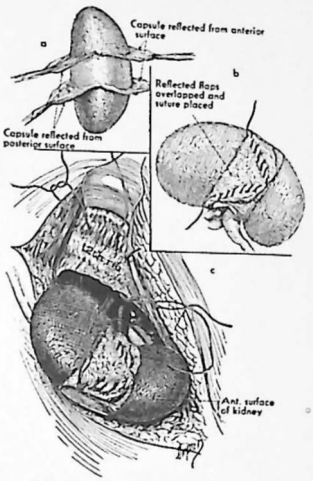


Fig. 2002. Decapsulation of both upper and lower poles of kidney allowing central hand so that three layers of capsule may be used to hold running interlocking chromic suture with ends left long enough to be carried above the twelfth rib. b, c. Where both anterior and posterior sutures are tied after lowering kidney elevator. (Courtesy of Dr. Vincent O'Conor.)

Step 5. A No. 2 chromic catgut, continuous, U-shaped interlocking suture is now placed through the pleated capsular layers from the convexity toward the hilum, anteriorly and posteriorly. The ends of the sutures are left long to be continued above the exposed portion of the twelfth rib. O'Conor lays emphasis on the fact, that sutures placed as described have great tensile strength and will not separate the capsule from the underlying parenchyma of the kidney (Fig. 2002 b).

Step 6. Replace the kidney downward in the wound; enlarge the renal fossa by stretching it bluntly with warm, moist gauze packs. The posterior tension sutures are now carried under and above the twelfth rib, as far toward the costovertebral angle as possible. This is followed by placing the anterior sutures, carrying them also under and above the twelfth rib, one or two inches in front of the sutures from the posterior side of the kidney (Fig. 2002 c).

Step 7. Push the kidney up firmly beneath the diaphragm. Lower the elevating device of the operating table. While the kidney is being held in position, pull firmly on the sutures upward and tie them simultaneously above the rib. The remaining strands of all four sutures are tied again. Adhesions

of the decapsulated portions of the kidney will form to the diaphragm and psoas muscle. No further anchoring of the kidney is necessary.

Step 8. Close the wound as usual, without drainage (Fig. 2004).

Comment: In a series of cases (30 up to 1928) operated on by O'Conor by this procedure, the results were gratifying. All patients were allowed

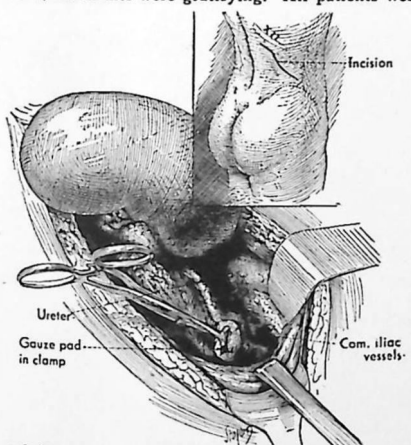


Fig. 2003. a. Incision paralleling twelfth rib in first portion, then passing slightly downward and forward. b. Kidney and ureter completely freed from all surrounding attachments except renal pedicle. (Courtesy of Dr. Vincent O'Conor.)

to sit up in bed fourteen days following the operation. No corsets or belts were used. Patients left the hospital in from sixteen to twenty days.

In discussing nephropexy[1] Bransford Lewis and Grayson Carroll concluded that:

"1. Movable kidney is a reality both clinically and pathologically and demands prompt recognition and appropriate surgical relief.

2. Such recognition is to be based on the modern methods of examination.

3. Diagnosis requires proof on two points in particular: (a) As to the presence of unduly movable or displaced kidney; (b) as to whether the symptoms complained of are coming from this displacement or mobility.

4. Methods of relief are both palliative and surgical: abdominal binders and nephropexy, the latter affording permanent results when properly carried out.

5. Binders are effective only as long as they are worn, no cure or permanent relief being afforded by them.

6. The 'fattening' methods of treatment offer no probability of success and are pure waste of time."

[1] The Journal of Urology, November, 1930.

DECORTICATION (DECAPSULATION) OF THE KIDNEY

This operation was suggested by Edebohls for the relief of acute or chronic nephritis with hyperpiesis and urinary manifestations. It has also been used in acute suppression of urine, in uremia and in mercurial poisoning. The object is to release the kidney from pressure and to supply a new anastomotic circulation through the cortex of the kidney. It should be done under local or spinal anesthesia. It consists of stripping and removal of the kidney capsule (Figs. 1998 a, b, p. 1868).

NEPHROSTOMY AND NEPHROTRESIS

Nephrostomy consists of incising the kidney and suturing the lips of the renal wound to the parietes followed by drainage which may be either temporary or permanent.

Nephrotresis denotes the establishment of long continued or permanent drainage of the kidney and is used in cases of irremediable ureteral obstruction or in malignant tumors of the bladder demanding total cystectomy.

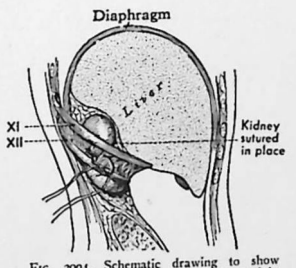


Fig. 2004. Schematic drawing to show position of kidney when sutures are drawn tight and tied. (Courtesy of Dr. Vincent O'Conor.)

Both of the procedures will be described together. They are practically the same as nephrotomy except that drainage (tube) is established and the urine collected in a receptacle. (Figs. 2005-2006.) Patients may be permitted to go about their business with a properly constructed apparatus. The skin and clothing of the patient may be kept dry and a comfortable existence assured. Lumbar drainage allows compensatory hypertrophy of the opposite kidney; inflammatory products may become absorbed, a blocked ureter the result of inflammation may become patent again. Later, after the function of the opposite kidney is adequate again, nephrectomy of the diseased organ may come under consideration.

NEPHROTOMY

Step 1. Expose and explore the kidney as described above.

Step 2. Deliver the kidney onto the patient's back. Secure temporary hemostasis by having an assistant compress the hilum of the kidney with his fingers or surround the pedicle with a small rubber tube applied snugly but not too tightly; an artery forceps clamping the two ends of the tube prevents its slipping. An intestinal forceps of the Doyen type, the blades of which are covered with rubber, may be used instead of the preceding methods. The operation is thus rendered bloodless. Of course, the ureter cannot be explored when constriction of the pedicle is used as outlined. The delivery of the kidney into the wound is sometimes difficult or well-nigh impossible. Under such circumstances an index finger is hooked in front of the organ and its convex border brought into the wound as nearly as possible.

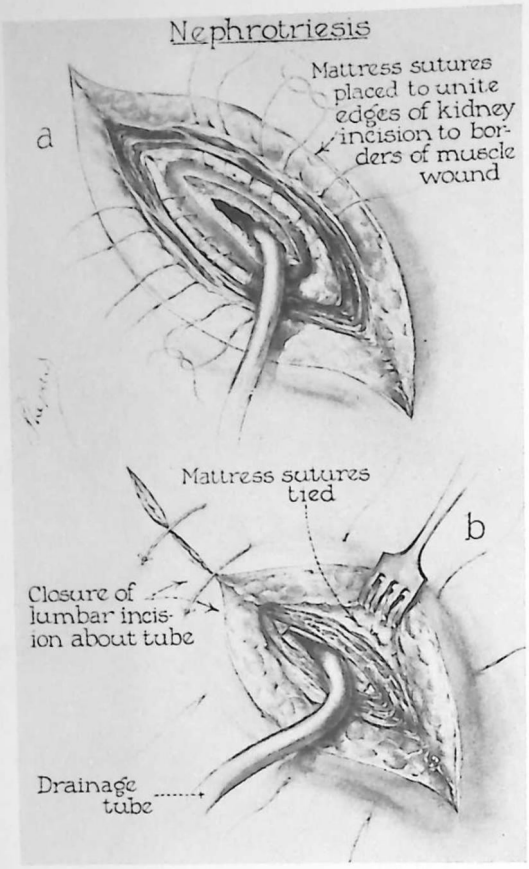
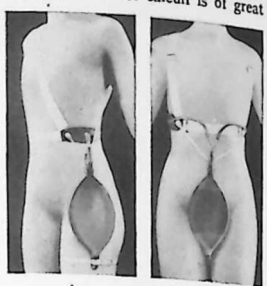


FIG. 2005. Nephrostomy and Nephrotresis. a. Kidney opened and explored. Method of placing mattress sutures which unite the edges of the kidney incision to the borders of the muscle wound. b. Closure of lumbar incision about tube.

Step 3. Grasp the kidney between the fingers and the thumb. Make a longitudinal incision along its convex border of a size sufficient to pass the exploring finger into the pelvis of the organ. The incision should be ample for thorough exploration (a portable x-ray unit to fluoresce the exposed kidney in order to ascertain the presence or absence of calculi is of great aid). Needling of the kidney to ascertain the presence of calculi is uncertain and now rarely used. With a finger in the opening made, the interior of the kidney is explored, aided by counter-palpation on the outside. When no constriction has been used catheterization of the ureter from above will aid in ascertaining the presence or absence of ureteral calculi.



A B

FIG. 2006A. Buchstein Nephrostomy and Ureterostomy Drainage Appliance for unilateral fistula. B. Buchstein Nephrostomy and Ureterostomy Drainage Appliance for bilateral fistula.

Step 4. The exploration completed, the wound is closed with interrupted catgut sutures carried on a round (atraumatic) needle. A pad of fat or muscle is sutured over the incision line. The lumbar wound is closed in layers with through-and-through silkworm-gut sutures. Drain when deemed advisable. An admirable method to accomplish this is to place a cigarette drain over the suture line and retain it in place by the ends of the catgut sutures left long for this purpose.

Comment: Calyces are best explored with a blunt-pointed probe of sufficient size so as not to penetrate their walls. An incision extending the whole length of the kidney may be utilized when such exploration is called for. It is safer to drain for a day or two following exploration of the kidney. In abscess of the kidney the site of the incision should be located directly over the abscess. In palpable stone incise directly over the calculus. In nephrotomy for hydronephrosis and pyonephrosis make the incision in as dependent a position as possible to favor evacuation of contents. Arrest of hemorrhage is accomplished by either (a) suture or (b) tamponade.

NEPHROLITHOTOMY

Step 1. The position of the patient is the same as in lumbar nephrotomy. Compress the pedicle of the kidney as outlined above.

Step 2. An incision is made into the kidney as described under nephrotomy.

Step 3. If the calculus is small and lying free in the pelvis of the kidney, pass a forceps through the wound in the kidney and extract the stone. (Fig. 2007.) When the stone is impacted, an incision is made directly over it; when the position of the calculus is uncertain the more extended incision is resorted to. Thorough exploration is essential. The extraction of large stones filling the calyces often becomes a matter of great difficulty. Through

an ample incision, stones are peeled out from the calyces, preferably unbroken. If that is difficult, the calculus should be split up and extracted in sections. All fragments of stone are removed separately by means of forceps, gauze or irrigation. Several incisions made over several stones is preferable to one large mutilating incision.

Step 4. Explore the ureter for calculi.

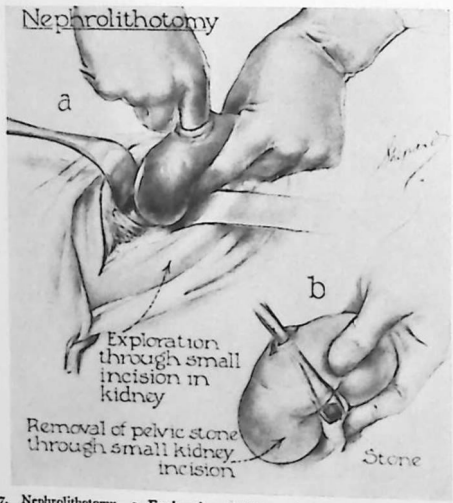


FIG. 2007. Nephrolithotomy. a. Exploration of kidney. b. Removal of stone from pelvis of kidney through small renal incision.

Step 5. Fix a drain in the renal wound.

Step 6. Close the wound in the kidney with catgut around the drain.

Step 7. Close the lumbar wound.

Comment: Hemorrhage may be a serious complication in nephrolithotomy.

PYELOTOMY AND PYELOLITHOTOMY

This consists of delivering the kidney as already described. An incision into the pelvis of the kidney is made (pyelotomy): through this incision stones may be extracted (pyelolithotomy). "Fix" the stone before manipulation to prevent its descent into the ureter. (Fig. 2008.) Israel admonished that incisions into the pelvis of the kidney should not be made too close to the parenchyma of the organ in doing a pyelotomy for the following reasons:

(a) Sutures are here inserted with difficulty.

(b) The renal parenchyma may be injured during a pyelolithotomy, followed by bleeding and an accumulation of clots in the pelvis of the kidney or ureter, giving rise to colic.

The wound in the pelvis of the kidney should be united with interrupted catgut sutures. Incisions heal very rapidly here, in the absence of infections.

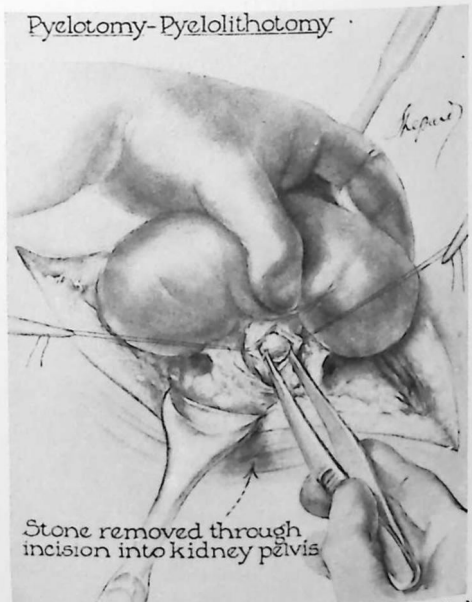


FIG. 2008. Pyelotomy-pyelolithotomy. Fixing stone with fingers of left hand. Method of extracting stone after incising pelvis of kidney.

According to the Mayos, closure of the renal pelvis without leakage may be effected even by imperfect sutures if a flap of fatty fascia is made to cover the incision.

Close the lumbar incision. Drain.

Comment: Often grasping a small calculus in the pelvis of the kidney offers difficulties because of the anatomic approach from the loin to the pelvic opening and the angulation from there to any one of the usual three major calyces. The stone should be grasped and withdrawn easily to avoid fragmentation and trauma of the surrounding structures. Gallstone for-

ceps are usually used but as these have a slight curve, the ability to easily reach into the middle or lower calyx in search of an elusive calculus is abortive and vexatious.

Randall's forceps (Figs. 2009-2010) consist of a set of four clamps, made by Lentz and Sons, Philadelphia, progressive in angulation, but of similar construction and weight and are very advantageous in locating, grasping and removing renal calculi through the preferable pyelotomy approach, with a minimal amount of trauma and time.

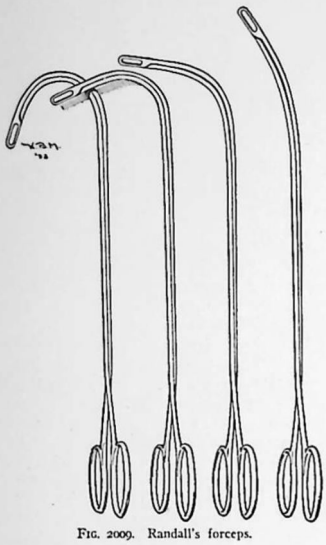


FIG. 2009. Randall's forceps.

NEPHRECTOMY

Historical Notes. Walcott, an American surgeon performed a nephrectomy (transperitoneal) for the first time in 1861. The patient was a woman 58 years of age and was suffering from carcinoma of the kidney; she died on the 15th day after the operation. The second nephrectomy was also performed by an American surgeon, Peaslee in 1866. This was also a transperitoneal procedure. The credit for the lumbar approach in nephrectomy belongs to Simon of Heidelberg who in 1869 exposed the kidney through a vertical incision in the lumbar area for the relief of a renal fistula. His patient recovered. In 1870, Gilmore, another American, removed the kidney in a woman a few months pregnant. The patient recovered. Simon again operated by the lumbar route for renal calculus in 1871; the patient died. In England Durham did the first nephrectomy in 1872. In the same year Peters of New York also removed

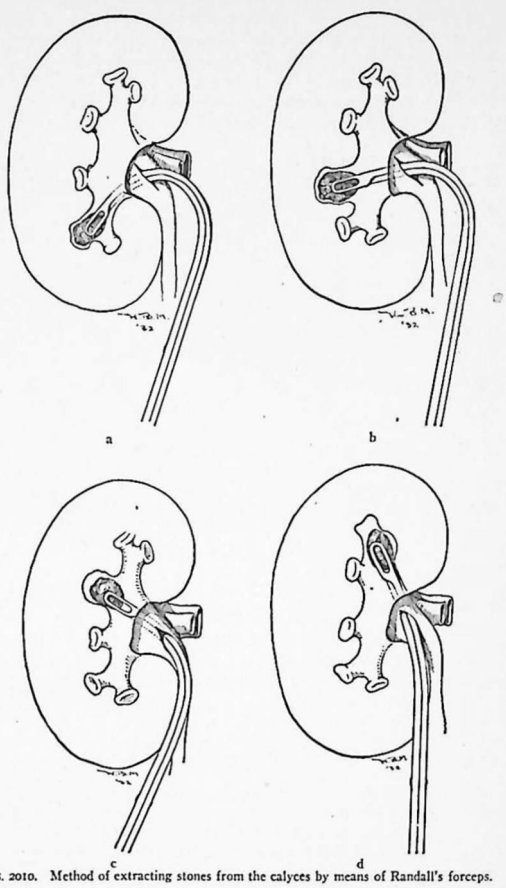


FIG. 2010. Method of extracting stones from the calyces by means of Randall's forceps.

a kidney—both patients died. Le Fort is credited with having done the first nephrectomy in France in 1880; his patient succumbed. The first successful removal of the kidney in France is credited to Péan. Byford of Chicago performed the first successful transperitoneal nephrectomy for carcinoma of the kidney in 1878.

Lumbar Nephrectomy

The position of the patient, anesthesia, etc., have already been described.

Step 1. Expose the affected kidney by any of the incisions described above; exposure must be ample and the various steps of the operation must proceed unhampered. Good retraction is important.

Step 2. The kidney must be separated from its surrounding structures and attachments. Finger dissection is best. I often find it advantageous to stand with my back toward the side upon which the operation is performed. The hand is introduced into the wound guided by the sense of touch. The kidney is detached from the structures surrounding it. The detachment proceeds until the kidney is suspended by its pedicle. It may then be delivered into the lumbar wound. The fatty (perirenal) capsule must be separated from the fibrous capsule. When little perirenal inflammation is present the stripping of the fatty capsule from the fibrous one is easily accomplished. When, however, as the result of long-continued inflammation, the fatty capsule is firmly and densely adherent to the fibrous capsule, the utmost care must be exercised in the separation of the organ. It is here that a liberal incision will display its advantages and render a difficult task easier. With scissors or scalpel, keeping close to the fibrous capsule, the kidney is gradually freed by sharp dissection, care being taken to avoid the peritoneum and colon, and, if necessary, a section of fibrous capsule is left, if too adherent to these structures. It is in these cases, done secondarily, as subsequent to a nephrostomy, that the adhesions become so dense, almost leather-tough in consistency, that enucleation becomes impossible and subcapsular separation of the kidney becomes necessary.

Ligate any blood vessels encountered in separating the kidney from the contiguous structures. Do not attempt to free the pedicle of the kidney which is buried in a mass of adhesions. Under such circumstances it is safer to remove the kidney by intracapsular morcellation (see below). When difficulties are encountered in bringing the kidney into the lumbar wound (adhesions, short blood vessels) great care should be exercised not to use too much traction lest the kidney be torn from its pedicle. The right kidney is usually delivered with greater difficulty than the left, because the renal vein is shorter on the right side.

Step 3. Examine the pedicle. Recognize the ureter and renal vessels; the former is either felt or seen lying on the psoas muscle and covered snugly with peritoneum. Place a right-angled clamp on the renal vessels and ureter near the hilum. Pass a ligature carrier, armed with silk or reliable catgut, between the ureter and the blood vessels. (Fig. 2011.) Ligate the ureter separately and divide it between the ligature and the clamp. Cauterize the divided end of the ureter with phenol. The blood vessels are ligated with silk or No. 2 chromic catgut and divided. The ligature of the blood vessels should be applied at as great a distance from the kidney as possible; this,

for the purpose of permitting the division of the pedicle at a sufficient distance from the ligature assuring a stump of sufficient size to frustrate the danger of a slipping ligature. The vascular bundle is then divided between the ligature and the clamp holding the stump of the kidney. For the present the ligatures are left long. In ligating the vessels it should be remembered not to place them too close to the vena cava and aorta. Remove the kidney.

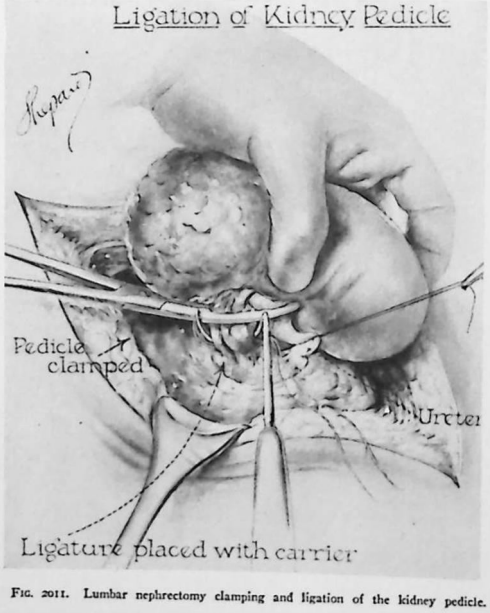


FIG. 2011. Lumbar nephrectomy clamping and ligation of the kidney pedicle.

Some surgeons prefer to ligate the renal vessels separately. There is no need for this; in doing so there is some danger of injury to one or the other of the vessels by the needle en passage.

Step 4. In cases of malignancy, excise the fatty capsule carefully. Expose the retroperitoneal space thoroughly. Attend to hemostasis. If the peritoneum has been accidentally opened, repair it. Dry the operative field. Drain. Close the wound.

Comment: When the ureter is infected, dilated and contains pus, it must be cleaned and either allowed to retract after being ligated and removed (ureterectomy), or left open and fixed in the lumbar wound. If the operation is done for tuberculosis, a ureteronephrectomy (Fig. 2012) should be done by following the ureter down to the brim of the pelvis or even further down and then removing it. In such instances destruction of the ureteric mucous membrane and closing the upper end of the ureter are desirable. Mayo has injected carbolic acid into the ureter (about 4 per cent) and found the method effective and harmless.

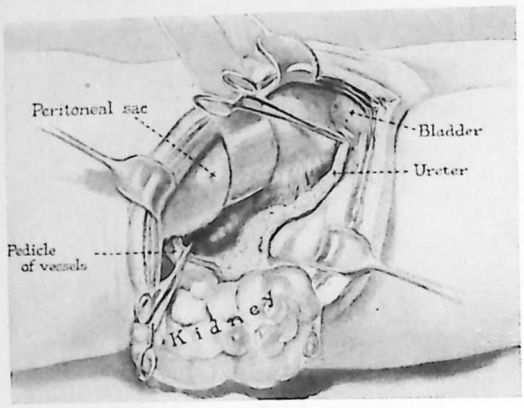


FIG. 2012. Total ureteronephrectomy.

TUFFIER'S MORCELLEMENT OPERATION

In secondary nephrectomies this is a safer procedure than classical nephrectomy. (Figs. 2013-2014-2015.) It consists in removing the kidney piecemeal.

Step 1. Expose the kidney and isolate it as described above.
Step 2. Clear its lower pole.
Step 3. Apply a right-angled clamp transversely to the long axis of the kidney.
Step 4. The portion of the kidney below the clamp is cut away.

Comment: When the pedicle cannot be ligated a clamp should be left in situ and removed after two or three days. By that time all danger of hemorrhage is gone. In threatening hemorrhage and in friable structures, clamps may be applied to the pedicle, the kidney removed and the clamp left in situ, surrounded by gauze tampons for two or three days. In hydronephrotic kidneys causing technical difficulties the following method should be resorted to.

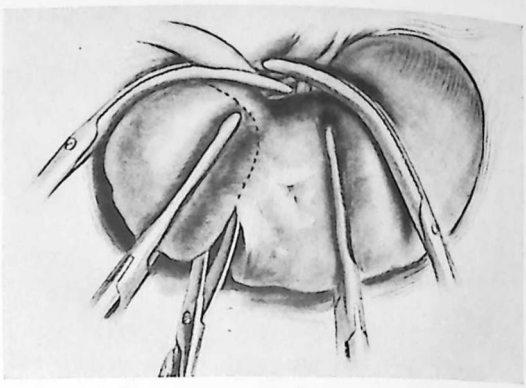


FIG. 2013. It is often an error to proceed with classical operations in the face of complicating renal or perirenal pathology. Under such conditions morcellation of the kidney substance (Tuffier) will frequently prevent operative disaster. This illustration depicts the procedure. Note clamping of the hilum of the kidney with forceps.

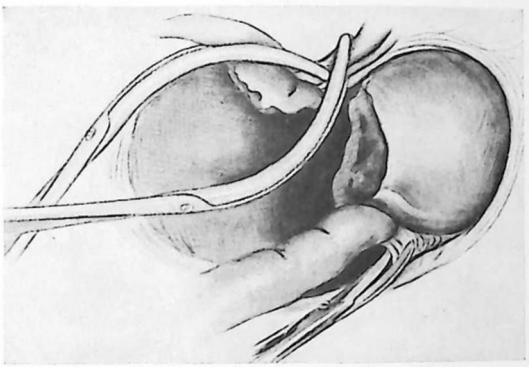


FIG. 2014 (continued). Morcellation of the kidney (Tuffier). Note removal of kidney substance with finger and scissors. The middle and lower thirds of the kidney have been morcellated. Note position of the clamp and stump of hilum.

ISRAEL'S METHOD

This consists of:

Step 1. Getting down step by step to the capsula propria.
Step 2. Evacuation of the hydronephrotic sac with a trocar.
Step 3. After collapse of the kidney following the evacuation of its liquid contents, deliver the kidney into the wound under visual control, using scissors in the separation of the organ from its surroundings. When the hilum is reached, great care should be exercised in separating adhesions, for in hydronephrosis, the veins are greatly spread out; they should be carefully ligated. When the ureter is to be tied low down, the lumbar incision should be extended to the crest of the ilium, the superimposed structures drawn aside and the ureter attacked extraperitoneally.

FIG. 2015 (continued). Segments of the kidney removed by the morcellation method of Tuffier (semi-diagrammatic).

Comment: In difficult removal of kidneys, Langenbeck's principle, first to secure the blood vessels and then proceed with the ablation of the kidney, is good advice.

The dangers in nephrectomy are numerous, particularly when the operation becomes necessary in cases where a previous nephrostomy has been done, and when the experience of the surgeon is limited. Shock (proximity to the solar plexus) is common; hemorrhage (primary or secondary) owing to slipping of a ligature or loosening of a clamp must be reckoned with.

Retraction of the Renal Vessels. Ligation under ocular guidance, or, that cannot be effectively accomplished, tight tamponade is often life saving. Hemorrhage from a torn vena cava or aorta is better avoided than treated. When occurring, suture or tamponade must be resorted to. Injury to the large bowel or duodenum should be repaired at once lest dire consequences follow, particularly in injuries to the duodenum, which usually result from clamping the pedicle and with it a portion of duodenal wall with subsequent necrosis. If discovered, proceed to repair them at once (closing the opening; jejunostomy for feeding). In anuria following nephrectomy first try medical measures, glucose, etc., if of no avail do a nephrostomy on the opposite kidney promptly.

Abdominal (Transperitoneal) Nephrectomy

In large benign or malignant tumors, particularly in the latter, the abdominal approach will give better exposure and tend to more thorough work than in the lumbar operation.

Step 1. Make a Langenbeck's incision on the affected side, in the linea semilunaris, along the outer border of the rectus abdominis muscle and extending from the costal margin to within two inches of the pubes. Follow the semilunar line to the peritoneum (p. 1864).
Step 2. Displace the colon to the median line. Pack the surrounding structures out of the way.
Step 3. Isolate the mesocolon.
Step 4. Open its outer leaf by a small incision, which is extended by blunt division. By avoiding the inner leaf of the mesocolon, injury to the blood vessels will be avoided (Fig. 1997, p. 1866).
Step 5. Separate the kidney from its surroundings as far back as the hilum.
Step 6. Ligate the renal vessels with double ligatures in a manner similar to that described under lumbar nephrectomy, and divide them (Fig. 2011, p. 1833).
Step 7. Liberate the kidney. When many adhesions are present this step may be one of much difficulty. Deliver the kidney through the abdominal wound.
Step 8. Divide the ureter between artery forceps.
Step 9. Inspect the renal pouch for bleeding.
Step 10. Drain through a stab wound in the loin.
Step 11. Close the abdominal wound in layers.

The drain through the wound is executed as follows: Thrust a closed clamp backward through the lumbar tissues, just external to the quadratus lumborum muscle, until the skin is raised. Incise the skin over the point of the clamp; this permits the clamp to pass through the opening made. If necessary, the opening may be enlarged to permit the passage of an appropriate-sized drainage tube.

When the kidney is bound down by adhesions, the operation may become one of great difficulty. When cysts hamper its delivery, they will have to be emptied before satisfactory delivery of the kidney can be effected. Often the treatment of the pedicle offers difficulties.

Dangers Encountered in Nephrectomy

1. Shock
2. Hemorrhage
3. Peritonitis
4. Empyema
5. Embolism (pulmonary and cardiac)
6. Anuria

RESECTION OF THE KIDNEY

Partial Nephrectomy

The greatest usefulness of this operation is in traumatic lesions, anomalies—reduplication in upper half—carbuncle, benign tumors of a calyx, benign tumors of moderate size and cysts of the kidney.

Czerny was first to perform this operation in 1887. This case demonstrated that it was possible to obtain satisfactory healing. Thiriar and Bardenheuer's experimental studies on dogs have demonstrated that wedge-shaped resections of the kidney heal by first intention.

As much renal tissue as possible should be saved. Even though only a portion of a kidney can be saved, this should be done. Compensatory hypertrophy in the remaining kidney tissue takes place as well as in the opposite kidney.

Step 1. Expose the kidney and deliver it.
Step 2. Gently clamp its vessels.
Step 3. An assistant steadies the organ while the surgeon removes a wedge-shaped portion. The incision should extend into healthy kidney tissue.
Step 4. The cut surfaces should be carefully approximated with noncutting needles carrying catgut mattress sutures which must include the capsule of the kidney and not be tied too tightly in order to avoid their cutting into the kidney structure. Fat or muscle may be used over the suture line to prevent tearing the parenchyma of the organ.
Step 5. After suturing is completed, the clamp is removed and the wound is closed.
Step 6. Institute drainage. The drain should not extend to the kidney. No packing should be used.

Horseshoe Kidney

Where heminephrectomy is indicated a careful line of cleavage should be found. A wedge-shaped incision permits the wound edges to be brought together with mattress sutures. When this cannot be done, fascia or fat should be sewn against the raw surfaces. Rovsing's operation consists of crushing the bridge connecting the two halves of the kidney with a crushing clamp followed by severing the ribbon of kidney or fibrous tissue between two ligatures.

PERINEPHRITIC ABSCESS

This is best treated by an ample, oblique lumbar incision and evacuation of the pus. Do not wait until pus forms. Early incision, even when no pus is present, often gives prompt relief. Spontaneous opening of a perinephritic abscess is not infrequently followed by fistula; this usually does not occur when the scalpel is used. It is important to remember that when operating for perinephritic suppurations the area immediately below the diaphragm should be thoroughly explored. The finger should be passed over the whole surface of the kidney, down its pelvis and about the upper part of the ureter. The reason for this thorough exploration is that if no pus is encountered where such was suspected purulent accumulations may be found walled off at one of these points, and may be overlooked, if not thoroughly looked for. Rubber drain.

RENAL FISTULAS

Step 1. Circumscribe with a sharp, pointed scalpel the opening of the fistula on the surface, together with a small margin of skin surrounding it, and dissect it out.
Step 2. Introduce a probe through the cutaneous orifice along the entire extent of the fistulous tract.
Step 3. Ligate the freed orifice of the fistula snugly around the probe.
Step 4. Dissect out the entire fistulous tract, with the tissues immediately surrounding it, from the contiguous structures, until the kidney is reached.
Step 5. Clear the surface of the kidney around the point where the fistula enters it.
Step 6. Resect a margin of kidney tissue about the entrance of the fistula and excise the fistula with it.
Step 7. Close the opening in the kidney with interrupted catgut sutures.
Step 8. Close the structures about the kidney.

SURGICAL TREATMENT OF INJURIES TO THE KIDNEY

Treatment on Surgical Diagnosis

Where the diagnosis of injury of the kidney has been made by means of a laparotomy and it is found that conservative surgical measures would prove inadequate, do a nephrectomy.

Step 1. Convert the straight abdominal celiotomy incision into a Rutherford Morison incision by adding a horizontal incision to the vertical one.
Step 2. Pack away the small bowels toward the median line.
Step 3. Incise the outer leaf of the mesocolon on the respective side.
Step 4. Remove bloodclots. Secure the pedicle of the kidney and remove the latter as outlined above in discussing transperitoneal nephrectomy (p. 1887).

Treatment on Clinical Diagnosis

When diagnosis of injury to the kidney has been made from symptoms and signs and the lumbar approach has been decided upon:

Determine that there is another kidney present (one case of congenital absence of a kidney is found in every 1,500 individuals) by: palpation under anesthesia, intravenous urogram, or transperitoneal exploration with immediate closure of the peritoneum.

Make every possible effort to save the kidney.

Conservative Measures

1. Tamponade—considered best by Küster.
2. Partial nephrectomy (Tuffier).
3. Suture of the rent in the kidney.

HAMILTON BAILEY'S TECHNIC

Step 1. Pass a deep mattress suture carried on a substantial round semicurved needle, the blunt end of which penetrates the kidney substance first. Leave the ends of the sutures long; they are temporarily held in hemostats.
Step 2. Introduce deep interrupted sutures of catgut near the margins of the laceration.

Step 3. Include a segment of muscle from the erector spinae as shown in Fig. 2016. Place it into the rent between the sutures already placed and tie the interrupted sutures over the muscle segment; lastly tie the mattress sutures.

Comment: Hamilton Bailey points out that the advantages offered by this procedure are: the sutures do not cut through; the muscle thrombokinase favors clotting; the rent is plugged with "nature's own material."

Nephrectomy is done when (a) the pedicle of the kidney is torn; (b) in multiple lacerations of the kidney substance; (c) when it is impossible to suture the rent in the kidney and (d) in avulsion of the ureter, or when an extensive rent in the kidney cannot be repaired.

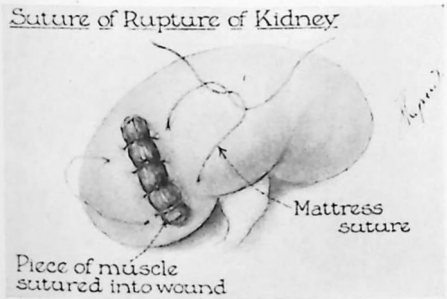


Fig. 2016. Method of suture of rupture of the kidney.

THE PELVIS OF THE KIDNEY AND THE URETER

SURGICAL EXPOSURE OF THE URETERS

The ureters may be exposed either through a retro- or transperitoneal approach. The former is the procedure of choice; the latter is used mainly in operations on the pelvic portion of the ureter.

Retro- (Extra) Peritoneal Route

This method permits the exploration of the ureter throughout its entire length.

MORRIS' LUMBOINGUINAL ROUTE

Exploration of the Lumbar Portion of the Ureter. Place the patient on his healthy side. Beginning at the outer border of the lumbospinal mass of muscles, a little below the twelfth rib, an incision is made and carried obliquely downward and forward to a point one inch internal to the anterior superior spine of the ilium. Continue this incision parallel to and one inch above Poupart's ligament as far as its center (Fig. 1995, p. 1864). Divide the tissues down to but not into the peritoneum. Expose the kidney and its pelvis; slight traction

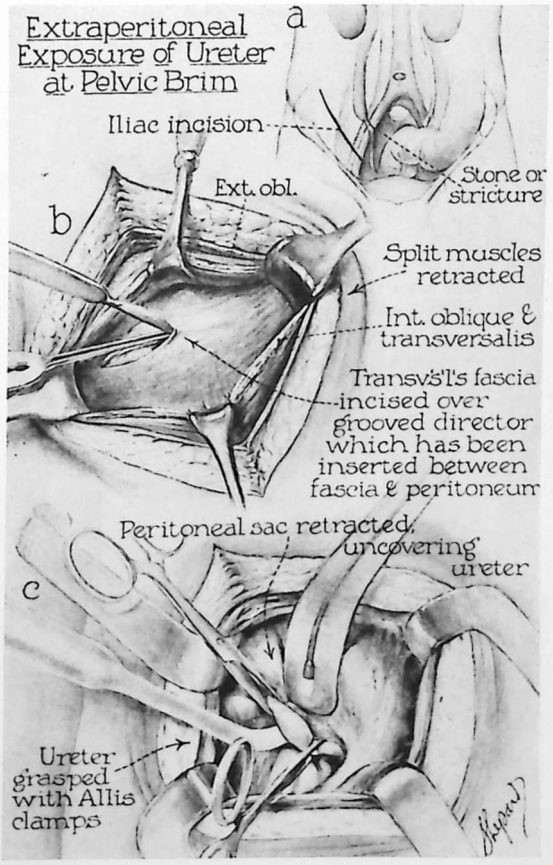


Fig. 2017. Extraperitoneal exposure of ureter at pelvic brim. a. Iliac approach. b. Division of muscles and transversalis fascia. c. Unopened peritoneum retracted, ureter isolated.

on the latter will bring the upper portion of the ureter forward. By gauze dissection strip the peritoneum from the parietes until the ureter comes to view. It must be kept in mind that the peritoneum adheres to the ureter; it must be separated.

Exploration of the Pelvic Portion of the Ureter. If the pelvic portion of the ureter is to be explored, the patient is placed on his back. The wound is enlarged forward if necessary "even as far as the external abdominal ring" (Morris). Care is to be exercised at all times not to enter the peritoneum; if inadvertently opened, it should be repaired at once. An iliac, transrectus or pararectus straight incision (Fig. 2017 a) without opening the peritoneum will accomplish the same end. I do not like the "muscle-splitting" incision under these circumstances. If the kidney cannot be used as a guide to the ureter, this should be looked for at the pelvic brim. The guide here is the place where the ureter crosses the common iliac artery. The ureter should be stripped off the peritoneum; in the male, it may be traced, in this manner, to the bladder; in the female, the procedure is rendered difficult because the ureter courses in the broad ligament, the uterine artery lying in front and the uterine veins posterior to that structure. Median abdominal incisions may also be used for retroperitoneal exposure of the lower fourth of the ureter. The incision commences just below the umbilicus in the median line and extends to the pubes. The peritoneum is not opened; the bladder is recognized, pulled up into the wound and the ureters sought as they enter the bladder. A Pfannenstiel incision or its modification may accomplish the same end.

Transperitoneal Route

The ureter may be exposed through a median or a lateral transperitoneal incision. It is under many conditions the preferred incision because it permits the exploration of the opposite kidney, etc.

PLASTIC OPERATIONS ON THE KIDNEY PELVIS

If, after finishing a pyelotomy or pyelolithotomy operation (p. 1878) it is found that the opening in the pelvis of the kidney cannot effectively be closed by the usual method, Payr's operation is of value.

Payr's Operation

This consists of dissecting and turning back a small flap of fibrous capsule from the posterior surface of the kidney, followed by its approximation over the line of the suture in the pelvis of the kidney by catgut sutures (Fig. 2018).

PYELOSTOMY

As in nephrostomy, used for draining the kidney, the object may be accomplished by draining through the pelvis of the kidney. It is indicated when more radical procedures are out of the question for the time being (pyonephrosis, hydronephrosis, etc.). The operation consists of exposing the pelvis of the kidney and splitting it. A drainage tube is introduced and the pelvis of the kidney sewn around it as in cholecystostomy. Drain the lower calyx.

Operative procedures are indicated in small hydronephrotic sacs under certain conditions, such as intermittent hydronephrosis or in strictures or occlusions of the first part of the ureter.

The following operations sometimes come under consideration:

Nephropexy

The technic for this procedure has already been described (see p. 1866), the object being to avoid kinking of the ureter thus avoiding reaccumulation of urine.

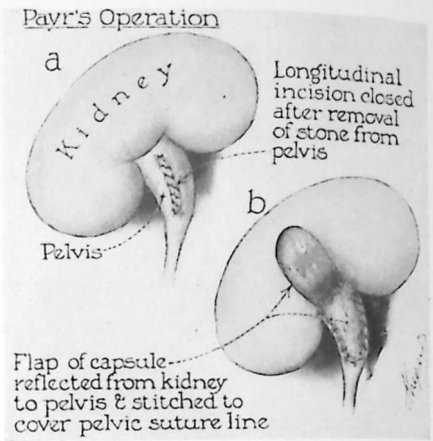


FIG. 2018. Payr's operation for plastic repair of pelvis of the kidney. Above (a) repair of pelvis under favorable conditions.

Nephrostomy and Pyelostomy

These also are occasionally considered. They are used either as independent procedures or in conjunction with plastic operations to secure the uninterrupted healing of the latter.

TRENDELENBURG'S OPERATION

This is used when there is a spur at the junction of the ureter with the pelvis of the kidney, causing difficulties. Trendelenburg first performed this operation in 1886. It consists of incising of the hydronephrotic sac and exposing the spur through the transpelvic incision. The ureter is incised thus obtaining a V-shaped defect, the apex of which forms the new opening into the ureter after suturing the mucosa of the ureter and pelvis of the kidney with catgut sutures.

STRICTURE OF THE URETER

Christian Fenger's Operation

This operation is useful in strictures of the upper portion of the ureter. It was later used with success by Minter, Israel, Bardenheuer and others. The

operation is based on the Heinecke-Mikulicz principle of pyloroplasty, e.g., a longitudinal incision is made through the strictured area embracing the affected portion of the pelvis of the kidney and ureter, and the defect is sutured transversely.

PYELO-URETEROTRESIS

Morris' Operation

This operation is useful in cases of hydronephrosis in which distention of the renal pelvis has caused a displacement of the ureteral orifice or a valve-like condition at this point, creating an impediment to the outflow of urine from the pelvis of the kidney.

Step 1. Expose the kidney and the upper part of the ureter in a manner already described.

Step 2. Clear and expose the pelvis and first part of the ureter. Deliver these into the wound.

Step 3. If the pelvis of the kidney is distended with urine, evacuate it with a trocar, entering the pelvis through its posterior surface near its ureteral junction. An incision about half an inch in length is made in the renal pelvis in the direction of the outlet of the pelvis.

Step 4. Introduce a pair of scissors so that one blade of the latter is in the ureter, the other in the pelvis of the kidney. The incision is made in such a manner that the cut in the ureter will approximately correspond to the lowest point of the hydronephrotic sac.

Step 5. The posterior wall of the ureter and that of the hydronephrotic sac are now united by a continuous catgut suture and continued along the anterior wall.

Israel's Operation

This consists in plicating the hydronephrotic sac. A diminution of the sac and straightening of the course of the ureter is aimed at.

Albarran's Operation (Resection Orthopedique Pyelorenale)

This operation consists in resecting the hydronephrotic sac with retention of normal conditions at the ureteropelvic opening and a plastic reconstruction of the renal pelvis.

URETEROPYELONEOSTOMY

Küster's Operation (1891)

This procedure is mainly useful in severe impermeable stricture of the upper ureter.

Step 1. The operation consists of first doing a nephrotomy.

Step 2. Divide the ureter immediately below the stricture.

Step 3. Separate it sufficiently from its surroundings so that it can be brought up to the sac without tension.

Step 4. Split the upper end of the ureter.

Step 5. Make an incision through the posterior wall of the hydronephrotic sac, at its lowest level.

Step 6. Spread the split ureter open and suture it to the vivified internal surface of the anterior wall of the sac. The ureter is thus formed with a funnel-shaped opening into the sac.

URETEROTOMY AND URETEROLITHOTOMY

Ureterotomy indicates incision into the ureter; it is usually done for the removal of a calculus in which event we speak of ureterolithotomy. Either the retro- or the transperitoneal approach may be used in accomplishing this end. In stricture dilatations should be attempted before resorting to surgery.

Ureterotomy for Stricture of the Ureter

Step 1. Locate the stricture by ureteral catheterization; the catheter is permitted to remain in situ (Fig. 2116, p. 2000).

Step 2. Expose the stricture.

Step 3. Make a longitudinal incision into the strictured ureter dividing all its coats.

Step 4. Push the catheter past the strictured point.

Step 5. Place sutures in such a manner as to convert the longitudinal incision into a transverse wound. Leave the catheter in the ureter for a few days. Use additional drains if deemed advisable.

Ureterotomy for Other Conditions

Step 1. Expose the ureter by one of the extraperitoneal methods described. (Figs. 1991-1995.) For efficient work, exposure must be thorough and adequate. During the exposure of the ureter, care must be taken not to injure the peritoneum, the blood vessels or the spermatic cord.

Step 2. Deliver the ureter into the wound on a tape akin to delivery of the spermatic cord in hernioplasty.

Step 3. The incision in the ureter should always be longitudinal and made while it rests on the index finger.

Step 4. Explore the length of the ureter upward and downward with probes, bougies and sounds (Fig. 2019); these will detect the presence of calculi, strictures, diverticulae, etc. Wax-tip bougies may be used to advantage.

Step 5. Close the ureterotomy wound with fine chromic catgut carried on a small, curved intestinal needle which is made to penetrate all the coats of the ureter except the mucosa.

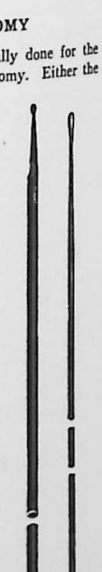


FIG. 2019. a. Ureteral catheter. b. Ureteral bougie.

Comment: The marked tendency of wounds in the ureter to heal is well known; nevertheless it is wise to close the opening as outlined. In strictures of the ureter that have been divided, or if development of a stricture is feared it is well to close the wound in the ureter transversely (Heinecke method) and thus obtain an enlarged lumen. Dilatations of strictures are attempted via the cystoscopic route using special catheters and bougies or by dividing the stricture as is practiced in internal urethrotomy. When the stricture is located above

the bladder an extraperitoneal approach may be resorted to. When caused by adhesions these may be released and a cure effected.

Surgical Management of Calculi in the Lower Ureter

Accurate exposure of calculi in the pelvic portion of the ureter demands a precise knowledge of the regional anatomy.

Anatomic Considerations. The pelvic portion of the ureter is about fifteen centimeters in length and consists of two divisions, a parietal and an intravesical. The former is in close relation to the peritoneum. The ureter crosses the brim of the pelvis a little lateral to the bifurcation of the common iliac artery, and descends between the peritoneum and the internal iliac artery. In the male, just before it enters the bladder, it is crossed lateromesially on its anterior aspect by the vas deferens. The superior vesical artery will also be noted in close relation to the ureter just above this point. In the female, the ureter passes to the posterior peritoneal layer of the broad ligament and enters the parametrium, through which it passes toward the cervix. At the side of the cervix, the ureter is covered by the veins of the vesicouterine plexus. It is crossed anteriorly by the uterine artery, and then inclines anteriorly, mesially, and downward to reach the wall of the bladder.

In its intra-vesical course, the ureter traverses the bladder wall obliquely from without inward for about three-fourths of an inch, to end in the ureteral orifice.

Blood Supply. The blood supply of the pelvic portion of the ureter is obtained in the male from branches of the superior vesical and internal iliac arteries, and in the female from the uterine and inferior vesical arteries. The arteries and veins form a network enclosing the ureter.

Nerve Supply. The ureter receives its innervation chiefly from the inferior hypogastric and vesical plexuses and the upper sacral ganglia. Fibers from all these sources anastomose freely.

Peritoneal Relationships. At this level in the pelvic area, the ureter will be found definitely adherent to the peritoneum.

Anesthesia. Spinal anesthesia, regional field block, or ethylene-gas inhalation may be used, spinal anesthesia being preferred because of the relaxation afforded.

Preliminary cystoscopy is performed and a ureteral catheter or bougie is inserted up the ureter on the affected side. This acts as a helpful guide in subsequent exposure of the ureter.

Position of the Patient. The patient is placed in a moderate Trendelenburg position after the cystoscopy is completed.

ILIAC INCISION (MUSCLE-SPLITTING INCISION)

Step 1. This approach is utilized in attacking calculi located slightly above the brim of the pelvis, and is the one preferred by Lower. The incision should be carried out as a muscle-splitting procedure. (Fig. 2020 a.) The skin is incised parallel to Poupart's ligament, beginning just above and medial to the anterior superior iliac spine and terminating at the lateral border of the rectus muscle. The external oblique aponeurosis is divided in the direction of its fibers, and the internal oblique and transversus muscles are similarly separated. The transversalis fascia is then incised over a grooved director inserted between it and the peritoneum. The wound is widely exposed by means of self-retaining retractors.

Step 2. The peritoneum is freed carefully from the lateral wall of the abdomen and the iliac fossa, by peeling it gently toward the midline. The ureter

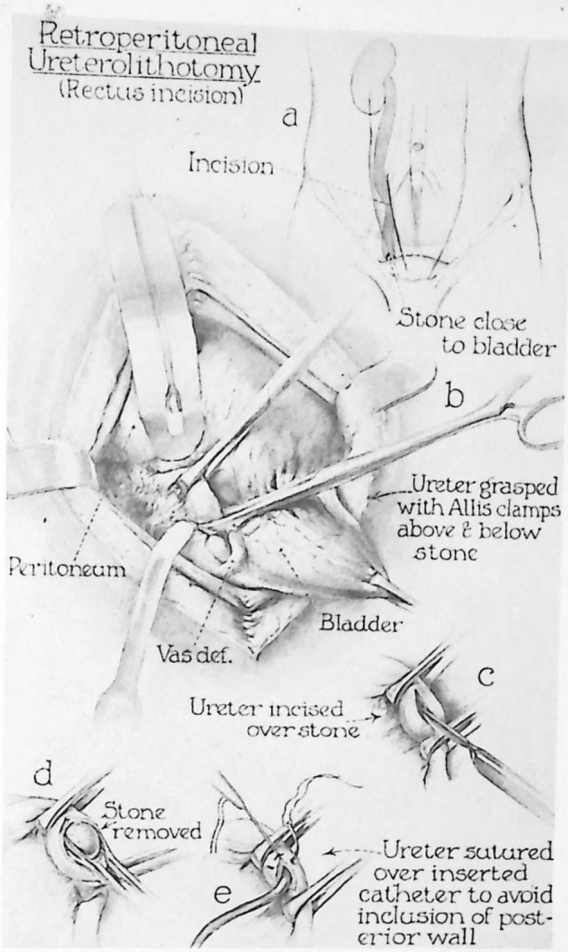


Fig. 2020. Retroperitoneal ureterolithotomy. a. Rectus incision. b. Engagement of calculus between two Allis clamps. c. Ureteral incision. d. Removal of calculus. e. Closure of incision in ureter. (Courtesy, Dr. A. G. Fleischman.)

must not be sought on the floor of the pelvis; it is always adherent to the posterior peritoneum, and can invariably be located by palpation just above the bifurcation of the iliac vessels.

Step 3. Exposure of the ureter can be facilitated by the introduction of the Cameron lighted retractors into the depths of the wound.

Step 4. The ureter is liberated from the peritoneum for the shortest distance compatible with good exposure, in order to conserve its blood supply. The calculus is located by palpation, and immobilized by the application of Allis clamps to the ureter above and below the stone (Fig. 2020 b).

Step 5. The ureter is incised longitudinally, preferably slightly above the site of the calculus rather than exactly over it. The stone can then be extracted by means of specially designed ureteral forceps, scoops, or Lower's resilient, flexible curet (Fig. 2020 c, d).

Step 6. Following removal of the stone, the ureter should be explored by bougies to determine its patency down to its termination in the bladder. Whenever feasible, the ureteral incision should be sutured with very fine chromic catgut. Suture should be carried out over a ureteral catheter, to avoid inclusion of the posterior wall of the ureter in the stitch (Fig. 2020 e).

Step 7. Drainage should always be instituted, preferably with non-rigid material such as Penrose tubing placed parallel to the iliac vessels to avoid pressure on these important structures. The abdominal wall is closed in layers, interrupted sutures being used throughout, and the drain brought out at the lower angle of the wound.

PARARECTUS INCISION

This is the approach advocated by Beer. The skin incision is placed just mesial to the linea semilunaris, and is ordinarily made about ten centimeters in length. It is carried through the lateral aspect of the rectus sheath, the rectus muscle being retracted mesially. Like the iliac incision, this is also an extraperitoneal approach, the peritoneum being pushed medially to expose the ureter.

This route is utilized for stones below the brim of the pelvis and in the juxtavesical portion of the ureter. The deep epigastric vessels are exposed by this incision, and must either be ligated or pushed aside. Caution must be exercised in the male to avoid injury to the vas deferens as it crosses the ureter. In the female, the uterine artery must be pushed off the ureter or doubly ligated and divided to avoid troublesome hemorrhage.

Once the ureter is exposed, the subsequent steps of the operation are similar to those outlined under the discussion of the iliac approach.

MEDIAN SUPRA-PUBIC INCISION

Judd's Approach. This is suitable for stones in the ureter just above the bladder, or for calculi situated in the intramural portion of the ureter. The incision is comparatively bloodless; it enables the operator to open the ureter close to its junction with the bladder, and it permits exposure of both ureters through one wound. Its chief disadvantage is that detection of the ureter is somewhat more difficult than through the other approaches.

Step 1. The skin incision begins just below the umbilicus in the midline and is carried to a point just above the symphysis pubis. The rectus muscles

are separated along the linea alba, and the prevesical pad of fat and the peritoneum are carefully stripped away from the lateral walls of the pelvis and the bladder on the side where the stone is situated.

Step 2. The bladder is grasped by small Allis forceps and pulled to the side opposite the location of the calculus. The ureter is carefully liberated for a short distance, and the calculus immobilized and removed by the method previously described.

Step 3. Stones situated in the intramural portion of the ureter necessitate cystotomy. The bladder is incised, and self-retaining retractors are inserted together with illuminated retractors to expose the upper and lower limits of the bladder wound. Incision over the stone is made with the electrosurgical scalpel, and the stone is removed (Fig. 2021). The margins of the incision are then gently coagulated with a fine pointed bulbous electrode to control hemorrhage, which frequently occurs from the small circular artery in this area as recommended by A. G. Fleischman.

COMPLICATIONS

Injury to the Peritoneum. If the peritoneum is inadvertently torn, the rent should be accurately closed with a continuous suture of fine catgut.

Hemorrhage. Most hemorrhages can be controlled by digital compression and by careful ligation of the uterine artery and of the deep epigastric artery, when these vessels cannot be safely pushed out of the operative field. If hemorrhage occurs, its control can be greatly facilitated by employment of illuminated retractors to expose the bleeding site.

Infection. In the prophylaxis of infection, three factors are of importance: limited mobilization of the ureter, in order to conserve its blood supply; suturing of the ureteral incision, whenever feasible; and institution of drainage according to the principles outlined above. If infection does ensue, the incision must be kept open and drainage instituted for a prolonged period. Insertion of an indwelling ureteral catheter, by diverting the urinary flow, in many cases hastens control of the infection.

Ureteral Fistulas. These are usually due to a stricture of the ureter or accidental inclusion of the posterior wall during closure of the ureteral incision. Fistulas of brief duration can usually be treated successfully by insertion of a ureteral catheter from below, which is kept in place four to ten days. Occasionally the ureter must be resected proximal to the stricture and reimplanted into the base of the bladder. If the above procedures fail, temporary nephrostomy or nephrectomy may be necessary.

POSTOPERATIVE CARE

Prompt stimulation of renal function is essential. Administration of fluids orally and parenterally is carried out routinely, especially with 5 per cent glucose in physiological saline solution intravenously. The latter procedure is of great value in the presence of impending anuria.

Control of pain is achieved by small doses of narcotics, pantopon and dilaudid being preferable to morphine because of lessened nausea.

Postoperative abdominal distention is a common complication. It is combated by insertion of a small rectal tube, administration of 1 cc. of pitressin

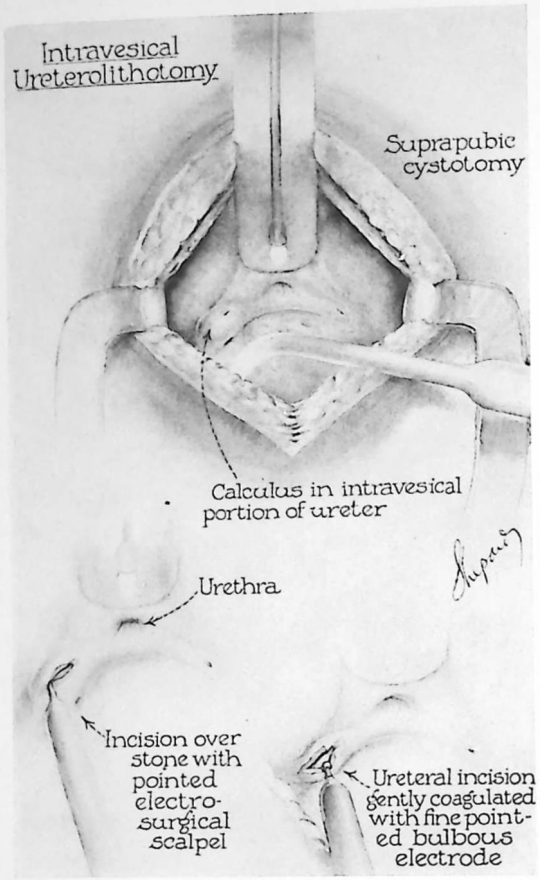


FIG. 2021. Intravesical ureterolithotomy by the median suprapubic approach. (Above.) Illuminated retractors aid in identifying position of ureteral calculus. (Right.) Ureter incised with electrosurgical scalpel. (Left.) Margins of ureteral incision gently coagulated. (Courtesy, Dr. A. G. Fleischman.)

hypodermically at eight-hour intervals, and application of hot abdominal stupes, frequently changed.

The skin sutures are removed on the eighth and the tension sutures on the fourteenth day in the usual case. The patient is allowed out of bed on the eighth to the tenth day.

Comment: That not all renal calculi demand surgical removal is pointed out by Bransford Lewis.[1]

URETERAL ANASTOMOSIS

(See Chapter on Gynecology, p. 1818.)

URETEROSTOMY OR DERMATO-URETEROTRESIS

In cases of malignancies of the urinary bladder, in exstrophy of the bladder, in tuberculosis of certain parts of the urinary apparatus, in impending death from anuria and in loss of substance of the ureter, transplantation of the ureter onto the loin becomes necessary; an appropriate vessel collects the urine on the loin. Le Dentu was first to employ this method. The operation consists of exposing the ureter extraperitoneally where the ureter crosses the iliac vessels, ligating it doubly and dividing it. The lower ligature is cut short, the upper is left long. An appropriate opening into the parietes through which the ureter is delivered, is made. The end of the ureter now lying on the surface of the skin is split open longitudinally for about half an inch and the flaps are folded over the skin to which they are sutured.

ENTERO-URETERAL ANASTOMOSIS

The following methods are at the disposal of the surgeon, depending upon the degree of injury to the ureter: (a) nephrectomy; (b) dermato-ureterotresis; (c) transuretero-ureteral anastomosis; (d) uretero-ureteral anastomosis (see p. 1818); (e) ureterovesical anastomosis.

Comment: P. Brooke Bland[2] emphasized the important points for identification of the ureter which are:

1. (Kelly's Test). The vermicular or peristaltic test, excited by gently stroking the tube. This, when observed, is regarded as pathognomonic.
2. The absence of bleeding when the ureter is incised. This, of course, one would not deliberately do to identify the duct, but is obvious when done accidentally.
3. The consistency and thickness of the ureter; it is thicker and harder than a vein, thicker but softer than an artery.
4. The absence of pulsation.
5. The yellowish-white hue of the ureter.
6. The changing contour of the tube, flat and ribbon-like while at rest, tubular or cylindrical when in action.
7. The relation of the tube to certain anatomical landmarks.
8. At the pelvic brim it dips into the pelvis in traversing, from without inward, the iliac vessels.
9. The abrupt upward curve assumed as the ureter approaches the side of the cervix.

[1] Jour. A.M.A., Oct. 3, 1925.
[2] Atlantic Medical Journal, 1923.

10. The inward curve assumed as it approaches the bladder wall.
11. The horizontal course of the uterine vessels in front of the ureter as they approach the side of the cervix.
12. The constant tendency of the tube to adhere to the sacral, inner or posterior leaflet of the peritoneum. (This tendency is never displayed by blood vessels.)
13. Identification, as already mentioned, by inserting indwelling catheters immediately before starting operation.
14. Finally, differentiation between the ureter and the remains of the hypogastric artery must be kept in mind. The artery, followed backward, leads into the anterior division of the internal iliac artery. The ureter, on the other hand, travels over the pelvic brim and the iliac vessels into the renal fossa.

Correct identification and isolation of the ureter should eliminate injury or occlusion of the ureter.

In a later publication P. Brooke Bland[1] states that:

While hysterectomy, either abdominal or vaginal—but more commonly the former—is largely responsible for ureteral injury, there are a great many other surgical procedures on which responsibility may be placed. A tabulation of operations—twenty-four in all—in which the accident has occurred, is given below. In order of frequency they may be summarized as follows:

1. Radical abdominal hysterectomy (Wertheim's method for cervical carcinoma).
2. Radical vaginal hysterectomy (Schauta's method for cervical carcinoma).
3. Combined vaginal and abdominal hysterectomy for cervical carcinoma.
4. Vaginal hysterectomy (clamp method for uterine conditions other than carcinoma).
5. Total abdominal hysterectomy for uterine myomata, especially if adherent and associated with intraligamentous growths.
6. Operations for the removal of intraligamentary cysts.
7. Subtotal hysterectomy (supravaginal) for myomata, especially if adherent or complicated by intraligamentary neoplasms.
8. Hysterosalpingo-oöphorectomy for extensive pelvic inflammatory disease.
9. Herniotomy, especially if complicated by congenital or acquired malposition of the bladder and ureter (Corliss in 1904, reported eleven such cases, six inguinal and five femoral). (Herman).
10. Operations for the removal of vesical neoplasms.
11. Surgical correction of vesicovaginal fistulae.
12. Operations upon or in the region of the kidney itself.
13. Porro operation.
14. Operations upon or about the appendix and cecum.
15. Operations upon or about the sigmoid and rectum.
16. Operations for removal of retroperitoneal pelvic tumors.

[1] Med. J. and Rec. Opr., 1925.

17. Extensive plastic operations upon the anterior vaginal wall, especially for uterine prolapse.
18. Perforation of the ureteral wall in passing the ureteral catheter (Noble).
19. Operations upon a horseshoe kidney or where double ureters exist.
20. Trauma of the ureteral wall from undue manipulation or from damaging the blood supply, followed by necrosis in various pelvic operations.
21. Kraske's operation for rectal carcinoma.
22. Percy's method of treating uterine carcinoma.
23. Ureteral injury sustained from the application of radium. (Baldwin's case).
24. Instrumental labor. (P. Brooke Bland.)

Transplantation of the Ureters Into the Large Intestine

Historical Notes. Cyril A. R. Nitch surveyed this important field of surgical endeavor admirably.[1] The earliest attempts to divert the flow of urine from its natural receptacle were made in the endeavor to relieve the distressing symptoms associated with extroversion of the bladder. The first recorded operation for this purpose was performed in 1851 by Sir John Simon of St. Thomas' Hospital. He established a fistula between the ureter and the rectum by means of a tight ligature passed through their adjacent walls with an ingenious instrument he devised for the purpose. Subsequently, he ligated the lower end of each ureter. The operation was not entirely successful, for though some urine passed by the bowel, the ureteric orifices were not completely obliterated. The patient, a boy 13, died a year later and at the postmortem "the ureters were blocked with calculi and both kidneys were seriously diseased." It is interesting to note that Coffey's latest technic (and the one which has been more successful in dogs than any other) is similar in principle to the operation devised by Simon over eighty years ago.

The next attempt was made twenty-seven years later by Sir Thomas Smith of St. Bartholomew's Hospital in 1878. He actually transplanted each ureter into the back of the ascending and descending colon, so to him belongs the credit for the first operation of this nature. Although it failed, it deserves full recognition as the work of a pioneer and a brilliant surgeon. He operated on the left side first, but the ureter came away from the bowel and, unknown to him, its lumen was obliterated by scar tissue and the kidney atrophied. The patient recovered and, being in good health, fourteen months later the transplant was done on the right side, but unfortunately, the ureter was so compressed by the sutures that death from suppression of urine took place on the third day.

After an interval of thirteen years in which not a single case was recorded, though some may have been attempted, surgeons suddenly awoke to the possibilities of the operation for between 1891 and 1897 a number of cases were reported in which the operation was performed for growths, tuberculosis and fistula of the bladder as well as for extroversion. The dangers of leakage, stenosis and renal infection were fully realized and many methods of overcoming them were devised. Trendelenburg (1895) preserved a button of vesical mucosa; Boari used a metal button; Tuffier (1896) used ureteral catheters, and Rein (1894) and Chalot (1896) tied tubes of glass and of nickel into the ends of the ureters, but those cases which did not die of shock or peritonitis succumbed sooner or later to pyelonephritis.

In this period the transplantation was effected by the direct method with little or no attempt at valve formation until 1896, when Krynski and later Martin, 1899, placed the ureters between the walls of the bowel in imitation of their vesical course, while Fowler, in 1898, made a valve with a flap of rectal mucous membrane.

Though many surgeons reported cases operated on by one or other of these

[1] Proceedings of the Royal Society of Medicine, July, 1932.

methods, the immediate mortality was still very high and most of the survivors died of renal infection within two and a half years.

The only operation with almost negligible mortality and prolonged survival was the extraperitoneal rectal transplantation of the ureters by Peters, in July of the same year. Two patients were alive and well seven and four years later and several cases operated on by other surgeons were successful. But of course this operation could be employed in pathologic lesions of the bladder only.

In 1907 Sir Harold Stiles introduced his semioblique method which was attended with remarkable success, for five of his cases (traced by G. Grey Turner) were alive and well six, nine, fifteen, sixteen and twenty years after operation.

Subsequently G. Grey Turner (in 1929) reported seventeen cases operated on by the same method between 1912 and 1927 with four deaths,[1] the survivors being quite well from one and a half to fifteen years after operation. These figures given by two surgeons whose reports can be relied on, make Nitch wonder if the more complicated oblique transplantation is necessary, but on the whole he thinks that it is worth persevering with, for the ureter is less liable to be compressed and the valvular action diminishes the danger of ascending infection. Moreover, one must remember that most of Stiles' and G. Grey Turner's operations were performed in two stages and all were for either extroversion or epispadias, so that in most of their cases the ureters and kidneys would be more or less healthy.

Finally, in 1925, Coffey performed his first oblique bilateral transplantation with tubes, in man, and since then has so improved his technic that in his latest publication he was able to record thirty-five cases, both simple and malignant, with a mortality from all causes of 20 per cent and a mortality directly attributable to the operation of only 14 per cent.

Nitch stresses that the mortality was 60 per cent for unilateral and 87 per cent for bilateral transplants (Steinke) and most of the survivors developed some form of renal infection.

Peterson has not been able to trace a single case in which the kidneys were found to be normal beyond dispute; postmortems on all animals surviving showed unmistakable evidence of either stenosis of the ureteral orifice, hydroureter, hydronephrosis or pyelonephritis.

The chief causes of the high operative mortality in dogs are the technical difficulties of the operation, the small ureter and the rigid thick-walled rectum peculiar to this animal, while in the successful cases the renal infections can be ascribed to the mode of implantation, for in the majority the ureters were transplanted by the "direct" as opposed to the "oblique" method.

Coffey, in 1909, made a notable advance with his oblique submucous method. Signs of renal infection ensued. However, further experimental work on similar lines by Coffey and others has been disappointing.

In 1930, Walker-Taylor conceived the idea of tunneling instead of dividing the wall of the bowel and by means of his latest aseptic-irreversible-tunnel technic has succeeded in eliminating peritonitis and reducing postoperative renal infection.

Animals operated on by Coffey's latest technic, oblique transplantation with delayed fistula formation by transfixion suture, in his words "show incomparably better results than have been exhibited by any other method." More than a dozen specimens obtained by him up to six months after operation all showed normal kidneys. If this operation yields as good results in a larger series of animals and after a long period, and if it is not followed by stenosis of the ureteric orifice, it will undoubtedly be the operation of choice in suitable cases in man.

Two operations have now been standardized, each giving satisfactory results. They are the **semi-oblique method of Stiles**, with the catgut urine guide of Charles Mayo, and the **oblique interlamellar method of Coffey**, with tubes or catheters. Coffey's method imitates as closely as possible both the vesical course of the ureter and the valvular action which prevents the irregular high pressure in the muscular bowel being transmitted to the kidney, in which the pressure is low and regular. But in

[1] British Jour. Surg. XVII, pp. 114 et seq.

spite of this, one cannot overlook the fact that the results of the Stiles' operation, in which there is no attempt to make a perfect valve, are remarkably good.

The third method of **oblique transplantation with delayed fistula formation** (Figs. 2022-2023) devised by Coffey is now on trial and promises to give even better results.

STILES' OPERATION

Step 1. Divide the ureter as low as possible. Preserve its blood supply.

Step 2. Cut the end of the ureter obliquely.

Step 3. Pass a catgut suture through its point and tie it; the short end of the suture is threaded up the ureter (Mayo's urine guide) and the other is armed with a needle.

Step 4. Make a small transverse incision in one of the longitudinal bands in the lower end of the pelvic colon and puncture the mucosa. The needle carrying the suture on the ureter is passed into the lumen of the bowel through this opening and brought out half an inch lower down.

FIG. 2022

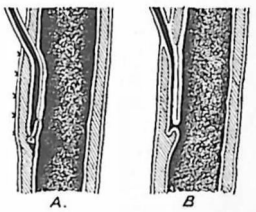


FIG. 2023

FIG. 2022. Coffey's transfixion suture technic of ureteral transplantation. Needle transfixes ureter and intestinal mucosa and carries a doubled ligature of fine thread which is tied firmly and eventually cuts through both coats, leaving a uretero-intestinal fistula.

FIG. 2023. Longitudinal section. A. Ligature tied and ureter embedded. B. Fistula formed after ligature has cut out. (After Coffey: Brit. Jour. Urol., 3:419.)

Step 5. Draw the ureter into the bowel and keep it in position by tying the suture.

Step 6. Bury it finally in the wall of the intestine for a distance of one and a half inches by two rows of Lembert's sutures in the manner of a Witzel gastrostomy.

The opposite ureter is transplanted at a higher level two or three weeks later.

COFFEY'S OPERATION (WITH TUBES OR CATHETERS)

This procedure is indicated when vesical anastomosis is for some reason or other impossible as in

1. Cystectomy.
2. Ectopia vesicae.
3. To remedy ureteral fistula.
4. When the ureter is divided so high that it cannot be pulled down to the bladder without undue tension.

The operation consists of uniting the proximal end of the ureters to the large intestine, preferably the sigmoid flexure or rectum, although the cecum and colon may be utilized. The transperitoneal route is chosen. The principles of the operation are to allow the ureters to open obliquely upon the mucous membrane of the bowel in a valvelike manner, to minimize as far as possible the danger of infection. Much commendable work in this phase of surgical research has been done by Chaput, Bové, Krynski, Martin, Van Hook, Coffey, C. H. Mayo, Hendricks, and others.

Step 1. Insert a sigmoidoscope, clamp the pelvic colon and irrigate the bowel thoroughly, first with water and finally with mercurochrome.

Step 2. Pass a transfusion needle through the wall of the bowel just below the clamp.

Step 3. Pack the rectum with gauze and withdraw the sigmoidoscope.

Step 4. Divide the ureters close to the back of the bladder and free them as required, usually to about the common iliac artery on each side.

Step 5. Either No. 1 rubber tubing or No. 12 whistle-tip catheters are then passed up the ureters for about 15 cm. and held in position by firm catgut ligatures. Divide the muscular coat of the lowest part of the sigmoid, regarded as the site of election, diagonally for one and a half inches from the edge of the mesentery toward the midline on each side at different levels, being lower on the left; and separate it freely from the mucosa to make a good bed for the ureter.

Step 6. Puncture the mucous membrane at the lowest part of each incision.

Step 7. Pull out a small knuckle of the gauze packing and the corresponding catheter or tube attached to it.

Step 8. Withdraw the gauze from the anus which pulls with it the attached catheters until the ends of the ureters lie just within the bowel.

Step 9. Bury the ureters by one or two layers of Lembert sutures, some of which catch up their wall.

Step 10. Suture the pelvic peritoneum in such a way as to cover the ureters completely and fix the intestine.

NITCH'S MODIFICATION OF COFFEY'S OPERATION

Preparation. Nitch does not irrigate the bowel when the abdomen is opened but relies on a good purge, an enema overnight, another on the morning of the operation and a thorough wash-out two hours before the patient comes to the operating room. Coffey may consider irrigation one of the secrets of his success, but Nitch doubts if it is really of any practical value. If it be required it can be done more rapidly and more effectively with a long rectal tube passed up the sigmoidoscope.

The site of the transplant (i.e., the "site of election") cannot be predetermined, for it is, or should be, controlled by the blood supply of the ureter. The arteries which supply the pelvic portion of the ureter arise from the superior vesical and the middle hemorrhoidal and are very variable in size, length and position, even differing on the two sides in the same individual. The spermatic artery does not seem to give off any ureteric branches below the brim of the pelvis. Mr. A. L. P. Jeffery, Demonstrator of Anatomy at St. Thomas's Hospi-

tal, ascertained this for Nitch by injecting several spermatic and internal iliac arteries showing the variation on opposite sides of the same body.

"When the ureteric arteries arise near the brim of the pelvis they can be preserved without difficulty and the transplant can be made into the termination of the pelvic colon, but when they join the ureter near the base of the bladder it may only be possible to save them by a very low and difficult transplant or, as usually happens, they have to be divided. The vitality of the implanted portion of the ureter will then be seriously jeopardized and will depend solely upon the extent of the anastomosis with the spermatic branches. This applies particularly to the right ureter, for being further from the bowel than the left, it has to be swung further inward to make contact, and consequently vessels reaching it low down are always divided. The blood supply of the left ureter is generally safe, for besides being closer to the bowel it is also closer to the middle hemorrhoidal artery."

Nitch is convinced that sloughing of the implanted portion of the ureter, a not infrequent cause of postoperative death, is due more often to avascularity than to infection, for it occurred on the right or difficult side in three of his four fatal cases which were due to this cause. In two of these the vessels were so short that they had to be divided, and in the third, when preparing the field for transplantation of the left ureter a fortnight after transplantation of the right, the blood supply of the latter was damaged while separating some firm adhesions over the anastomosis. Death took place twenty-four hours later, and at the postmortem the recent left junction was sound but the terminal one and one-half inches of the right ureter had sloughed completely. Nitch therefore came to the conclusion that if the blood supply of the lower end of the right ureter cannot be preserved, about an inch of it should be excised, the pelvic colon pulled well over to the right, and the junction made at a higher level than usual. Nitch further states:

"Mr. Jeffery has suggested that anaemic necrosis may also be caused by spasm of the muscular wall of the intestine and has pointed out that in benign proctitis there is no spasm, but in the true ulcerative form where the muscular wall is invaded, the spasm is so pronounced as to be diagnostic in sigmoidoscopic and x-ray examinations. He makes the helpful suggestion that the injection into the wall of the bowel of a local anaesthetic having a prolonged antispasmodic effect, such as A.B.A., might overcome this danger."

The Use of Tubes or Catheters in the Ureters. Coffey insists on tubes or catheters in bilateral transplantations to prevent compression of the ureters by edema and extravasated blood. Nitch has given up catheters, as on each of the two occasions he used them they became blocked with phosphates on the fourth and sixth days respectively, and had to be removed with much difficulty by cutting the ligatures with a pair of long scissors through a proctoscope.

For all other cases No. 0 or No. 1 rubber tubing has been used by Nitch and, on the whole, "has been fairly satisfactory, but great care must be taken not to tie the fixation ligatures too tightly or the lumen of the tubes will be obliterated." This happened on one occasion and Nitch had to reopen the abdomen six hours later, incise the rectum below each suture line, hook up the tubes, cut the ligatures and apply others. Urine began to flow immediately and the patient recovered but "it is not an experience" he wishes "to repeat," and now he takes

particular care to see that urine is flowing freely from each tube before it is drawn into the bowel. The method of fixation he now employs is shown in Figs. 2024-2025-2026. Nitch points out:

Fig. 2024

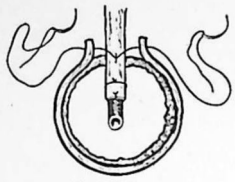


Fig. 2025

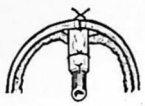


Fig. 2026

Fig. 2024. The ureter has been drawn into the bowel and the stay suture passed through the muscular coat on each side of the incision.

Fig. 2025. Oblique transverse section showing ureter after it has been drawn into the bowel and the stay suture passed through the muscular coat.

Fig. 2026. The stay suture tied. (Nitch.)

"Even rubber tubes cause trouble and anxiety, for they must irritate the ureter, and if they become blocked, syringing and the passage of wires to remove the obstructing phosphates or mucopus must cause some infection. If tubes become obstructed I think the best plan is to remove them at once either by traction or, if this fails, by cutting the ligature through a speculum.

Fig. 2027. Bowel stretched over open end of rectal tube and mucosa punctured. (Nitch.)

"As the catgut urine guide is so satisfactory in Stiles' operation it ought to be equally satisfactory in the Coffey operation and in my experience with tubes it would be infinitely preferable."

Embedding the Ureter. In embedding the ureter by the Coffey method the important points are: (1) complete hemostasis to prevent compression by clot, and (2) care not to cause strangulation by a tight suture at the point where it enters the wall of the bowel.

Drawing the Ureters Into the Bowel. In Nitch's first few cases he followed Coffey's tube technic, in which the ureteric catheter or tube is attached to a tube in the rectum with a suture passed through the opening in the mucous membrane. As this was a weak spot in an otherwise clean operation Nitch, for some years, employed a method which is practically completely aseptic. After the rubber tube is fixed in the ureter, a ureteral catheter is attached to its distal end. A curved leaden rectal tube is then passed by an assistant and guided to the site of anastomosis by the operator's hand within the pelvis. After using it as a support for dividing the muscular layer it is tilted up, and the lowest part of the incised wall of the bowel is so

held as to be stretched tightly over its open end (Fig. 2027). The mucosa is then punctured with a fine knife and the ureteral catheter attached to the ureteral tube passed through the opening into the rectal tube to be caught and withdrawn by the assistant until the end of the ureter is within the bowel (Fig. 2028). The opening in the mucous membrane is made just large enough to take the ureter, so that no suturing is required. The stay suture is then passed through the muscular coat and tied.

Comment (Nitch): "Transplantation of one ureter at a time or simultaneous bilateral transplantation depends on the condition and age of the patient and the condition for which the operation is being performed.

"For malformations in young children, or as a palliative for inoperable carcinoma in aged and debilitated adults, the two-stage operation is probably safest. When the operation is preliminary to total cystectomy simultaneous bilateral transplantation is advisable, for the dangers of 3 operations and the time that must elapse before the cystectomy can be performed, are more to be feared than the slight additional risk of the double operation.

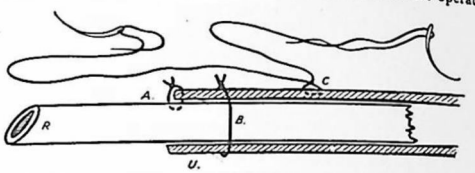


Fig. 2028. Nitch's method of fixing rubber tube in ureter. R. Fine rubber tube. U. Ureter. A. Fine catgut suture attaching divided end of ureter to tube but not entering lumen of tube. B. Circular ligature which must not be tied too tightly. C. Stay suture inserted in long axis of ureter to avoid injury to blood vessels.

"The chief disadvantage of the two-stage operation is the formation of firm and sometimes dangerous adhesions. It was owing to this that I lost what should have been a successful case, for in separating adhesions, the blood supply of a transplanted right ureter which had been functioning perfectly for a fortnight, was so damaged that it sloughed. When a two-stage operation is necessary I advise transplantation of the left ureter first, for the disturbance of the intestines and the injury to the peritoneum are less and subsequent adhesions are generally limited to that side. When the right operation is performed first the pelvic colon has an unpleasant way of falling downward and forward and forming with its mesentery an adherent sheet which must be separated before the pelvirectal junction can be exposed.

"For the delayed fistula operation single transplantation is, of course, essential."

Renal infections combined with dilatation of the ureters and kidneys are the chief causes of the immediate and late mortality. Out of Nitch's seven patients that were traced, four complained of intermittent renal pain and pyrexia. It is his belief, that the majority of survivors develop some form of renal infection, which, though silent and unsuspected for many years, ultimately determines their death.

The causes of death peculiar to the operation are:

1. Operative peritonitis, a complication which should not occur if the aseptic technic Nitch described is employed.

2. Peritonitis from sepsis at the site of transplantation, due to ascending infection or to leakage.

3. Sloughing of the ureter.

4. Various forms of chronic or acute renal infection.

The operation undoubtedly has a high mortality due to both technical and constitutional causes, but as it is intended to relieve physical and mental distress, and in suitable cases of malignant disease, to permit of complete removal of the neoplasm, Nitch considers it is justifiable, no matter how high the mortality, when it brings relief and comfort to the survivors.

G. Grey Turner and James H. Saint,[1] have tabulated the pathologic changes in the kidneys and ureters together with renal functions in six cases of transplantation of the ureters. In five of these cases the renal function was good and in one case impaired on the left side. In two cases the renal function was good and in four cases impaired on the right side.

COFFEY'S OPERATION MODIFIED BY FURNISS

The essentials of this procedure consist in preserving the blood supply of the ureter by retaining its peritoneal attachment when freeing the portion of the ureter to be anastomosed. Furniss, citing Reuben Peterson, stressed the importance of keeping the opening into the intestine, through which the ureter is to be implanted small and of cleansing the bowel after the patient is anesthetized.

Step 1. Spinal anesthesia unless contraindicated.

Step 2. Place a rectal tube in the lower bowel.

Step 3. Make a low midline incision.

Step 4. Close the sigmoid, above the point of anastomosis by gently clamping it with a rubbercovered intestinal clamp.

Step 5. Attach a needle connected to an irrigator filled with saline solution.

Step 6. Irrigate the bowel. Connect the needle to an airpressure apparatus and dry the intestine by blowing air into it; this drives out through the rectal tube any fluid that may have been left after the irrigation. Furniss feels that this is as efficient as Coffey's method of packing with gauze, and is more easily carried out. Only one ureter is to be implanted at a time. It is less of an operation, and should it prove that the particular patient has a tendency to develop an ascending infection shortly after operation, this complication may be better handled than if both ureters are implanted at one time. It matters little which side should be done first. To prevent narrowing of the intestine, the ureters should be placed at different levels, at the right lower.

Step 7. Place the patient in a moderate Trendelenburg position. Pack off the intestines.

Step 8. Locate the right ureter where it crosses the iliac vessels; open the peritoneum on the posterior abdominal wall, just to the outer side of the ureter.

[1] British Jour. Surg. Vol. 23, No. 91, 1936.

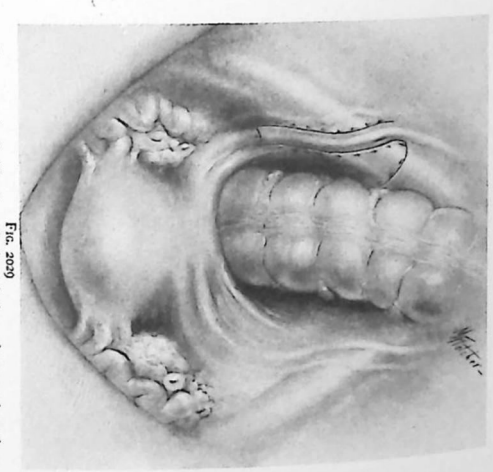


Fig. 2029

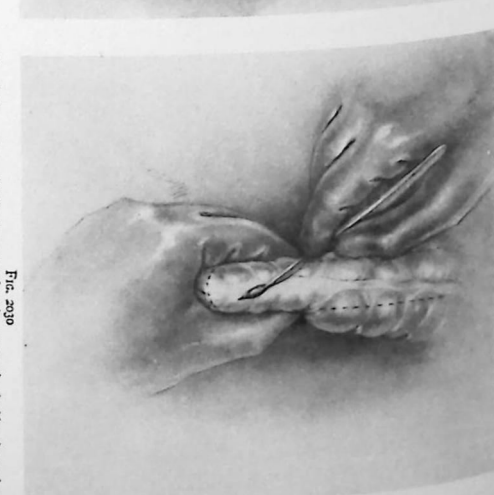


Fig. 2030

Fig. 2029. An incision is made through the peritoneum along the outer side of the ureter. At the lowest point the ureter is doubly clamped and divided. Cephalad end is gently lifted and the peritoneum along its inner side and the cellular tissue posterior to the ureter is carefully dissected free. Retaining the peritoneal attachment and the surrounding tissue insures a better blood supply. The inner incision is prolonged for ureter implantation.

Fig. 2030. The proctoscope is passed by an assistant, under manual guidance of the operator, to a point above the projected ureter implantation. The intestine is made taut over the tube and incised down to the mucosa. The incision should be longer than shown. (Courtesy of Dr. H. D. Furniss.)

Carry the incision parallel to the ureter 3 to 16 inches distant, to the broad ligament (Fig. 2029).

Step 9. Clamp the ureter doubly and divide it between the clamps.

Step 10. Lift the ureter up gently with the upper clamp and incise the peritoneum along its inner side to a level at which the dissection was begun.

Step 11. Shift the ureter over toward the rectum and choose the site of the implantation into the rectum. This should be at a point where the ureter may be implanted without tension.

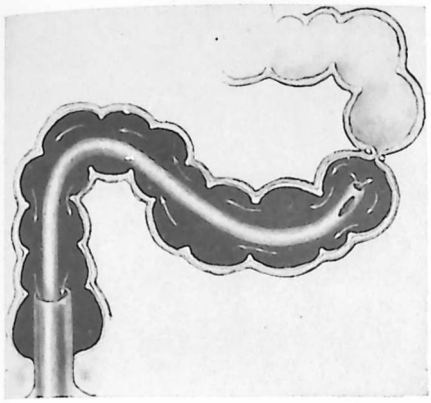


Fig. 2031. The large intestine above the pelvic brim is gently clamped with light intestinal forceps, the jaws of which are covered with rubber tubing. Through a proctoscope inserted above the internal sphincter a rectal tube is passed to just below the occluding clamp. It is necessary that the surgeon guide the tube manually, otherwise it will coil up in the rectum. The intestine is cleansed with saline solution followed by one liter of ½ per cent mercurochrome. The rectal tube is then withdrawn. (Furniss.)

Step 12. Extend the last part of the peritoneal incision to the rectum, so that the ureter may, after the anastomosis, be covered with peritoneum and excluded from the peritoneal cavity. The incision into the rectum should be approximately one and one-half inches long, running from its outer side toward the median line, and extending through the peritoneal and muscular coats to the mucosa (Figs. 2030-2032).

Step 13. Remove the clamp from the ureter and pass a suture of No. 1 ten-day chromic catgut through the entire thickness of its anterior wall and tie it firmly. Pass a spear-pointed trocar into the intestinal lumen. Enlarge the opening into the mucosa to make the subsequent step easier.

Step 14. Thread the suture that has been attached to the ureter into the eye of the needle, and by withdrawing the needle and pulling the suture the ureter is drawn into the intestine. This suture is then transferred to a curved intestinal needle, and by passing this through a portion of the peritoneal and muscular coat of the intestine and tying it, the ureter is firmly anchored to the interior of the rectum (Fig. 2032).

Step 15. Place two infolding sutures over this which will insure against leakage at this point.

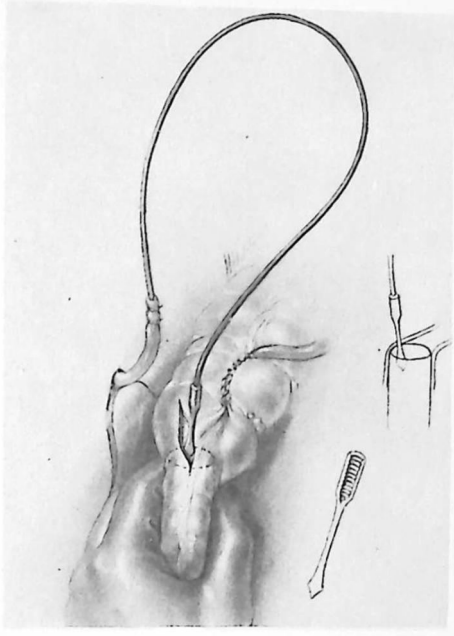


Fig. 2032. A No. 8 ureteral catheter is tied into the ureter; the distal end is screwed into a spear-pointed instrument. The lowest part of the incision is made taut over the end of the proctoscope, and the trocar plunged through it, the catheter and ureter following into the intestinal lumen. The catheter is sufficiently long to pass well beyond the anus by the way of the proctoscope. The proctoscope is withdrawn and the trocar unscrewed. The left ureter is shown transplanted. This illustration does not show the extraperitonealization of the ureter. (See next fig.) (Furniss.)

Step 16. Fold the peritoneal and muscular coats of the rectum over the ureter with a continuous suture of No. 1 ten-day chromic catgut; three of these sutures should include a bit of the peritoneum that was dissected up with the ureter. Care is taken not to include the ureteral wall in any of these sutures (Fig. 2033).

Step 17. Close the primary incision, made to isolate the ureter, and the upper, inward prolongation is closed over the ureter, so that it is excluded from the peritoneal cavity.

Step 18. Close the abdominal wound without drainage.

Comment: Furniss points out that the left ureter is not so closely adherent to the peritoneum, and, therefore, it is somewhat more difficult to retain it than on the right.

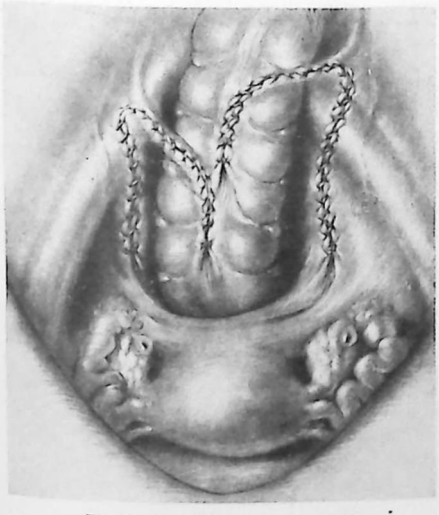


Fig. 2033. Operation completed. (Furniss.)

OPERATIONS ON THE URINARY BLADDER

Anatomic Considerations. The disposition of the peritoneum under natural and artificial conditions of retention and distention is the main surgical consideration (Figs. 2034-2035-2036-2037). The upper part of the base of the bladder is covered by the peritoneum of the rectovesical pouch; the lower part is uncovered by peritoneum and is separated from the rectum in the male, by the seminal vesicles and vasa deferentia and in the female by the cervix uteri and upper part of the vagina. The so-called prevesical space or space of Retzius comprises the area below the peritoneal reflection; it is filled by a loose connective tissue reticulum and adipose tissue and communicates laterally with the general extraperitoneal space. The neck of the bladder comprises the area surrounding the urethral orifice and adjacent to the superior surface of the prostate gland. When the bladder is filled with fifteen to twenty ounces of liquid the line of reflection lies usually about two inches above the symphysis pubis;

an incision in the linea alba below this point will expose the bladder without injury to the peritoneum. The trigonum vesicae comprises a triangular area in the interior of the bladder bounded by the ureteric orifices laterally and the urethral opening in the front. Between the ureteric orifices the mucosa is raised into a slight fold by the inter-ureteric bar of muscle.

The arterial supply of the bladder consists of the superior and inferior vesical branches of the anterior division of the internal iliac (hypogastric) artery. The vesi-

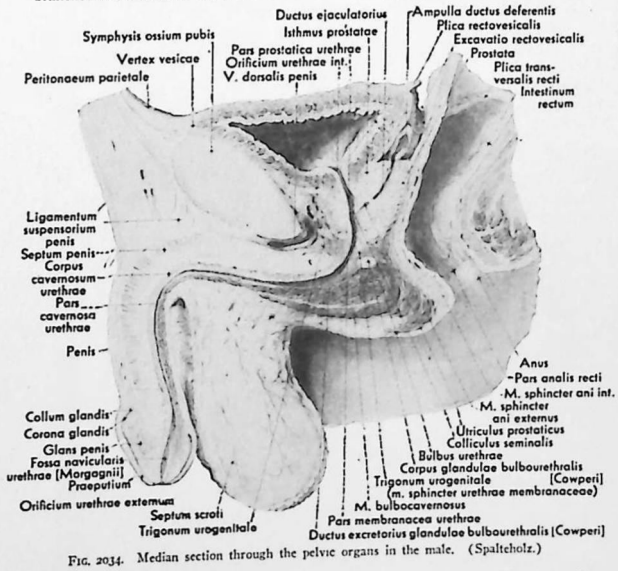


Fig. 2034. Median section through the pelvic organs in the male. (Spalteholz.)

cal veins drain into the prostatic plexus situated around the neck of the bladder and terminate by three or four veins into the internal iliac vein.

The lymphatics are arranged in two networks (in the muscle and beneath the peritoneum), the efferent vessels emptying into the internal iliac lymph nodes.

The nerve supply consists of

(a) Sympathetic fibers from the hypogastric plexus and

(b) Autonomic (parasympathetic) from the nervi erigentes.

SUPRAPUBIC ASPIRATION OF THE BLADDER

Paracentesis Vesicae

This is an emergency or temporary expedient for the relief of acute urinary retention.

The puncture point is made in the median line just above the symphysis pubis. A trocar and cannula are the instruments used (Fig. 2038) the latter having a caliber of about a No. 20 French catheter and it should have a slight curve. An aspirating syringe (about 10 cm. long and of about 14 mm. bore) may occasionally be used to advantage. Infiltrate the point of entry of the trocar with novocaine solution (1-2 per cent). The course of the instrument is to be directed forward and downward and the intervening tissue is penetrated with a quick thrust. After the bladder is entered (giving of resisting bladder wall) the trocar is withdrawn and the urine is permitted to drain off through the cannula

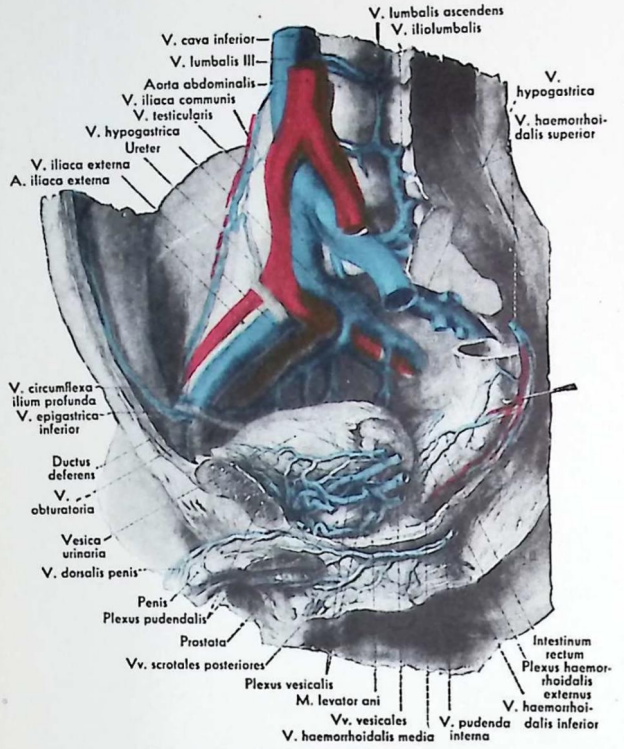


Fig. 2035. Veins of the male pelvis. (Spalteholz.)

which is withdrawn and the catheter retained in place as long as desired (adhesive plaster fixation; suture to skin).

Do not drain off the urine too quickly, lest intravesical hemorrhage supervene. Always leave a small quantity of urine in the bladder. Young warns against catheter drainage as practiced (possibility of prevesical infection); suprapubic cystostomy avoids this danger. Cases on record show where the trocar injured a loop of bowel before reaching the bladder.

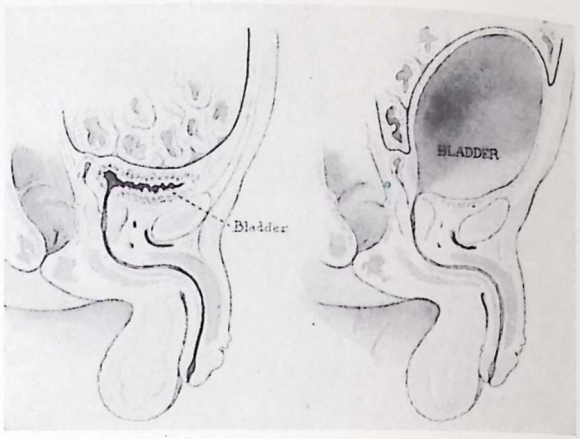


Fig. 2036 Fig. 2037

Fig. 2036. Sagittal section through the male pelvis. The bladder is empty.
Fig. 2037. Position of the peritoneum when the bladder is full.

William E. Lower described a trocar and cannula for suprapubic drainage of the bladder[1] as follows:

"In certain cases of retention of urine due to tight stricture and in many cases of hypertrophy of the prostate, serious and often fatal traumatisms have resulted from attempts to empty the bladder by catheterization with metallic instruments when soft catheters have not been available or could not be used. As many of these cases of retention occur in the practice of the general practitioner who is not equipped with a proper armamentarium, and who is often far removed from surgical aid, some other method of relief is required. Although most practitioners are timid about the use of the trocar, yet they do not hesitate to forcibly push the everready silver catheter through a stricture or prostate in spite of the facts that this procedure may produce a severe hemorrhage, and that as a rule it does not relieve the patient. As a result the catheter becomes clogged with blood, and even if relief is secured it is generally but temporary. A better and safer procedure, which will give prolonged relief, is the use of the trocar and

[1] Urologic and Cutaneous Review, Vol. XVIII, No. 1, 1914.

cannula herein described (Fig. 2039). This cannula has a metal collar so manipulated by a thumb screw that its length can be regulated so as to avoid the possibility of forcing the trocar beyond the necessary distance for relief.

Fig. 2038. Suprapubic trocar.

"By the use of a local anesthetic, or without any anesthetic even, the trocar and cannula may be forced into the bladder at a point sufficiently distant from the pubis to avoid puncturing the plexus of veins which lies just behind the pubic bone (Fig. 2040). The trocar is then withdrawn, and a boiled No. 14 soft rubber catheter is inserted through the cannula into the bladder (Fig. 2041). The cannula is withdrawn (Fig. 2042) and the bladder emptied through the catheter which is allowed to remain. The retained catheter can be held in place by adhesive plaster, the end being plugged or compressed until relief is again needed. The catheter may remain in place for days if necessary without doing any harm and in the meantime the patient can be transferred for operation or further treatment. It may happen that after several days of suprapubic drainage the patient will again be able to void urine. This method often is a more comfortable way of securing continuous drainage of the bladder as a preparation for prostatectomy than is the insertion of a catheter through the urethra, as the latter is generally irritating and disturbs the patient greatly.

"If no soft catheter of the proper size is available, the cannula itself may be retained if it is fastened with tape inserted through the small slits in the collar (Fig. 2043). I have never seen a permanent fistula follow the use of the trocar."

Fig. 2039. Lower's trocar and cannula with metal collar.

SUPRAPUBIC CYSTOTOMY AND CYSTOSTOMY

(Sectio-alta: Epicystostomy)

This operation consists of an extraperitoneal incision into the bladder immediately above the symphysis pubis through the prevesical space and below the peritoneal reflection. Fill the bladder with saline solution before the operation is begun. The Trendelenburg position is of aid.

When drainage is established cystostomy is spoken of; this may be either temporary or permanent (Fig. 2044).

The operation is essentially the same as cystotomy except that a drainage tube of one type or another is permitted to remain in the bladder, for as long as necessary to assure drainage. Either a de Pezzer self-retaining catheter (Fig. 2045) is used, around which a row or two of Lembert sutures are placed and inserted akin to a Kader gastrostomy

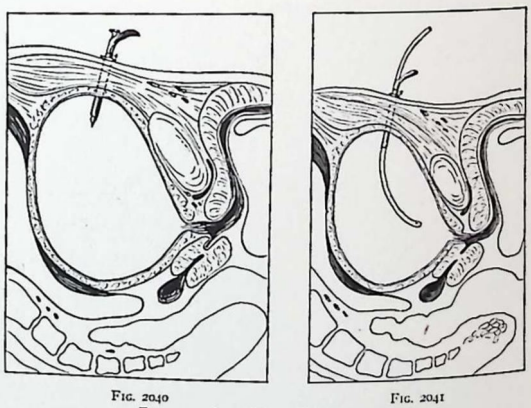


Fig. 2040 Fig. 2041

Fig. 2040. Introduction of Lower trocar.
Fig. 2041. Introduction of catheter through cannula.

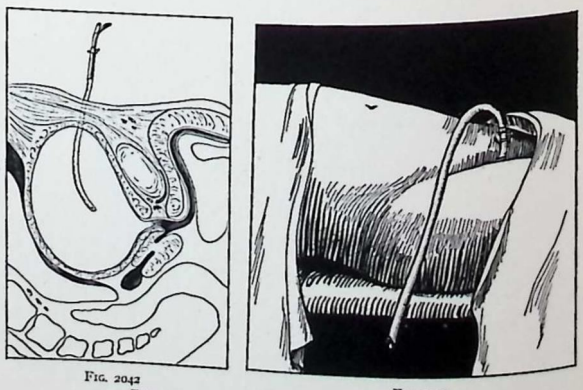


Fig. 2042 Fig. 2043

Fig. 2042. Cannula withdrawn. Catheter remaining.
Fig. 2043. Cannula fastened and secured by tapes through small openings in the metal collar. (Courtesy of Dr. Wm. E. Lower.)

operation after the tube has first been fixed to the bladder wall by a single catgut stitch embracing the entire thickness of the bladder wall; or, drainage is assured by means of one or two rubber tubes attached to the edges of the vesical and abdominal incisions by catgut or linen sutures. The intravesical ends of the tubes should project into the bladder sufficiently to drain off the urine and not impinge upon the floor of the bladder; the distal portions of the tubes projecting through the dressings are attached to other tubes by glass couplings to carry

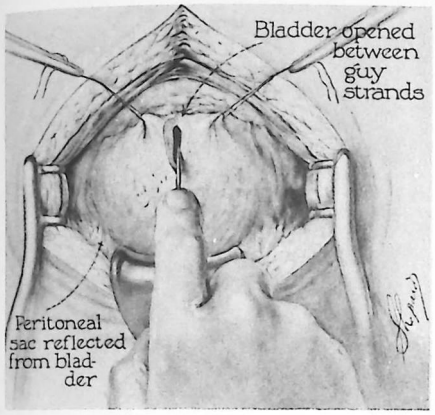


Fig. 2044. Suprapubic cystostomy. Exposure of the bladder. Introduction of traction sutures. Incision.

off the urine. For security, the tubes should also be attached to the skin margins (safety pins; sutures).

Cystostomy Through a Longitudinal Incision

Step 1. **Incision.** Divide the skin, superficial and deep fasciae down to the anterior sheath of the rectus abdominis muscle, a little to the left or right of the midline, as preferred, from the superior border of the symphysis pubis to as far up as seems indicated (usually about three inches). Open the rectus sheath, retract the recti and pyramidalis muscles. Expose the peritoneum and properitoneal fat (Fig. 2044).

Step 2. Push the peritoneum gently upward and out of the way. The partially filled bladder is easily recognized by its bluish pink color, by the particular disposition of its muscle fibers, by the presence of large branching veins coursing on its surface and the firm elastic sensation the viscus imparts to

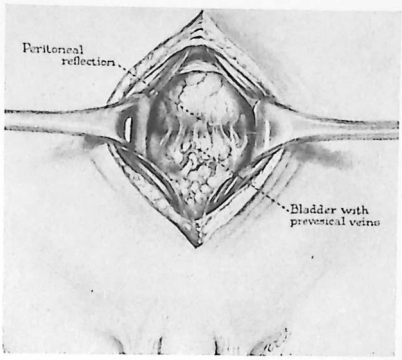


Fig. 2045. Exposure of the anterior wall of the bladder. Note peritoneal reflection and prevesical veins. If the anatomic relations are not carefully observed, besides opening the peritoneum, other damage may be inflicted.

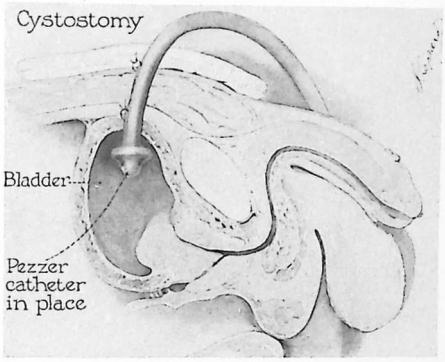


Fig. 2046. Cystostomy. To prevent irritation the catheter should not come in contact with the floor of the bladder or the prostate gland. The catheter should be stitched to both the bladder and the abdominal wall.

the palpating finger (fluid cushion sense). (Fig. 2045.) Pack off the surroundings with adequate lap sponges.

Step 3. Introduce two traction sutures one on either side of the bladder. (Fig. 2044.) These are of catgut and penetrate the muscular wall; they are placed at the midpoint of the exposed bladder about 1 cm. from the proposed line of incision. The bladder is entered with a scalpel thrust into the viscus between the traction sutures. As soon as the bladder is entered, a suction apparatus rids the field of the escaping fluid and a finger hooking the upper border of the incision brings the opened bladder into the wound. The incision may be enlarged upward or downward according to indications present.

Step 4. After the intravesical part of the operation is completed the opening in the bladder is closed around drain with interrupted catgut sutures; these encompass the entire thickness of the bladder wall except its mucous membrane. As many sutures as are necessary are used (8-12). A row of Lembert sutures are superimposed over the first suture line. (Fig. 2046.)

Step 5. Close the abdominal wall in layers. A small cigarette drain or two is placed in the space of Retzius, and another in the upper angle of the wound between the muscles.

Cystostomy Through a Trendelenburg-Kelly Transverse Incision

Lédran as far back as 1730 suggested the use of a transverse incision. Trendelenburg (1877) popularized the procedure.

Step 1. Distend the bladder. Trendelenburg position. Divide the skin, superficial and deep fascia. Expose the sheaths of the recti abdomini muscles. Ligate and divide the blood vessels coming to view. A transverse incision from six to eight inches in length is made; it should be slightly curved, with its concavity upward, in the interspinous field and extend from one internal inguinal ring to the other.

Step 2. The anterior sheath of the recti muscles is incised transversely and the recti and pyramidalis muscles thoroughly exposed and divided transversely. Engage these muscles in sutures the ends of which are left long to counteract the retraction of the muscular masses, which is inevitable. The ends of the sutures left long will greatly aid in bringing them down when reunion is to be effected. Some surgeons make this incision longitudinally to avoid injury to the deep epigastric vessels. Divide the transversalis fascia and expose the peritoneum.

Step 3. Strip off the properitoneal fat and peritoneum from the upper surface of the bladder and identify it by the characteristics mentioned above. An assistant now holds the peritoneum out of the way by a broad retractor.

Step 4. Protect the surroundings with gauze packs. Incise the bladder transversely about the level of the upper border of the symphysis pubis. If a longitudinal incision is decided upon, the technic described above is used. Evacuate the bladder contents with the suction apparatus. Grasp the edges of the incision with traction sutures as above.

Step 5. The intravesical procedure having been completed the bladder wall is sutured as outlined above around a drain.

Step 6. Lower the patient from the Trendelenburg position. Close the abdominal wall meticulously. Drain Retzius' space. The longer ends of the su-

tures holding the recti muscles are brought down and united to the muscular segments and fasciae below.

Comment: If drainage of the bladder is to be instituted cystostomy is practiced. If the peritoneal cavity is accidentally opened it should be promptly closed. Bladder retractors may be used to hold the incision open (Fig. 2047). Blood vessels of the bladder wall should be ligated to avoid the loss of blood.

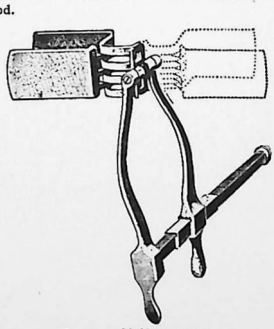


Fig. 2047. Bladder retractor.

Perineal Cystostomy

Indications: (a) Exploration of the bladder (rarely done); (b) Removal of calculi and foreign bodies; (c) Drainage of the bladder.

Step 1. Place the patient in the lithotomy position. Parasacral or low spinal anesthesia. Pass a curved staff with a deep groove on the convexity of the curve, into the bladder (Fig. 2048 a). This is steadied by the hand of the assistant while the surgeon proceeds with the next step of the operation. Keep the scrotum out of the way by the assistant steadying the staff; pull it upward as shown in the illustration. The curved portion of the staff is pushed toward the perineum, thus, bringing the membranous urethra toward the front. This is accomplished by the assistant, holding the staff, inclining the hand toward the abdomen.

Step 2. Feel the staff resting in the membranous urethra. Make a vertical incision about two inches in length from above downward along the raphé of the perineum extending to about one-half inch in front of the anus. The incision is deepened until the staff is exposed. This opens the membranous urethra.

Step 3. Introduce into the wound a probe-pointed gorget (Fig. 2048 a) which is placed accurately into the groove of the staff; this is brought forward by the surgeon's left hand and then pushed along the groove inward and upward

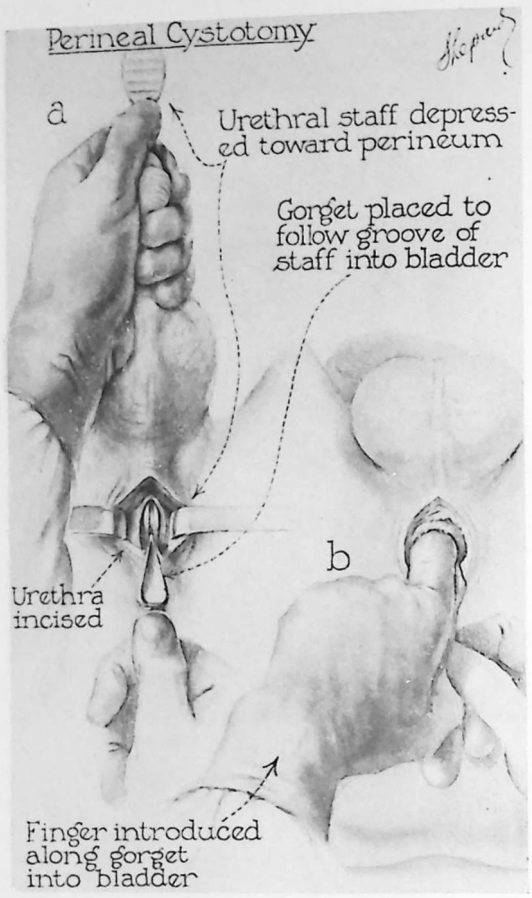


FIG. 2048. Perineal cystostomy. a. Grooved staff at depressed perineum held by assistant who displaces scrotum upward. Opening membranous urethra and introducing probe pointed gorget into the groove of the staff. b. Staff withdrawn as soon as gorget enters bladder. Forefinger of left hand introduced into bladder along gorget.

toward the bladder. A gush of urine announces that the gorget has entered the bladder. It is left in position, while the staff is withdrawn. The forefinger of the left hand is now introduced into the bladder along the gorget by a boring, dilating motion. Exploration, removal of stones and drainage may now be accomplished.

Comment: In the early days of surgery this procedure was extensively practiced. The incision was either median or lateral. The suprapubic approach is now practiced by most surgeons; nevertheless this procedure finds its indications when calculi project into the prostatic urethra—or when prostatic hypertrophy has complicated the condition or in removing foreign bodies.*

RUPTURE OF THE URINARY BLADDER

Rupture of the urinary bladder usually occurs in instances of injury to the abdomen when the bladder is distended. The diagnosis must be promptly made and proper therapy instituted if good results are to be obtained. The mortality rate is high.

Methods of Diagnosis. (A) Excretion urography, which consists of taking X-rays seven or eight minutes after an intravenous injection of uroselectan B. (B) If catheterization reveals the presence of blood, inject about 10 ounces of normal salt solution into the bladder. If none, or very little, of the solution is returned, the bladder is ruptured.

Cystoscopy and the introduction of air into the bladder are to be deprecated (shock, peritonitis, air embolus).

In the large majority of cases the rupture is located on the posterior aspect of the bladder dome and is intraperitoneal.

Operation for Intraperitoneal Rupture of the Bladder

Step 1. Make a good-sized paramedian incision below the umbilicus down to the pubic bone.

Step 2. Open the peritoneum and mop up the urine with lap sponges, or still better use a good suction apparatus.

Step 3. Pack the intestines out of the way. Open Retzius' space by

Step 4. stripping away the peritoneum from the upper anterior surface of the bladder by means of gauze dissection.

Step 5. Make an incision into the bladder as for suprapubic cystostomy. Insert the left index finger into the bladder and explore. Locate the laceration in the bladder wall. Repair it with interrupted catgut sutures which penetrate the bladder wall musculature. (Figs. 2049-2050.)

Step 6. Institute suprapubic bladder drainage; this is of utmost importance. Introduce a de Pezzer catheter into the suprapubic incision in the bladder and close the bladder around it (see suprapubic cystostomy, p. 1918).

In the presence of peritonitis insert a suprapubic peritoneal drain. Drain the space of Retzius with a cigarette drain.

A suction apparatus should be employed to keep the bladder evacuated during the period of healing.

* The author recently removed a glass violet-ray sound which the patient broke off in the prostatic urethra while giving himself a "violet-ray treatment," through perineal cystotomy. A previous suprapubic attempt at extricating the broken sound failed.

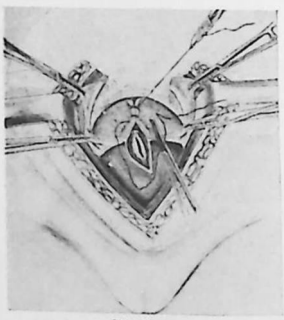


FIG. 2049

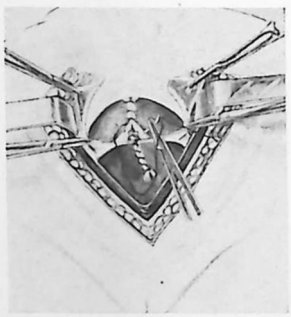


FIG. 2050

FIG. 2049. Combined intra- and extraperitoneal rupture of the bladder. First layer of suture, uniting the two lips edge to edge and including the whole thickness of the walls with the exception of the mucous membrane.

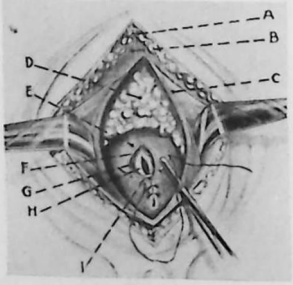


FIG. 2051

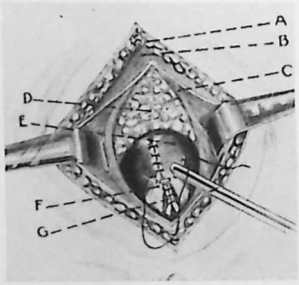


FIG. 2052

FIG. 2051. Extraperitoneal rupture of the bladder. First layer of suture; continous suture, including the whole thickness of the bladder wall with the exception of the mucosa. A. Subcutaneous fatty tissues; B. aponeurosis; C. rectus muscle; D. prevesical fat, pushed up; E. apex of the bladder; F. external fibrous coat of the bladder; G. muscular coat; H. mucous membrane; I. needle traversing the two lips outside the mucosa.

FIG. 2052. Extraperitoneal rupture of the bladder. Second layer of suture infolding the first suture line. A. Subcutaneous fatty tissue; B. aponeurosis; C. rectus muscle; D. Prevesical fat; E. apex of the bladder; F. superficial suture; G. deep suture.

Extraperitoneal Rupture of the Bladder

In most instances this occurs in conjunction with a fractured pelvis. The treatment consists of performing a suprapubic cystostomy and draining the space of Retzius. (Figs. 2051-2052.) In some cases the bladder may be closed.

If the anterior wall is the site of injury the drainage tube is inserted through the wound and the bladder closed snugly around the tube. The urethra should be examined for possible injury by introducing a catheter from the external meatus, before concluding the operation.

In ruptures which involve both the intra- and extraperitoneal parts of the bladder the procedure recommended for intraperitoneal rupture is followed. (Figs. 2049-2050.)

OPERATIONS FOR VESICAL CALCULUS: LITHOTOMY; LITHOLAPAXY

Historical Notes. Suprapubic Lithotomy; Perineal Lithotomy. In the early writings of the Indians, references are found to cutting operations for stones in the bladder. In the era of Hippocrates there were a sect of men who specialized in "cutting for stone." This became a fine art and often became tradition, usually handed down from father to son. All of these operations were done by the perineal route. Celsus about 2,000 years ago described the operation accurately. He counseled perineal lithotomy in children between the ages of nine to fourteen years. Crude, indeed, was the method of Celsus' who described it as "cutting on the gripe" meaning that the middle and forefinger of the left hand are to be introduced into the rectum, the stone being drawn toward the surface of the perineum and held there firmly, and then surgically removed. Ammonius an ancient "stone cutter" devised and used an instrument which when introduced into the bladder through the perineum held the stone immobile while another instrument acted on the principle of a hammer with which the stone was shattered (litholapaxy); the fragments were then removed. Lateral perineal lithotomy was described by Paulus of Aegina. The guide or staff passed through the urethra into the bladder was introduced by Marianus Sanctus de Barletta in 1543. The lithotomy position as it is used today dates from the 13th century and is described in a book called the "Physicians of Mydvay." Pierre Franco, the most noted of the "stone cutters," practiced Marianus' method in the 16th century. He wrote a treatise on surgery (Lyons, 1556) and is credited with being the originator of the suprapubic operation for calculus of the bladder (1560). He operated for the first time on a child 10 years of age; failing to deliver the stone by the perineal route he resorted to the suprapubic operation—the child recovered. A priest, Frére Jacques Beaulieu and a barber, Rau, became famous among the great group of "stone cutters." The credit of having placed lateral lithotomy on a scientific anatomical basis belongs to an English surgeon, Cheselden (1730), who at the time of his death had 213 lateral lithotomies to his credit with a mortality of only five per cent. Dolbeau elaborated the median incision and dilating of the urethra. Dupuytren practiced two lateral incisions through the lobes of the prostate. Elevation of the bladder to facilitate the removal of a stone by the suprapubic route was practiced as early as 1581 (Rousset). Jean Doot of Amsterdam, assisted by his apprentices, removed by means of a shoemaker's knife a stone from his own bladder. Frére Come recorded one hundred suprapubic lithotomies with 19 deaths. The higher mortality as compared with the perineal method caused the operation to become obsolete between 1840 and 1880. Peterson revived the procedure, urging aseptic technic with improvement in the results.

Litholapaxy (Lithotrity). Ultzman is the author of the statement that lithotrity was practiced by the ancients. According to this authority, Olympius of Athens stated that the procedure was performed in the 9th century. Benedetti and Sanctorius described the method in the 16th century. The method was suggested again in 1813 by Gruithuisen who did not perform the operation himself. Civiale, a French surgeon,

in 1818 practiced and advocated the method and published a work on lithotrity. The development (devising of instruments for crushing stones) was enhanced by Elderton of Scotland (1819), and Amussat and LeRoy d'Etiolles in 1822. The first operation of passing an instrument through the urethra into the bladder, engaging the stone and crushing it, was done by Civiale, January 13, 1824. In 1827, Eisenstein introduced the method in Australia and in 1831 Pirogoff in Russia. In England Huerteloupe was first in 1831 and in America, Dupeyre in 1831. Improvements in the instruments were soon followed but up until 1846 the fragments of the crushed stone were permitted to be passed during the act of urination and by the patient's own efforts. Sir Philip Brompton of Dublin was the first to attempt the evacuation of the fragments from the bladder by a suction apparatus. Clover, in 1855, introduced an instrument by means of which, bulb suction brings the fragments of stone from the bladder into a glass chamber. Numerous "sittings" were then the accepted practice until 1878, when Henry J. Bigelow of Boston introduced the operation of "lithotrity in one sitting" which he named "litholapaxy."

Suprapubic Lithotomy

This operation is practically that of a suprapubic cystotomy, plus the removal of the stone. If the calculus is a large one, the transverse incision is to be preferred as it affords more room. Do not subject the bladder to undue trauma by endeavoring to deliver a large stone through a small opening in the bladder. The stones should be removed by appropriate forceps. Direct visualization through the suprapubic opening prevents overlooking of stones. In the presence of infection, drain. If the stone is in a diverticulum it is best to do a diverticulectomy.

Perineal Lithotomy*

This operation consists of opening the prostatic urethra and vesical orifice by an incision extending across the surface of the left side of the perineum and entering the prostatic urethra by further incisions in the line of the first one. The prostatic urethra is sectioned, as it is part of the prostate and the outlet of the bladder. Through the opening thus produced the stone is extracted. Although the sovereign procedure in the days of yore, this operation is rarely, if ever, practiced nowadays, and while the results in expert hands were remarkable (50 consecutive cases without a death by Allan Smith of Baltimore) the operation was abandoned because of the frequent occurrence of urinary incontinence.

LITHOLAPAXY (LITHOTRITY)

Bigelow's Operation

As stated above, prior to developing the procedure to be described, the custom prevailed of removing the stone by frequent "sittings for crushing" allowing the patient to pass the débris from the bladder. The mortality was high and patients who did not succumb suffered more or less constitutional reactions. Bigelow of Boston showed that these untoward results were due to the persistent irritation of the bladder by sharp fragments of calculus remaining for lesser or greater periods in the bladder before finding their way to the outer world. These manifestations could be obviated, Bigelow showed, if the fragments were removed at one sitting. The instruments Bigelow devised to obtain these results were stronger in construction than those produced before and so designed that they would not injure the bladder. The addition of a powerful evacuating bulb through which complete evacuation of the fragments was accomplished was

*The operation is here alluded to for its historical interest.

most helpful. The term litholapaxy was coined by Oliver Wendell Holmes. Among others who have made important contributions to the development of the operation may be mentioned Guyon, Chismore, Freyer, Young, Keegan and others.

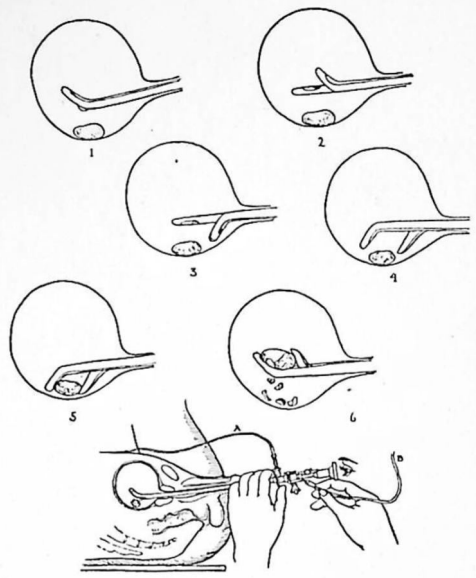


FIG. 2053. Cystoscopic lithotrity. First step. Illustration showing instrument introduced. 2. Second step. Advance the telescope into the bladder through the sheath of the lithotrite. 3. Third step. Rotate the lithotrite so that its beak and telescope are directed downward. Determine position of stone. 4. Fourth step. Open blades of crushing instrument. 5. Fifth step. Grasp the stone with the crushing forceps. 6. After the stone is engaged in the instrument rotate it outward, thus avoiding injury to the bladder. Turn the lens of the telescope away from the stone. Close the blades of the lithotrite. Crush the stone. A. Cable leading to illuminating apparatus. B. Wire electrode leading to diatherm apparatus for destruction of bladder tumors.

Dorsal decubitus.

Step 1. **Anesthesia.** General, spinal or caudal; general anesthesia is preferred for children. Local anesthesia, 5 cc. of 4 per cent novocaine solution is introduced into the bladder and equal amounts are instilled into the posterior and anterior urethra. Fill the bladder with 200 cc. of salt solution.

Step 2. Introduce the lithotrite into the bladder (Fig. 2054 a). A new surgical instrument now enables the operator to perform this operation under vision

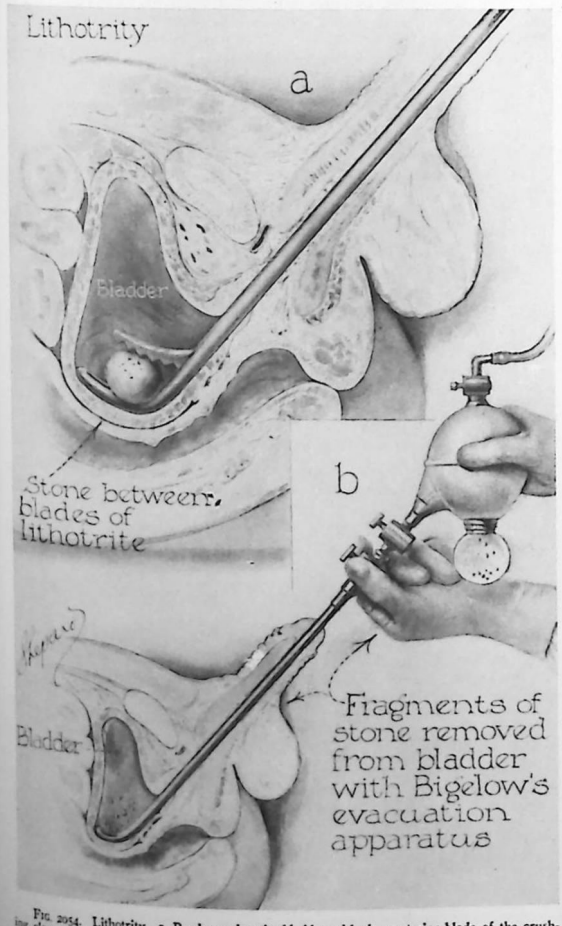


FIG. 2054. Lithotrity. a. By depressing the bladder with the posterior blade of the crushing clamp a funnel is formed which causes the stone to fall between jaws. b. Removal of calculus fragments by suction is facilitated by depressing the posterior bladder wall.

because of a lens at the beak of the lithotrite. (Fig. 2053.) Do a meatotomy when the instruments cannot be passed with ease. Avoid injury to the deep urethra (particularly in prostatic hypertrophy) during the passage of the instrument. Let the instrument proceed by its own weight along the trigone until it reaches the base of the bladder (its most dependent part), on which it is permitted to rest.

Step 3. Unlock the instrument; open the blades by withdrawing the male blade an inch or more, depending upon the size of the stone; the female blade is held steadily in position.

Step 4. Close the blades; often the stone will be found between them. Lock the lithotrite and lift it slightly off the base of the bladder.

Step 5. Crush the stone by screwing the male blade home.

Step 6. Unlock the lithotrite again. Engage a large fragment—crush it. Repeat this several times. In case the stone is not promptly found it must be searched for. This is accomplished by opening the blades of the instrument and turning them at an angle of 45° to the left and right and closing the blades. If the stone is still elusive, depress the handle of the instrument toward the horizontal position between the thighs and push it about an inch or so toward the posterior surface of the bladder and search persistently to the right and left until the aim is accomplished.

In cases where the stone is located behind an enlarged prostate, depress the handle of the lithrotrite and turn it around on its axis so that its beak points to the trigonum vesicae but with which it should not come in contact. Open and close the blades as outlined above and engage the stone. Avoid injury to the mucous membrane of the bladder. Continue the crushing of fragments persistently until no other fragment is found; the instrument is then withdrawn. Make sure that the blades are securely approximated before you attempt the withdrawal of the instrument.

Step 7. Proceed to evacuate the crushed fragments by passing the evacuating tube; evacuate the bladder contents through it (Fig. 2054 b). The evacuating tube should be passed to the most dependent part of the bladder, holding the evacuating tube in the left hand and the evacuator in the right. Turn the beak of the instrument into various positions of the bladder; do not overlook the pouch behind the prostate. Evacuate the bladder thoroughly. If a large fragment is discovered to have been left behind, the lithotrite should be reintroduced and the procedure of crushing repeated. Avoid sucking up a portion of the mucous membrane of the bladder into the evacuating tube.

Contraindications for Litholapaxy

H. Cabot[1] gives the following contraindications for litholapaxy:

(1) Disproportion between bladder and stone (large stone, small bladder).
(2) A stone formed around a foreign body of metal.
(3) A urethra which is too small to admit a lithotrite.
(4) Ankylosis of the hip.
(5) When the stone is located in a dilated prostatic urethra.

[1] J. A. M. A., Dec. 22, 1928, p. 1968.

OPERATIONS FOR TUMORS OF THE BLADDER

Nonmalignant Tumors

In these cases it is best to excise the tumor and the mucous membrane surrounding it. (Fig. 2055 a, b.)

Step 1. Place the patient in the Trendelenburg position. Suprapubic cystostomy. Thorough exposure and adequate illumination are essential.

Step 2. Grasp the tumor with a pair of forceps. Circumincise the area to be excised in the form of an ellipse. Remove the mucous membrane and tumor from the underlying muscularis as shown in the illustration. Bleeding is often free. Rapid sponging (suction) and compression with final ligation of the bleeding points secure hemostasis.

Step 3. The wound remaining, after the removal of the tumor, is closed with interrupted catgut sutures. The nearer the tumor is to the neck of the bladder the more difficult will be its excision; the nearer to the vertex and the lateral walls the simpler its ablation. Introduce a retention catheter. Close the suprapubic opening in the bladder. Drain the space of Retzius. Dress the wound.

Resection of the Bladder Wall

In this operation the entire thickness of the bladder wall is taken away with the tumor resting upon it.

Historical Notes. Anterior and Lateral Walls. Sonnenburg, in 1884, was first to resect a portion of the entire thickness of the bladder wall. This operation was done by the abdominal route. Morton, in 1879, did the first partial resection of the bladder through the vesicovaginal septum.

Step 1. Trendelenburg position. Expose the bladder as described in the above procedure.

Step 2. Separate the bladder freely from the posterior surface of the pubes.

Step 3. Strip the peritoneum out of the way.

Step 4. Open the bladder in a healthy territory away from the tumor mass.

Step 5. Engage the edges of the wound with Allis' forceps. Define the extent of the tumor by palpation and inspection.

Step 6. Excise the tumor with scissors, curved on the flat, taking a considerable margin of healthy tissues with the tumor. (Fig. 2055 c.) Large portions of the bladder may thus be removed effectively. Hemostasis must be perfect. Avoid implantation metastases by meticulous attention that tumor particles do not come in contact with the bladder surfaces. When the peritoneum has to be entered, it should be closed after removal of the tumor.

Step 7. The defect in the bladder wall should be repaired by interrupted catgut sutures, in either the transverse, vertical or irregular position depending upon the configuration of the defect. (Fig. 2055 d.) Drainage by (a) de Pezzer catheter; (b) Retzius' space drainage.

Tumors of the Base of the Bladder

Here again the operation may be extra or transperitoneal depending upon existing exigencies. In principle the operation consists of opening the bladder

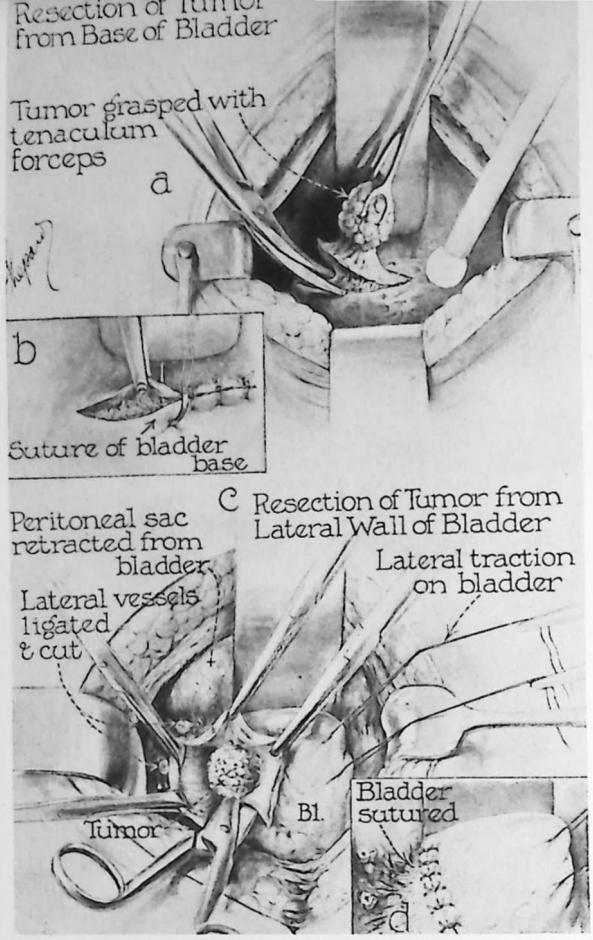


FIG. 2055. Excision of bladder tumors: a. Suprapubic abdominal incision. The peritoneum is pushed back and the bladder opened. The tumor is grasped with a tenaculum forceps and an elliptical incision made with a knife through the bladder mucosa at the tumor base. Excision is completed with scissors as traction is applied. b. Suture of bladder after extirpation of tumor. c. Extravesical resection of tumor of lateral wall of bladder. Suprapubic incision; the peritoneal sac pushed back after dividing the urachus. The dome of the bladder is grasped and retracted to the side away from the tumor exposing the vessels on the tumor side. These vessels are ligated and severed before excision of the bladder wall supporting the tumor is attempted. d. Approximation of bladder wall after excision of tumor.

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longitudinally through a median incision. Good exposure (wide retraction) and adequate illumination are indispensable prerequisites for thorough work. The extent of involvement determines whether one or both sides of the bladder are to be freed externally. The blood vessels supplying the particular affected section of the bladder are doubly ligated and divided. Dissect the bladder bluntly from its contiguous structures (peritoneum, rectum, ureters, vas deferens and seminal vesicles). Preliminary catheterization of the ureters in order to avoid injury to these structures and facilitate their recognition is of value. The base of the bladder is excised by a wide, healthy margin surrounding the affected portion. If a ureter has to be divided, its reimplantation into the reconstructed bladder may have to be done. If there is very extensive involvement, the question of total or subtotal cystectomy may have to be considered. The closure of the defect requires considerable ingenuity and resourcefulness. The surgeon will have to be conversant with the principles underlying plastic surgical procedures; the better equipped he is in that direction the better his operative results will be. A de Pezzer catheter is introduced into the reconstructed bladder around which the bladder wall is sutured. Drain the space of Retzius.

Tumors of the Trigone

When the tumor involves the trigone or ureteral orifices, transplantation of the involved ureter is usually indicated. Do a ureteral catheterization whenever possible. For circumscribed tumors involving the ureteral orifices, the Albarran operation is advisable. Transverse cystotomy is done. An incision is made through the healthy mucous membrane surrounding the tumor including the ureteric opening. The tumor is caught with proper forceps; the incision previously made is deepened with sharp pointed scissors through the muscular wall of the bladder. The ureter is included in the muscular tissue, and by further dissection a pedicle is formed by the ureter. An incision is now made through the wall of the ureter beyond the tumor and a fine suture of catgut is passed through it. The ureter is now completely divided across and another similar suture is passed through its wall opposite the first. The portion of the wall of the bladder carrying the tumor is now resected. The ureter is drawn into the bladder by means of two catgut sutures previously introduced. The ureter is now split with fine scissors so as to form a right and left flap. The catgut sutures are picked up again and the needles carry them through the entire thickness of the bladder wall on each end of the lower side of the wound. The sutures are tied. When no catheter can be passed into the ureter, the growth is first removed, the ureter looked for and isolated.

The removal of tumors about the trigone showing a high operative mortality make the use of electrosurgery and X-ray preferable.

Electrosurgical Methods in the Treatment of Tumors of the Bladder

In expert hands localized tumors about the trigonum vesicae may be effectively destroyed by electrosurgical methods via the urethra.

For the surgeon of average experience, proper exposure is essential and it is best to resort to wide opening of the bladder and thorough electrocoagulation of the neoplasm. It must be remembered that too much tissue destruction is just as bad as too little.

Step 1. Ascertain the position of the neoplasm by cystoscopy. Spinal anesthesia usually suffices. Place the patient in position as for cystoscopy. An indifferent electrode is snugly applied to the sacrum.

Step 2. Perform suprapubic cystostomy.

Step 3. Evacuate the bladder thoroughly (suction). Retract efficiently; expose the tumor. Traction should not be exerted laterally on the bladder but vertically (cephalocaudal) (Gustav Kolischer). This pertains particularly to cases where the tumor is situated behind the trigonum vesicae.

Step 4. Coagulate the protruding tumor (papilloma) with an appropriate-sized, disc-shaped electrode and proper amperage, sufficiently, but not too ambitiously. Experience here is the best guide. Work under ocular guidance. The interior of the bladder should be thoroughly illuminated by appropriately projected light. To ascertain the depth of heat transmission an assistant introduces a finger or two into the patient's rectum or vagina respectively and reports to the surgeon the intensity of the heat transmitted during the coagulating process. There are no formulae for the intensity or duration of the current to be used. Observe the extent of marginal action of the active electrode; couple this with the reports of heat transmission to the assistant's finger and thus gauge the necessary degree of current required for effective electrocoagulation. As a general proposition, however, when the base of the tumor has been coagulated down to the level of the bladder wall and its base appears dry, the assumption is that the coagulating process is sufficient.

Pedicled tumors may be removed after first carbonizing them, by detaching the pedicle with the diatherm knife (acusection) and finally by coagulating the base of the neoplasm.

Voluminous tumors may be attacked by coagulating the superficial sections, then curetting away the coagulated stratum and again coagulating until the base of the tumor is reached.

Step 5. Close the abdominal wall. Drain the bladder (large de Pezzer catheter) (vide supra pp. 1918-1920.)

Comment: Radium is advocated by some in tumors of the bladder (radon seeds through a suprapubic cystostomy). Joseph Muir implants radon through an instrument devised by him enabling the surgeon to enter the bladder per urethram. A combination of electrocoagulation with radium may be used in selected cases.

TOTAL EXTIRPATION OF THE BLADDER (CYSTECTOMY)

Historical Notes. The first cystectomy was done by Bardenheuer in 1887. In 1888 the first successful operation was done by Pawlik in the following manner: A woman, aged 56 years, had been operated upon for a small vesical tumor by Pawlik one year before. Recurrence took place. The bladder was extirpated by two distinct operations. In the first of these the ureters were implanted in the upper end of the vagina. When these wounds had healed and the urinary stream had been successfully diverted, the second operation was carried out thus:

The bladder was filled with 10 ounces of iodoform emulsion; it was then exposed above the symphysis and stripped of its peritoneal investment. The contents of the bladder were evacuated. The anterior wall of the vagina was incised, the bladder drawn through this incision just above its outlet and removed. The posterior end

of the urethra was then connected by suture with the anterior wall of the vagina in front, and its posterior wall behind. A reservoir was thus formed out of the vagina into the upper end of which the ureters entered, and the lower end of which was in continuity with the urethra. The woman recovered and lived for fifteen years.

In 1905, Watson proposed bilateral lumbar nephrostomy and tying off of the ureters close to the renal pelvis as a preliminary step to total extirpation of the bladder. In 1907, Bottomley suggested as a preliminary step to total cystectomy, implantation of both ureters into the loin as done by Le Dentu, Pozzi, Wassilujew and others. While Young "never felt justified in carrying out an operation of total cystectomy" recent literature shows some encouraging results reported by other observers.

Reed M. Nesbit in an article on "Total Cystectomy and Ureteral Transplantations in Malignant Conditions of the Bladder"[1] remarks that Edwin Beer, Quinby and William have pointed out that removal of the bladder with a malignant tumor is not a very formidable procedure. Cystectomy would, no doubt, be the popular treatment for most bladder malignancies if it were not so difficult to dispose of the urine.

European surgeons have long been in favor of cutaneous ureterostomy; in this country Edwin Beer and Hugh Cabot have announced their belief that it is superior to uretero-intestinal anastomosis. Some believe it is almost impossible to apply the drainage tubes and other postoperative apparatus necessary in the former procedure so that no leakage of urine takes place. Nesbit considers uretero-enterostomy the best method. The three Coffey technics or modifications of them are most commonly used at the present time.

Nesbit concludes that the greatest obstacle to radical surgery for the cure of cancer of the bladder is a lack of safe and satisfactory methods of urine disposal; that cutaneous ureterostomy is probably the safest method available at this time and that uretero-intestinal anastomosis provides the best functional results.

Figure 2056 depicts the two-stage ureteral transplantation.

Diverticulectomy

Historical Notes. Various methods of treating vesical diverticulae have been devised from time to time. Pousson advocated closure of the orifice of the diverticulum by suture. Alexander suggested ligature and excision of the sac.

A. If the diverticulum is on the anterior surface or side of the bladder, make a transverse or median abdominal incision. Do not open the peritoneum. Push it aside until the diverticulum is exposed. Excise the diverticulum and treat the bladder wound by appropriate suturing.

B. If the diverticulum is on the dome of the bladder and cannot be exposed extraperitoneally, open the abdomen, protect the peritoneal cavity with pads and excise the diverticulum. Close the wound and drain.

Since a diverticulum may be a source of infection the operation may be done in two stages:

Stage 1. Bring the diverticulum and part of the vesical wall into the abdominal wound and suture the parietal peritoneum to the bladder around the diverticulum.

Stage 2. After adhesions protect the peritoneum, excise the diverticulum and close the vesical wound.

[1] J.A.M.A., Sept. 14, 1935.

C. If the diverticulum arises from the posterior wall of the bladder and lies between the bladder and rectum, Grasser suggests the following operation:

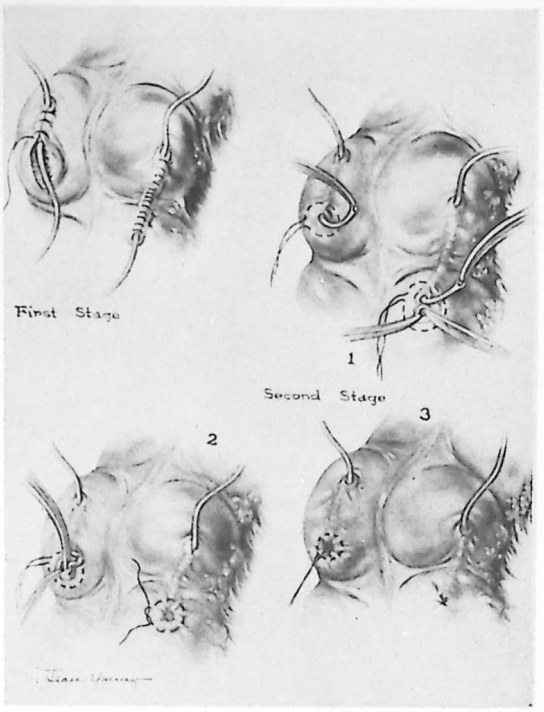


Fig. 2056. Two stage ureteral transplantation. In the first stage the ureters are mobilized and imbedded under the muscularis of rectosigmoid. In the second stage (1, 2 and 3) the ureters are cut distal to the embedded area and inserted in the lumen of the bowel through a puncture incision which is later closed with a purse-string suture. (Courtesy of Dr. Reed M. Nesbit.)

Grasser's Operation

Step 1. Drain and explore the bladder suprapubically. With a sound in the diverticulum and a finger in the rectum ascertain and define the size and location of the diverticulum.

Step 2. Place the patient in the combined Trendelenburg and lithotomy position. Make a curved transverse incision from one ischial tuberosity to the

other. Using a sound as a guide, expose the membranous urethra and the prostate.

Step 3. Separate the rectum from the prostate and bladder until the diverticulum is reached. This is fastened firmly to its surroundings. Remove the finger from the rectum and change gloves.

Step 4. Open the diverticulum. Insert a finger, separate the diverticulum from its surroundings by blunt and sharp dissection; push the peritoneum out of the way.

Step 5. Excise the diverticulum and invert its stump into the bladder by means of sutures, being careful not to injure or include the ureter.

Step 6. Drain the perineal wound. Provide for suprapubic drainage.

OPERATIONS FOR EXSTROPHY OF THE BLADDER

(Ectopia Vesicae)

W. Thomson Walker summarized the operations which have been formulated for the relief of exstrophy of the bladder as follows:

1. **Formation of a reservoir in the body.**
   - A. From the bladder.
     - 1. Closure of the defect by osteoplastic operation.
       - a. Of skin.
       - b. Of intestine.
     - 2. Closure of the defect by flaps.
   - B. From the rectum.
     - 1. By transplantation of the ureters.
     - 2. By vesicorectal fistula.
   - C. From the sigmoid flexure.
   - D. From the vagina.
2. **No reservoir formed in the body.**
   - A. Implantations of ureters.
     - 1. Into the urethra.
     - 2. Into the skin.
   - B. Nephrostomy.

Historical Notes. Simon transplanted the ureters into the rectum, in 1851, for the purpose of diverting the urine into the intestinal tract. In 1852, Roux constructed, by a plastic procedure, a bladder of the abdominal wall. In 1854, Nélaton modified Roux's procedure. Both these attempts were unsuccessful. Agres and Pancoast, American surgeons, were, according to Hutchins, first to report successful attempts at plastic operations for the relief of this condition in 1857. Trendelenburg,[1, 2] in 1855, proposed a technic which consisted of a sacro-iliac arthrotomy, on one or both sides followed by placing the afflicted child in an apparatus which was intended to approximate the pubic bones. The patient was obliged to remain in this for three or four months. The second stage of the operation consisted of a reduction and suture of the bladder and closure of the anterior abdominal wall. A special compressor was devised by Wilus which brought the bones together without injury to the soft parts. Legue is an antagonist to the Trendelenburg operation stating that "this operation not only does not give control, but is more fatal than the others, and has not justified the hopes upon which it was based." Hutchins from a review of the literature, declares that the only way to eliminate incontinence is by transplantation of the ureters into

[1] Centrbl. f. Chir., No. 49, Dec., 1885.
[2] Ann. of Surg., 1906, XIV, 281.

the intestine either intra- or extraperitoneally. Among those who have contributed to the surgical treatment of ectopia vesicae must be mentioned the Mayos, Moynihan, the Hutchins brothers, Burns, Maydl and others. (Fig. 2057.)

Remarks. The principal objection to most operations for reconstruction of the bladder is that the final result is merely the formation of a urinary receptacle bereft of any sphincter, hence incontinence results. The best that is accomplished is to avoid trauma to the exposed vesical mucosa and to direct the urine to the penile gutter where a portable urinal may more readily be attached. It must be remembered that in plastic reconstruction of the bladder the operation often results in fistulas. Ureterosigmoidostomy or ureterocolostomy invariably

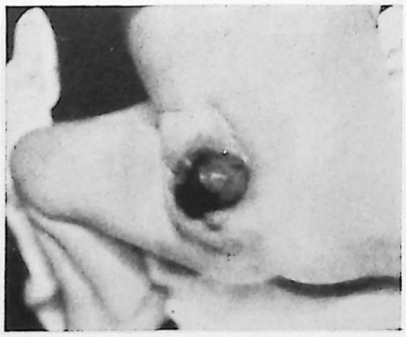


Fig. 2057. Exstrophy of the bladder.

results in ascending infections via the ureters. Maydl's operation of transplanting the ureters together with their sphincteric attachments to the wall of the bladder seems to avoid such ascending infections from the bowel toward the upper urinary apparatus. It is, therefore, considered by many the operation of choice. The lower bowel soon becomes tolerant to the influx of the diverted urine and the sphincters of the lower intestine effectively prevent the escape of urine.

Maydl's Operation[1, 2, 3]

Object. Transplantation of the trigone of the bladder together with the ureteric openings into the sigmoid flexure of the colon.

Step 1. (Fig. 2058 a.) Catheterize each ureter. Incise the abdominal wall at the junction of the mucous membrane of the exstrophied bladder with the skin beginning at the margin of the defect. Two fingers introduced into the peritoneal cavity act as a guide. The incision is carried clear around the circumference of the bladder to the edge of the urethral gutter. If one

[1] Wien. Med. Woch., 1894.
[2] Watson, Ann. of Surg., 1905, XLII, 813.
[3] Bransford Lewis, Ann. of Surg., 1900.

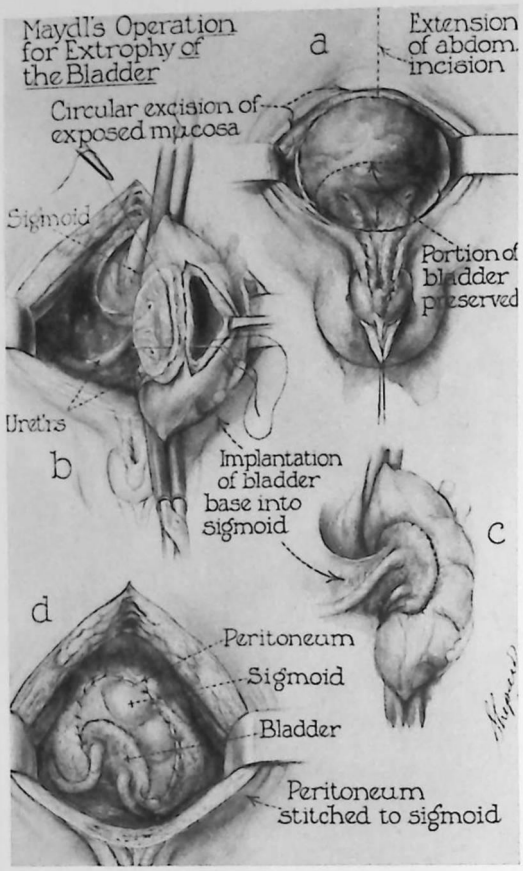


Fig. 2058. Maydl's operation for exstrophy of the bladder. a. All exposed bladder mucosa is excised except a small oval portion immediately about the urethral orifice. b., c. The abdomen is opened, a loop of sigmoid is brought out, emptied of its contents and incised for implantation of the portion of bladder attached to the ureters. The edges of the two structures are united with through-and-through sutures covered with a superficial running stitch. d. The peritoneal opening is closed by suturing to the sigmoid.

of the ureters opens near the skin a portion of the skin is to be removed with it.

Step 2. Divide the urethra across immediately above the ejaculatory ducts. Separate the ureters carefully at the lower part of their pelvic course. It is understood that during this step of the operation the blood supply of the ureters must not be interfered with.

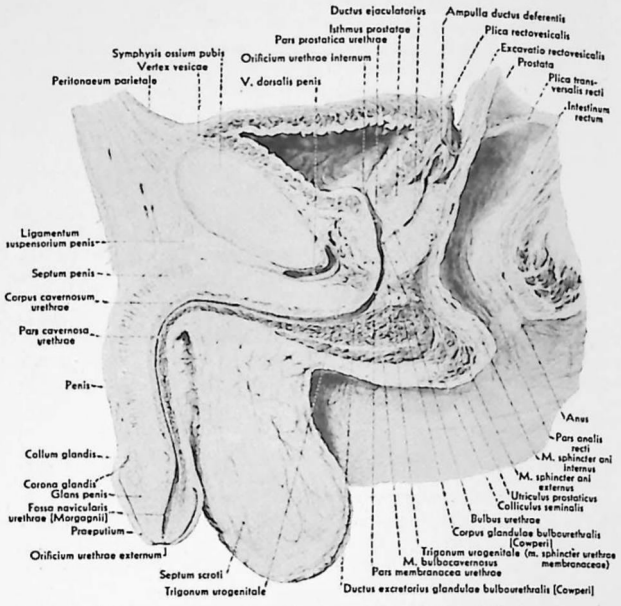


Fig. 2059. Median section through the pelvic organs in the male, right half, viewed from the left side (partly after a frozen section by W. Braune.)

Step 3. Cut away the bladder wall leaving an oval area in which the ureters open. Around this oval there should be a rather wide margin of peritoneum overlapping the muscularis of the bladder.

Step 4. Extend the abdominal incision upward in the median line. Deliver the sigmoid flexure of the colon (Fig. 2058 b). Empty the bowel by stripping it of its contents. Clamp the portion of bowel into which the implantation is to be done with intestinal clamps. Make a longitudinal incision along the free border of the bowel. Hold the lips of the wound apart with traction sutures; fix the bladder wall and the ureters into the opening made in the

intestine by bringing them into proper position. With through and through catgut or linen sutures the edges of the portion of the bladder wall attached to the ureters are sutured to the edges of the wound in the sigmoid. Superimpose this line of sutures by a line of continuous Lembert sutures. Thus, the normal ureteral valves or sphincters are retained preventing ascending infections (Fig 2058 c, d).

Step 5. Peritonealize thoroughly. Close the abdominal wound.

OPERATIONS ON THE PROSTATE GLAND AND SEMINAL VESICLES

Anatomic Considerations. (Figs. 2059-2060.) The normal prostate resembles in shape a chestnut. It has a base, an apex, a posterior and two lateral surfaces. It is traversed from base to apex by the prostatic part of the urethra and encloses in its upper part the ejaculatory ducts. The apex rests upon the superior layer of the triangular ligament (urogenital diaphragm). The posterior surface rests upon the anterior wall of the rectum. In its upper part there is a transverse slit into which enter the ejaculatory ducts. The lateral surfaces are supported by the levatores ani. The capsule of the gland extends over the entire surface, except over the anterior and posterior commissures which unite the lateral lobes across the urethra. It is composed of a powerful but thin layer of fibrous tissue which is intimately adherent to the prostate tissue. The so-called middle lobe is a somewhat indefinite wedge of prostatic tissue bounded by the urethra in front and by the ejaculatory ducts behind. The fibrous sheath of the prostate gland is a definite fascial covering formed by the visceral pelvic fascia and closely surrounding the gland and its capsule. Anteriorly the sheath of the prostate is connected by means of the puboprostatic ligament to the pubes. Laterally, it is continuous with the fascia of the levator ani muscle; posteriorly it blends with the fascia of Denonvilliers—a dense, well defined fibrous layer. At the base of the gland the sheath is continuous over the vesicoprostatic groove to reach the bladder; at the apex, it blends with the triangular ligament (urogenital diaphragm).

Fig. 2060. Hypertrophy of the prostate gland. Catheter is seen passing through the middle lobe.

The Blood Vessels of the Prostate. Arteries. Branches of the inferior vesical and middle hemorrhoidal.

Veins. Numerous veins from the prostatic plexus are embedded within the sheath which they reach by first piercing the prostatic capsule and traversing the space between the coverings; they enter into the internal iliac (hypogastric) vein.

The lymph channels issue from the surface of the gland; they pass upward and empty into the lymph nodes lying just below the external iliac vessels.

The sensory nerves of the prostate gland are derived from the tenth

eleventh dorsal, the five lumbar nerves and the first, second and third sacrals. The fibers supplying the gland substance and covering its secretory function are from the sacral plexus of the sympathetic nerve; they surround the external surface of the outer fibrous sheath.

The Seminal Vesicles. These are located at the base of the bladder obliquely, and are embedded within the visceral pelvic fascia. Each vesicle consists of a branched and sacculated tube coiled upon itself. It is pyriform in shape and about two inches long. The lower ends are located close together at the base of the prostate gland separated only by the terminal extremities of the vasa deferentia. At the top, the vesicles are about two inches apart, covered by peritoneum and overlapping the lower ends of the ureter. Below and in the middle they are uncovered by peritoneum lying directly on the anterior wall of the rectum. On the inner side of each seminal vesicle lies a vas deferens which joins the corresponding duct of the vesicle to finally form the common ejaculatory duct.

Historical Notes. Corvillard in 1639 removed a mass thought to be the prostate. A systematic attempt to remove a urinary obstruction due to an enlarged prostate was made by Mercier in 1856. Lafaye in 1766 is said by Chopart to have tunneled, with an instrument, the obstructing portion of the gland through the urethra. This method was later repeated by John Hunter, Brodie and others. Harrison in 1881 revived the method attacking the obstruction through a perineal urethrotomy. Leroy d'Étiolles (1832) removed median and lateral portions of hypertrophied gland through the urethra via the meatus (snare). Guthrie (1834) did the same through perineal urethrotomy. Amussat in 1827 removed a hypertrophied middle lobe with a pair of scissors through a suprapubic cystotomy. Sir William Blizzard divided a median enlargement in 1806 through an external median perineal urethrotomy. Lateral perineal lithotomy with removal of the obstruction was advocated by Sir William Ferguson in 1848. From 1886 (Mercier) to 1887 (McGill), surgeons attempted to establish the feasibility of systematic operation for prostatic obstruction. The former removed the median bar via the urethra with special instruments. In 1874 and 1877 Bottini adopted Mercier's principles but used the galvanocautery as the means of destroying the obstructing bar (this was modified by Trendelenburg). Gouley in 1873 used Mercier's operation through an external perineal urethrotomy. Gouley was also first to propose total enucleation of the gland by the finger through the same opening (total perineal prostatectomy). In 1882 Leisnuk repeated Billroth's total perineal prostatectomy operation with a recovery. The inverted V and Y incisions credited to Nicholas Senn and Hugh Young were used by Ferguson and other surgeons before Young's time. McGill in 1887 advocated suprapubic prostatectomy. He was succeeded by William Belfield, Mausell, Moullin, Mayo Robson and others although as late as 1901, Freyer endeavored to introduce the procedure as a new operation. In 1892 Pyle advocated the removal of the entire prostate perineally. Alexander in 1895 described a combined perineosuprapubic operation as did Nicoll in 1894. Pyle and Nicoll described the method of preserving the prostatic urethra intact. In 1895 Fuller championed the suprapubic operation suggesting bringing up of the prostate by a finger in the rectum. In the same year White proposed castration and vasectomy in the treatment of prostatic hypertrophy. In 1900-1902 Proust and Albarran described advances in the technic of perineal prostatectomy. Syme and Ferguson in 1901, later de Pezzer in 1902 and Young in 1903 described special forms of tractors to bring the prostate down and make it more accessible to the operative manipulations although tractors were used before de Pezzer, Young, et al. In 1903 Young modified Proust's technic of employing lateral prostatocapsular incisions. Freyer in 1901 drew the sparks of criticisms for describing suprapubic prostatectomy as a "new operation." It does not seem to differ from Fuller's technic. In speaking of Freyer, Francis J. Watson refers to him as "a universal usurper of previously pre-empted prostatic privileges." Bottini's operation was very popular between 1895 and 1905. Chetwood used a method similar to Bottini's through the perineum instead of through the urethra. Today, the methods in vogue are the suprapubic and perineal methods. To this is to be added the now popular electrosurgical transurethral resection of the obstructing adenoma of the

PERINEAL PROSTATECTOMY

Proust[1] and Albarran's Operation

The patient is placed on the operating table in the position described as "inverted perineal." (Position perinéale inversée of Proust.) After the bladder has been washed out a staff is inserted. The legs of the patient are held in a vertical position and the thighs horizontally by a metal framework fastened to the operating table. Elevate the buttocks so that the perineum is directed toward the ceiling of the room and the sacrum is almost vertical. An assistant holds the staff so that it lifts the urethra toward the pubic arch, precluding its being severed while the preliminary dissection of the perineum takes place.

Step 1. Make a curved incision with its convexity forward, about the width of two fingers from the anus, across the perineum to the ischium including the skin and subcutaneous tissues (Fig. 2061 a). The external anal sphincter posteriorly and the bulb covered by the bulbocavernosus muscles anteriorly are exposed. Divide the anobulbar raphé. Draw the bulb forward by means of forceps, exposing the posterior borders of the transverse perineal muscles to view (Fig. 2061 b).

Step 2. While the bulb is drawn forward the posterior lip of the incision is drawn backward exposing the recto-urethral muscles. Push the levatores ani aside with the fingers and divide the recto-urethral muscles close to the transverse ligament. The rectum then drops back and the apex of the prostate is brought into view. Push back the surrounding tissues with the fingers and further expose the prostate. If the incisions are correctly made there should be little bleeding (Fig. 2061 c).

Step 3. Insert a broad duck-bill retractor in the posterior part of the incision and draw the rectum backward (Fig. 2061 d). Open the urethra on the staff at the apex of the prostate. Proust emphasizes opening the prostatic rather than the membranous urethra. Draw aside the margins of the mucous membrane with forceps or ligatures. Introduce a depressor, the arms of which are fixed about the neck of the bladder. The assistant takes charge of this instrument and by means of it pushes the prostate through the wound (Fig. 2061 e). Apply two strong catch forceps to the prostatic sheath, one on each side of the urethra and peel the sheath from the prostate by means of a scissors and blunt dissector.

Step. 4. Enlarge the urethral aperture posteriorly as far as the neck of the bladder which should not be punctured, and bisect the prostate. Using the forefinger of the left hand as a guide, separate each lobe from the urethra with a scissors, a blunt dissector and the forefinger of the right hand; sufficient prostate tissue should be left as a support for the urethra (Fig. 2061 f). During this procedure the lobes are brought to the surface by means of a catch forceps and depressed by means of the tractor. When pediculated outgrowths of the prostate in the bladder are encountered they are pushed or hooked through the urethral wound with the finger and are either cut off with scissors or torn away.

Step 5. Clip off redundant portions of the urethra leaving sufficient membrane

[1] Med. Press, Oct., 1901.

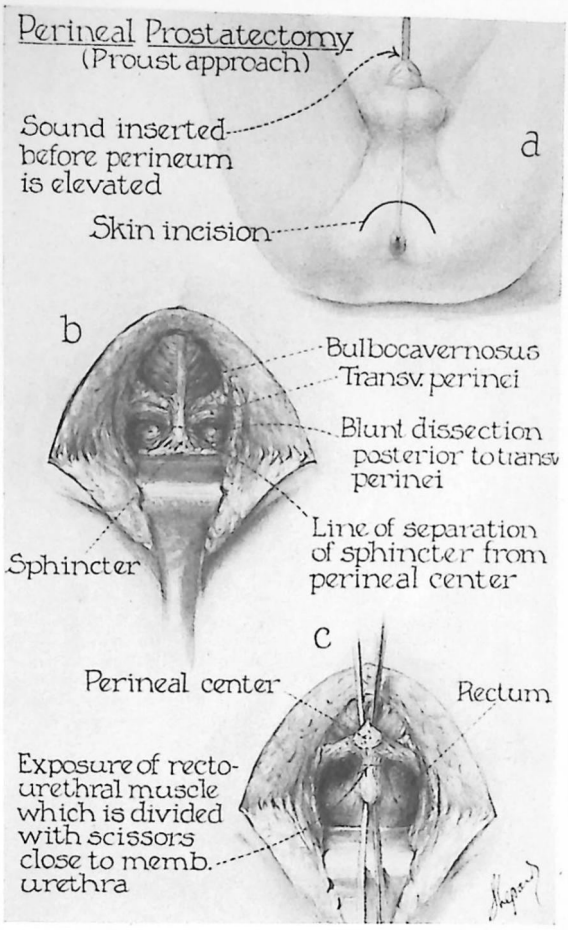


FIG. 2061. Perineal prostatectomy. Proust's operation, later modified by Young. a. A sound is introduced into the bladder. Skin incision exposing the bulbocavernosus, transversus perinei and sphincter ani muscles (b). c. Exposure and division of the rectourethral muscle close to the membranous urethra. Rectum is displaced.

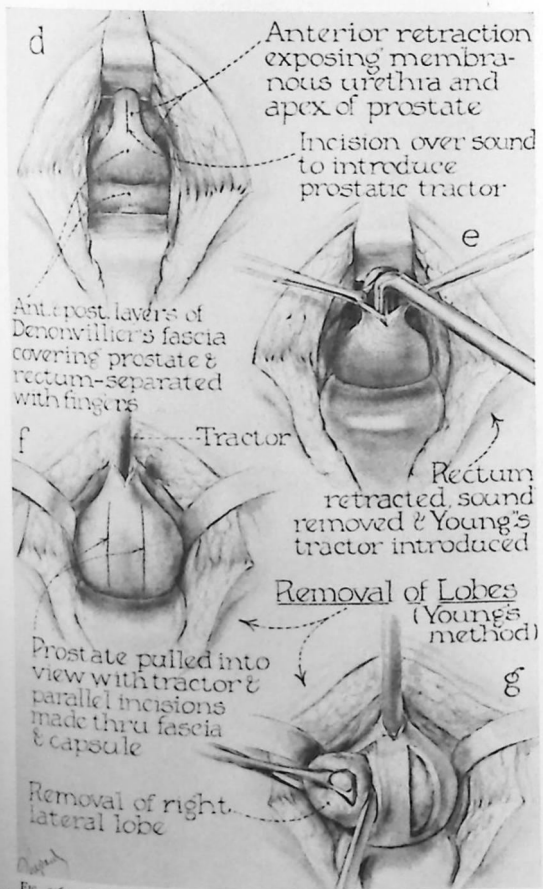


FIG. 2061. Perineal prostatectomy (continued). Proust's operation, later modified by Young. d. Duckbill retractor introduced exposing membranous urethra and apex of prostate in front and posterior retraction of Denonvillier's fascia. Incision of urethra at prostatic apex. e. Introduction of prostatic tractor. f. Parallel incisions into fascia and capsule of prostate. g. Removal of lobes of prostate. (Young's method.)

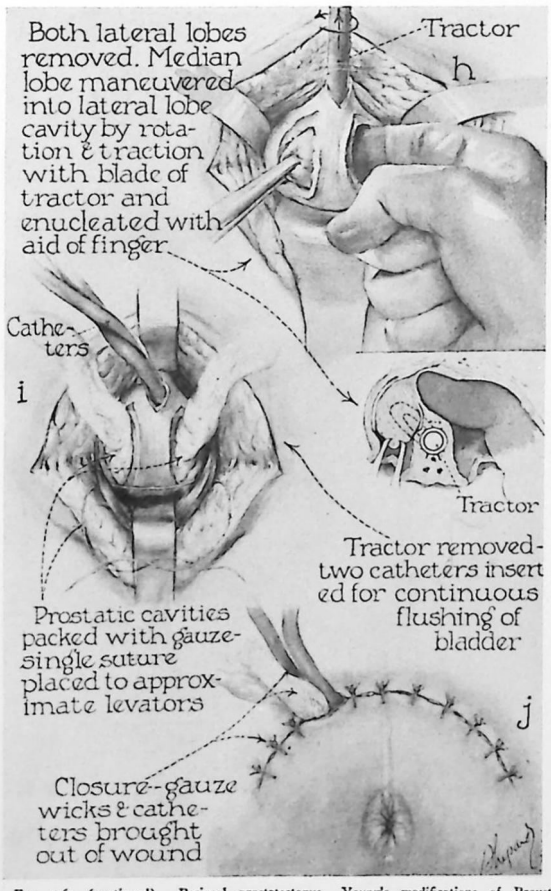


FIG. 2061 (continued). Perineal prostatectomy. Young's modifications of Proust's operation. h. Method of removing median lobe after both lateral lobes have been removed. Tractor and finger aid in enucleation (see insert). i. Prostatic cavities packed with gauze. Levators approximated with a single suture after tractor has been removed. Two catheters inserted into the bladder for continuous lavage. j. Closure of wound.

to cover a staff inserted through the urethra. Bring the edges of the urethra together with several catgut sutures, beginning at the vesical extremity of the wound, leaving enough space in front to insert a drainage tube into the bladder after the staff is withdrawn. Introduce a catheter into the bladder through the penis. This is for the purpose of irrigating the bladder and not for carrying off the urine which flows through the perineal tube. Bring together the levatores ani and adjoining structures by means of one or two deep catgut sutures. Place gauze drains in the perineal wound while the posterior skin flap is held in place by sutures on each side, leaving the central part open through which the gauze emerges. Dressings are held in place with a broad T-bandage, pressure being applied between the coccyx and the anus thus bringing the bladder and urethra in apposition with the rectum in the deeper parts of the incision.

A perineal tube conducts the urine to a receptacle under the bed. Irrigate the bladder twice a day and change the dressings daily after the second day. Remove the perineal tube after a week. The catheter is changed and cleansed from time to time but is not removed until the perineal wound is completely closed (usually three to five weeks) after which the urine is allowed to pass through the penis.

Albarran's Modification. This consists of removing the lobes by morcellation instead of in toto. Proust admits there are cases, especially where the prostate is friable, where this procedure is preferable.

YOUNG'S MODIFICATION OF PROUST AND ALBARRAN'S OPERATION (1903)

Young follows Proust and Albarran's procedure quite closely with the following modifications (Fig. 2061 g, h, i, j):

(a) The perineal incision is inverted, V-shaped.

(b) The membranous urethra is opened so that a tractor may be inserted, and later on a drain; an effort is made to keep the prostatic urethra intact while removing the prostate.

(c) A central wedge of the prostate is left so as to preserve the ejaculatory ducts. On this account, after exposing the posterior surface of the prostate, make an incision on each side of the midline for almost the whole length of the posterior surface of the prostate about 1.5 cm. deep. The lines diverge, being about 1.8 cm. apart posteriorly and 1.5 cm. apart anteriorly. The ejaculatory ducts lie in the tissue between them, thus rendering the preservation of this strip of tissue important if these ducts are to be left uninjured.

(d) A double catheter is placed in the bladder through the membranous urethral wound and secured by a suture permitting continuous irrigation. This is left in place for 24 hours after which the urine flows through the perineal wound until it heals by granulation.

(e) Pack the lateral cavities with gauze. Remove the packing after 24 hours; no further packing is done.

SUPRAPUBIC PROSTATECTOMY

(McGill, Belfield, 1887; Fuller, 1895; Freyer, 1901)

The majority of surgeons prefer this to the perineal procedure. The operation is performed in two stages:

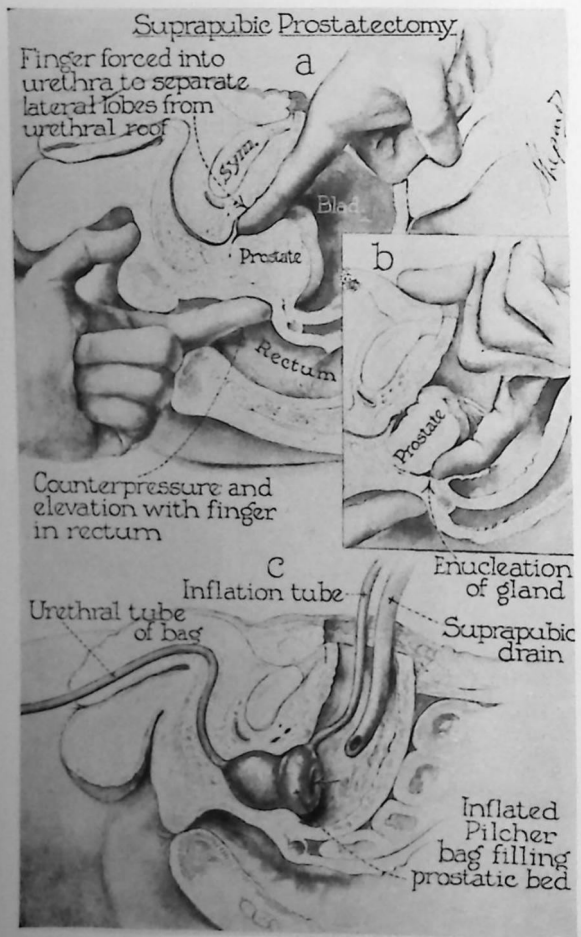


FIG. 2062. Suprapubic prostatectomy. a. Technic of enucleating the prostate with the finger. b. Mucous membrane torn through and finger enucleation begun. c. Drainage of bladder. Use of Pilcher hemostatic bag.

(A) Suprapubic Cystostomy.
(B) Transvesical Enucleation of the Prostate.

(A) Suprapubic Cystostomy

(B) Transvesical Enucleation of the Prostate

Step 1. Spinal or nitrous oxide-oxygen anesthesia; local infiltration anesthesia may be used to advantage. Trendelenburg position. Preparation of the field of operation. Catheterize the bladder. Wash it out with any antiseptic solution leaving some solution in the bladder. The catheter is left in situ.

Step 2. The incision in the bladder is usually short, about 1½ inches; if only a finger enucleation unaided by the eye is contemplated. If a complete exposure is desired so that the operation is carried out under the surveillance of the eye, a large opening is essential.

Enucleation of the prostate without ocular guidance: Introduce the index finger of the left hand into the rectum; push the prostate upward and forward (Fig. 2062). The forefinger of the right hand is introduced through the suprapubic opening. With the finger nail make a tear in the mucous membrane covering the most prominent intravesical portion of the prostate. The enucleation is begun externally; the mucous membrane covering the lobe of the prostate is pushed away and with it the vesical neck. The finger works its way between the mucous membrane and the prostatic substance hugging the latter closely. Reaching the anterior surface of the prostate, the prostatic lobes are separated from the mucous membrane of the urethra as completely as possible. The adhesions at the apex of the gland are broken through. The capsule is thus separated from the prostatic sheath. The finger is then swept in a circular fashion from without inward, in front of and to the inner side of the lobe detaching it from the urethra which is felt covering the catheter. The other lobe is treated in similar fashion. With downward pressure, the finger passes immediately behind the posterior surface of the median lobe or commissure and above the ejaculatory ducts. The urethra usually breaks off at the triangular ligament, a short distance above the "cock's comb" (veru montanum). The opposite enlargement undergoes the same digital manipulation. Vigorous upward pressure by the finger in the rectum is of great aid to the enucleating finger in the bladder, and when totally freed the prostate is pushed by the finger in the rectum into the bladder, whence it is extracted with a pair of strong forceps, through the suprapubic wound. Occasionally the lobes become detached along both anterior and posterior commissures and come away separately. A strong compression forceps properly used will much reduce the size of the freed gland so that it may be delivered with greater facility.

Step 3. There is no advantage to be gained, some authors argue (Freyer), by leaving the vesical end of the urethra behind. The finger in the rectum pushes up the prostatic bed while the finger in the bladder compresses the intervening tissues on top of it for a short period. Massage, thus carried out, diminishes the size of the prostatic bed; bleeding ceases. The procedure may be likened to uterine massage or the kneading of the gums by the

dentist. Irrigate the bladder through the catheter still in situ with hot boric acid solution at about 110° F. This irrigation must be short (one or two minutes); if persisted in too long it encourages bleeding instead of arresting it. Introduce a large drainage tube into the suprapubic wound (Fig. 2062 c). The management of this tube in the postoperative care is regarded as of utmost importance. The size of the tube is of importance. Freyer states, "I now invariably employ ⅞ inch tubing with a lumen of ⅝ inch in diameter." Two large fenestrae are made near the vesical end of the tube. It is of importance that only about an inch or so projects into the bladder. If permitted to project into the bed of the prostate its contraction is retarded and much annoyance is experienced by the patient (pain radiating to the penis; vesical tenesmus, etc.). Bring the edges of the wound around the tube (a large de Pezzer may be used to advantage). Close the abdominal wall with as few silkworm-gut sutures as possible. Use no buried sutures; they are sure to become infected. One of the sutures should transfix the tube.

Step 4. Remove the urethral catheter. Pack or use a Pilcher bag if necessary. Drain the space of Retzius. Dress the wound with voluminous dressings.

J. E. Cannaday's Technic of Suprapubic Prostatectomy

Historical Notes. This technic is based, in part, on the early work of Dr. Harris of Sydney, Australia, Lower of Cleveland and Neff of Charlottesville. Suture of the floor of the bladder for control of hemorrhage was probably first carried out by Deaver. He sutured the bladder mucosa over a gauze pack. Later, Judd attained hemostatic control by placing interrupted sutures around the torn edges of the bladder mucosa, and thereby was able to control bleeding subsequent to prostatectomy. Both Lower and Harris carried out plastic reconstruction procedures on the floor of the bladder. Cannaday's method differs to some extent from that of the others in that the indwelling catheter is first placed in the urethra, after which the reconstruction is made around the catheter. The edges of the bladder mucosa are brought together in such manner that practically all of the raw surface is covered.

Stage I

Step 1. Make a transverse incision down through the skin and fat to the bladder wall. Do not enter the perivesical space.

Step 2. Pack the wound with vaseline-gauze (Neff). Leave the gauze pack in place from eight to ten days. (In some cases Cannaday sutured the skin over the gauze packing.) This builds up a defensive wall that will protect the prevesical space from subsequent infection. Introduce an indwelling catheter wherever it is advisable to have suprapubic drainage instituted.

Stage II

Step 1. About two weeks later, after the patient has become properly stabilized, especially with reference to blood and urine chemistry, the prostate is enucleated through a suprapubic incision mainly by digital dissection (Figs. 2063-2064).

Step 2. Introduce an indwelling urethral catheter into the bladder (Fig. 2065).

Step 3. Reconstruct the floor of the bladder along the lines suggested by Lower (Fig. 2066). Transfix the tip or eye end of the catheter with a non absorbable suture (linen or silk). Bring this suture out through the fundus of

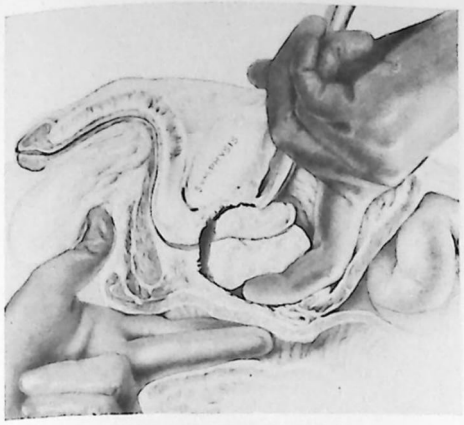


FIG. 2063. Digital enucleation of hypertrophied prostate.

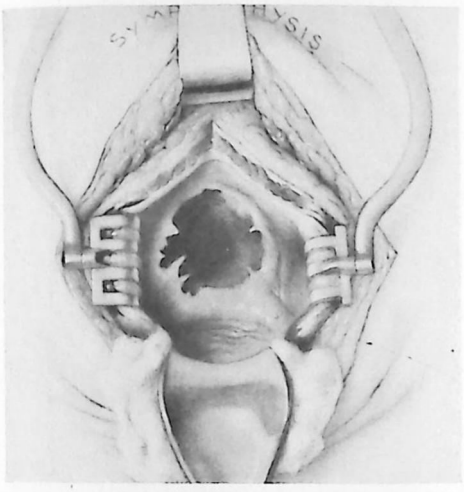


FIG. 2064. Bed of prostate after digital enucleation. (Courtesy, Dr. J. E. Cannaday.)

the bladder and secure it over a button or piece of rubber tubing so as to prevent the catheter from slipping out of the bladder (Figs. 2067-2068).

Step 4. Secure perfect hemostasis by meticulous reconstruction of the floor of the bladder with interrupted catgut sutures carried on an offset or boomerang type of needleholder. Where reason exists to doubt that hemostasis is perfect the fundus of the bladder is left open; otherwise it is closed.

Step 5. Close the abdominal wound partially.

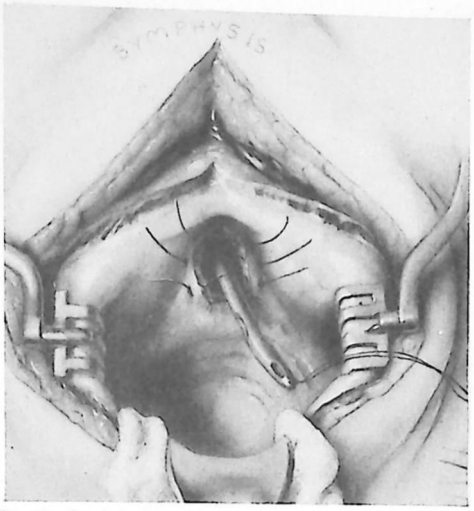


FIG. 2065. Introducing indwelling catheter. (Courtesy, Dr. J. E. Cannaday.)

Comment. Leave the indwelling catheter in the bladder as long as feasible (usually about a week). Cannaday states that many patients thus operated on were able to void naturally two or three days after removal of the indwelling catheter.

Squier's Intraurethral Method

With the index finger in the prostatic urethra, the point of least resistance in the urethra is sought, which usually is on the lateral walls, where division between the prostate and urethra is accomplished with ease. After the finger has found its way to the proper line of cleavage, it sweeps first slowly around the distal portion of the adenoma, and then upward over the anterior surface of the tumor, separating it from the prevesical space. The finger then glides over the urethra to the other side and the opposite lobe is freed similarly. The operating

finger then pushes the loosened adenoma into the bladder after detaching it in all directions and from the urethra.

Comment. Following the removal of the prostate, all foreign material should be removed from the bladder (blood clots, portions of prostatic tissue, calculi).

Control of hemorrhage is effected by

(a) Natural contractions of the prostatic bed.
(b) Massage of the prostatic cavity as detailed above.
(c) Bag hemostasis—the inflatable bag of Hagner or Pilcher's hemostatic bag.

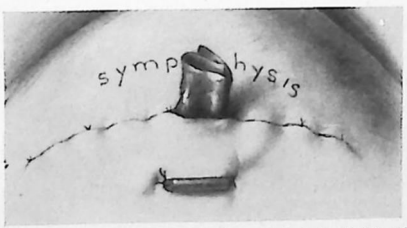


FIG. 2068. Method of fixing indwelling catheter in prostatic bed and skin. (Courtesy, Dr. J. E. Cannaday.)

Suprapubic Prostatectomy Under Visual Guidance
(Thomson Walker, Judd, Hunt)

In cases where firm, fibrous adhesions prevent enucleation of the prostate as described above, the patient is put in full Trendelenburg position, the prostatic bed is exposed, bleeding vessels caught and ligated, tags of mucous membrane are trimmed away and in difficult cases, the mucous membrane about the adenomatous mass, incised by the scissors under adequate exposure and illumination.

ELECTROSURGICAL RESECTION OF THE PROSTATE*

Periurethral Resection (McCarthy's Operation)

Step 1. Put a lead belt around the patient's waist. Connect it to one terminal of the diatherm apparatus. A pad is inserted between the buckle and skin to prevent sparking.

Step 2. Inject 20 cc. of coagulen (Ciba) into one buttock. Paint the external genitals with a 3 per cent picric acid solution and isolate them with sterile towels.

Step 3. Screw the operating table to its highest position. Lubricate the sheath of the electrotome and with its obturator in position, pass it gently down the urethra. If any obstruction is encountered at the neck of the bladder, withdraw the instrument. Dilate the obstruction with graduated sounds up to a degree which will permit the electrotome to pass (Figs. 2069-2670).

Step 4. Remove the obturator.

FIG. 2066. Reconstruction of the floor of the bladder.

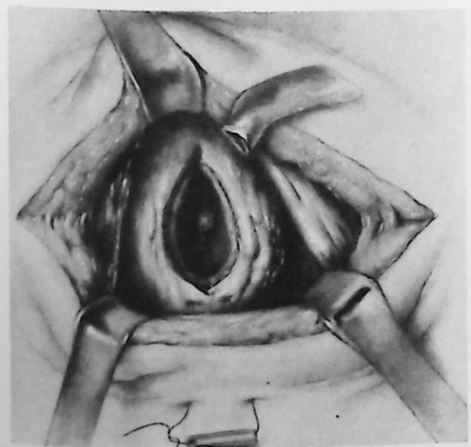


FIG. 2067. Method of anchoring indwelling catheter. (Courtesy, Dr. J. E. Cannaday.)

* See also "Operations for Obstructions of the Trigonum Vesicae," p. 1961.

Step 5. Allow residual urine to escape. Wash out the bladder with sterile water until the return flow is entirely clear.

Step 6. Attach the cords from the battery to the telescope of the loop-electrode carrier and test the light.

Step 7. Insert the carrier with retracted loop into the sheath. Connect the inflow cock on the sheath to the irrigating stand and attach a piece of rubber tubing to the outflow cock which is permitted to hang in a floor receptacle.

Step 8. Attach the cable from the diatherm apparatus to the electrotome. Examine the prostate thoroughly. Orientation as to the position of the

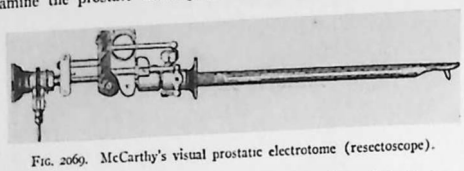


Fig. 2069. McCarthy's visual prostatic electrotome (resectoscope).

median lobe or prostate bar is essential. Withdrawal of the instrument into the posterior urethra gives one an estimate as to the extent of the intravesical enlargement of the obstructing prostate.

Step 9. Locate and inspect the veru montanum and the sinus pocularis into which the two ejaculatory ducts open. The topographic anatomy is of vital importance and the landmarks mentioned must be avoided from inclusion by the electrocutting loop.

Step 10. Empty the bladder. Open the inflow cock. Advance the cutting loop. Hook it over the edge of the prostatic neck.

Step 11. Elevate the ocular end of the instrument allowing the loop to engage the enlarged, projecting portion of the prostate (Figs. 2071-2072).

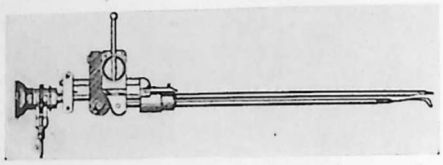


Fig. 2070. McCarthy's visual prostatic electrotome (resectoscope).

Step 12. Turn the current dial on setting No. 5. Wait a moment until the loop heats up. Drag the loop slowly forward through the large median lobe by rotating the pinion handle of the instrument. During the second half of the cut the small lever on the pinion block forces the telescope back by engaging with its pin. When the cut is completed, close the inlet cock, turn off the current and remove the electrode carrier from its sheath (Fig. 2073). This will permit the bladder to empty itself. The cut is about 1 inch long and it should take about 10 seconds to perform. At no time should force be applied to the pinion handle. If this precaution is not heeded the loop is

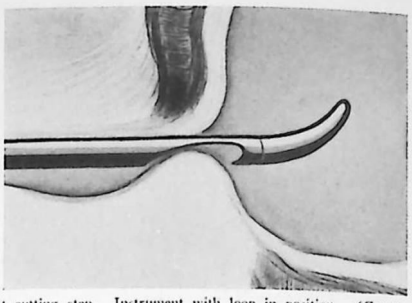


Fig. 2071. First cutting step. Instrument with loop in position. (Courtesy of Dr. J. F. McCarthy, Penn. Med. Jour.)

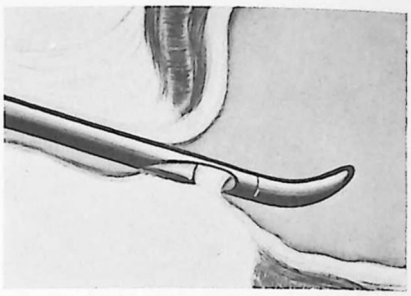


Fig. 2072. Tissue partly severed. (Courtesy of Dr. J. F. McCarthy, Penn. Med. Jour.)

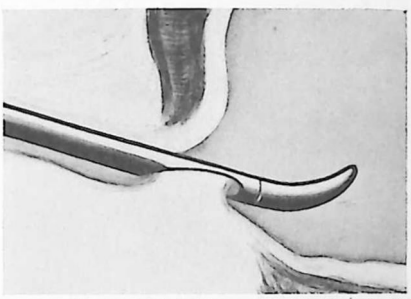


Fig. 2073. First step in cutting completed. (Courtesy of Dr. J. F. McCarthy, Penn. Med. Jour.)

liable to break or bend, causing bleeding. As a rule, the excised portion of the prostate adheres to the cutting loop and is removed by forceps. Before inserting the loop electrode carrier to perform the second cut, the small lever on the pinion block which has been forcing the telescope back is raised and the latter pushed home. This is repeated from 10 to 20 times, the object being to have the floor of the posterior urethra leveled as far as possible in one straight line. Be sure that while cutting, the water flows into the bladder distending it partially at the beginning of the incision, thus preventing burning the mucous membrane or perforating its wall. Bubbles which result from the cutting process obscuring the view can generally be dislodged by rotating the instrument. J. C. Aynesworth Davis points out that any vessels may be ignored while water is running into the bladder.

Step 13. When through, withdraw the electrode carrier from the sheath and replace it by a button electrode.

Step 14. Survey the field for any bleeding vessels in the posterior urethra and if any are found insure hemostasis by coagulation.

Comment. Too rapid resection encourages hemorrhage. Hemostasis must be perfect. Ragged edges must be destroyed with the electrode and cut portions of prostate searched for and removed. The flow of the irrigating fluid must be rapid. McCarthy employs two telescopic attachments, ready for immediate use. When resection of the floor is completed, one lateral lobe is attacked and then the other. McCarthy leaves an indwelling catheter from two to four days. The operation may be completed in one or more stages. He points out the occurrence of encrusting cystitis which may result in pyelonephritis and he stresses the limitations of the operation. Only an experienced surgeon should undertake this operation. Bransford Lewis admonishes against excessive optimism with this operation. In a recent résumé entitled "Prostatic Resection Without the Moonlight and Roses"[1] this is ably discussed by Lewis.

SUPRAPUBIC RESECTION

J. C. Aynesworth Davis' Method

By this method, the prostatic tissues to be removed are made visible and the entire operation is carried out under ocular guidance.

Step 1. Place a lead plate covered with gauze soaked in salt solution under the patient's buttocks and connect the plate to one terminal of the diatherm machine, inserting a pad between the buckle and the skin to prevent sparking.

Step 2. Inject 20 cc. of coagulen (Ciba) into a buttock of the patient and paint the buttocks with a 3 per cent picric acid solution. This preparation should include the skin, lower abdomen and external genitals. The front and inner aspects of the thighs should also be included, particular attention being paid to the glans penis.

Step 3. Pass a catheter. Wash out the bladder and do a suprapubic cystotomy.

Step 4. Place the patient in the Trendelenburg position. Insert a self-illuminating bladder retractor. Inspect the prostate.

Step 5. Seize the intravesical projection of the median lobe or posterior margin

[1] Urol. and Cut. Review, Jan., 1933.

of a fibrous prostate with a pair of special prostatic forceps. Pass the enlargement through the cutting loop and withdraw it as far as possible into the cavity of the bladder in the manner of engaging a tonsil in a snare.

Step 6. Excise the seized portion of the prostate by means of the cutting loop mounted on a bakelite handle connected by an insulated cable to another terminal of the diatherm apparatus. Any spurting vessels are sealed by the prostatic forceps by bringing the diatherm loop in contact with the forceps while switching the current on momentarily. The vessels will promptly be sealed by coagulation. The other portions of the prostate needing removal are treated similarly.

Step 7. When this part of the operation is completed, hemostasis assured and oozing controlled by the button electrode, disconnect the diatherm current. J. C. Aynesworth Davis admonishes that much experience is necessary to gauge the extent of prostate to be removed pointing out that if too little tissue is taken away the obstruction persists and healing of the wound will be either considerably delayed or prevented.

Step 8. Close the bladder around the proper tube as described under cystostomy.

Step 9. Dress the wound.

PROSTATECTOMY FOR CARCINOMA OF THE PROSTATE

The first operation for removal of the prostate for carcinoma was done by Billroth and later by Zuckerkandl. Among French surgeons, Gosset, Proust, Albarran and others; in America, Young, Goodfellow, Watson and others; while in Germany, Czerny, Völker and others contributed to the development of the operation.

Young's Radical Operation for Carcinoma of the Prostate[1, 2, 3]

Step 1. Make an inverted-U incision with the lateral incisions about an inch longer than is usually practiced. Divide the levator ani muscles slightly on each side.

Step 2. Retract the wound to afford thorough exposure.

Step 3. Insert Young's prostatic tractor into the exposed and incised membranous urethra.

Step 4. Free the rectum carefully from the posterior surface of the prostate and from the seminal vesicles above, care being taken not to penetrate the Denonvilliers fascia anteriorly or to enter the prostate or seminal vesicles covered by it.

Step 5. Free the lateral margins of the prostate by blunt dissection. At this stage of the operation, make a careful inspection to make sure that the carcinoma has not extended beyond operative limits and that at least the upper portions of the seminal vesicles are free from invasion and that no malignant infiltration of the lymph nodes along the pelvic wall on either side has taken place. If in doubt, Young counsels that a frozen section should be made for prompt verification of the diagnosis.

Step 6. Search for a point along the lateral surface of the prostate where the fascia springing from the lateral wall of the pelvis divides to encircle the

[1] H. H. Young, Johns Hopkins Bull., 1905, XVI, 305-321.
[2] ——— Idem. Ann. of Surg., 1909, XLIX, 1144-1233.
[3] ——— Idem. Practice of Urology, p. 654.

prostate. Incise the posterior layer close to the prostate and by means of blunt dissection strip the anterior layer from the prostate on either side until the membranous urethra is reached.

Step 7. Make downward traction with the tractor and divide the membranous urethra transversely at a point below the membranous urethrotomy wound.

Step 8. Continue blunt dissection upward. Push away the anterior layer of the fascia and free the prostate until the bladder is reached, immediately above the vesical prostatic juncture in the median line. Plunge a scalpel into the bladder. Enlarge the wound on each side and place a long retractor within the anterior wall of the bladder thus exposing its interior. Identify the trigone of the bladder.

Step 9. Divide the trigone of the bladder by means of a curved incision, the knife passing within 1 cm. of the urethral orifice on each side and dividing the muscles of the trigone and the bladder wall beneath it.

Step 10. Push the bladder upward by blunt dissection and expose the anterior surface of the seminal vesicles and vasa deferentia.

Step 11. Continue this dissection upward until the tip of the seminal vesicle is reached and its ampulla is isolated.

Step 12. Pick up the respective vas deferens with a hook. Divide the fibrous attachment of the upper portion of the seminal vesicle. Clamp these and ligate them carefully in order to avoid bleeding.

Step 13. Clamp the vasa deferentia, divide them and remove en bloc the entire prostate, with its capsule, with the freed cuff of the bladder, and both seminal vesicles and ampullae. Inspect and make sure that the entire tumor has been removed. If portions of suspicious tissue remain, Young counsels the introduction of radium.

Step 14. The large open wound of the bladder must now be anastomosed with the membranous urethra. This is accomplished by pulling down the anterior part of the bladder wall and joining it with the stump of the membranous urethra by means of heavy chromic catgut sutures so that the sutures include the mucous membrane and the ligature knots are placed exteriorly. About eight or ten sutures are sufficient to accomplish this anastomosis. Young admonishes that the sutures should be placed deeply through adjacent muscle structures, and not tied too tightly. A catheter projects into the bladder during this procedure and it is left in place for drainage.

Step 15. Close the remainder of the bladder posteriorly by continuous chromic catgut sutures not including the mucous membrane.

Step 16. See that hemostasis is perfect. In one of Young's cases a blood vessel retracted, giving rise to retroperitoneal hemorrhage.

Step 17. Unite the levator ani muscles with chromic catgut sutures. Close the wound without drainage. Fasten the indwelling catheter to the penis with adhesive plaster.

PROSTATOTOMY

Operation for Prostatic Abscess

Place the patient in an exaggerated perineal position. Both lobes of the prostate are usually explored to make sure that a suppurative focus in one of the lobes does not escape detection.

Step 1. Shave and prepare the perineum. Anesthetize the patient and place him in the lithotomy position.

Step 2. Introduce the index finger of the left hand into the rectum; explore for points of fluctuation.

Step 3. Introduce the point of a sharp-pointed long scalpel through the median raphé of the perineum about an inch in front of the anus, directing it with firm pressure toward the finger in the rectum (Fig. 2074); enlarge the external incision as the knife is withdrawn.

Step 4. Introduce a stout curved clamp into the abscess cavity and withdraw it with jaws open.

Step 5. Discard the infected glove of the left hand. Don a fresh one.

Step 6. Introduce the finger into the abscess cavity; explore; break down septae and accessory collections of pus.

Step 7. Introduce a large drainage tube into the abscess cavity; fix it to the skin with a suture; irrigate the abscess cavity.

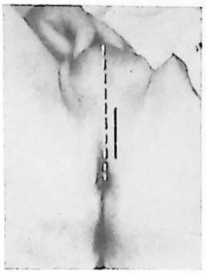


Fig. 2074. Dotted line indicates outline of raphé. Incision for opening a prostatic abscess indicated by vertical line.

Comment. When bleeding is profuse pack with iodoform gauze. If during these manipulations the urethra has been opened, introduce a catheter into the bladder through the urethral opening and encourage drainage for a few days.

The rectum or bladder may be opened during the operation; if so, repair the injured viscus at once. John Cunningham, Jr., opened the rectum six times, the bladder three times and the peritoneum three times in over four hundred operations. The end-results were satisfactory after prompt repair of the injury.

The less expert will do best to abstain from extensive dissections in this area and be satisfied with a less radical undertaking. In early cases conservative measures may suffice. Often prostatic abscesses burst into the urethra.

OPERATIONS FOR OBSTRUCTIONS OF THE TRIGONUM VESICAE*

Historical Notes. Vesical obstruction caused by median bar hypertrophy was first described by Guthrie in 1830; Bottini of Pavia introduced the operation of division of the prostatic bar or outgrowth by means of the galvanocautery. An electrode shaped somewhat like a Mercier catheter is introduced into the bladder through the urethra. The beak of the instrument is turned around and the instrument pulled forward until it impinges against the obstruction. The current is then turned on and the obstructing portion of tissue is burned through. This procedure is known as the operation of Bottini and Chetwood and was done either transurethrally or by the perineal route—perineal galvanoprostatotomy (Chetwood).

Alex Randall in 1927 contributed his observations of post-mortem studies of this condition. Notable progress was made through the enlightening studies of Randall, Young, Caulk, Wesson and others of our time. A. R. Stevens (1913), Collings and Tolson, Maximillian Stern, Luys and Heitz-Boyer perfected instruments and set down

* See also "Electrosurgical Resection of the Prostate," p. 1955.

indications and data for the proper and timely performance of this operation in such conditions as enlarged median bar, contraction at the vesical neck, and small rounded posterior commissural hypertrophy without hypertrophy of the median lobe. Joseph F. McCarthy, De K. Rose, Collings, Foley, Day, Braasch and Bumpus have done much to popularize electrosurgical resection of the prostatic obstruction lesions.

Step 1. Anesthetize the urethra. Young advises the use of 4 per cent procaine in the bladder and deep urethra. Infiltration of the neck of the bladder by means of a spinal needle is counseled by Caulk; Eisendrath and Rolnick prefer caudal anesthesia.

Step 2. Introduce the sheath together with the obturator of the instrument into the bladder.

Step 3. Withdraw the obturator and evacuate the urine.

Step 4. Pull the instrument forward until the vesical orifice engages in the slot or fenestrum when the instrument is pressed firmly downward and is simultaneously drawn forward.

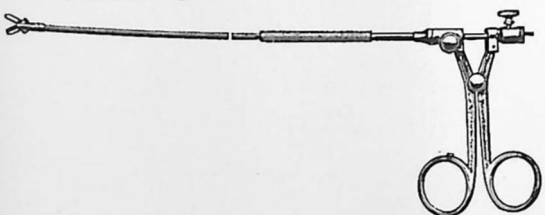


Fig. 2075. Cystoscopic bladder forceps.

Step 5. Introduce now the cautery blade through the sheath of the instrument until it engages the obstruction.

Step 6. Turn on the current; push the inner tube home, cutting away the tissue within the slot or fenestrum.

Step 7. Remove the ablated tissue with a long urethral alligator forceps (Fig. 2075).

Comment. Young points out that in order to remove all portions of the prostatic bar both median and lateral incisions are necessary. After completion of the operation, leave a catheter in the bladder for three or four days. Caulk emphasizes that the most important part of the operation is to maintain constantly firm pressure against the orifice in order to squeeze into the slot as much tissue as possible and retain it there. The average time for the action of the current is about four seconds. Do not omit, when removing the instrument, to have the cold cautery blade or obturator in place.

VESICULECTOMY

Hunt's Operation

Step 1. Make an incision in the median line about an inch above the anus to a little above the sacrococcygeal articulation. Carry the incision to the levator ani muscles.

Step 2. Divide the levatores ani in the midline; retract these laterally and expose the rectum.

Step 3. Excise the tip of the coccyx.

Step 4. Mobilize the rectum and displace it laterally, thus exposing the seminal vesicles. They are brought to view immediately after division of the recto-vesical fascia.

Step 5. Remove the vesicles together with the vas, where indicated. In oozing, pack lightly with gauze for forty-eight hours.

Step 6. Drain through a tube or cigarette drain.

Step 7. Reunite the divided levatores ani with chromic catgut.

Step 8. Close the skin.

Comment. Operating as outlined is not as technically difficult as with other procedures and obviates injury to the anal sphincters. It is less difficult than the perineal operation (Morrissey's and Young's Operation).

OPERATIONS ON THE SCROTUM AND ITS CONTENTS

Vasotomy and Vasectomy

Anesthesia. Infiltration with 2% novocaine.

Vasotomy

Step 1. Grasp the spermatic cord and steady it between the thumb and forefinger.

Step 2. Identify by palpation the vas deferens.

Step 3. Make a small linear incision over the tegmental coverings and deliver the vas by passing it forward.

Step 4. A blunt-pointed needle, attached to a syringe, filled with the fluid one desires to inject into the vas is thrust into the tubule and the fluid pressed home.

Comment. The two important features of the operation are:

(a) First, to fix the vas so that it does not slip away.

(b) The incision in the vas should only be large enough to permit the insertion of the vasotomy needle. Determine the patency of the lumen of the vas by introducing into its lumen a silkworm-gut strand. Methylene blue was used by the late William T. Belfield; a catheter in the bladder (per urethram) recovers the stained urine if patency of the vas is unimpeded. It is well to insert a silkworm-gut strand under the vas and through the skin and keep the vas closely apposed to the surface for the next twenty-four hours to prevent regurgitation of the fluid. This suture is removed after twenty-four hours. The procedure is nowadays looked upon simply as a test to ascertain the patency of the vas. Such therapeutic operations have been found valueless—hence the procedure has been abandoned as useless for all treatment of disease of the male genital adnexae (Rolnick).

Vasectomy

This procedure is frequently resorted to, preliminary to prostatectomy, to prevent ascending infection and consequent epididymitis. Vasectomy is also used

as a means of male sterilization. The term vasectomy means excision of the entire vas deferens. Partial vasectomy designates the removal of a section of the vas.

PARTIAL VASECTOMY

Step 1. Expose the vas as in the preceding procedure, through an incision in the skin immediately below the external abdominal ring, exposing the cord.

Step 2. Separate the vas from the other structures of the cord and divide it between two ligatures.

Step 3. Resect about half an inch of the vas.

Step 4. The divided, ligated ends are now brought into lateral apposition in such a manner as to frustrate the possibility of stomal reunion. This, as has been shown in experiments on lower animals, may ensue, if not guarded against (Rolnick). Close the wound in the skin.

Anastomosis of the Vas Deferens and Vaso-Epididymostomy

Historical Notes. A lateral anastomosis between the vas deferens and the head of the epididymis was practiced by Martin. The operation was performed entirely extraperitoneally; the suture material was catgut. The technical details and modifications were worked out by Fuller, Hagner, Bogoljuboff, Salvo, Quinby, McKenna, Rolnick and others.

Occasions may arise in surgery of the male genital organs where the vas deferens becomes torn, and an end-to-end or other anastomosis is necessary. This appears to have been done first by Parlavecchio, owing to a surgical accident. Some years later Lydston devised a method of cutting the ends off square, then introducing a filament of silkworm-gut on a filiform bougie through an opening in the side and sewing the two square cut ends together. The sheath of the cord was then sewed around the point of the suture and the bougie withdrawn after ten days. Later on Lydston reported that this method was not feasible when the distal end of the vas was atrophied, and that in such case the anastomosis of the proximal end must be made direct to the epididymis.

In **Davis' technic** the proximal end is cut off obliquely and pointed, the distal end being cut off on a short bevel. A piece of catgut threaded on a fine needle is passed through the tip of the proximal end, then introduced into the lumen of the distal end and made to pierce the wall, well beyond the opening. A second needle on the catgut is similarly brought out near the first. Traction is made on the threads and the pointed extremity of the proximal end enters the lumen of the distal end without trouble until its apex enters the point of emergence of the needles. The catgut is then tied and the apex is fixed in place. The distal end is fixed by a few fine sutures to the side of the proximal end. This operation is a modification of **Poggi's ureteral anastomosis.**

For "short-circuiting" the vas to the epididymis (especially in cases of male sterility) McKenna cuts down on the vas about two inches above the testicle, isolates and exposes the vas, and then slits and anastomoses it with the middle third of the epididymis.

Salvo has described a method of laterolateral anastomosis of the vas. Salvo's experimental work has been carried out on animals and he claims 50 per cent success Fig 2076 depicts a method of excising a stricture of the vas deferens with end-to-end anastomosis by means of a strand of silkworm-gut.

EPIDIDYMOVASOTOMY

(F. R. HAGNER'S TECHNIC)

The impetus to this operation has been given by Martin of Philadelphia.

Step 1. General anesthesia. Open the tunica vaginalis testis; expose the entire epididymis. Examine the parts. Ascertain the portion of vas to be anastomosed with the epididymis.

Step 2. Open the vas by a longitudinal incision (Fig. 2077). Explore the vas with the finest obtainable tear-duct probe; follow with a smooth strand of silkworm-gut. When the vas is found unobstructed proceed with the operation. Hagner admonishes that if the vas is found obstructed beyond a point 16 to 20 cm., chances are the vas is not patulous, hence the operation cannot succeed.

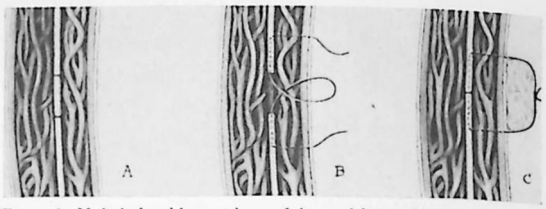


FIG. 2076. Method of excising a stricture of the vas deferens with end-to-end anastomosis by means of a strand of silkworm gut. A. Section of vas deferens removed. B. A strand of silkworm gut is inserted into each open end of the vas. C. The ends of the silkworm gut suture are tied over a gauze pad. (After B. W. Turner.)

Step 3. Cut out an elliptical portion from the epididymis (Fig. 2077). Promptly a milky fluid will issue which should be examined at once on a warm slide for live, motile spermatozoa. If no spermatozoa are found, close this incision and repeat the procedure at another place.

Step 4. The suture material is selected. Hagner states that fine silver wire was used in most successful cases; when other suture material was used, failures resulted. Hamilton Bailey propounds the question of why this should be so. Hagner states: "We cannot explain this unless there is less tissue reaction with silver wire than with other sutures."

Step 5. A lateral anastomosis is made between the opened vas and epididymis (Fig. 2078). Cut only into the lumen of the vas, taking care not to inflict injury to the wall opposite the incision. Place the first suture at the distal end of the incision in the vas. Take a substantial bite. Anchor this suture firmly in the lower end of the elliptical incision in the epididymis.

Step 6. Place two lateral sutures as shown in Fig. 2078. Include some of the tubules in the bite of the needle. Pass this suture through the cut edges of the vas, picking up just sufficient tissue to approximate the edges.

Step 7. Pass the last suture in the same manner through the upper end of the incision in the vas, taking care not to occlude the lumen.

[1] Young's Practice of Urology, W. B. Saunders Co., 1926, II, 541.

Comment. Hagner reports 21 cases. In this series, eight, or 38 per cent, were cured. The operation may be performed on both sides. If operation fails at the first sitting the procedure may be repeated. Hagner reoperated seven patients because of initial failure. Three of these were cured.

HYDROCELE OF THE TUNICA VAGINALIS TESTIS

Historical Notes. There is scarcely a condition for which so many therapeutic suggestions have been offered as for the relief of hydrocele. Internal medications and local applications were much in vogue. Tapping was practiced early. Electricity and electropuncture were much lauded. Injection of irritants was used extensively even up to the present day, although discarded by most surgeons as useless. Among

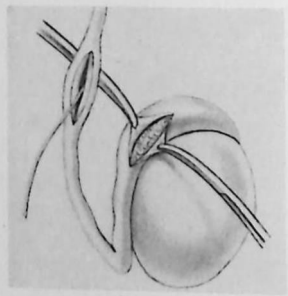


FIG. 2077

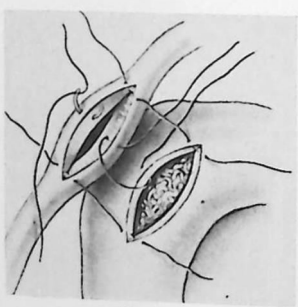


FIG. 2078

FIG. 2077. Hagner's operation for male sterility. First step: A fine strand of silkworm gut or finest tear-duct probe explores the vas deferens to ascertain its patency.

FIG. 2078. Hagner's operation for male sterility. Second step: Observe the placement of sutures of fine silver wire bringing into apposition the opened vas deferens and the head of the epididymis to create a lateral anastomosis between these two structures, thus side-tracking the obstruction in the vas.

the fluids injected into the sac for purposes of obliteration were wine, acids of one sort or another, iodine, chlorine, zinc chloride, bichloride of mercury, chloroform, alcohol, ether, silver-nitrate, ergotin, etc. Foreign bodies (metal strips, rubber tubes, silk, catgut, etc.) were advised on the basis that irritants are of only transitory value. Vaccine therapy: Mallanah used B. pyocyaneus or staphylococcus aureus; autoserotherapy: abstraction of hydrocele fluid and reinjecting it into the patient (buttock, thigh, abdomen) was said by some to cause regression and cure of the hydrocele (Cafforio). Heterosero-therapy produced no effects. Radical operation has been practiced since the time of Celsus. Volkmann in 1876 devised an operation which consisted of wide incision of the sac, swabbing the cavity with carbolic acid and sewing the edges of the sac to the skin with catgut. Drainage resulted and obliteration of the sac by granulation ensued. Von Bergman in 1885 was first to practice excision of the sac.

The procedures for the relief of hydrocele are either

(a) palliative (tapping) or

(b) radical.

Anatomic Considerations. The relation of the testis to the accumulation of fluid in the tunica vaginalis varies; it is usually behind the hydrocele and occasionally below it. The superimposed structures may glide loosely over the fluid-collection or

be tensely apposed to it, depending upon the degree of fluid distension. The scrotal blood vessels are usually seen coursing through the tissues near the surface of the hydrocele. It is important that the position of the testicle in relation to the hydrocele should be determined before any operative procedure is executed. This is best accomplished by transillumination. A hydrocele may be bilocular or even multilocular.

Tapping of a Hydrocele

This simple operation requires a small trocar and cannula, or an aspirating syringe of proper size (Figs. 2080-2081).

Step 1. The scrotum to be tapped is properly prepared (shaved and cleansed).

Step 2. Seize the affected scrotal section and make it tense with the left hand. Ascertain carefully the position of the testicle and note precisely the course of the scrotal vessels. Avoid these scrupulously during the tapping.

FIG. 2079. Blocking the nerves at the base of the penis. The penis is surrounded by a wheal of anesthetic solution blocking the nerves in its entire circumference. For tapping a hydrocele a little anesthetic solution is deposited at the point of puncture of the trocar on the scrotum.

Step 3. Hold the trocar in the right hand and guard it by the index finger to prevent too deep penetration of the instrument. Plunge the trocar quickly, upward and backward, into the distended scrotum at about the junction of its middle and lower thirds. By compressing the scrotum the fluid contents are evacuated.

Step 4. Touch the puncture made by the trocar with a dab of iodine.

Step 5. Apply a little collodion and a dressing.

Comment. The trocar may injure the testicle, epididymis or, perchance, a herniated loop of bowel. This may be avoided by exactly locating the fluid by means of transillumination. The point of the trocar should be sharp, for it, or an ill-fitting cannula, or a halting thrust may push a thickened tunica vaginalis in front of the instrument. Avoid puncturing of a scrotal vein (extravasation, ecchymosis). In old men with large hydroceles, it is advisable to remove the fluid partially, followed later by the removal of the remainder. After complete aspiration of large hydroceles, congestion and hemorrhage have been reported. After tapping, the hydrocele usually refills in from two to six months.

Operations for Hydrocele

SIMPLE EVERSION: ANDREW'S "BOTTLE" OPERATION

Step 1. Open the tunica vaginalis at its upper pole and evacuate its fluid contents.

FIG. 2080

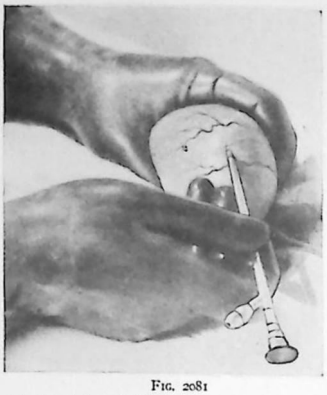


FIG. 2081

FIG. 2080. In evacuating a hydrocele be careful not to injure the blood vessels of the scrotum. Illustration shows wrong way of aspiration.

FIG. 2081. Evacuation of hydrocele. Proper way of introducing trocar between blood vessels.

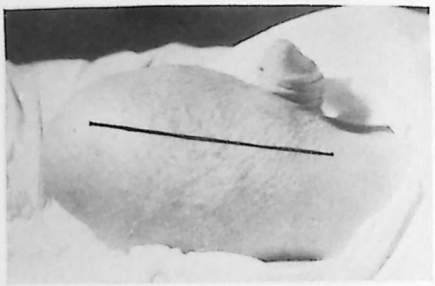


FIG. 2082. Jaboulay's operation. Hydrocele. Incision is made over most prominent part of hydrocele. Length of incision exaggerated in illustration.

Step 2. Bring the testicle outside the scrotum extruding it through the opening in the sac, which is to be only large enough to permit the passage of the testis through it (Figs. 2080-2081-2105, p. 1986).

Step 3. Turn the sac simply inside out without suture or, what is much better, pass one or more sutures through the divided edges of the sac, securing them behind the cord to prevent reinversion.

FIG. 2083. Disengagement and delivery of parietal layer of tunica vaginalis testis from inside of scrotum.

Step 4. Reposit the testis and everted tunica vaginalis into the scrotum.

Step 5. Close the wound without drainage.

Comment. The disadvantages of this procedure are that it is not successful in old thickened hydroceles and that recurrences are frequent.

FIG. 2084. Jaboulay's operations. Evacuation of the hydrocele contents by means of a trocar.

EXCISION AND EVERSION: JABOULAY OPERATION

Excision and eversion of the sac with suture behind the epididymis is the procedure accepted today as the best type of operation in hydrocele. Jaboulay's eversion operation for hydrocele is performed as follows:

Step 1. Open the tunica vaginalis testis by an incision shown in Fig. 2082.

Step 2. Deliver the testis through this aperture. Excise partially the tunica vaginalis (Figs. 2083-2084-2085).

Step 3. Suture the edges of the tunica vaginalis together behind the spermatic cord (Figs. 2086-2087-2088).

Comment. This turns the sac completely inside out, thereby bringing the secreting surface against a connective tissue layer. The method has the advantage that it can be done through a short high incision in which local

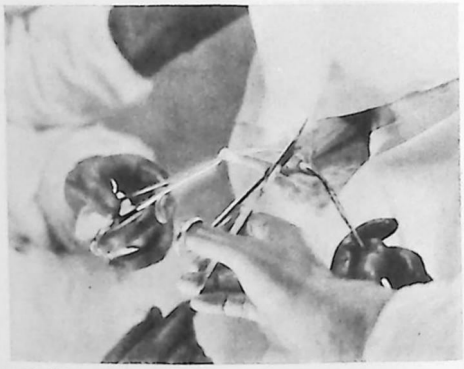


FIG. 2085. Jaboulay's operation. Opening and trimming away of redundant and thickened tunica vaginalis testis. Leave sufficient tunica vaginalis testis behind so it can be stitched about the cord loosely without strangulation.

FIG. 2086. Jaboulay's operation. Placement of first suture uniting the edges of the tunica vaginalis testis.

anesthesia may be advantageously employed. In Jaboulay's operation the smooth endothelial surface of the tunica will be in contact with the raw scrotal connective tissue and will adhere to it.

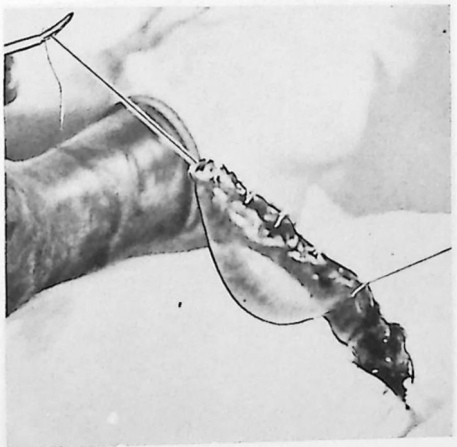


FIG. 2087. Jaboulay operation. Showing placement of sutures.

FIG. 2088. Jaboulay operation completed.

WINKELMAN'S OPERATION FOR HYDROCELE

Step 1. Dissect free the parietal layer of the tunica vaginalis.

Step 2. Trim off the sac to within one-half inch of its visceral insertion.

Step 3. Unite the two cut edges of the parietal stump of tunica with catgut sutures behind the testis. All bleeding points must be secured.

Step 4. Close the wound with (if suspicion of incomplete hemostasis exists) or, preferably, without drainage.

Step 5. Apply a snug dressing.

Comment. Operations for hydrocele may be followed by hemorrhage, atrophy of the testis (rare) and recurrence (5 per cent, H. L. Stanford).

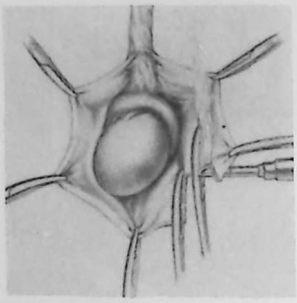


FIG. 2089

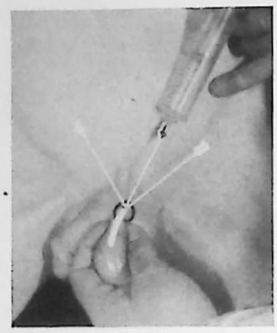


FIG. 2090

FIG. 2089. Hamilton Bailey's method of excising the tunica vaginalis testis for the cure of hydrocele by means of an electric cautery.

FIG. 2090. Blocking the nerves of the spermatic cord. Insert the needle at the point where the cord crosses the horizontal ramus of the os pubis. Deposit the anesthetic solution as indicated by the arrows. See also Fig. 2079, p. 1967.

HAMILTON BAILEY'S TECHNIC

Hamilton Bailey excises the hydrocele sac by means of the electrocautery. He proceeds as follows:

Step 1. Local anesthesia—1 per cent novocaine along the line of an inguinal incision.

Step 2. Identify the cord and inject it thoroughly with the same solution with a hypodermic needle. In order to obviate discomfort during the delivery of the hydrocele, the fluid is evacuated by tapping. Particularly is this advisable in cases of large hydroceles.

Step 3. Deliver the testicle onto the surface and open the sac to the extent of its entire length.

Step 4. Ablate the sac by means of the diatherm apparatus or any other form of cautery as near the testicle as possible (Fig. 2089).

Step 5. Place additional ligatures over the cauterized stumps wherever it seems desirable. This dual precaution will definitely assure against scrotal hematoma.

OPERATIONS FOR VARICOCELE

Anatomic Considerations. The spermatic vein (and its pampiniform plexus) originates at the posterior border of the testicle as a thick network of eight or ten ves-

sels lying anteriorly, and passing upward through the inguinal canal and uniting into one trunk in the abdominal cavity and passing on the right side into the vena cava, on the left into the left renal vein. Besides these there come under consideration the vas deferens and three arteries. The spermatic artery lies in front and the differential artery on the side of the vas deferens and the cremasteric artery at the outer side (superficially).

Step 1. Local or general anesthesia; the latter is preferable in neurotics. Expose the spermatic cord through a liberal incision in the upper part of the scrotum and extending partly along the inguinal region (Figs. 2079, p. 1967; 2090-2105, p. 1986).

Step 2. Deliver the cord; examine the parts thoroughly; expose the enlarged venous bundle; isolate the vas; recognize the spermatic artery.

Step 3. With the fingers separate the large plexus of veins to be excised from the vas and the spermatic artery; leave a smaller number of veins to carry on the return circulation.

Step 4. Clamp the venous bundle to be excised, above and below. Avoid the spermatic artery.

Step 5. Remove the large veins between the two clamps, to the extent of about two or three inches.

Step 6. Ligate the stumps with catgut and bring them together side by side, thus elevating the testicle.

Step 7. Return the exteriorized testis and cord into the scrotum.

Step 8. Suture the scrotal structures carefully. Do not drain. Keep the testicle elevated.

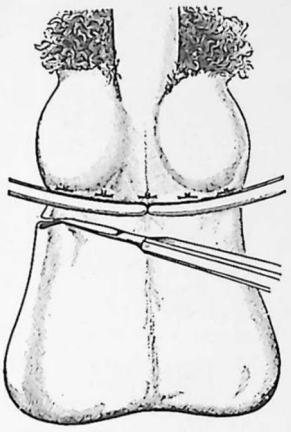


FIG. 2091. Resection of scrotum for varicocele. (Hartmann.)

Comment. A search for the spermatic artery should always be made and it should, of course, be excluded from the venous bundle to be excised. If the artery is not located, it is well to remember that no prolonged search for the vessel should be made and, while its inclusion in the ligation is undesirable, actual atrophy of the testis rarely occurs. Hemorrhage is the most immediate complication following varicocele operations; this is usually due to imperfect hemostasis during the operation. Large hematomas may require evacuation. An intact deferential artery and veins are usually able to obviate testicular atrophy—they must be scrupulously protected from injury. Hydrocele is usually an annoying postoperative complication. Some surgeons, in order to avoid its occurrence, open the tunica vaginalis. Partial ablation of the scrotum is sometimes indicated (Fig. 2091). When in doubt, it is better to excise too little than too much.

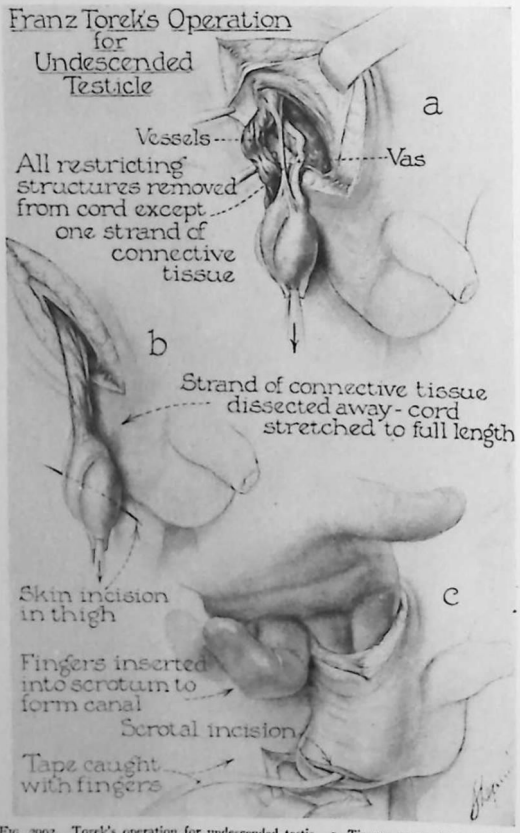


FIG. 2092. Torek's operation for undescended testis. a. Tissues exposed, freely liberated, identified and all restrictions removed. b. Skin incision in thigh. Note position of testicle and lengthened cord. c. Pocket formed in scrotum. Scrotal incision. Tape passed through scrotal tunnel.

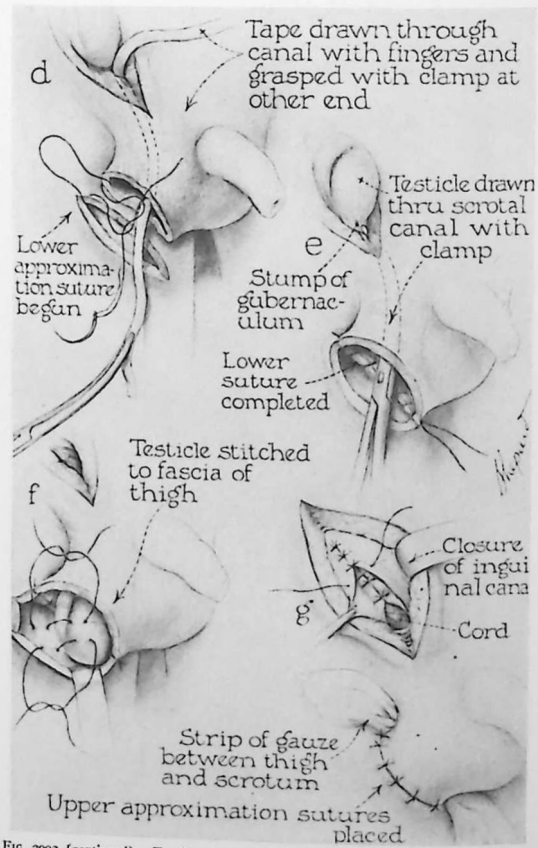


FIG. 2092 (continued). Torek's operation. d. Uniting edge of scrotal wound with upper edge of wound in the thigh. Note method of passing lower approximation suture. e. Delivery of testicle through scrotal canal. f. Testicle sutured to fascia of the thigh. Anterior lip of scrotal wound united to lower lip of the wound in thigh (g) and closure of inguinal canal. Note strip of gauze between thigh and scrotum.

OPERATIONS FOR UNDESCENDED TESTICLE (CRYPTORCHIDISM)

Torek's Operation (Orchiopexy)

This consists of laying bare the testicle, thinning down the cord till it consists of nothing but vas deferens and spermatic vessels, and continuing the dissection of the vessels upward as far as necessary to allow the testicle to come well down without traction. After bringing the testicle out through an incision at the bottom of the scrotum and carrying it through a corresponding incision in the skin of the thigh, it is fastened to the fascia of the thigh, and the rudimentary scrotum is fastened to the skin of the thigh. After a couple of months the testicle is released and replaced in the scrotum.

Step 1. Make an incision as in the operation for inguinal hernia. The exposure of the inguinal canal must be ample and large enough to permit of extensive dissection of the cord without injury to the spermatic vessels.

Step 2. The testicle must be freely liberated; it must be freed from cellular tissues, cremaster muscle and gubernaculum testis. The same holds true of the spermatic cord of which only the vas deferens and the spermatic vessels are preserved intact—all other tissues are removed including the vaginal process. If a congenital hernia is present, it is located in the vaginal process. If that process is obliterated, it is removed and its stump allowed to retract. Strands of connective tissue must be thoroughly removed; this will enable one to lengthen the cord very materially (Fig. 2092 a). The dissection of the vessels should always extend as high up as the transversalis fascia or even higher, if deemed advisable.

Step 3. The site of the incision in the thigh is determined by laying the liberated testicle on it without traction beyond that which is necessary for straightening out the vessels. A point somewhat higher than the one to which the testicle reaches is chosen for the incision (Fig. 2092 b). Return the testicle into the inguinal wound. A transverse incision is now made, the mesial end of which is somewhat lower than the lateral end; it should be of sufficient length to accommodate the long diameter of the testicle and deepened to the fascia of the thigh.

Step 4. With one or two fingers create a pocket extending from the lower end of the inguinal incision to the bottom of the scrotum. Open the pocket thus formed by an incision which should correspond exactly in length and direction with that in the thigh in order that the edges may properly be united (Fig. 2092 c). Pass a strip of gauze through the tunnel thus made.

Step 5. This step consists of uniting the upper end of the wound in the thigh with the corresponding end of the wound in the scrotum. In order to avoid the knots lying on the raw surface of the wound, it is passed as shown in the Fig. 2092 d, e.g., from surface to depth at the first edge and from depth to surface at the second edge, thus bringing the knot to lie on the skin surface. The sutures are interrupted. A sufficient amount of raw surface of each flap to be adapted should be aimed at. This is best accomplished by paying particular attention to the relation of the points of entry and exit of the needle, which should be such that on the skin side the stitch hole is much

closer to the edge than on the raw side; this prevents the skin from turning in—a tendency to which the skin of the scrotum is particularly prone. Rolling up of the skin prevents union. Unite the cut posterior lip of the scrotal wound with the corresponding edge of the wound of the thigh with catgut sutures as described, paying particular attention to details of suturings as outlined.

Step 6. (Fig. 2092 e.) Deliver the testicle from the inguinal wound through the channel created by the aid of a clamp until it emerges from the scrotal wound. Pass two fine sutures of chromicized catgut through the tunica albuginea and fascia of the thigh. Avoid injury to the saphenous and femoral veins (Fig. 2092 f).

FIG. 2093

FIG. 2094

FIG. 2093. Bilateral cryptorchidism. Torek's operation. Finger introduced into the space behind scrotum which is attached to thigh.
FIG. 2094. Torek's operation. Three months after operation.

Step 7. Unite the anterior lip of the scrotal wound to the lower lip of the wound in the thigh with fine silk or Pagenstecher linen. Here again avoid inversion of the scrotum.

Step 8. Close the inguinal canal as follows:

(a) Internal oblique and transversus muscle to Poupart's ligament. The cord is not transplanted.
(b) Where a hernia exists, the sac is treated in the usual manner.
(c) Unite the aponeurosis of the external oblique muscle; close the skin. Pull a small strip of gauze through the canal of skin existing between the scrotum and thigh. Dress the wound (Fig. 2092 g).

Allow firm union to take place. The deep layer of catgut sutures need not be bothered with. The anterior row of sutures of silk is removed on the 11th or 12th day (Fig. 2093).

Two or three months or longer should be permitted to elapse before the testicle is freed from its attachment in the thigh.

Release of the Testicle. The testicle is detached by passing a sharp scalpel through the scar, not deeper than the thickness of the tissues that were united at the previous operation (skin and superficial fascia). Lift up the

flaps; lift up the scrotal side to a slight extent. Lay the testicle bare with extreme gentleness, by blunt dissection. Defer the division of the posterior part of the scar until the underlying tissues have been separated from it.

Bury the testicle in the scrotum.

Close both wounds with interrupted sutures (Fig. 2094).

In bilateral cryptorchidism, operate in two stages.

Comment. H. W. Meyer reports sixty-four cases (1906-1926) in which the success of the Torek operation was perfect in all cases. The most propitious time for operation is before puberty (6-10 years). Antuitrin S should be given a trial before operation is resorted to. It should not, however, be persisted in after a reasonable trial if not followed by the desired result.

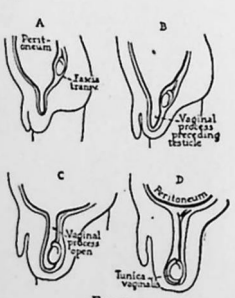


FIG. 2095

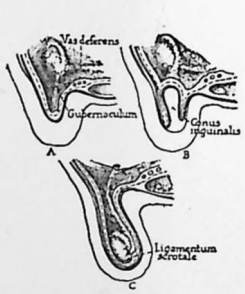


FIG. 2096

FIG. 2095. The descent of the testis.
FIG. 2096. The descent of the testis. (Courtesy of Dr. A. D. Bevan.)

Bevan's Operation

The salient features of the operation are referred to in recent literature by Bevan as follows:

"I want to say that I have been a good deal surprised and a good deal shocked at the evidence of the careless way in which many medical men read descriptions of operative procedures and then, without a complete understanding or without any mastery of the subject, proceed to operate in a bungling way.

"I would cite as evidence of this fact two examples: In developing the operative technic, I found that, in a small number of cases (5 to 10 per cent), I was not able to lengthen the cord sufficiently to bring the testicle down into the scrotum, without tension, unless I divided the spermatic vessels; so that in this limited number of cases, which may have been at first 10 per cent and which has since dropped down to 5 and later to 3 per cent, rather than give up the operation and push the organ back into the abdominal cavity, I divided the spermatic vessels, which enabled me to lengthen the cord sufficiently to place the testicle into the scrotum; this procedure necessarily carried some risk. Much to my horror and chagrin, I found that a number of my colleagues referred to the

division of the spermatic vessels as the Bevan operation and proceeded to do the division of the spermatic vessels indiscriminately, in all cases with resulting atrophy and necrosis in a considerable percentage. As a matter of fact, I have not ligated the spermatic vessels in a single case for the last four or five years, because, with increased study and experience, I have been able, without the division of the spermatic vessels, to bring the organ down into its normal position without tension. I should not, however, hesitate a moment, in a case where it is impossible to do this, to ligate the spermatic vessels, and to bring the testicle down into the scrotum, rather than to place it back into the abdominal cavity.

"As another example of the casual way in which medical men read descriptions of operations, one of my German colleagues, in referring to the purse string suture which I place at the neck of the scrotum in front of the cord leaving ample

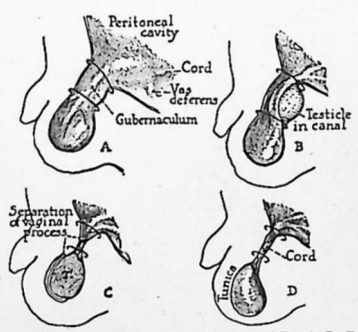


FIG. 2097. The descent of the testis. (Courtesy of Dr. A. D. Bevan.)

room for the cord behind, after reading my article stated that he thought it was bad surgery to put a purse string suture at the neck of the scrotum surrounding the cord, because it was sure to interfere with the circulation of the testicle."

Many of us were under the erroneous impression for many years, that in order to "lengthen the cord," the division of the spermatic vessels was a part of the Bevan operation. Like others, I have, for a long time, imparted that teaching to my students, until Dr. Bevan, in his later writings, called the attention of the profession to the incorrect notions entertained on his procedure. The description for the correct technic for the operative correction of cryptorchidism can best be accomplished by citing Dr. Bevan's own language.

"For a thorough understanding of the principles involved, the mechanism of the descent of the testis should be kept in mind (Figs. 2095-2096-2097-2098).

"The incision made is exactly the same as that which we employ for operations of radical hernia. I am careful not to extend the incision into the scrotum, but keep it just above the scrotal tissue (Fig. 2099). I divide the skin and superficial fascia, and in the superficial fascia I divide the small arteries and veins, branches of the femoral artery and vein that pass up above Poupart's ligament,

at the lower angle of the incision the superficial pubic and about the middle of the incision the superficial epigastric.

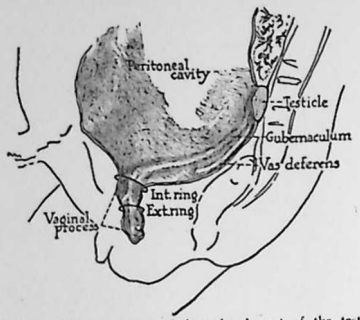


FIG. 2098. The peritoneal process formed before the descent of the testis. (Courtesy of Dr. A. D. Bevan.)

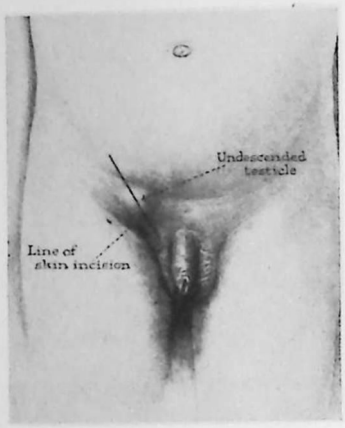


FIG. 2099. The skin incision. (Bevan.)

"After dividing the skin and superficial fascia and clamping these small vessels, I expose the white shining aponeurosis of the external oblique, and as I expose the external ring I come to the testicle, which is surrounded by a large peritoneal sac and covered by the three layers of fascia found in inguinal herniae (Fig. 2100[1]). I very carefully separate this peritoneal sac from the surrounding

fascial layers. I split the external oblique over the canal for a distance of about two inches well up to the internal ring (Fig. 2100[2]). I am now able to bring the testicle out of the incision and place it upon an abdominal pad. By making a little tension on the testicle and the peritoneal sac surrounding it, I bring that part of the peritoneal process surrounding the cord well into view and free the cord well up into the internal ring (Fig. 2101[1]).

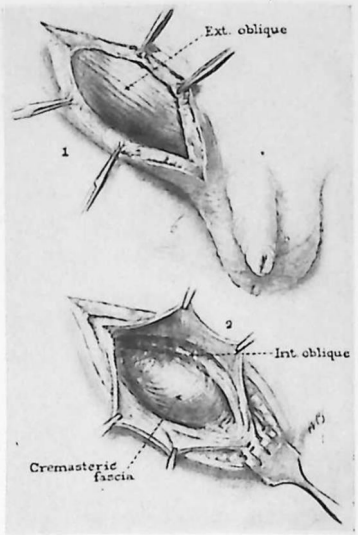


FIG. 2100. 1. The skin and superficial fascia divided. 2. The external oblique divided. (Courtesy of Dr. A. D. Bevan.)

"The next step of the operation is to divide the peritoneal process transversely at a point about an inch below the internal ring. This requires a delicate dissection, and we have developed some operative technic that is of value. I first split the vaginal process by a short incision, about one-half inch in length, parallel with the cord. I then place on the edges of the incision in this thin peritoneal process four small artery forceps, mosquito forceps, so as to be able to make the peritoneum tense (Fig. 2101[3]). It is difficult to dissect off the peritoneal vaginal process from the cord. In order to facilitate this dissection I take a fine hypodermic needle and syringe and inject some normal salt solution under the peritoneum, so as to lift the vaginal process up from the cord (Fig. 2101[2]). This makes the separation of the peritoneal process much easier. The peritoneum is so delicate in the child, being like tissue paper, that you must make a very

delicate and careful dissection. I have now completed the transverse division of the peritoneal process, and have stripped the upper part of the vaginal process well up in the internal ring. I now ligate this upper end that enters into the

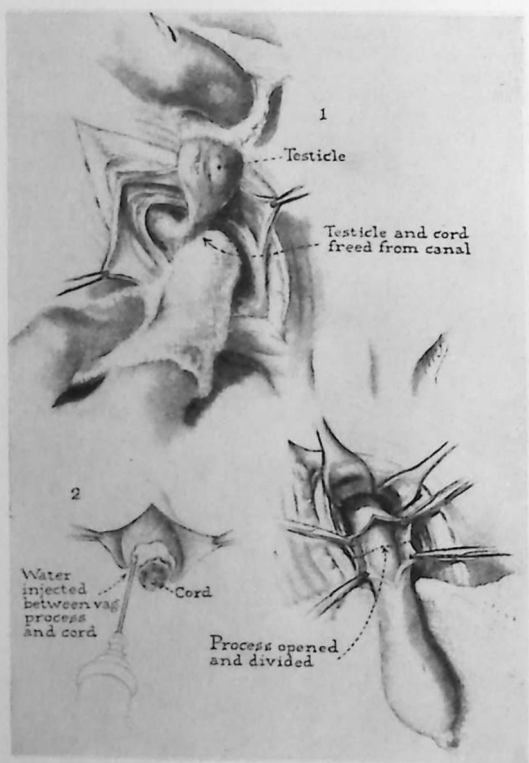


FIG. 2101. Freeing the testis. (Courtesy of Dr. A. D. Bevan.)

general peritoneal cavity with catgut ligatures, just as we do the stump of a hernial sac (Fig. 2102[1]). Picking up the lower part of the vaginal process with fine dissecting forceps with teeth, I strip it down from the cord so as to

expose the entire length of the cord uncovered by any peritoneum (Fig. 2102 [2]). The lower part of the peritoneal pouch is used to make a tunica vaginalis for the testicle. This is accomplished either with a purse string suture or simply a running suture closing the opening (Fig. 2102[3]). As I lift up the testicle and cord there is still some tension, but I find as I examine it carefully that this

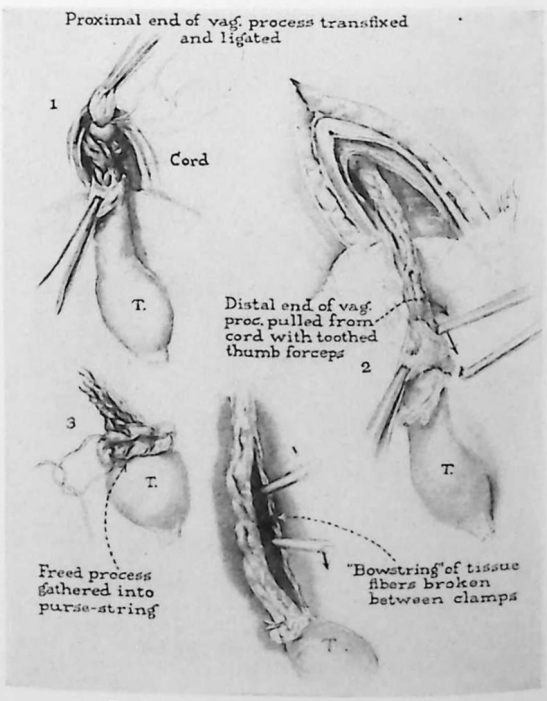
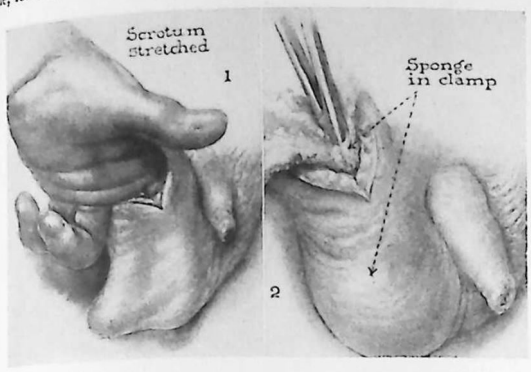


FIG. 2102. The Bevan operation for cryptorchidism.

tension, preventing a sufficient elongation of the cord, is due to some shortened fibrous bands, which I tear across between dissecting forceps. These bands are derived from the fascial coverings of the cord and vaginal process. I regard this as an important step in the operation, and it is one that should be thoroughly understood (Fig. 2102[4]). One can with care divide and tear these shortened fibrous bands, leaving simply the vas and its vessels and the spermatic vessels,

without interfering in any way with the essential structures in the cord. You will see that by this manipulation you have been enabled to free the cord, as a rule, for four or five inches, a length quite sufficient to place the testicle in the



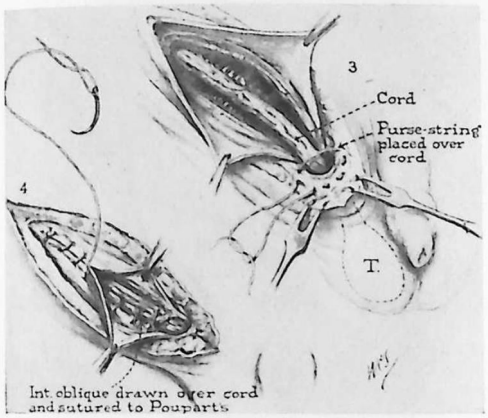


Fig. 2103. The Bevan operation for cryptorchidism. (Courtesy of Dr. A. D Bevan.)

scrotum without any tension whatever. With the index and middle fingers and a blunt dissection and by packing into it sufficient gauze, I now make a large pouch in the scrotum which must be large enough to receive the testicle without compressing it in any way (Fig. 2103[1-2]). The scrotal tissues are so elastic

and so yielding, that with the gloved fingers and gauze packing we have always been able to make a scrotum large enough to receive the testicle without pressure. The organ is now placed in this pouch, and with a purse string suture of catgut the neck of the scrotum is closed, this suture simply being one that goes through the superficial fascia and does not involve the skin or include the cord. This suture must not endanger the blood supply of the testicle (Fig. 2103[3]). This prevents the testicle slipping up into the groin, and keeps it well down in the scrotum. The canal is now closed, not as in a Bassini operation, but with the cord deeply situated in the canal; the transversalis and internal oblique are sewed to the shelf of Poupart's ligament, over the cord and the external oblique is now closed (Fig. 2103[4]). The skin and superficial fascia are closed in the

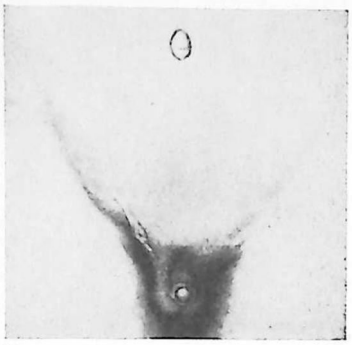


Fig. 2104. The result of the operation. (Courtesy of Dr. A. D. Bevan.)

same way that we would close them in a hernia operation. You will find that the organ is now in the scrotum without any tension whatever, looking very much the same as on the other side (Fig. 2104).

"I would like to emphasize the fact that the technic must necessarily be difficult to one who undertakes it for the first time, especially without having had the opportunity of seeing a number of these operations performed by one who has had experience with it. I would also like to emphasize the fact, from my observations of cases that have been done by some inexperienced surgeons, that the operation has not infrequently been undertaken by men who have not fully understood the technic of the procedure, and who have not carried it out in all its details. I would also like to emphasize very strongly the fact that division of the spermatic vessels is but exceptionally called for, and is not at all an essential part of the operation which I have developed; and it is in our own hands not necessary in but 5 per cent of the cases. On the other hand, wherever it is indicated, it should be done and thoroughly done, on the principle that the basic idea of my operation is the necessity of placing the testicle in the scrotum without any tension whatever. Care should be taken in the primary dressing of the case not to put on enough pressure over the groin to interfere with the circulation in the cord.

"On the whole, the operation seems to me to be one of the most interesting pieces of surgical anatomy in the whole field of operative surgery. The skillful unraveling of this congenital condition, which enables the surgeon to accomplish in a half hour by good operative technic what requires weeks and months in the process of development, with, as a rule, perfectly satisfactory results, has furnished one of the most satisfactory examples of modern surgery."

EPIDIDYMOTOMY

Hagner's Operation

F. R. Hagner has done much to popularize this operation and to stress its great value in acute epididymitis mainly of Neisserian origin.

Local anesthesia may be used (Fig. 2105).

Fig. 2105. Infiltration anesthesia in operations on the scrotum and its contents. Observe that a line of infiltration block is carried above the root of the penis which is joined by the ring of infiltration circumscribing the scrotum.

Step 1. Make an incision through the skin over the point of junction between the swollen epididymis and the testicle 6 to 10 cm. in length; this incision includes skin, fascia and tunica vaginalis which is opened longitudinally at the junction of the testicle and the epididymis.

Step 2. Deliver the testicle with its adnexae through the opening made in the tunica vaginalis. Surround it with warm compresses. Examine the affected epididymis. Make multiple small punctures in it with a sharp-pointed bistoury—particularly where the epididymis shows the greatest tumefaction. When the scalpel penetrates the thickened fibrous capsule of the epididymis a marked decrease of resistance is perceived. If pus issues from any of the

puncture openings, that opening is enlarged and a small probe is inserted into it. Small pus cavities are washed out with a fine pointed syringe.

Step 3. The tunica vaginalis is restored to its normal position, and washed out with salt solution. Close it lightly with a few catgut sutures. Place a cigarette drain in the lower angle of the wound. Close the skin. Hot packs will stop bleeding; however, the flow of blood should be encouraged for a few moments. This will aid in decongesting the affected area.

Comment. I have practiced this operation for many years. It certainly conduces to a more rapid recovery and causes almost immediate cessation of pain; it reduces morbidity and cuts convalescence short. When the time element is of no moment and the possibility of sterility not a factor to that particular patient, conservative measures usually suffice.

DECORTICATION

DECAPSULATION OF THE EPIDIDYMIS

In the treatment of acute epididymo-orchitis excellent results are obtained by this procedure. It is a simple procedure followed by prompt relief to the patient.

Step 1. Make a crucial incision through the inflamed covering of the epididymis.

Step 2. Strip the covering off the underlying epididymis as shown in Fig. 2106.

Step 3. Evacuate any accumulated fluid in the tunica vaginalis.

Step 4. Insert a cigarette drain and close the scrotal wound.

Comment. Decapsulation may be combined with puncture (Hagner's Operation—see above).

Fig. 2106. Decapsulation of the epididymis by a cruciform incision. (After Hamilton Bailey.)

EPIDIDYMECTOMY

Step 1. Incise the scrotum beginning just below the external abdominal ring and extending downward. If there are skin adhesions and fistula formations, they should be embraced in the incision.

Step 2. Deliver the testicle through the incision in the scrotum and incise the tunica vaginalis along the outer side of the line of junction of the epididymis with the testicle (Fig. 2107 a). Separate the epididymis from the testicle by blunt dissection (blunt dissector) beginning at the globus major and loosening its attachment to the testis by snipping with a pair of sharp-pointed scissors the tunica albuginea at this point. Blunt dissection permits the separation of the rest of the epididymis with facility. The blood vessels passing to the testicle lie along the inner side of the line of junction between the epididymis and the testicle (on the side of the epididymis opposite to that along which the incision has been made). Putting the epididymis on the stretch will afford the possibility of slow separation of the vessels from it,

taking care not to injure the layer of tissue in which the vessels course (inner surface of the epididymis).

Step 3. Separate, bluntly, the vas from the rest of the structures of the spermatic cord. Incise the fascia of the external abdominal oblique when the

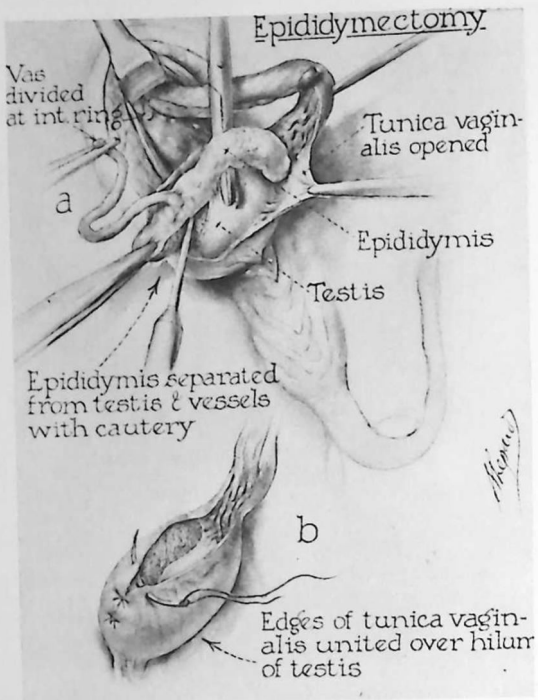


FIG. 2107. Epididymectomy. a. Blunt or electrocautery separation of the epididymis from the testis; dissection may begin from the vas downward. c. Closure of tunica vaginalis.

external inguinal ring is reached; free the vas from the inguinal canal as far as the internal inguinal ring; ligate and divide the vas. Unite the divided edges of the tunica vaginalis (Fig. 2107 b).

Step 4. Close the fascia of the external abdominal oblique with catgut sutures. Close the wound with or without drainage as indicated.

FIG. 2107 A. Drawing in illustration of the technical steps of radical resection of the primary lymph zone. a shows two types of incision. The one following the outer edge of the rectus for some distance and then curving out along the lower side of the twelfth rib gives a better exposure. b shows the initial inguinal incision exposing the cord which is clamped before delivering the tumor mass from the scrotum. c, cautery division of the cord after gross inspection has confirmed the diagnosis. d shows the method of stripping back of the peritoneum, beginning in the iliac fossa. The ureter and spermatic vessels strip up with the peritoneum. The vas deferens is seen crossing the ureter and is divided low down behind the bladder. (Hinman et al.)

OPERATIONS ON THE TESTIS

Orchidectomy (Castration)

Step 1. The incision is the same as in hernia operations; viz., parallel to and about a finger's breadth above Poupart's ligament and about 8 to 12 cm. long,

FIG. 2107 B. Drawing to show completion of the operation. The spermatic vessels at their point of junction with the abdominal vein and artery have been isolated, ligated and divided before resection is attempted, which may then be carried out from above downward or from below upward. (Hinman et al.)

extending to the pubic spine and dividing the skin and subcutaneous tissue. Ligate doubly and divide the superficial blood vessels. Expose the external abdominal ring and open the inguinal canal by splitting open the external abdominal oblique fascia along the line of incision.

Step 2. Separate the external abdominal oblique fascia with sharp retractors. Isolate and lift up the spermatic cord. Gauze dissection aids in freeing it up as high as possible.

Step 3. Incise the covering of the spermatic cord. Isolate the vas deferens up to the internal abdominal ring. Clamp, ligate doubly and divide the vas. Carry a needle around the rest of the constituents of the cord, doubly ligate it and sever it.

Step 4. The opened inguinal canal is now closed by either interrupted or continuous sutures. Protect the wound with hot compresses and proceed to remove the testicle. The cord is followed down to the testicle which is freed by sharp dissection including its investing membranes, from the attachments to the scrotal tissues.

Step 5. Close the deep and cutaneous wounds.

Extended Orchidectomy in Malignant Tumors of the Testis

In malignant tumors of the testis an extended procedure aiming at the removal of the lymph nodes is essential, if success is to be attained. Frank Hinman proceeds as follows: (Figs. 2107 A, B).

"The patient is better turned a little to the opposite side, with a small pad under the back. The cord is exposed through an inguinal incision and clamped so that the subsequent pressure and manipulation in delivering the testicle will not spread cells into the blood stream. If, upon delivery of the scrotal mass, a solid testicular tumor is found, castration should be completed by severing the cord below the clamp with cautery. The tumor mass is immediately sectioned by a pathologist or an assistant in order to confirm the diagnosis. Too many radical resections of retroperitoneal glands for tuberculosis or syphilis have been performed (four are reported) to warrant the omission of this necessary diagnostic step. In case of malignancy, the inguinal incision is extended to the twelfth rib, which it then parallels. Muscle and fascia are then divided in the line of this skin incision down to the peritoneum. Beginning in the iliac fossa, the peritoneum is stripped back to and beyond the large abdominal vessels. The ureter and spermatic vessels with lymphatics strip up with the peritoneum but the lymph nodes remain upon, sometimes being quite adherent to, the vena cava and aorta. Theoretically, the lymph area should be removed from above downward, but practically its clean and complete removal is more difficult in this way than by resection from below, for the reason that traction on the cord greatly facilitates following it and making a clean dissection. It is probable that the cleaner, more complete removal permitted by dissecting from below upward offsets the theoretical advantage of peripheral attack. It would seem advisable, therefore, to combine the methods of first isolating, ligating and dividing the spermatic vessels at their point of union with vena cava, aorta or renal vein and then proceeding with resection of the area from below upward. Occasionally, the glands may be so matted along the inferior mesenteric artery that in order to effect a clean removal, the artery must be sacrificed near its origin. The practicability of this procedure seems feasible on the basis of a series of cats and dogs in which the artery was ligated and cut near its origin without apparently the least untoward effects. This procedure was necessary in one personal case, but the patient died of acute cardiac dilatation a few hours after the operation so that the efficacy of the collateral circulation in the human could not be determined.

"After completion of the resection, immediate exposure on the operating table of the retroperitoneal and iliac area to roentgen radiation is an added protection against recurrence because of possible isolated cells or metastatic areas left behind. The placement of rubber tubes for drainage of the serous discharge, with exit at the back or upper end of the wound, and additional ones if desirable, is used to carry radium for radiation of the resected area for twelve to fourteen hours after operation."

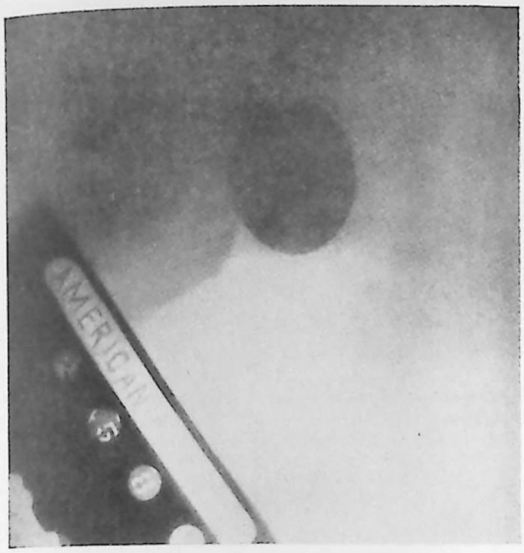


Fig. 2108. Testicular prosthesis of silver scrotum. X-ray outlines foreign body, penis and scrotum. (Author's observation.)

Testicular Prosthesis

The surgeon is often called upon to relieve psychic distress in individuals who have lost their testicles for one reason or another. Hypochondriasis frequently results and in certain well marked cases this form of introspection has led to suicide. Silver, glass, ivory, rubber, etc., have been used to fashion such artificial testicles. In some cases paraffin injections have been resorted to (Carnabel). Hermance reported a case in a young man of 25 years whose left testicle had never descended and who had been advised nothing could be done to remedy the condition. A mental state bordering on insanity resulted. The patient submitted to the introduction of a silver testicle into his scrotum and he recovered his mental poise, carried the testicle with no trouble, married and had several children. Morestin is partial to vulcanite in forming a testicular prosthesis. It is easily asepticized and is well tolerated by the tissues. Figures 2108-2109 depict respectively a silver and aluminum prosthesis introduced by the author for psychic depression resulting from absence of the testicle in the scrotum. In both cases excellent results followed.

Fig. 2109. Testicular prosthesis of aluminum in scrotum.

OPERATIONS ON THE SPERMATIC CORD

Torsion of the Spermatic Cord

Mechanical strangulation of the spermatic cord, by torsion on its long axis, may interfere sufficiently with the nutrition of the testicle to produce a sphacelous condition in the cord itself, in the testicle, or in both. The condition probably occurs with much greater frequency than a perusal of the literature would suggest, but owing to its simulating other conditions, the correct diagnosis often is not made unless operation is carried out (Fig. 2110).

The first case seems to have been reported by Delasiauve, in 1840. Vanvaerts, in 1904, collected forty-four cases; Rigby and Howard, reporting in 1907, could find only 40 cases; but O'Connor, in 1919, found the number of cases increased to 124.

In recent times the condition has been much more frequently reported; thus Keyes and his associates in the Bellevue Hospital, New York City, found seven cases in the records there; Chute observed three personal cases; and in my own practice I have operated upon the same number,[1, 2, 3] one of which I reported in 1919.

[1] Thorek, Max. Interstate Med. Jour., 1919, Vol. XXVI, No. 3.
[2] ——— Clinical Med. and Surg., 1927.
[3] ——— Surgical Errors and Safeguards, J. B. Lippincott Co., 1932.

Although some authors seem to consider that orchidectomy is not called for in a torsion of less than seventy-two hours' duration, I do not think that any arbitrary rules can be laid down. The clinical findings (after a fair attempt at detorsion) must be the surgeon's guide, no matter how long the torsion may have lasted.

There are two well-recognized types of torsion of the cord: the acute and the recurrent. The acute type is that in which the symptoms are so fulminating that the wrong diagnosis is often made and the true condition only discovered at operation. The recurrent type is more likely to be correctly diagnosed if a careful history is taken and epididymitis is ruled out. In this type the symptoms are not so severe as in the acute type and the condition subsides after spontaneous untwisting—until the recurrence of a new attack.

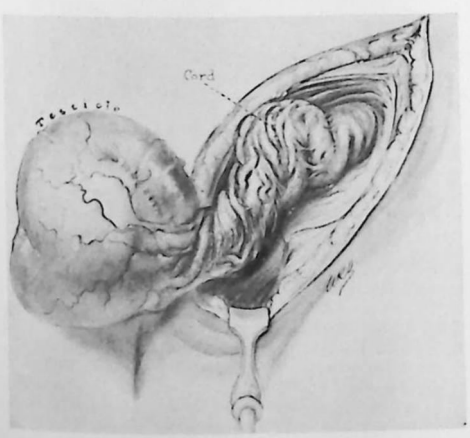


Fig. 2110. Torsion of the spermatic cord. Showing general edema of parts surrounding the cord.

Orchidectomy seems to be the proper procedure in the majority of cases.

In a fourth case I recently operated on (March 1938) detorsion and fixation of the testicle and cord were done. At present writing (September, 1938) the testicle seems to have atrophied.

OPERATIONS ON THE MALE URETHRA

Anatomic Considerations. The male urethra is about 8 inches long. It is divided into the following parts: (a) cavernous or spongy (pars cavernosa), (b) membranous (pars membranacae), and prostatic (pars prostatica).

For clinical purposes the urethra is divided into an anterior and posterior portion, the former comprising the spongy portion, the latter the prostatic portion. They are separated by the membranous urethra. This part of the urethra is situated between the layers of the triangular ligament and is surrounded by the compressor urethrae muscle. The narrowest parts of the urethra are: the external meatus and the membranous part; the widest is the fossa navicularis, the bulbous urethrae (bulb) and the prostatic part (most susceptible to infection). (Fig. 2111.)

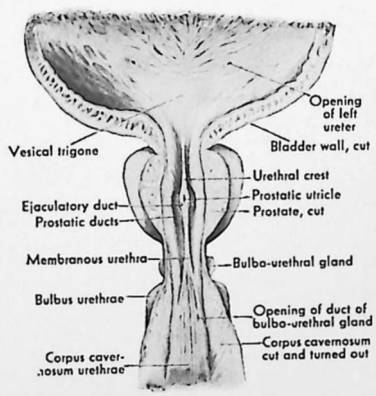


Fig. 2111. Part of bladder and male urethra, exposed by opening and turning aside anterior wall, showing posterior surface of prostatic, membranous, and beginning of cavernous portions of urethra.

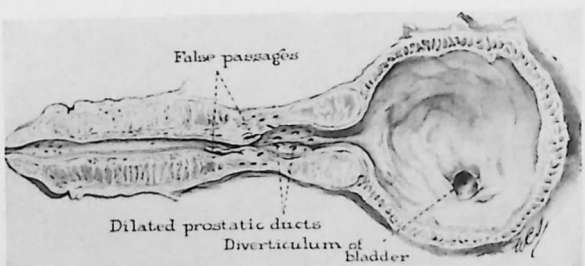


Fig. 2112. Stricture of the urethra. Note false passages, dilatation of the prostatic ducts and a diverticulum of the bladder.

Normally, the urethral walls are in contact with one another; the lumen on section appears as a narrow slit transverse in direction in the penal part and vertical in the external meatus.

Strictures (inflammatory) (Fig. 2112) most frequently occur in the region of

the bulb; they are almost unknown in the prostatic urethra. Traumatic strictures are usually found in the membranous urethra.

URETHROSCOPIC DIAGNOSIS AND TREATMENT

In recent years, remarkable progress has been made in the diagnosis and treatment of urethral disease. Study of pathology of the urethra brought to light many hitherto obscure distressing urologic manifestations.

FIG. 2113. 1. Position of patient for cystoscopy. 2. Washing out bladder. By removing the thumb from the end of the sheath, the solution which distends the bladder is quickly flushed out (hand should be gloved). 3. Method of examining the trigone, vesical fundus and lateral walls. 4. Arrows show how beak of cystoscope is rotated when examining the trigone, fundus and lateral walls. 5. Diagram shows the position of the examining cystoscope when inspecting the upper and lateral zones of the bladder. 6. Diagram showing the arc of rotation of the beak of the cystoscope when examining the upper and lateral zones of the bladder.

Urethral instrumentation should never be done without proper preparation of the patient and instruments. Examination must be omitted in all acute inflammatory conditions of the lower urogenital tract as well as in certain malformations of the urethra. Hypersensitive patients offer a real problem in this connection.

Instruments for examination of the urethra include sounds, filiform bougies, dilators, endoscopes, panendoscopes, urethroscopes and cysto-urethroscopes. Due

to the ever-increasing models, it is quite impossible to illustrate them all. A simple type of endoscope is the Koch instrument. Variations consist mainly in the manner of lighting, some being direct and others indirect.

Position and Preparation of the Patient. The patient having emptied his bladder, lies prone on his back at a 45-degree angle with his or her feet in stirrups. (Fig. 2113.) The external genitalia are thoroughly cleansed with green soap and water after which an antiseptic sponge is placed between the labia in females and sponged over the meatus and vicinity in males. Potassio-mercuric-iodide, bichloride and lysol are some of the antiseptics used. Anterior urethral irrigation is occasionally used in the male.

Anesthesia is usually not necessary for ordinary instrumentation. Thorough lubrication and an experienced touch are prime requisites. However, when painful areas are encountered or in operative procedures, anesthetization of the urethra, hypodermic injections of morphine or even general anesthesia may have to be resorted to in some cases. Caution must be exercised in urethral medication and instrumentation. Fatalities have been reported from injections of novocaine and oil emboli have resulted from the oil used for lubricating the instruments.

Preparation of Instruments. Careful sterilization of instruments is essential. Transmission of infection from stock jars of lubricant and instruments is an ever present source of danger. K. Y. jelly, oil or sterile glycerin are the most common lubricants used. While sterile gloves are dispensible for ordinary passage of catheters, sounds or endoscopic instruments, care must be taken to avoid contamination of that part of the catheter or instrument entering the urethra. Gloved hands however, are good insurance for both patient and surgeon alike.

Endoscopy

Urethroscopes commonly used are of two general kinds: 1. endoscopes which are simple straight tubes; one type carrying a light at the inner, the other at its outer end; 2. Urethroscopes, cysto-urethroscopes and panendoscopes which are closed tubes permitting the use of water or air inflation. (Figs. 2114-2115.)

Endoscopes are used principally for topical application; the same instrument may be used for both men and women. In the male, the instrument is introduced in such a manner that its tip follows the urethral curve without using any force. At times the urethra must be anesthetized with a 4 to 6 per cent novocaine solution which is held in situ for five minutes. Pass appropriate sounds to dilate the constricted end of the urethra. Meatotomy may have to be performed in certain instances. Spasm of the sphincter vesicae is overcome by holding the instrument in situ for a few minutes until relaxation takes place after which the instrument usually slips into the bladder.

The obturator is now withdrawn and the area to be treated is swabbed with dry stick sponges, as needed. Adjust the light of the instrument; slowly withdraw the endoscope and while so doing, inspect in sequence, the neck of the bladder, trigone, urethral canal, veru montanum and ejaculatory ducts and finally, the orifices of the urethral glands. Never push the instrument upward without the obturator in place. Considerable damage may result from disregarding this precaution.

In the female, the knee chest position with atmospheric air inflation of the bladder may afford opportunities for treatment of the extremely common lesions

at the neck of the bladder. The most sensitive portion of the female urethra is the meatus; this may be satisfactorily anesthetized with novocaine or cocaine by simply inserting a cotton swab saturated with an 8 per cent solution of cocaine left in situ for a few minutes. Urethral caruncles, strictures and prolapse of the urethra are frequent occurrences and should be sought for first; if simple methods such as dilatation or cauterization fail, operative procedures may become necessary to remedy the conditions.

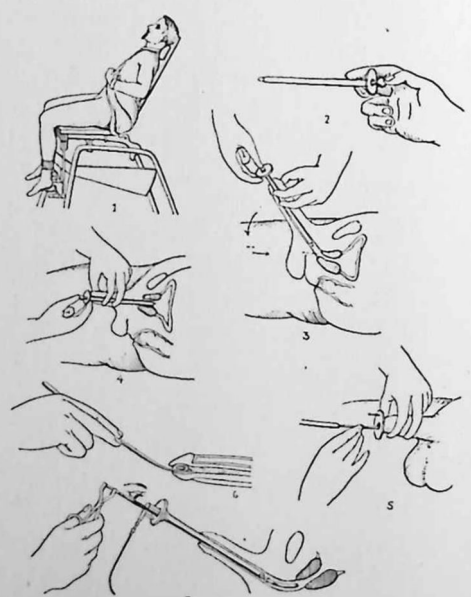


FIG. 2114. 1. Position of patient for endoscopy. 2. Manner of holding endoscopic tube and obturator for introduction into urethra. 3. Introduction of tube and obturator through the anterior urethra down to the cut-off muscle. 4. Manner of introducing tube and obturator through the posterior urethra. 5. Technic of clearing and drying urethra. 6. Manner of using ring curet for dislodging urethral stone. 7. Technic of removing broken catheter from deep portion of urethra. Observe relative position of endoscope and foreign body forceps.

Cystoscopy

Ordinary cystoscopes are of the following types:

1. Observation and catheterizing cystoscopes.
2. Operating cystoscopes: 21-24 F.

3. Cysto-urethroscopes.
4. Smaller caliber instruments for infants: 12-16 F.

The preparation of the patient is the same as for urethral instrumentation. A very satisfactory method in the male is to inject about an ounce of 5 or 6 per cent novocaine solution into the bladder and into the posterior urethra. (Fig. 2113.)

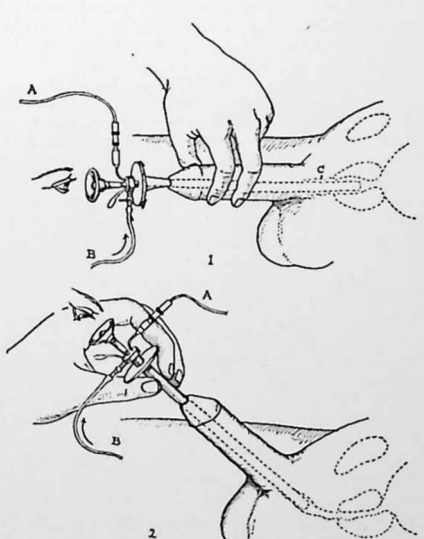


FIG. 2115. 1. Posterior urethroscopy. The ocular end is lowered as the instrument is withdrawn in order to see the roof of the urethra. A. Electric cable for lamp. B. Rubber tube connected for irrigation. 2. Anterior urethroscopy.

Close the meatal end of the urethra for about three minutes with the fingers; satisfactory anesthesia usually results. Besides local caudal or spinal anesthesia, gas or the intravenous administration of evipal anesthesia may be resorted to.

In women a pledget of cotton saturated with novocaine is usually sufficient. Sensitiveness to novocaine should be ascertained beforehand and reactions should be met with phenobarbital hypodermically.

In operative procedures or even in urethral catheterization aseptic procedure is essential as in any other operative manipulation elsewhere in the body.

The instruments to be used should first be tested as to degree of light, clarity of lenses, etc. The cystoscopic sheath is passed gently into the urethra

on a sound, amply lubricated. In the female, no resistance is usually encountered as the urethra is short and straight. In the male, resistance may be encountered at the neck of the bladder; this may be due to spasm, enlarged prostate, etc. and the tip of the cystoscope may have to be lifted by a finger in the rectum; this must be remembered in swinging the shaft of the instrument into correct position successfully; entrance is never accomplished by forceful pushing.

Once the cystoscope is in the bladder, withdraw the obturator; determine the quantity of residual urine, note its character. Inject enough sterile water into the bladder to permit vision; the patient should not experience discomfort. If the fluid is cloudy or bloody, irrigation may be made by simply allowing it to pass in and out. The examination is begun as soon as the bladder starts filling with water. The patient's sensibility or the obliteration of the folds of the bladder is the signal for shutting off the influx of water.

Follow a definite system of inspection lest an unsuspected lesion be overlooked in urethroscopy and cystoscopy (Figs. 2113-2115).

A good method to pursue is to locate the air bubble at the upper end of the vault of the bladder; bring the cystoscope forward; inspect the vault, fundus, ureteral orifices, neck, and trigone of the bladder. Certain instruments permit the examination of the posterior urethra by withdrawing the instrument from the bladder.

Through the operating cystoscopes, various procedures are possible (fulguration of bladder tumors; crushing and removing small or large stones by means of the lithotrite, etc. (Figs. 2053-2054). These lithotrites are of two types: (a) blind, e.g., directed by the sense of touch; and (b) direct vision.

Ureteral Catheterization

This is the final step in urologic examination in so far as instrumentation is concerned. (Fig. 2116.) The ureteral orifices having been inspected in the routine cystoscopic examination, the catheters, usually about a No. 5 or 6 flute end, are passed into the right and left ureteral orifices respectively. It is important that the two catheters are not similar. A simple method is to cut one slantwise at its distal end and leave the other straight. The catheters must be sterile and previously tested as to patency. The appearance of the ureteral orifice sometimes gives information of existing pathology. In tuberculosis a "golf hole" appearance is characteristic while edema and redness indicate infection or stone, above. The ease of passage, the presence or absence of obstructions is carefully noted as the catheters are inserted. The character of the flow of urine and its appearance is also observed. Temporary anuria owing to instrumentation is overcome by slight withdrawal of the instrument, ingestion of fluids or the introduction of a small amount of sterile water and its aspiration. Specimens are collected in sterile tubes and sent to the laboratory for culture, smear, etc. Indigo carmine is next injected intravenously to determine the relative kidney function. Phenolsulphonphthalein may also be used. The dye is usually secreted in from three to six minutes in normally functioning kidneys. In pathologic conditions the dye is absent on one side, delayed, or the concentration is poor. If the flow of urine has been even and continuous previous to injection of the dye, there is very little chance of a temporary inhibition confusing the picture.

In the presence of anomalies, it is sometimes necessary to catheterize three

or even four ureters at the same time. Such occurrences, however, are not very frequent.

Roentgenography is the next step in diagnosis. Occasionally a simple flat plate with the ureteral catheter in place may rule out a shadow by placing it

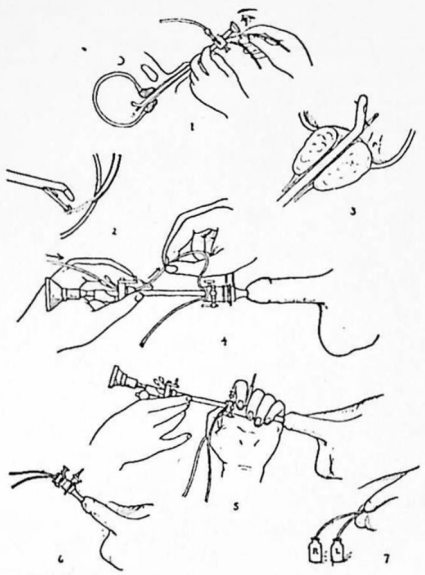


FIG. 2116. 1. Technic of catheterization of ureters. 2. Indirect ureteral catheterization. 3. Prostatic hypertrophy acting as an impediment to proper catheterization of ureter. 4. Manner of removing cystoscope. Catheters left in ureters. Steps of procedure: a. Pull out cystoscopic sheath for about one inch. b. Free catheters from the telescope by pulling them through the catheter outlets from within outward (arrows). Leave some mark of identification on one of the catheters (split, etc.). 5. Pull out from the telescope while steadying catheters. Avoid dislodging of catheters during this step by retaining them in place with thumb of left hand. 6. The telescope is removed. Push the catheter into sheath for from 3 to 5 inches; this will prevent the dislodgment of catheters when sheath is removed. 7. Cystoscope removed. Catheters in position and discharging respective kidney contents into properly labelled bottles.

out of the ureteral line. Stereoscopic images may also be resorted to. Retrograde pyelography is accomplished by the injection of 10-15 cc. of pyelographic media. Shivdan hippuran, sodium iodide in 12 per cent solution or sodium bromide may be used. The amount used varies from 2-20 cc. although usually 8-12 cc. suffices.

The indications for taking a pyelogram are: diagnostic purposes or to control interventions. It is contraindicated in tuberculosis, and in acute infections

study should be delayed for a safer period. Also, the patient's reactions should be watched and prolonged maneuvers avoided.

The simultaneous injection for bilateral radiograms as a routine is to be condemned as deaths have occurred from such attempts. It is much safer first to take a radiogram of one side and if no reaction ensues proceed with the other side.

In exploration of the ureter, stones may also be diagnosed by waxing the tip of the catheter and noting scratches on the wax by means of a magnifying lens. Where resistance is met and the catheter noted to jump as if passing a stone, examine the tip of the catheter and if no scratches are present, stricture should be looked for.

When ureteral catheterization is difficult or impossible, resort to other methods. Ofttimes skillful handling of the cystoscope or bringing a cystocele up by inserting a finger into the vagina will help to pass the catheter. Sometimes a catheter may have to be stiffened by a wire stylet. Force should never be used lest false passages or perforations be created. Occasionally indigo carmine may be injected intravenously and the ureteral orifices sought for by the efflux of the dye.

Intravenous pyelography is indicated in all cases in which cystoscopic and ureteral pyelography are impossible or contraindicated because of the general condition of the patient or for anatomic or pathologic reasons.

Contraindications include all cases in which renal function is impaired to such a degree that excretion is seriously retarded or concentration hindered.

The technic is simple. Clean out the bowel on the evening preceding the procedure. Reactions are comparatively few and no deaths have occurred with the newer dyes. (Iopac, Shiodan, diodrast, Na orthoiodohippurate or hippuran.)

Radiographs are taken five or ten minutes after the slow injection of the dye. Interpretations should be made only by a competent radiologist conversant with the proper interpretation of the systolic and diastolic movements of the ureter. Filling defects may have to be checked by retrograde pyelography.

The advent of intravenous urography is the greatest advance in urology in the last twenty years. It is simple of execution and permits facile recognition of urogenital anomalies, stones, renal tumors, renal ptosis, etc. Neo-Iopax (Schering) is an excellent medium for intravenous urography. About twenty cc. enables one to visualize the kidneys, ureters and bladder in normal and pathologic states.

LOCAL ANESTHESIA OF THE URETHRA

In instrumentation of the anterior urethra, in hypersensitive cases, it is not necessary to fill the anterior urethra with solution in order to make the application complete. Twenty minims of solution of whatever drug selected is as capable of being spread over the mucosa of the whole anterior urethra as is two or three drachms. This is done by sending a cushion of air into the urethra following the solution. This distends the urethra and permits the application to be distributed as willed by the operator, only a minimal quantity of solution being used.

Bransford Lewis believes that the anterior urethra is the most dangerous part of the urinary tract in this relationship, and the one that has been the source of the deaths recorded. It is therefore doubly necessary to be conservative in this area. Fortunately anesthesia here is necessary only for anterior urethral manipulations—for strictures, glandular abscesses, etc. When it comes to cystoscopy or instrumentations in the posterior urethra or bladder it is both

unnecessary and inappropriate to anesthetize the anterior urethra; likewise the bladder, per se. Under these circumstances the posterior urethra is the exact location demanding anesthesia. It is precisely this area that is tender and that offers resistance to the approaching cystoscope or sound.

A method that provides a confined application of any anesthetic drug selected, and in concentrated form must be the method of choice. Bransford Lewis states, "I have been using such a method for about twenty-five years, and have never in a single instance had anything to occur to disturb my conviction that it is by far the best and safest of all methods for local urethral anesthesia. It consists in the use of readily soluble tablets of either novocaine, alypin or cocaine, deposited in the urethra of either male or female, at any desired point. For cystoscopy in the male the point of election is the posterior urethra—just past the external sphincter. The means of depositing the tablets is furnished by a very simple little instrument, a urethral tablet depositor (Fig. 2117), which I submitted to the profession about twenty-five years ago and which has proved the most frequently used instrument in our armamentarium since then . . . when alypin was introduced by the Schieffelin Company with the claim of less toxicity made for it, I used it until the recent war took it off the market. Since then I have used novocaine tablets, 1 gr. each, supplied in proper size and shape by the Metz Laboratory. I have no idea how many thousands of times I have made use of this method, but assuredly more than enough to establish my belief in its safety and its efficiency. The depositor with novocaine tablets is prepared and used with all urethral instrumentations that are liable to cause pain, including dilatings, deep endoscopies, cystoscopies, deep urethral soundings, meatotomies, fulgurations in urethra or bladder, litholapaxies, etc. If there were danger in it I should assuredly have uncovered that fact in twenty-odd years' use. It is applicable to both men and women.

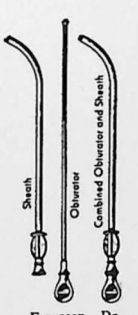


FIG. 2117. Dr. Bransford Lewis' improved tablet depositor for local anesthesia of the urethra.

"Technic. The tablet method for urethral anesthesia is so simple and obvious that it would seem hardly necessary to describe a technic; yet there are some details that might be mentioned that might, indeed meet some of the theoretical objections that must be entertained in the minds of those who have never taken it up.

"In ordinary routine cases it is not necessary, either in the male or female, to use any solution preceding the dropping of the tablets at the site desired. In these the depositor with the obturator is withdrawn, the tablet inserted into the funnel-shaped opening and pushed through the tube with the obturator. The obturator for the past several years has been made with a flexible shaft that prevents its 'hanging' in the tube. The tablet is permitted to dissolve in the mucus of the urethra for a half-minute or so, when by to and fro motions of the depositor the semi-liquid mass of tablet is smeared over the adjacent membrane. If one or two tablets are not enough to produce the desired effect, as determined by the patient himself, an additional one or two may be used; after which the cystoscopy or instrumentation may be proceeded with. In supersensitive cases,

in which, for instance, the introduction of even a soft rubber catheter cannot be borne, 10 minims or so of 5 per cent novocaine solution may be injected with the air cushion, as previously described, or with the deep urethral syringe, depositing the fluid along the urethra as the syringe is withdrawn. Of course, the captious might say that this in itself furnishes the anesthesia; but it does not. It supplies only enough anesthesia to reduce the supersensitiveness to reasonable proportions; after which the depositor does the rest. If the sensitiveness of the patient is so great that even these measures do not suffice, caudal anesthesia or preliminary hyoscine 'twilight sleep' may be resorted to; but this is seldom necessary."

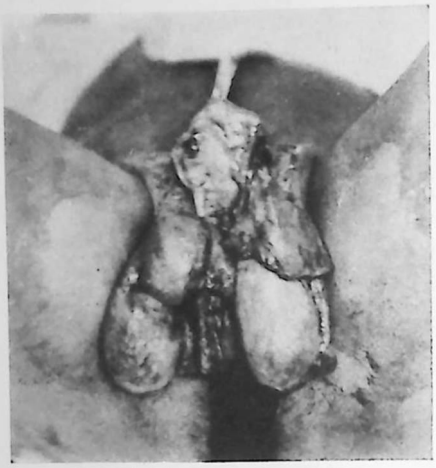


Fig. 2118. Urinary extravasation. (Soloway.)

EXTRAVASATION OF URINE

"When the urethra has given way behind a stricture and urine has become diffused into the cellular texture, very prompt and vigorous measures are necessary" (Sir Benjamin Brodie). (Figs. 2118-2119.)

The two important factors one must promptly meet are: First, avoid septicemia; second, institute treatment against toxemia. Urinary urethral phlegmons tend to spread toward the posterior scrotal region. Careless incisions in the perineum to remedy urinary extravasations without respect to hemostasis have claimed many victims. Proper free incisions and proper drainage are of utmost importance. (Fig. 2120.) A perineal cystostomy is regarded by some as a much safer procedure than a suprapubic cystostomy which according to Hamilton Bailey should never be done. He counsels the following line of procedure:

1. Wash out the urethra. Instill procaine solution.
2. Attempt to pass a bougie into the bladder. In doing this, be very gentle lest perforation of the urethra ensues. "However, it is usually possible to pass a No. 3 or 4 French." (Bailey). If a bougie has been passed, it should be fixed in position.
3. A perineal urethrotomy is performed.
4. If impassible, Cock's operation is practiced. The infiltrated cellular tissues must be thoroughly drained. The incisions must be of sufficient depth to penetrate the limiting fasciae.

Fig. 2119. Urinary extravasation with necrosis of the skin of the scrotum exposing both testicles, the greater part of the penis and marked infiltration of the perineum and suprapubic area. Suprapubic cystostomy. Deep long incision in the affected area. Secondary plastics. Recovery.

5. Jungo has shown that anaerobic microorganisms are largely responsible for the advancing cellulitis present in these cases. Hydrogen peroxide is, therefore used freely, introduced through an aspirating syringe.
6. Moist dressings of Dakin solution are very beneficial.

OPERATIONS FOR STRICTURE OF THE URETHRA

Meatotomy

Step 1. Introduce a probe-pointed knife (meatotome) (Fig. 2121) into the urethra (after injecting some anesthetic solution into it) for about three-quarters of an inch or to a point immediately behind the narrowest portion.

Step 2. Make an incision in the median line below, not allowing the incision to penetrate to the exterior—otherwise a hypospadias may result.

Gradual Dilatation

This is accomplished by means of graded urethral sounds introduced at intervals. (Figs. 2122-2123.)

Internal Urethrotomy

This operation is used when the patient cannot be treated for one reason or another by gradual dilatation of the stricture (preferable method) and when rapid results must be obtained.

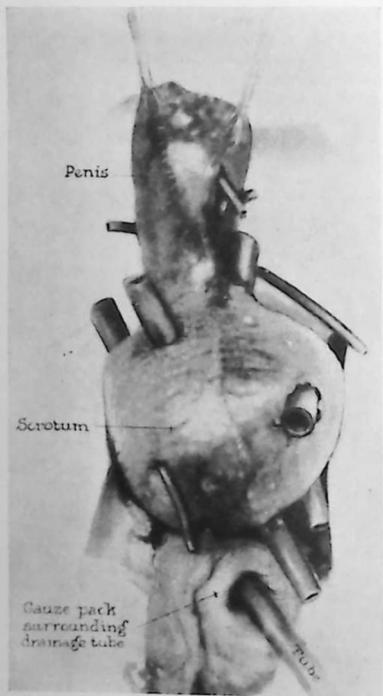


Fig. 2120. Urinary extravasation following the creation of a false passage as a result of faulty urethral instrumentation. Careful free incisions. Proper drainage. Recovery.

Preparation of the Patient. A few days preceding the operation the patient is given urotropine or caprokol. Immediately before the operation the parts are thoroughly washed with soap and water and the urethra is irrigated with a mild antiseptic solution and a teaspoonful (4.0) of sterile olive oil is introduced into the urethra. The operation may be done under local anesthesia.

The methods of procedure consist of

(a) **division of the strictures from before backward, or**
(b) **division of the strictures from behind forward.**

In the latter case the stricture must be large-calibered or dilated to a caliber sufficient to permit the passage of the urethrotome.

Fig. 2121. Kreissl's meatotome.

DIVISION OF THE STRICTURE FROM BEFORE BACKWARD (MAISONNEUVE'S OPERATION)

Step 1. Pass a filiform guide through the stricture.

Step 2. Attach the metal staff of the Maisonneuve urethrotome (Fig. 2124) to the guide by screwing the end of it into the metal cap upon the outer end of the filiform bougie. Pass the staff with the guide thus attached through the stricture while pulling on the penis makes it taut. The staff is made to slowly pass the stricture until its inner end has reached the interior of the prostatic urethra. Enter the knife blade into the slot on the shaft.

Step 3. Push the urethrotome along the urethra in such a manner that the blade of the knife is kept in contact with the middle of the roof of the urethra. The knife blade being blunt at its apex, cannot injure the normal urethra, its distal end being the cutting one which divides the stricture when pressed against it. A sensation of release of the obstruction denotes to the surgeon that the stricture has been divided. Unless imperative, do not carry the knife blade beyond the posterior part of the bulb; i.e., into the membranous urethra containing the external sphincter, which should not be divided in internal urethrotomy; considerable hemorrhage may be invited.

Step 4. Withdraw the staff and guide. Irrigate the urethra through a small rubber catheter.

Step 5. Pass a steel sound the normal size of the urethra of the individual operated upon.

Comment. The merit of the operation is that it can be used in any stricture which permits the passage of a filiform bougie.

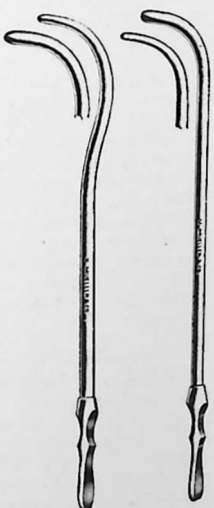


Fig. 2122. Urethral sounds.

DIVISION OF THE STRICTURE FROM BEHIND FORWARD (OTIS' OPERATION)

Step 1. Do a meatotomy. Determine the extent and location of the stricture or strictures with a urethrometer (Fig. 2125) or bougie à boule (Fig. 2126).

Step 2. Pass the Otis urethrotome (Fig. 2127) with its blade closed and with the knife in position in the slot in the other end of the shaft. Pass the stricture so that the concealed blade of the knife comes to lie just a little

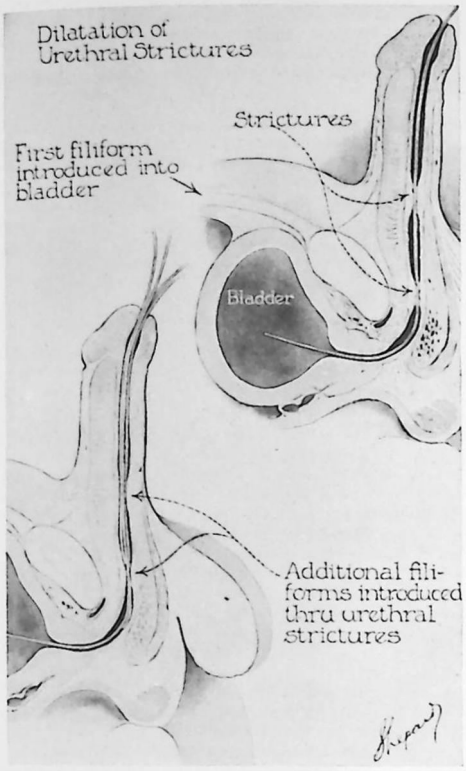


Fig. 2123. Dilatation of urethral strictures (above). Introduction of first filiform bougie (below). Additional filiforms introduced.

beyond the posterior limit of the stricture to be divided. Steady the penis. The shaft of the urethrotome must be in position so that the incision of the strictures is on the roof of the urethra, in its midline. By means of the screw at the proximal end of the instrument, separate the blades so as to put the

tissues of the stricture on the stretch without tearing them. The knife, concealed up until the present time, is made to appear; it is drawn steadily along the slot until all strictured tissue is divided. Sheath the knife blade again. Bring the two arms of the shaft into apposition by turning the screw head in the opposite direction used for their separation. Slowly and cautiously withdraw the instrument lest injury to the urethra ensue by catching a portion of mucous membrane which may be torn off during the withdrawal.

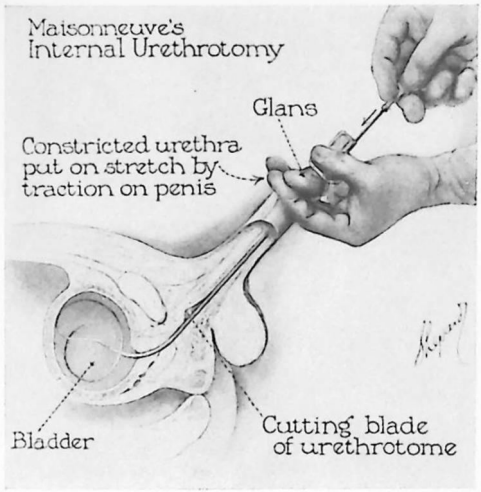


Fig. 2124. Internal urethrotomy. The point in this procedure is to divide the stricture by a longitudinal incision while the urethra is pulled tense by means of traction on the penis. The blade of the urethrotome is held directed toward the roof of the urethra in the midline. Blade of urethrotome passed forward (arrow) past the stricture.

If the instrument is stopped during its withdrawal open the blades slightly, push it backward a little, close it again and slowly remove it.

Step 3. Irrigate the urethra and the bladder. Pass a full-sized sound.

COMPLICATIONS OF INTERNAL URETHROTOMY

(1) **Hemorrhage.** This may be avoided by cutting exactly in the midline of the stricture on the roof of the urethra. Sclerosed tissues do not bleed much. When bleeding is severe, pass a full-sized catheter; if persistent it may become necessary to splint the urethra by external pressure against the catheter. Avoid operations by this method in the membranous urethra; retrograde hemorrhage into the bladder may ensue. In view of this, internal urethrotomy should be reserved for strictures in the pendulous and anterior part of the bulbous urethra. When the hemorrhage becomes alarming do a perineal section; expose the bleed-

ing point, ligate it. If all this fails drain the bladder (perineally) with a large tube and pack the wound thoroughly.

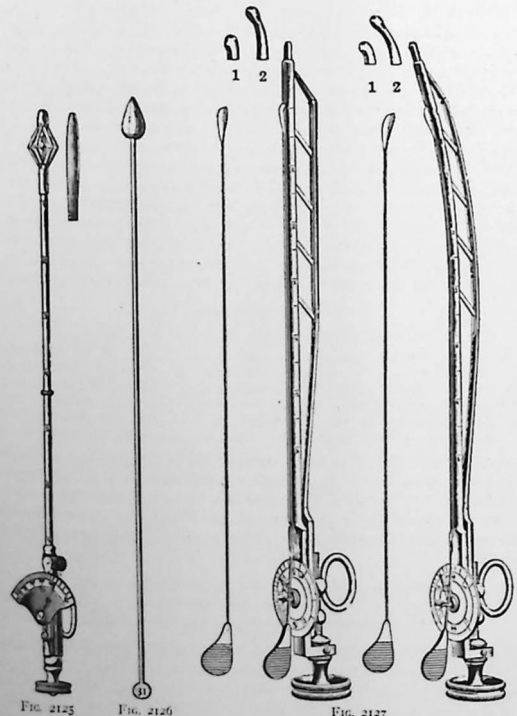


Fig. 2125 Fig. 2126 Fig. 2127

Fig. 2125. Urethrometer.
Fig. 2126. Bougie à boule.
Fig. 2127. Otis' urethrotome.

(2) **Urethral Fever.** 1. Prophylaxis (caprokol). 2. Rigid asepsis. 3. Irrigate the bladder with a mild antiseptic solution, immediately following the operation and leave a few ounces of the solution in the bladder (König).

Keep the patient in bed for a few days. Pass a catheter for urinary retention. After five or seven days, pass a full-sized sound and pass sounds every two or

three days thereafter. Decrease gradually the time between passing sounds until satisfactory results are obtained.

External Perineal Urethrotomy

PERINEAL SECTION—THE BOUTONNIÉRE

With a Guide—Syme's Operation[1]

The object of this operation is to pass as a guide Syme's staff through the stricture and cutting upon this immediately in front of the obstruction and then dividing the stricture.

Preparation of the Patient. Either by tying a filiform bougie overnight into the urethra or by gradual dilatation, the stricture is made as large as possible to facilitate ease of operative maneuvers.

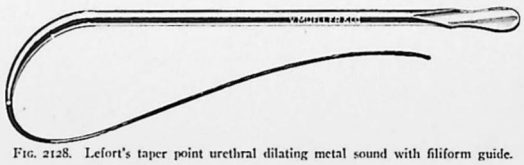


Fig. 2128. Lefort's taper point urethral dilating metal sound with filiform guide.

Prepare as for internal urethrotomy (scrub, shave, asepticize the perineum, buttocks and scrotum). Place the patient in the lithotomy position. Have on hand a Syme's staff and filiform whalebone bougies. General anesthesia.

Step 1. Pass the thin portion of the Syme instrument through the stricture until its shoulder becomes arrested at the stricture. An assistant holds the staff vertically in the middle line. With his left hand, the assistant pulls the scrotum up and out of the way.

Step 2. Palpate the sound through the perineum. Make an incision in the median line from a point just behind the scrotum to about an inch in front of the anus, cutting through all the tissues down to the staff. This opens the urethra immediately anterior to the stricture. Retract the edges of the urethral wound with fine forceps or a couple of fine sutures introduced for this purpose. (Fig. 2129 a.)

Step 3. Split the stricture completely by carrying the point of the knife along the groove of the staff, in the middle line. The urethra should be divided as far back as the beginning of the membranous portion.

Step 4. Pass a Teale's gorget through the perineal wound into the posterior urethra as far as the stricture. Withdraw the staff. A finger may be passed along the gorget into the bladder. The tight margin of the cut-off muscle is first felt and through this, the finger is gently but firmly pressed; the prostatic urethra is passed after which the neck of the bladder is encountered. Explore the urethra from the front.

Step 5. A perineal drainage tube is introduced into the bladder and the gorget withdrawn. Flush out the urethra with boric acid solution after which the

[1] Edin. Jour. Med. Sci., Oct., 1844.

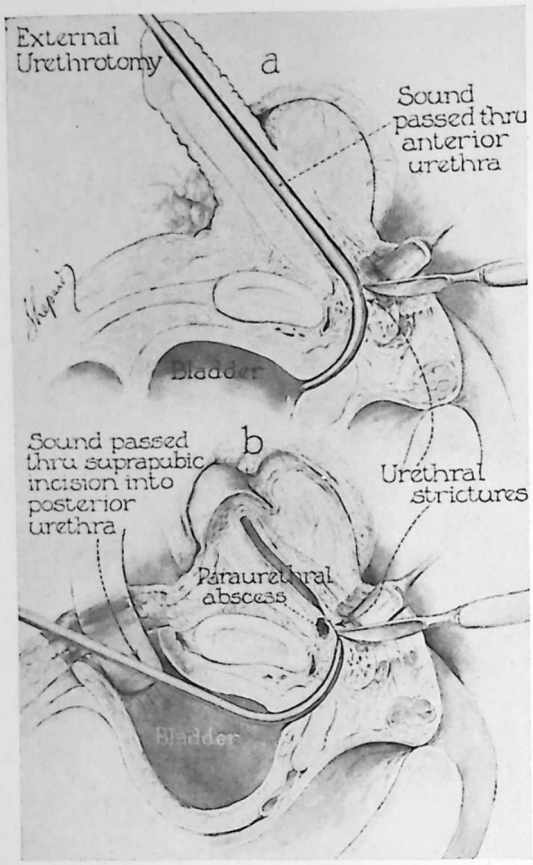


FIG. 2129. External urethrotomy. a. *With a guide.* Sound passed stricture. Incision of stricture along guide. b. *Without a guide.* Where the Wheelhouse operation fails (Fig. 2130) open the bladder, introduce a sound into the posterior urethra and divide the stricture. This method is safer than a prolonged search for the urethra in case of abscess, urinary extravasation, etc., which render a search of the urethra via the perineum hazardous.

bladder is irrigated through the tube with the same solution. The perineal tube is then withdrawn until its edge just rests within the bladder. Pain and spasm result when the tube projects too far into the bladder. To make sure just at which point the tube is in its proper location in the bladder, fill the latter with fluid, draw on it until the flow ceases, then push it back again. When the flow starts, the tube is in its proper location. Anchor it there (adhesive tape or safety pin). Close the perineal incision about the tube with interrupted sutures. Apply voluminous dressings held in place by a T-bandage.

Comment. The tube from the perineum is removed in about four or five days. Pass a sound about that day. Pass urethral sounds early, at first every three or four days for about a month, then less often. If only a filiform can be passed before the external urethrotomy is done, either a Le Fort follower (Fig. 2128) or a Bank's bougie can be inserted. When it is caught at the point of the stricture, the incision in the urethra is made at this point and the stricture divided along the filiform bougie. The operation is then continued as described above.

External Urethrotomy Without a Guide
Arnott-Wheelhouse's Operation

Arnott was the first to perform this operation in 1822. Wheelhouse slightly modified it. This operation is resorted to when even a filiform cannot be passed through the stricture. Prepare the patient as in the previous operation.

Step 1. Pass a Wheelhouse staff to the point of the stricture. Have an assistant hold the staff firmly and steadily in the median line, the grooved portion facing the skin (Fig. 2130 a).

Step 2. Make a midline incision in the perineum, opening the urethra on the groove of the staff. Enlarge the opening toward the penis for about two inches. Since the groove does not reach the end of the staff, the incision does not reach the point of the face of the stricture—thus preserving the relation of the stricture to the rest of the urethra.

Step 3. Turn the staff around and withdraw it so that its projection on the end hooks up the upper angle of the wound. Transfix the mucous membrane of the middle of the opened urethra on either side with sutures of silk as shown in the illustration; unite these temporarily to the skin; remove the Wheelhouse staff and retract the upper end of the urethra with an ordinary hook (Fig. 2130 b).

Step 4. Under good illumination the search for the opening in the stricture is now begun. It must be kept in mind that the opening may be in any position on the face of the stricture. The search may be aided by pressure on the hypogastrium forcing some urine through the urethral opening searched for. Note the point of emergence of the urine. Probe even the finest spot or depression for the opening. If oozing of blood obscures the field, J. W. T. Walker advises a soaked sponge be firmly applied until the oozing is under control. Walker further admonishes to use adrenalin with caution.

Step 5. When diligent search is rewarded by finding the opening the rest of the operation is easy. A probe is passed through the stricture, a sharp knife

following the probe as a guide and the stricture is completely divided. The incision into the stricture should be longitudinal, exactly in the midline.

Step 6. A gorget or director is passed through the usually dilated portion of the urethra, behind the strictures, into the bladder. Pass a large calibered catheter along the penile urethra, guided by a gorget.

Step 7. The perineal wound may be left open without suturing, or the urethra and perineal tissues may be drawn together with a few sutures.

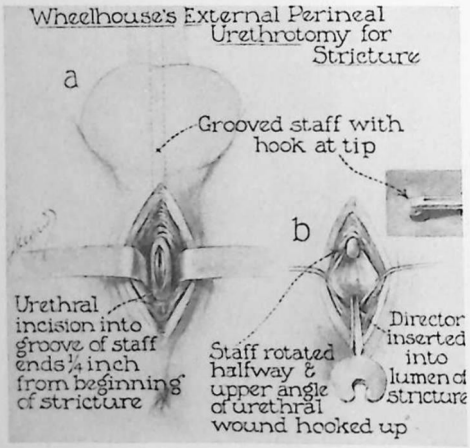


FIG. 2130. Wheelhouse's perineal urethrotomy for stricture. a. b., Incision: perineoscrotal junction to anterior border of sphincter ani. After the incision into the urethra has been made lateral traction sutures of silk are placed, the grooved staff is withdrawn from the ¼-inch of intact urethra and turned a half rotation to present its angulated tip. The upper margin of the urethral wound is now hooked upward and through the retracted portion of intact urethra a small probe or grooved director is insinuated along the strictured urethral lumen.

Step 8. Anchor the catheter in the urethra. Permit it to remain for 5 or 6 days; then remove it. Begin the passage of sounds about a fortnight after the operation.

When the Finding of the Opening Fails. Several methods of procedure are at the disposal of the surgeon.

Method I. If, after a diligent search for a reasonable length of time, the opening is not located, do not waste more time and effort and inflict lacerations to the tissues; endeavor to incise the urethra posterior to the stricture and open it. While cutting, keep strictly to the median line. When the urethra is opened the stricture may readily be divided and a sound be made to readily pass through the meatus, past the perineal wound and into the bladder. The incision in such cases is prolonged anusward over the posterior extremity of the bulb. The bulb

is exposed; at its posterior extremity the urethra is easily exposed at its membranous portion (usually dilated here). Pass a probe penisward through the stricture and slit the latter from behind forward.

Method II. Open the bladder by a suprapubic cystostomy and attempt retrograde catheterization (passing a metal sound from the bladder toward the front). A Bénique sound (Fig. 2129 b) is well adapted for the purpose. It is made prominent at the perineum posterior to the stricture. Place the patient in the lithotomy position. Incise in the midline at the point of the sound. Attempt to pass a probe forward through the opening made and divide the stricture If this cannot successfully be accomplished, pass a sound through the meatus toward the stricture and divide the scar tissue intervening. Drain through the perineum as described above. Close the suprapubic wound. Irrigate the bladder. Attempt the passage of a sound through the meatus six or seven days after the operation. This often is a very difficult task. Binnie "more than once found a spur in the depth of the perineal wound which rendered the passage of the sound impossible. Division of the spur was all that was necessary. The spur itself was undoubtedly the result of insufficient division of the stricture at the primary operation." Sounds should be passed as already outlined above.

Urethrectomy

RESECTION—EXCISION OF THE STRICTURE

Historical Notes. The operation dates back to 1812. It has been popularized by König who in 1882 successfully removed a stricture of the perineal portion of the urethra. He divided the urethra transversely at each end of the stricture, the intervening scar tissue was excised and the ends of the urethra united by sutures. Since 1891, the method has been widely used by French surgeons (Guyon, Albarran, Poncet, Mollière); in Germany by Wölffer and in America by Keyes, Cabot, and others.

Indications. Cases of stricture not amenable to other methods of treatment. Traumatic strictures are usually subjected to this form of surgical therapy.

Methods. A: Complete division of the urethra in front and behind the stricture; removal of the strictured segment and allowing the intervening urethral gap to heal over an indwelling catheter which is permitted to remain until healing is complete.

B: Same, except that the divided ends of the urethra are united by sutures.

C: Instead of completely dividing the urethra the roof is permitted to remain. **Incomplete urethrectomy is the method usually practiced.**

Step 1. Pass a probe through the stricture, if possible. Prepare the patient as outlined above. Expose and open the urethra as in external urethrotomy.

Step 2. Dissect the stricture all around its urethral extent, with the exception of a portion of mucous membrane at the roof of the urethra. Every vestige of scar tissue composing the stricture should be removed by sharp dissection.

Step 3. This consists of restoring the continuity of the urethra. Introduce a retention catheter into the bladder.

Methods of Union of the Urethra. End-to-end union with the urethral catheter in situ. Use fine chromic catgut interrupted sutures which do not include the mucosa. Longitudinal sutures are passed as follows: one on either side to unite the gap in the side walls, one in the median line and one on either side of this (Albarran). (Fig. 2131.)

Step 4. Close the superficial perineal wound with sutures or leave it open to heal by granulation.

After-Treatment. The soft rubber catheter is permitted to remain in the bladder for about one week. When it causes irritation it is removed earlier. After the catheter is removed the passage of sounds is commenced gradually.

Comment. Young's procedure consists of opening the urethra in front of the stricture which is found by a filiform introduced through it. The filiform is withdrawn and a delicate grooved director is introduced and the stricture divided with a sharp knife. Resection of the stricture is accomplished by thorough ablation of the cicatrized mass leaving a narrow bridge

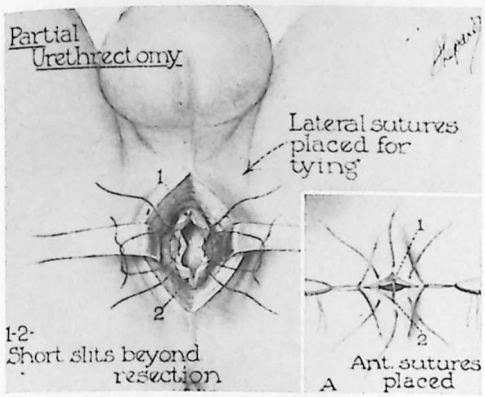


Fig. 2131. Alharran's method of partial urethrectomy. After the lateral urethral sutures (1-2) are tied, they are used as traction sutures while the anterior sutures (A) are placed.

of mucous membrane connecting normal anterior and posterior portions of the urethra. The soft tissues are united fairly tight over a large catheter introduced into the bladder through the meatus, closing the defect completely. A second row of catgut sutures reinforces the first. The skin and subcutaneous tissues are closed completely, except at the anterior angle where a small drain is inserted. The catheter in the bladder is fastened in place. The bladder is irrigated. The catheter is permitted to remain for about a week unless suppuration supervenes. Beginning on the twelfth day dilatation with urethral sounds is begun: the procedure is repeated every fourth or fifth day until the desired results are obtained.

RUSSEL'S OPERATION[1]

Rationale. It has been shown that the male urethra can be divided from the meatus to the membranous portion and healing will take place without stric-

[1] Hamilton Russel, Brit. Jour. Surg., 1915, II, 375.

ture formation, provided that sufficient perineal drainage is instituted during the healing process.

Operation

Step 1. High lithotomy position. An incision with its apex at the central point of the perineum is made. Open the ischiorectal fossae. The external anal sphincter is detached at the central tendon from the bulbocavernosus muscle. Retract the sphincter with a bifid retractor, backward. Expose the membranous urethra and the apex of the prostate by pulling forward the bulb of the urethra and the transversus perinei muscles. Open the membranous urethra longitudinally. Introduce a silk traction suture on each side of the wound. The urethra is split forward toward the stricture.

Step 2. Introduce a guide or sound through the meatus to the face of the stricture and at this point also divide the urethra longitudinally in front of the stricture in the median line, the incision meeting the apex of the first incision. The urethral wound is also separated by lateral traction sutures. The exposed stricture is visualized and with it the urethra is found behind it and with the stricture split open for an inch or so.

Step 3. The stricture is now excised completely together with its extraurethral scar tissues; the removal of the latter must be thorough.

Step 4. The divided ends of the urethra are mobilized by undercutting. They are then united with fine interrupted catgut sutures.

Step 5. A catheter is placed into the bladder through the perineal wound and there anchored with sutures. The lateral perineal wounds are united with deep silkworm-gut sutures. No sutures are placed in the perineum in front of the catheter.

Step 6. Remove the catheter from the bladder in about a week. After healing has taken place (several weeks), sounds (full-sized) should be passed.

REMOVAL OF FOREIGN BODIES FROM THE URETHRA

The technic of removal of foreign bodies from the urethra depends upon the type of foreign body and upon its location. As a general rule methods should be employed that will not injure the mucous membrane of the urethra. Stones arrested in the urethra en passage may be removed by Bivona's method. This consists of first injecting an anesthetic solution into the urethra. The patient is asked to urinate, the stream of urine is then suddenly interrupted by compressing the end of the penis. This dilates the urethra and when urination is resumed the stone may be swept out.

Stones May be Removed With an Alligator Forceps

Needles or pins in the urethra may be effectually dislodged and removed as shown in Fig. 2132.

RUPTURE OF THE URETHRA

Usually ruptures of the urethra occur in its membranous portion. It is of utmost importance to know whether the rupture is complete or incomplete. A minor incomplete rupture of the urethra may heal spontaneously. In more severe injuries, the sooner operation is undertaken to repair the damage, the better.

Catheterization per urethram often leads to trouble (infection, etc.). Suprapubic cystostomy is indicated (p. 1918).

Incomplete Rupture

Perineal drainage will often prevent stricture formation in incomplete rupture of the urethra without extravasation of urine.

Step 1. Suprapubic cystostomy (p. 1918).

Step 2. Retrograde catheterization.

Step 3. Open the perineum. Search for the ends of the divided urethra. Mobilize them.

Step 4. Suture the mobilized urethral ends by the method described above (p. 2015, Fig. 2131). Use interrupted sutures of chromic catgut. To avoid the sutures from cutting out, a "firm grip of the corpus spongiosum as well as the mucous membrane should be taken." (Hamilton Bailey.)

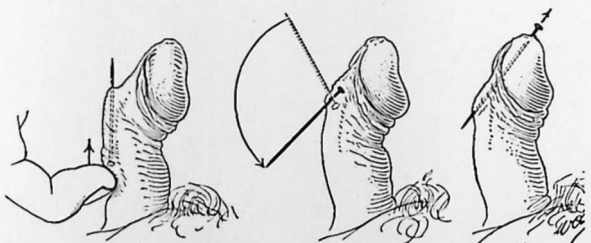


Fig. 2132. Proper method of removing a pin from the urethra.

Step 5. Pack the wound tightly with gauze. Dress. Take the patient down from the lithotomy position. Suture a de Pezzer catheter into the suprapubic wound.

Comment. Fowler position after the operation and strict asepsis are essentials. Begin passage of bougies after fourteen days—gently, gently.

Complete Rupture of the Urethra with Extravasation of Urine

1. Suprapubic cystostomy.
2. Retrograde catheterization.
3. Perineal section. Pass a Condé catheter from the meatus into the perineal wound; it is then threaded into the posterior urethra guided by the retrograde bougie.
4. Fix the catheter to the penis.
5. Drain the space of Retzius.
6. Leave the perineum open. Incise the infiltrated areas as described above under extravasation of urine.

OPERATIONS ON THE PENIS

Anatomic Considerations. The penis is composed of three cylindrical masses of erectile tissue—two corpora cavernosa on the dorsal surface and one corpus spongiosum on the ventral surface of the organ. The corpora cavernosa are attached posteriorly to the rami of the ischia and pubes and terminate in blunt ends anteriorly; the corpus spongiosum commences at the bulb, at the central point of the perineum posteriorly and ends in the glans penis anteriorly; thus, the glans is the extended portion of the corpus spongiosum and covers the ends of the corpora cavernosa. Its extended rim is known as the corona glandis, the groove immediately behind it the collum glandis. An artery courses in the center of each corpus cavernosum. The skin of the penis is thin and loosely attached throughout. Behind the corona glandis it forms a reduplication known as the prepuce which is attached by its inner layer to the neck of the penis. A median fold is formed by the prepuce on the under surface of the glans which is known as the frenulum; this extends forward to the lower part of the external meatus. Buck's fascia is a fibrous sheath which surrounds the corpora cavernosa and corpus spongiosum, binding the three together. Anteriorly it is continuous with the suspensory ligament and posteriorly with the deep layer of the superficial fascia (Colles fascia) and with Scarpa's fascia on the abdominal wall. The corpora cavernosa and corpus spongiosum have each a separate fibrous sheath separating the two corpora cavernosa by its septum pectiniforme. The suspensory ligament of the penis extends from the symphysis pubis to the adjoining part of the dorsum of the penis.

Vessels and Nerves. The superficial dorsal vein is situated within the superficial fascia in the midline and extends along the dorsum of the penis toward the pubes; its right and left branches join the external pudic veins. After entering the penis it joins the prostatic venous plexus. In the groove between the corpora cavernosa are situated the two dorsal veins and the two dorsal arteries, the vein occupying a central position. In the body of the penis are two arteries of the corpus cavernosum, terminal branches of the internal pudic; also a few septal vessels.

Lymphatics of the Penis and Urethra. The superficial lymphatics of the penis accompany the dorsal vein and end in the superficial inguinal nodes. The deep vessels originate in the glans penis. They also run with the dorsal vein and drain into the deep subinguinal nodes, one duct passing up the inguinal canal to terminate in the external iliac nodes. A very complex drainage occurs in connection with the urethra. The prostatic portion terminates in a similar manner to that of the prostate gland; the bulbous and membranous parts emptying in the hypogastric or external iliac chain while the penile group accompany the dorsal vein of the penis, to terminate in the deep subinguinal and external iliac group of nodes.

PHIMOSIS

The following principal factors come under consideration in the treatment of phimosis:

a. To remove the constricted prepuce.

b. To have the preputial orifice sufficiently large to permit its easy retraction over the glans penis.

c. To obviate injury to the frenulum.

Anatomic Considerations. It must particularly be remembered that (1) the foreskin (prepuce) is made up of an outer layer of skin and an inner tunic of mucous membrane. These two are separated by a loose network of connective tissue, permitting the skin to freely move over the mucous membrane. A clamp, therefore, placed upon the foreskin as is practiced in certain operations for phimosis engages only the outer layer of the prepuce while the inner (mucous membrane) requires a separate incision.

(2) The integuments of the prepuce and penis are extremely loosely attached to the underlying structures, while the mucous membrane, on the contrary, is firmly attached just behind the corona glandis: it is for that reason that the former can be drawn toward the preputial opening with facility. In circumcision, care must be taken not to pull the foreskin too far forward: the clamp is applied at the point of junction

of the skin with the inner layer of the mucous membrane; if this is not observed a disproportionately large area of skin will be removed compared with the mucous membrane; the skin will retract too far to the root of the penis and difficulty might arise from a deficiency of skin to cover the resulting defect. Careful calculation is, therefore, necessary to determine the amount of prepuce to be removed so that upon completion of the operation neither too little nor too much has been taken away.

(3) The looseness of skin may contribute to a large hematoma if perfect hemostasis is not obtained.

FOREIGN BODIES AROUND THE PENIS

On occasion the surgeon is called upon to remove metal rings and similar objects from the body of the penis. Some years ago the author had to call a jeweler to saw through a small hammer from which the penis could not be extricated by ordinary means. Under anesthesia the hammer was sawn through, but the penis was much traumatized before being liberated.

John E. Cannaday[1] writes:

"From time to time we hear of cases in which a ring or other closely fitting circular device has been placed around the penis. After a short time so much swelling has taken place that the possessor is unable to remove the ring. Some of these instances, no doubt, are the result of boyish pranks; again this has at times been done with the idea of preventing bed wetting. Other cases occur among those having psychopathic or neurotic tendencies, and in some instances rings or other similar devices have been placed on the male organ by practical jokesters while the victim was in a drunken sleep.

Fig. 2133. Metal ring removed from around penis. (Courtesy of Dr. John E. Cannaday.)

"The portion beyond the ring swells, the skin immediately under the ring becomes eroded, and about this time the patient usually consults a physician. The ring can usually be removed by cutting it in two at one side and springing the ends apart. Occasionally some hard and highly resistant metal may be encountered, as was the case in the subjoined report.

"Case Report: E. M., aged fifteen years, of St. Albans, W. Va., was admitted to the Charleston General Hospital in a very uncomfortable condition. He gave a history of slipping a bicycle cone over his penis two weeks before admission to the hospital. He was unable to remove it and was ashamed to tell anyone about it. Finally, he became so disabled that he told his mother who called a physician, Dr. T. S. Tompkins, who sent him to the hospital.

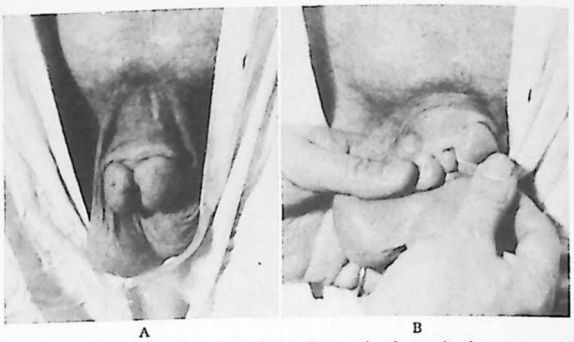
"On examination he showed an enormous swelling of the penis; the skin was very badly eroded all around the circumference due to the pressure of the ring.

"It is well known that the cone and other of the wearing parts of bicycles are usually made of vanadium or chrome steel, either one of which is of extreme hardness and is cut with great difficulty. Numerous ineffectual attempts were made to divide this piece of metal with a hack saw, 8 or 10 hack saw blades having

[1] Amer. Jour. Surg., 1931.

been worn out in the course of eleven hours without making any headway at all worth while. It finally was decided that the only possibility of getting off this ring, or cone, was by reversing the manner in which it had been put on.

"Under gas anesthesia, after making multiple punctures in the edematous skin and forcing out the serum, compressing the penis manually and with an Esmarch bandage, we finally succeeded in reducing its size sufficiently to enable us gradually to force it back through the opening in the cone by grasping a portion of the body with a sponge forceps and gradually working it back through the opening. The penis was considerably traumatized in the process but after a few days was apparently restored to normal (Fig. 2133).



A B

Fig. 2134. A. Hemisection (complete) of the glans penis—the result of an auto accident. B. The two halves of the glans separated showing the meatus urinarius.

"The case is reported merely because the ring could not be removed in the usual manner by dividing and spreading it and to describe a different method of removal of the ring from that usually practiced in such cases."

INJURIES TO THE PENIS

Injuries to the penis may be manifold and may be occasioned by a variety of factors. Figure 2134 shows a complete bisection of the glans penis. The patient was run over by an automobile and the wheel passed over his pubic region resulting in considerable damage besides bisecting the head of the penis. The pictures shown here were taken 20 years after the accident. The urinary meatus is shown between the two halves of the glans. The patient did not suffer any ill effects in his vita sexualis by reason of the injury. Erections were perfect and the consummation of the sexual act entirely satisfactory.

CIRCUMCISION

Classical Operation—Posthectomy

In the Newborn. Often no anesthetic is required. A sucker consisting of a sponge dipped in some sugar water will often suffice to calm the baby.

Step 1. Draw back the prepuce. Expose the glans penis. Separate adhesions. Clear away the smegma and débris. If the preputial orifice is too narrow introduce an artery forceps and divulse it.

Step 2. Draw the prepuce forward. Apply to it an appropriate clamp obliquely, keeping in mind the points stressed above (see anatomic considerations). Cut away the prepuce in front of the forceps.

Step 3. Remove the clamp. Introduce a pair of delicate scissors between the glans penis and the mucous membrane. Be careful not to introduce the scissors into the urethra. Trim away the excess mucous membrane.

Fig. 2135. Infiltrating the prepuce and frenum in circumcision. Posthectomy.

Step 4. Often no sutures are needed. If bleeding points are active at the frenum, ligate them.

In the Adolescent and Adult. Prepare the parts carefully by scrubbing with soap and water followed by a nonirritating antiseptic fluid (metaphen, mercurochrome, etc.). Note carefully the position of the corona glandis beneath the skin of the penis while the organ is flaccid; grasp the glans penis; pull it strongly forward and note the position of the corona glandis in its relation to the skin of the shaft of the penis and prepuce, thus obtaining an idea of how much of the prepuce is to be removed to obtain the best possible results. Always err on the side of safety; remove rather too little than too much of the prepuce.

Anesthesia. Infiltration or general anesthesia (Fig. 2135). If the former is used, apply a constrictor at the root (base) of the penis. Infiltrate the lines of the proposed incision with a 2 per cent novocaine solution. Deposit the anesthetic fluid in the skin and beneath the mucous layer of the foreskin. Fill the preputial sac with a 4 per cent solution of novocaine and permit it to remain for about five minutes. General anesthesia may be used when indicated. In the neurotic or excessively apprehensive patient evipal or nitrous-oxide-oxygen anesthesia may be used to advantage.

Step 1. Engage the prepuce with an artery forceps in the midline at the junction of the skin and mucous membrane. Sweep a grooved director beneath the prepuce over the head of the penis, thus breaking up any adhesions present. Again note the position of the corona glandis and apply an artery clamp extending obliquely forward from the glans to the orificium urethrae as shown in the illustration (Fig. 2136, upper). Do not include the attachment of the frenum to the glans, in the artery forceps.

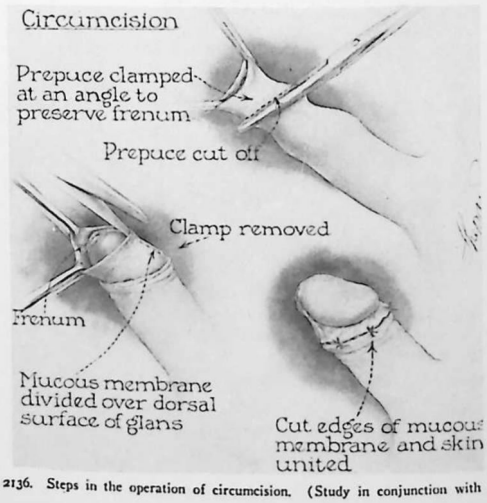


Fig. 2136. Steps in the operation of circumcision. (Study in conjunction with text.)

Step 2. Cut away the prepuce by an incision which passes just above and close to the upper margin of the clamping forceps. Remove the clamp.

Step 3. Pass one blade of the scissors between the glans penis and the inner layer of the mucous membrane (Fig. 2136, middle); do not inadvertently enter the urethra; divide the mucous membrane as far back as the margin of the corona glandis. Turn back the cuff of mucous membrane. Trim away the mucosa to a desirable degree (not too short).

Step 4. If there is any bleeding, arrest it promptly and thoroughly with ligatures. Remove the constrictor from the penis. Unite the edges of the mucous membrane to the integumental border with interrupted catgut sutures or

Pagenstecher linen sutures. Use as many sutures as are necessary to complete coaptation (Fig. 2136, lower).

Step 5. Dress. It is wise to keep the patient in bed for a day or two.

Comment. Many methods for circumcision have been devised; it is best to thoroughly master one standard method than to know many incompletely. If edema results, pressure and minute punctures with a needle will control it. Do not trim off the mucous membrane too close to the corona glandis. In patients who have undergone previously an unsuccessful circumcision operation, the problem is to free the glans penis from adhesions and bring the strictures into normal relationship.

Dorsal-Slit Operation

This operation is practiced in inflammatory conditions, ulcerations, etc., when the classical posthectomy is contraindicated (chancres, chancroid, impossibility of retracting the glans penis, etc.).

Infiltration anesthesia along the line of incision is effective. The anesthetic fluid is introduced into the skin of the prepuce and just beneath the mucous surface.

Step 1. Wherever possible insert a grooved director into the preputial cavity.

Step 2. Incise the prepuce along the director. If a director cannot be introduced, dissection without injury to the corona glandis is done to expose the affected parts.

Step 3. Retract the lips of the wound; expose the lesions present and treat them according to conditions present (chemo- or electrocauterization, asepticization, curettage, etc.). Establish free exposure and drainage. The line of incision should be kept free from infection; if the margins appear healthy after resection of redundancies, they may be loosely approximated with catgut sutures.

Beware of introducing the director or scalpel into the urethra.

PARAPHIMOSIS

Treatment may be (a) manipulative or (b) operative. If the former, it is endeavored to push back the glans and manipulate the prepuce forward. If the latter is successfully brought down, prompt circumcision should be considered, to avoid recurrence.

The nonoperative treatment of paraphimosis (Fig. 2137) is described by Keyes as follows: "Squeeze the penis behind the strictured prepuce in the fork of the index and middle fingers of both hands, one placed on each side. Now make pressure with the thumbs on both sides in such a direction as to compress the glans laterally rather than from before backward, and at the same time pull the strictured portion of the prepuce forward, the effort being rather to pull the stricture over the glans than to push the glans through the stricture. If these methods fail, operation must be resorted to."

Step 1. Grasp the top of the glans penis with the left hand and draw it down in such a manner as to arch the dorsal surface upward.

Step 2. Pass the point of a curved bistoury through the mucous membrane, just

anterior to the constricting ring, a little to the side of the median line in order to avoid injury to the dorsal vein of the penis. The point of the knife is pushed through the constriction which is completely divided (Fig. 2138).

Step 3. Draw the prepuce down over the glans.

AMPUTATION OF THE PENIS

This may be (a) partial or (b) complete. The former is usually performed in crushing injuries and certain limited lesions; the latter in malignancies (Fig. 2139). Before resorting to amputation be sure of your diagnostic grounds; serious mistakes have been made in both directions.

Fig. 2137. Paraphimosis.

Partial Amputation

Step 1. Apply an elastic constrictor to the root of the penis (Fig. 2140 a). Carry a circular incision around the penis about three-fourths of an inch distant from the disease, dividing the tissues down to the fibrous sheath of the corpora cavernosa. Retract the skin.

Step 2. Expose and ligate the dorsal vessels of the penis.

Step 3. Divide the corpora cavernosa transversely down to the corpus spongiosum.

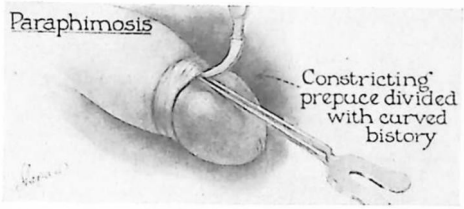


Fig. 2138. Operation for paraphimosis. Showing the curved bistoury introduced under the constricting ring to one side of the median line.

Step 4. Carefully dissect the corpus spongiosum from the inferior surface of the cavernous bodies. Divide the corpus spongiosum and urethra about a quarter of an inch in front of the line of incision through the corpora cavernosa.

Step 5. Four or more catgut sutures are passed transversely across the divided surface of the corpora cavernosa (Fig. 2140 b), passing the encasing fibrous

sheath on either side and through the septum, situated between the two corpora. After the placement of the sutures is accomplished, tie the sutures (Fig. 2140 c) thus compressing the blood spaces and securing hemostasis.

Step 6. Remove the constrictor. Make an incision in the median line of the skin flap (dorsally). Make a corresponding cut in the urethra in the midline above and below. Bring the edges of the circular part of the skin flaps to the edges of the urethral orifice. The edges of the circular skin flaps are adapted to the margins of the urethra with interrupted fine Pagenstecher linen sutures (Fig. 2140 d).

Step 7. Insert a catheter into the bladder. Dress the wound.

Fig. 2139. Carcinoma of penis.

NICOLL'S MODIFICATION

In addition to the above, Nicoll suggests the following additional steps.

Step 1. An incision is made over each inguinal region uniting the incisions thus made in the middle at the root of the penis and from this point of junction continue the incision along the mid-dorsal line of the penis to the place chosen for amputation.

Step 2. The lymph nodes of both inguinal regions are dissected free from above downward and from without inward including those on the dorsum of the penis. This should be a block dissection. Proceed with the amputation as outlined above.

EXTIRPATION OF THE PENIS

A block dissection of the penis and its lymph apparatus is the object of this operation. The principle of the operation is akin to block removal of the breast and the axillary lymph nodes. There is no need to sacrifice so important endocrinous structures as the testes since their blood and lymph supply is entirely different from that of the penis.

Step 1. The patient is placed in the dorsal position. An incision is made be-

ginning at the spine of the ilium on each side running parallel with Poupart's ligament about a finger's breadth above it and carried to the median line

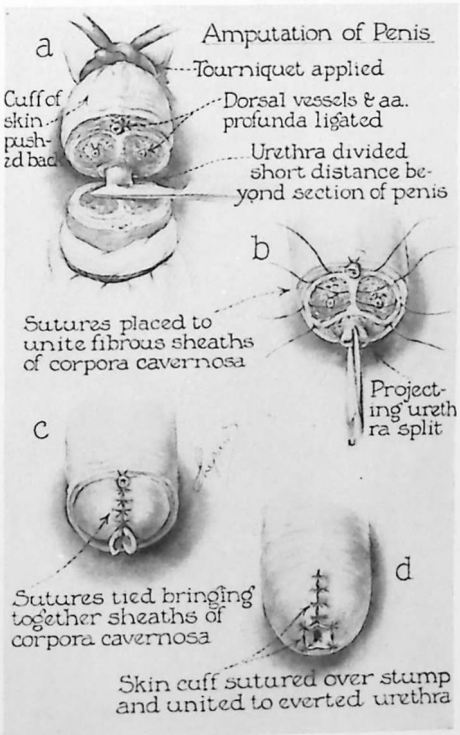


Fig. 2140. Amputation of the penis. a. Tourniquet. Circular incision. Ligation of dorsal vessels of penis. Division of corpora cavernosa down to corpus spongiosum. Dissection of corpus spongiosum and division of urethra a short distance beyond section of penis. b. Splitting of projecting urethra and placement of sutures. c. Sutures tied compressing corpora cavernosa thus aiding hemostasis. d. Suturing skin cuff over stump of penis, to everted urethra.

above the base of the penis. Young adds two longitudinal incisions on each side of the front of the penis to the point of amputation.

Step 2. Deepen the incisions to the aponeurosis of the external oblique muscle; dissect out completely the chain of lymph nodes en masse with the superimposed subcutaneous tissues, working from above downward and made in such a manner that the block of tissue removed will, when completed, embrace the portion of the penis to be ablated. Strip the tissues overlying the spermatic cords cleanly. On reaching the femoral regions the dissection extends to the thigh disengaging the lymph nodes of these regions and carrying the dissection into the upper part of the scrotum. "The saphenous and superficial epigastric veins," says Young, "should be sacrificed, the cribriform fascia incised, and the deep group of femoral nodes dissected away cleanly from the artery and vein. This is necessary because some channels from the glans run directly to the deep group of the lymph nodes."

Step 3. It is usually necessary to divide the penis at its base and excise the bulb and corpora cavernosa. Divide the suspensory ligament of the penis. Dissect from above downward to a point where the corpora cavernosa are to be divided. Divide these transversely after first applying a rubber constrictor to the upper segment of the remaining stump.

Step 4. Treat the corpora cavernosa, the corpus spongiosum and the urethra as outlined above in partial removal of the penis. (Steps 4, 5, 6 and 7 above.)

Total Extirpation of the Penis—Dávalos' Technic

Alexander J. Dávalos of Paraguay described the following surgical technic:[1]

Step 1. Skin Incision. The patient is placed on the back with hips elevated by a cushion. The limbs are prepared and flexed upon the abdomen. Make an incision through the skin of the perineoscrotal raphé about 8 cm. in length ending about 3 cm. in front of the anus (Fig. 2141).

Step 2. Isolation of the Corpora Cavernosa and the Urethra. After the urethra has been exposed, isolate the corpora cavernosa from the contiguous structures by a grooved director and hold the parts with a Faraboeuf retractor (Fig. 2142).

Step 3. Dissection and Division of the Urethra. The urethra is dissected free and detached from the corpora cavernosa for about 3 or 4 cm.; divide it transversely (Fig. 2143). During the dissection of the urethra one must proceed through a proper line of cleavage and to keep away as much as possible from the corpora cavernosa. Loss of blood is thus avoided.

Step 4. Division of the Corpora Cavernosa. After the urethra has been divided, displace it laterally or downward. Divide transversely the corpora cavernosa as near as possible to their ischiopubic insertions. Clamp the dorsal vessels of the penis with artery forceps and while an assistant compresses the proximal end of the corpora cavernosa, place a clamp on their distal ends. This reduces bleeding considerably (Fig. 2144).

Step 5. Suture of the Corpora Cavernosa. The ends of the corpora cavernosa are united with interrupted catgut sutures. Ligate the dorsal vessels of the penis (Fig. 2145).

Step 6. Completion of Extirpation of the Penis. Make an incision into the skin encircling the root of the penis. Prolong this incision on both sides laterally over the scrotum, the lateral incisions joining the ends of those

[1] Revue Sud-Americaine, de Med. et de Chir., T. H. No. 12, Dec., 1931.

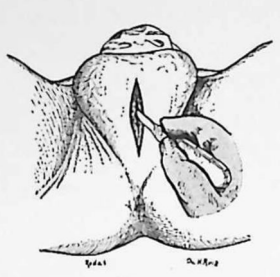


FIG. 2141

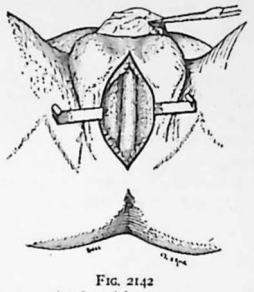


FIG. 2142

FIG. 2141. Incision along the perineal raphé.
FIG. 2142. Isolation of the corpora cavernosa and of the urethra.

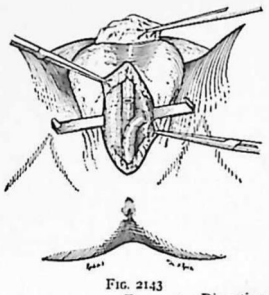


FIG. 2143

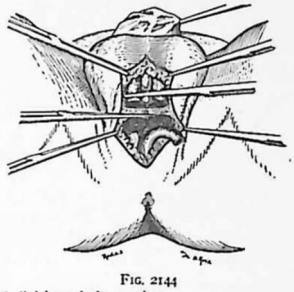


FIG. 2144

FIG. 2143. Dissection and division of the urethra.
FIG. 2144. Division of the corpora cavernosa.

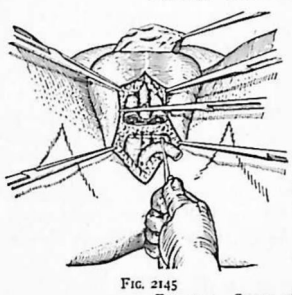


FIG. 2145

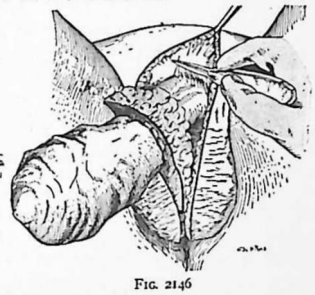


FIG. 2146

FIG. 2145. Suture of the corpora cavernosa.
FIG. 2146. Freeing of the corpora cavernosa and of a portion of the scrotum, from above, downward. (Courtesy, Dr. A. J. Dávalos.)

made on the median raphé. Endeavor to remove as much as possible of the scrotum. Divide above and below the suspensory ligament of the penis and the attachments of the corpora cavernosa. When the inferior surface is reached, the penis together with a portion of the scrotum are removed en block (Fig. 2146).

Step 7. Suture of the Scrotum. Begin at the pubic end and close the lips of the wound of the scrotum by interrupted silk sutures. Continue in the fashion indicated in Fig. 2147.

Step 8. Implantation of the Urethra into the Perineum. Split the urethra for about 1 cm., on its lower surface, and suture it to the skin of the perineum.

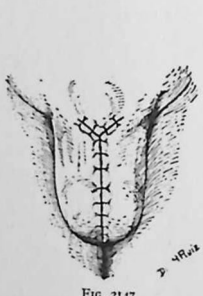


FIG. 2147

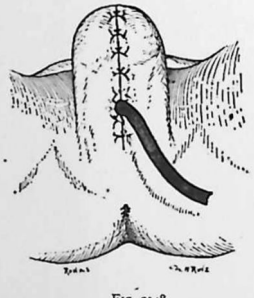


FIG. 2148

FIG. 2147. Incision sutured; anterior view of the peno-scrotal segment.
FIG. 2148. View of the perino-scrotal aspect. The central end of the urethra is sutured to the perineum.
(Courtesy of Dr. A. J. Dávalos.)

Pass a retention catheter into the urethra and permit it to remain there during the time of healing—approximately 8 to 10 days (Fig. 2148).

Comment. After the operation is completed and the scrotum united properly, it will give the appearance of a penis. It is for that reason that sufficient tissue from the scrotum should be removed. It will be noted that after cicatrization has taken place and the catheter removed, the patient will urinate standing without wetting the scrotum. This together with the appearance of the newly shaped scrotum will tend to alleviate the mental suffering of these patients.

Most surgeons object to complete emasculation, a procedure Robert Allesandri of Rome strongly advocates. Young comments on this question as follows: "in our experience, patients object seriously to such mutilation since some of them are able to have fairly satisfactory coitus after even very extensive resections of the penis."

The thought is comforting that carcinoma of the penis is usually of slow growth. (Butlin.) Amputation at the junction of the middle and distal thirds or at the middle of the penis does not necessarily interfere with the "potentia coeundi" nor with the "potentia generandi."

PLASTIC OPERATION ON THE PENIS

Hypospadias

This consists of an abnormal opening on the inferior wall of the urethra. If situated on the glans penis it is spoken of as balanic; if on the shaft, penile; or, it may be scrotal or perineal in location. Often some deformity exists which should be remedied before repair of the defect is undertaken. Fortunately the abnormal opening in the vast majority of cases of hypospadias is located at the glans penis or immediately below it. These require no surgical intervention. It is different in cases of penile, scrotal or perineal hypospadias, which should be subjected to painstaking surgical repair.

Perineal urethrostomy or suprapubic cystostomy as a preliminary is not only advisable but often essential to success. Young advocates the procedure warmly. The **Young-Shaw apparatus** enables one to obtain continuous, efficient bladder drainage at the same time keeping the bladder bathed in an antiseptic solution, this, to frustrate infection.

Perineal Urethrostomy. By this procedure the retention catheter and its evil influences (urethritis, cystitis, etc.) are avoided. The operation consists of cutting an opening in the perineum leading to the bladder. Incisions sufficiently long are made in the skin and urethra which, when united by sutures, form a mucocutaneous fistula for diverting the urine. The opening is mustered into service until desired results are obtained. "Until recently," Young says, "almost all hypospadias cases which had been drained through a perineal retention catheter have become infected."

VON HACKER-BECK OPERATION

Von Hacker of Germany and Carl Beck of New York popularized this operation which is useful in glandular and anterior penile hypospadias.

The method consists essentially of mobilizing the meatus and anterior portion of the urethra, tunneling the glans penis and advancing the urethra through this tunnel (Figs. 2149-2150-2151-2152). A rim of skin surrounding the meatus urinarius is carefully preserved. The tunnel is made with a sharp, slender, bistoury; the meatus and its tegumentary rim is brought to the surface of the glans and then sutured in place with Pagenstecher celloidin linen. Young prefers the Duplay operation to this procedure, stating that the curve of the penis already existing is accentuated by this operation.

DUPLAY'S OPERATION FOR GLANDULAR HYPOSPADIAS

This operation is well adapted to cases in which there is a groove on the under surface of the glans representing the glandular urethra. The edges of this groove are freshened and brought together in the midline over a retention catheter by interrupted sutures of fine silk or chromic catgut. When the flaps are too short to come together without undue tension, lateral incisions into the tissues of the glans penis are made which will overcome this difficulty. The retention catheter is retained until complete healing takes place.

Comment. Many procedures have been devised and modified for the treatment of hypospadias. There is no procedure which will suit every

condition. Individualization is necessary before attempting to repair the urethral defect. As already stated, the curvature of the penis must be corrected. The organ is often held down to the scrotum; it must be freed first by transverse incisions which are united in a vertical line. The penis must be retained in an extended position while the wounds heal. About six months should elapse before an attempt is made to repair the urethral defect. Do a cystostomy.

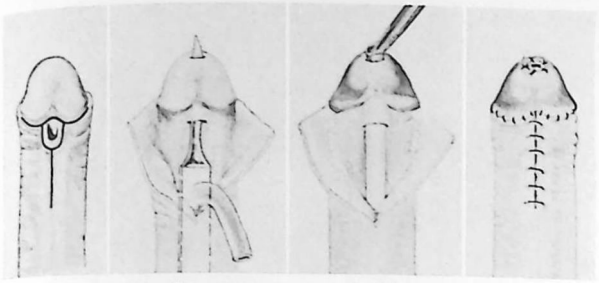


Fig. 2149 Fig. 2150 Fig. 2151 Fig. 2152

Fig. 2149. Carl Beck's (New York) operation for balanitic hypospadias. Illustration shows lines of incision placed below the corona glandis circumscribing the abnormal opening and longitudinal lining extending from the middle of the latter.

Fig. 2150. The skin flap and urethra have been dissected free. A knife is thrust through the head of the penis to form a tunnel through which the urethra is to be passed.

Fig. 2151. The mobilized urethra has been passed through the tunnel created by the knife and brought out with a pair of tissue forceps onto the surface of the glans penis.

Fig. 2152. The free end of the urethra has been attached with interrupted sutures to the aperture created in the glans penis. The skin flaps have been united with interrupted sutures.

Epispadias

The deformity here is on the dorsal surface of the penis. It is rare as compared with hypospadias. It usually is accompanied by deformities of the anterior wall of the bladder, the sphincters of the bladder and urethra as well as the symphysis pubis. Little can be gained in these cases by a plastic operation on the urethral defect alone. In these cases the deformity of the penis is corrected first, preceded by a urethrostomy.

Operations for Epispadias. As stated, the surgical treatment of epispadias is difficult and tedious, requiring time, patience and skill. The preliminary steps as in the surgical treatment of hypospadias are:

1. Urethrostomy.
2. Redressement of the penis.

the latter, after any existing dermatitis has cleared up. (Division of constricting bands; splinting the penis, etc.)

DUPLAY'S OPERATION (URETHRORRHAPHY)

This operation can be carried out only when the urethral sulcus is deep enough to permit the reconstruction of a canal of proper caliber. Two parallel areas are

denuded on each side of the urethral sulcus, from the face of the glans penis to the margin of the epispadiac opening and these two areas are united with sutures over a catheter placed in the sulcus (Figs. 2153-2154). After healing of the wounds, the posterior extremity of the new canal thus formed is united by sutures to the margin of the epispadiac opening. To complete the meatus the prepuce may be used.

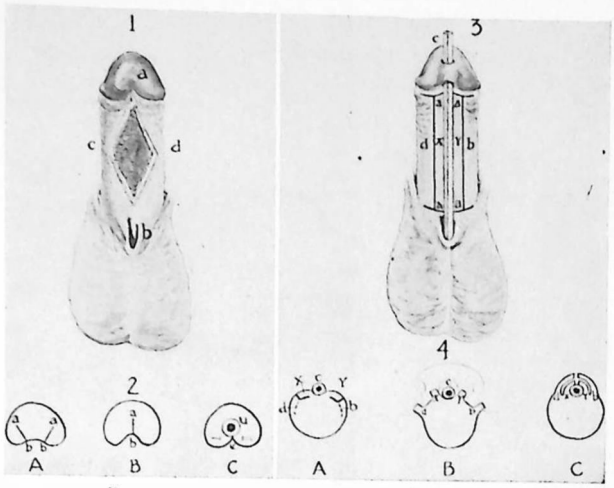


Fig. 2153 Fig. 2154

Fig. 2153. Duplay's operation for hypospadias: 1. a, b, c, d. Excision of the scar for the purpose of straightening the penis, 2 A. Make two oblique incisions (a to b and a to b), 3. B. Make a vertical incision (a to b), 4. C. Perforate the tissues with a pin bringing the urethra together. u. Urethra.

Fig. 2154. Duplay's operation for hypospadias. 3. Formation of flaps: A. Transverse section showing relation of flaps X and Y to the catheter placed as shown in the illustration marked C. B. Transverse section illustrating the flaps X and Y reflected, C. Transverse section showing flaps X and Y almost meeting.

THIERSCH'S OPERATION

In this operation the new urethra is constructed of flaps secured from the penis, prepuce and pubic region.

Step 1. Two rectangular flaps are fashioned on each side of the urethral gutter. One flap is made by a longitudinal incision upon the summit of one margin of the urethral furrow, running parallel with the furrow for its entire extent. Carry an incision at right angles from each extremity of the incision just described out over the side of the penis. Dissect up this flap, which is to become the external surface of the canal formed by the next flap. The base of the flap lies along the outer aspect of the penis (Fig. 2155).

Step 2. The second flap is fashioned by making two transverse incisions from the anterior and posterior extremities of the other side of the urethral furrow, outward over this side of the penis for a distance of one centimeter, or more, and the extremities of these transverse incisions are connected by an incision which lies upon the other side of the penis running parallel with its axis. This flap is dissected out so that its base runs along the margin of the urethral furrow and it is turned over the furrow so that its skin surface forms the roof of the new urethra and its raw surface is exposed over the new channel.

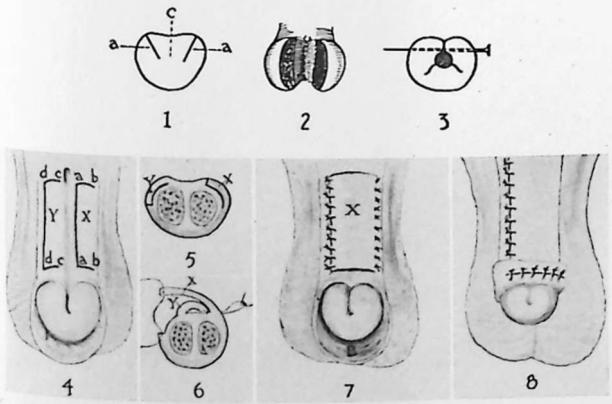


Fig. 2155. Thiersch's operation for Epispadias. 1. Transverse view illustrating converging incision to be made. 2. Dorsal aspect showing the freshened edges. 3. Transverse view showing the depression created in the middle portion with a pin. 4. Forming of flaps as illustrated in X and Y. Note the position of the epispadiac opening. 5. Illustrates the formation of the flaps X and Y (transverse section). 6. Transverse section illustrating the formed flaps being drawn over. 7. The dorsal flap X sutured in place. With this step the third stage is completed. 8. The prepuce is split and brought over the glans penis to cover the gap.

Step 3. Suture the longitudinal margin of this flap along the line of the base of the first flap, the sutures passing through the first flap at its base line.

Step 4. Draw Flap No. 1 over the newly constructed urethra. Suture its longitudinal margin to the corresponding margin at the outer limit of the denuded area on the opposite side of the penis.

Wait until complete healing has taken place.

Step 5. Two orifices remain to be closed now, an anterior (the meatus) and a posterior (epispadias). The former is closed by a plastic procedure consisting of utilizing the prepuce. Make a transverse incision through a part of the width of the prepuce. Pass the glans through this opening. The prepuce is now united by its incised margin, which has been passed onto the dorsum of the penis, to the freshened edge of the anterior ends of the flaps made at the time of the first operation.

Closure of the posterior opening is accomplished by flaps taken from in front of the pubis, one turned down to be sutured to the posterior end of the canal and a second flap turned down to cover the raw surface of the first.

BURGHARDT'S OPERATION

Step 1. Lift a rectangular flap from the under-surface of the penis below the urethral orifice (Fig. 2156).

Step 2. Turn the flap up over the catheter which has been placed in the groove of the glans so that the skin surface faces the interior forming the wall of the new urethra (Fig. 2157).

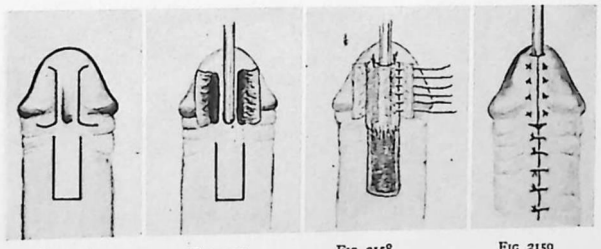


Fig. 2156 Fig. 2157 Fig. 2158 Fig. 2159

Fig. 2156. Burghardt's operation for balanitic hypospadias. Note outline of incisions on penis and glans beneath which the flap is to be placed.

Fig. 2157. Flaps have been reflected and catheter introduced through the epispadiac opening.

Fig. 2158. The penile flap is turned up into position and the retaining sutures have been inserted on one side.

Fig. 2159. Operation completed.

Step 3. Raise a small lateral flap on either side of the glans and insert the lower, larger, flap (Fig. 2158).

Step 4. Suture the lateral flaps together so that they form the new urethral covering (Fig. 2159).

The above operation is especially adaptable to adults.

Operation for Penile and Perineal Hypospadias

There are many different operations to correct this condition; all of them consist in (a) correcting the curvature of the penis and freeing the latter from its attachments to the scrotum and (b) the formation of a canal in the penile part of the urethra.

In the formation of a new penile urethra, it must be remembered that:

1. Broad surfaces and not skin edges should be brought together no matter what sort of repair one resorts to.
2. Avoid tension.
3. The circulation of the flaps must not be interfered with.
4. Flaps must be rather over-sized to allow for contraction.
5. Avoidance of infection.
6. In case the operation fails the patient is in no worse condition than before the operation.

7. Use hairless skin for the formation of a new urethra.
8. Divert the urinary stream.

No matter what type of operation is used, the first thing to do is correct the curvature of the penis. This is accomplished as follows:

Make a transverse incision dividing the fibrous band which attaches the penis to the scrotum. The penis must be completely liberated, and straightened; to accomplish this purpose the incision may have to be extended into the sheath of the corpora cavernosa. This accomplished, the incision is closed by longitudinal sutures. Apply dressings and place the penis in a position of overcorrection onto the abdomen supported by a splint until healing is complete.

HAGNER'S METHOD OF STRAIGHTENING THE PENIS

Step 1. Insert a trocar transversely through the corpora cavernosa just over the line of fibrous tissue causing the curvature. Remove the trocar.

Step 2. Place a skin graft which has been taken from the inner surface of the thigh, and which includes all layers of skin, with the skin side in, around the trocar using two or three fine catgut sutures to hold it securely.

Step 3. Reintroduce the trocar carrying the skin graft through the puncture; slip the skin graft off and hold in place with two sutures at each end.

Step 4. Place two of these grafts (three if necessary) about 2 cm. apart. Dress.

Drain the urine by placing a retention catheter in the urethra. After two or three weeks, divide the graft on a grooved director from within outward. After four or six weeks a smooth surface, free from scar formation, should result.

The reconstruction of the urethra shuld be undertaken from three to six months after the first step of the operation is completed.

NISSEN'S OPERATION FOR THE CORRECTION OF SCROTAL HYPOSPADIAS

Nissen stresses the difficulties encountered in recreating by plastic operation a new urethra in cases of perineal and scrotal forms of hypospadias.[1] Nissen points out that transplantation of segments of veins, ureter or appendix is only seldom followed by success. Also, that the various methods of flap plastic according to Thiersch, Beck, Rochet and others have not been followed by the desired results. This, perhaps, because the skin of the scrotum pedicled on one side easily succumbs to necrosis. However, in order to take advantage of using the skin of the scrotum for these plastic procedures and to insure the nutrition of the flaps, Nissen devised a method of operating which is performed in three stages. This procedure has improved the outlook for recovery in this class of distressing conditions.

Stage I

Step 1. Do a perineal urethrotomy and introduce an indwelling catheter.

Step 2. Make two parallel incisions on the under surface of the penis the length of which is indicated by the demands for covering the urethral defect (Fig. 2160). In order to obtain broad surfaces for healing, the incisions are extended by sharp and blunt dissection. Place the penis on the scrotal skin in such a manner that the future external urethral orifice corresponds to the lower ends of the incision. The apposed margins of the incision are united with interrupted fine sutures of silk.

[1] Zentrbl. f. Chir., 1929, No. 16.

Stage II

This is done eight days after the first stage of the operation.

Step 1. Remove ½ cm. of both longitudinal scars.

Step 2. Make two parallel running incisions on the scrotum as shown in Fig. 2161.

Step 3. Elevate the skin between these two incisions creating a bridge flap by blunt dissection as shown in Fig. 2162.

Step 4. Unite the edges of the bridge of skin thus created and close the wound surfaces on the scrotum with interrupted silk sutures. Fig. 2163.

FIG. 2160

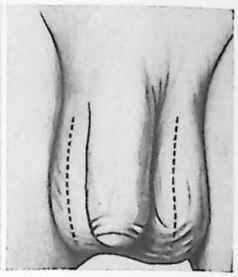


FIG. 2161

FIG. 2160. Nissen's technic in scrotal hypospadias. Parallel incisions on underside of the penis, long enough to cover defect.
FIG. 2161. Parallel incisions on scrotum.

Stage III

In order to counteract the tendencies of the penis to contract, a rubber tube is inserted between penis and scrotum, three or four days after the second stage of the operation and the penis is extended as shown in Fig. 2164. Eight days after the above procedure the bridge flap attached to the glans penis is divided. This concludes the plastic of the urethra. An appropriate sound may now be introduced (boutonnière) into the urethra. Nissen recommends that an indwelling catheter be permitted to remain in the newly formed urethra for a number of days.

Comment. It may be argued against this operation, Nissen states, that it takes three sessions to accomplish the desired result. If one takes into consideration the drawbacks of one-stage operations which result, as a rule, in more or less extensive necrosis with fistulizations, demanding a number of secondary operations, the advantages of this procedure become apparent.

Arthur B. Cecil[1] made an exhaustive study of the literature on the surgical treatment of these conditions from the efforts of Dieffenbach (1836) up to the present time. He stresses that "the whole question is in a state of surgical bewilderment which needs logical consideration" and points out that many splendid operations have been ruined by the neglect

[1] Jour. Urol., May, 1932.

FIG. 2162

FIG. 2163

FIG. 2164

FIG. 2162. Nissen's operation for scrotal hypospadias. Elevation of the skin between the scrotal incisions to make a bridge.
FIG. 2163. Bridge of the skin united.
FIG. 2164. Rubber tube inserted between the scrotum and penis and the penis extended, to prevent its contracting.

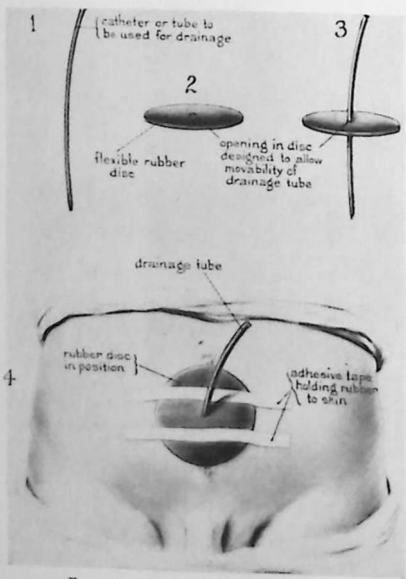


FIG. 2165. Cecil's suprapubic drainage tube.

of some small detail and that experience taught him that 3.5 per cent iodine solution immediately washed off with alcohol is the most satisfactory method of preparation. Bidgood injects a 2 per cent mercurochrome in the hypospadiac urethra. While Hagner believes silver wire to be best as suture material, Cecil finds No. 000 plain catgut for buried sutures and black silk for skin approximation best. Sutures should be

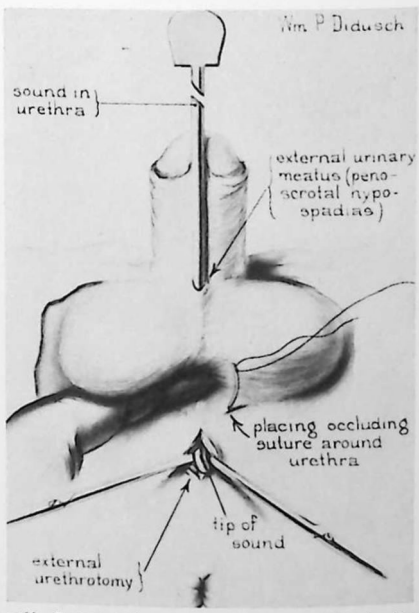


FIG. 2166. Perineal drainage and ligation of the urethra after Young. (Courtesy of Dr. Arthur B. Cecil.)

interrupted. Failure to obtain hemostasis contributes to the greatest number of failures. Diverting the urine during the process of healing is essential. Such drainage should be done about ten days prior to doing the plastic work (Fig. 2165). In penile and penoscrotal hypospadias perineal drainage is resorted to (Fig. 2166). Sutures should be tight enough to include the urethra but not so tight as to cut into it. The credit for having first introduced perineal drainage belongs to Thiersch. Operation for deformity of the penis should be done early in life. In subsequent operations several years later suprapubic drainage should sometimes supplement perineal

drainage. No operation should be done for minor degrees of hypospadias in childhood. Subcutaneous division of the fibrous bands was first carried out by Duplay and is most universally used today. Buck's fascia and all constricting bands must be thoroughly divided. The deformity must be corrected thoroughly. Cecil advises against making an opening in the glans penis but insists that the urethral canal terminates at the frenum. He uses the foreskin for the reconstruction of a portion of the penile urethra in perineal hypospadias and points out that the flaps must have a broad base, be constructed from the penis itself and give the assurance that

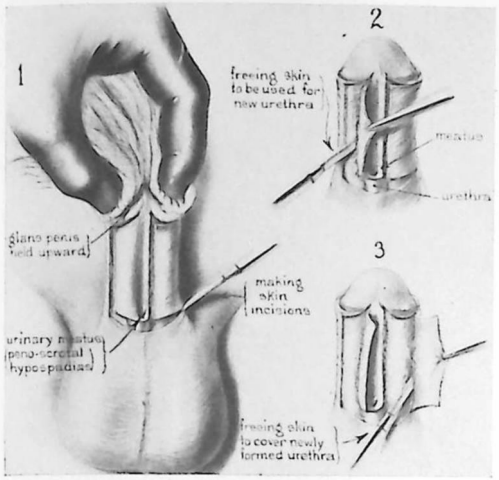


Fig. 2167. Adaptation of Thiersch's method for reconstructing the urethra in penile hypospadias. Posterior skin flap has been dissected back.
(Courtesy of Dr. A. B. Cecil.)

the canal will develop with the development of the penis. Thiersch's operation has a distinct advantage over Duplay's in that the broad surfaces balance one another and that there is a counterbalance so that one flap in contracting tends to pull the other flap in position and vice versa. Thiersch's operation is a more difficult one to perform but the results are best. The steps of this operation for penile and penoscrotal hypospadias are depicted in Figs. 2167-2168. Figures 2169-2170 show the results obtained by Cecil in using the Thiersch's operation in a boy of 17 with penoscrotal hypospadias. Thiersch's operation is of equal value in perineal hypospadias. Here the perineal outlet is utilized for the passage of urine. After the urethra is satisfactorily reconstructed, do a suprapubic drainage and close the perineal opening by Duplay's method. Figures 2171-2174 depict a case of perineal

hypospadias cured by the Thiersch method. Where Thiersch's method fails Bucknall's operation[1] or one of its modifications such as the operation of Landerer and Bidder may be used as a secondary procedure. Where all methods fail, Pickerall's operation should be given a trial. This consists of forming a tubular graft from the skin of the abdomen. The urethra is

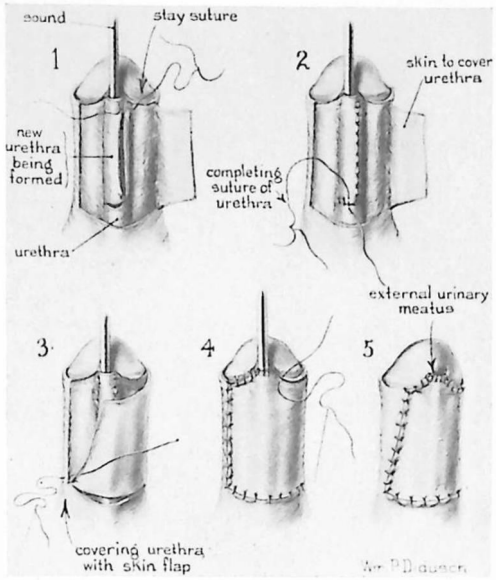


Fig. 2168. Hypospadias. Note that the anastomosing of the new and old urethra carries out the same principle as the lateral anastomosis. By dissecting back the skin over the urethra posteriorly, the urethral and overlying skin sutures are not in juxtaposition. This procedure avoids sinuses and saves one step in the operation as originally done by Thiersch.
(Courtesy of Dr. Arthur B. Cecil.)

gradually constructed in stages. In epispadias, Thiersch's operation is excellent. Billroth referred to it as one of the most brilliant achievements in practical surgery. In these cases the reestablishment of continence is a serious problem. Young (1922) devised an operation for bringing together the vesical sphincter by suprapubic approach in addition to the successful cases reported by Young; Sanchez-Covisa and others reported successes. The following conclusions are arrived at by Cecil:

1. In attempting to reconstruct deformities of the urethra the urologic

[1] Lancet, 1907, III, 887.

surgeon should familiarize himself thoroughly with the principles of plastic surgery.

2. No result can be obtained without an absolute diversion of the urinary stream and this is not likely to be brought about except by occlusion of the urethra by suture.

Fig. 2169

Fig. 2170

Fig. 2169. Result of Thiersch operation for penoscrotal hypospadias.
Fig. 2170. Urinary stream is large size and good force.

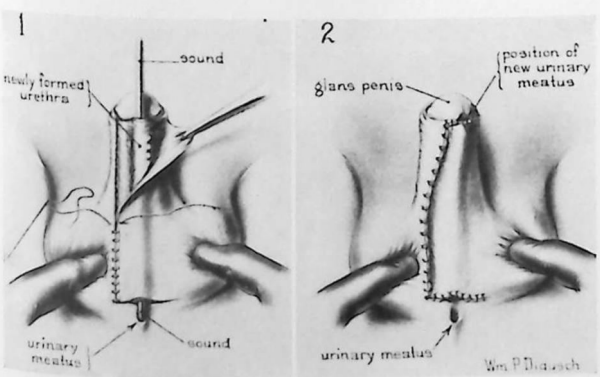


Fig. 2171. Skin incision for perineal hypospadias.
(Courtesy of Dr. A. B. Cecil.)

3. No drainage tubes, probes, nor any other foreign bodies should be left in the newly formed urethra.

4. The primary operation for the correction of the deformity of the

penis should be done during the first two years of life. It should be complete and no other operation should be done until the deformity is proven to have been cured.

5. Heteroplastic grafts are of no value for the reconstruction of the urethra.

6. There is much experimental evidence and clinical evidence against the use of isoplastic grafts and it is very doubtful as to whether one should attempt to reconstruct a urethra from them.

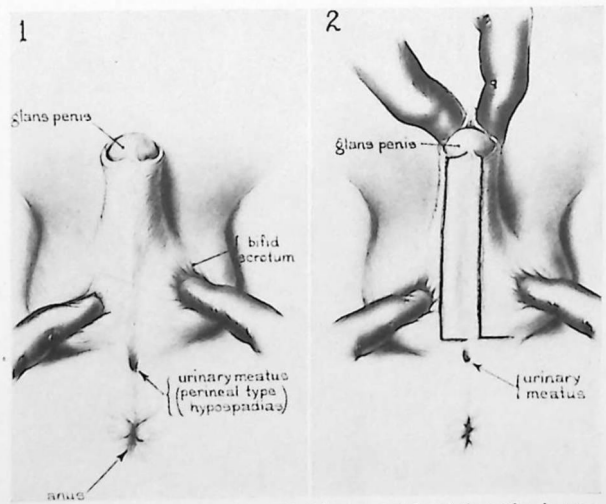


Fig. 2172. Adaptation of Thiersch's method for reconstruction of the urethra in perineal hypospadias.
(Courtesy of Dr. A. B. Cecil.)

7. Autoplastic free grafts such as the use of the appendix or the use of veins, arteries, or free skin grafts after the method of Nové-Josserand, are very unsatisfactory in reconstructing the urethra, and although urethral canals have been made by the use of this material the results have almost universally been bad.

8. The advancement of the urethra operation of Beck of New York is of use only in very minor degrees of hypospadias. In cases that probably should not be operated at all, in more extreme degrees of hypospadias, it is likely to result in failure or in the production of a condition worse than previous to the operation.

9. Cantas' operation of using a pedicle graft of the saphenous vein has

not been sufficiently tried to warrant its use. Among other objections to it is that the vein is likely to be too small or is likely to be branched.

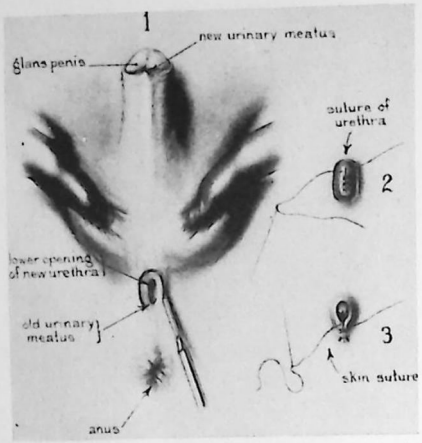


FIG. 2173. Method of closing perineal wound after peno-perineal urethra has been constructed. At this stage suprapubic drainage and suction apparatus is advisable. (Cecil.)

FIG. 2174. Result of combination of foreskin graft and Thiersch operation in perineal hypospadias. Opening of the hypospadiac urethra was very short distance in front of rectum. Scarcely any scrotum. Both testicles in abdomen. (Courtesy of Dr. Arthur B. Cecil.)

10. Small base pedicle grafts such as are exemplified by the Rochet method are likely to leave a fistula at the base of the pedicle graft. They have a tendency not to join in the development of the penis and to cause retraction of the penis and in some instances contraction of the caliber of the tube.

11. The most successful method of reconstructing the urethra is by the method of Thiersch which is applicable to all forms of hypospadias.

12. Many cases of epispadias with incontinence are curable.

13. Transplantation of the ureters to the bowel should be reserved for those cases in which one has utterly failed to reconstruct the vesical neck.

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