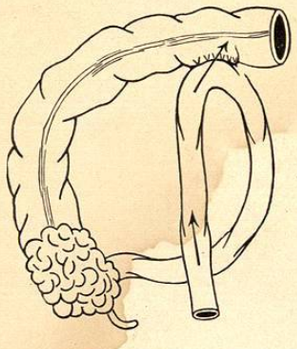
Entero-anastomosis is often associated with another operation, such as gastro-enterostomy, or a resection of intestine.

The technic of lateral entero-anastomosis by means of suture is similar to that of gastro-enterostomy. Figs. 209 and 210 show the technic as applied to the intestine. The anastomosis may be brought about by suture or by the use of a Murphy button.

Both methods are suitable for anastomosis in the small intestine. The choice of method should be made in accordance with the principles applicable to gastro-enterostomy. If the small intestine is to be anastomosed with the large, so that fluid or grumous contents will pass through the opening, Murphy's button is also practical. It is unsuited and even dangerous for an anastomosis between two portions of large intestine.

FIG. 211.



Entero-anastomosis with isoperistaltic arrangement of intestine. (Wölfler.)

FIG. 212.

Entero-anastomosis with antiperistaltic arrangement of intestine. (Wölfler.)

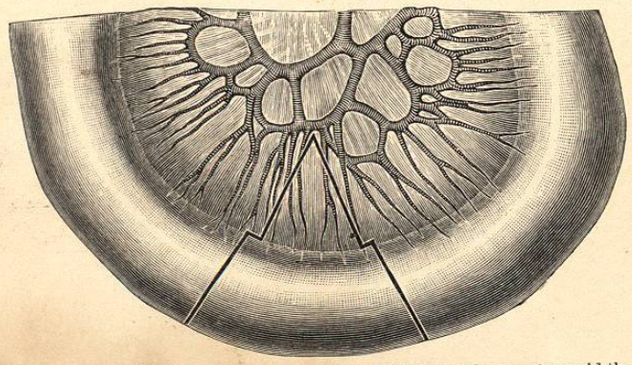
The arrangement of the two portions of intestine can be isoperistaltic or antiperistaltic. (Figs. 211 and 212.) In the first case the fecal matter flows more easily into the efferent loop, and this arrangement is therefore preferable. However, the other arrangement also gives satisfaction. The points in the intestine chosen for anastomosis are usually opposite to the attachment of the mesentery. In the large intestine the opening should be made through a muscular band.

**Resection of the Intestine.**—The term resection as applied to the intestine indicates the removal of a complete circle of the gut, while the removal of less than a complete circle is termed excision. The portion resected may be of any length. Experiments upon animals and observations upon man show that life is possible after removal of about half of the small intestine. The lower portion of the intestine can be spared better than the upper, and the large intestine best of all.

Successful instances of intestinal resection are mentioned by Ruggi (330 cm., 13.2 ft.), Montprofit, Fantino (310 cm., 12.4 ft.), Shepherd (234 cm., 9.3 ft.), Dreesmann (215 cm., 8.6 ft.), Kocher (208 cm., 8.3 ft.), Köberle (205 cm., 8.2 ft.), Lexer (200 cm., 8 ft.). In most of these cases no mention is made of the subsequent condition of the

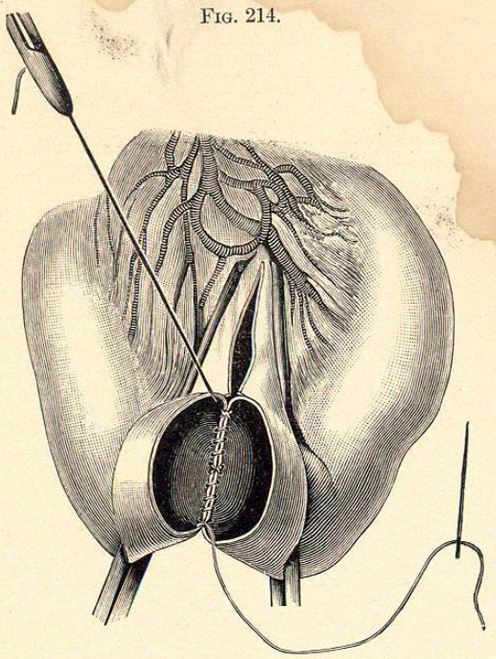


FIG. 213.



Resection of intestine, with circular enterorrhaphy. Incision made so as to avoid the vessels of the mesentery. (Hartmann.)

FIG. 214.

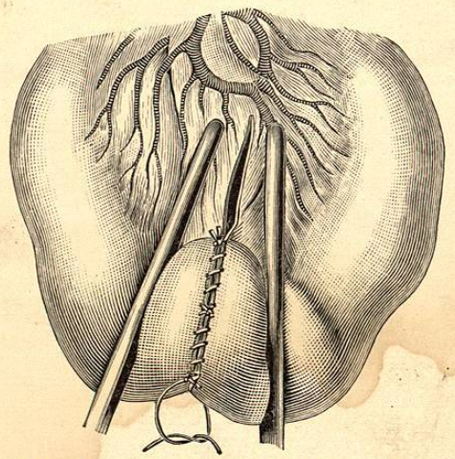


Circular enterorrhaphy. The beginning of the first suture. The elastic clamps prevent soiling of the wound by blood or feces. (Hartmann.)

patient. Mikulicz resected 215 cm. (8.6 ft.) of gangrenous intestine from a hernial sac in a man aged thirty. This patient was entirely well three years afterward and his nutrition was not apparently affected in any way.

**Circular Resection, or End-to-end Anastomosis.**—This is the simplest form of resection. The bowel is united by suture (Figs. 213–216), or, in case of the small intestine, by means of a Murphy button.

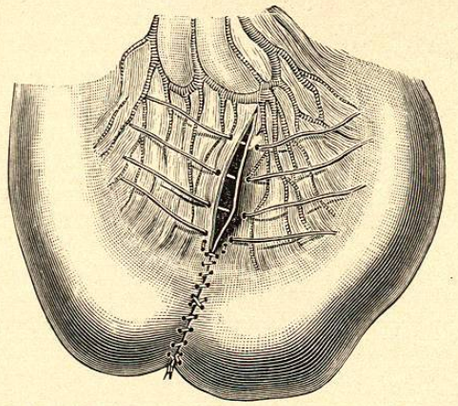
FIG. 215.



Circular enterorrhaphy. End of the first suture. (Hartmann.)

The lumen of normal small intestine is everywhere the same, and circular suture presents no difficulties. If small intestine is to be united to large intestine, or if the lumen of the small intestine is greatly

FIG. 216.



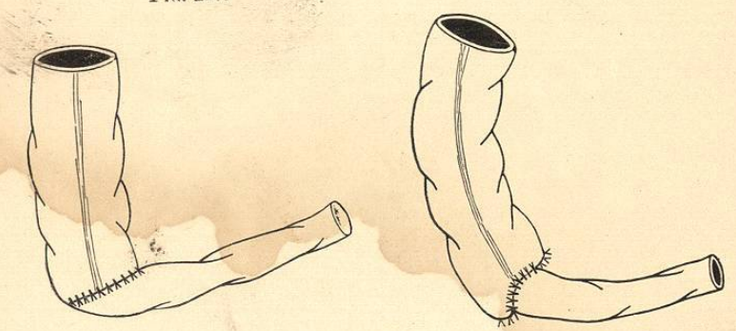
Circular enterorrhaphy. Clamps removed. Suture of mesentery. Second intestinal suture which does not perforate the lumen of the bowel. (Hartmann.)

dilated by chronic obstruction, the difference in size has to be met by special technic. The simplest plan is perhaps to cut the smaller bowel obliquely so that the cut edges of the two portions to be sutured



will have approximately the same length. (Fig. 217.) In the course of time the difference in lumen will disappear. Another method is to suture a part of the cut end of the intestine having the greater lumen, so as to reduce its end to the size of the other. (Fig. 218.) This method is faulty in that a weak point always exists where the transverse suture meets the circular suture. If the fecal stream passes from the intestine having the greater lumen to that having the smaller lumen, the strain upon the transverse suture is very great.

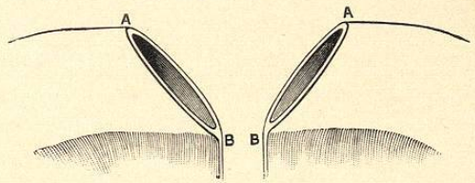
FIG. 217. FIG. 218.



Circular anastomosis of portions of the bowel having different lumina.

In using the Murphy button slight differences in the diameter of the intestine are easily overcome. If the differences are great, a lateral anastomosis is to be preferred.

FIG. 219.

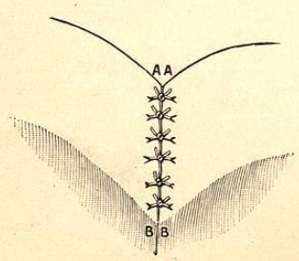



Resection of intestine. Incision oblique to increase the lumen of the bowel: A, free side of intestine; B, mesenteric attachment. (Hartmann.)

Even if both ends of the intestine have the same diameter, it is better to cut them a little obliquely. (Figs. 219 and 220.) The side of the intestine toward the mesentery is always more vascular, and as the vessels radiate from the mesentery around the intestinal wall and form few anastomoses one with the other, an oblique incision which removes less of the mesentery than it does of the opposite wall best provides for the nourishment of the cut edge of the bowel. An oblique incision in the opposite direction is always to be avoided. Furthermore, every circular suture of the intestine reduces the lumen by folding in a portion of the intestinal wall. In the course of time this

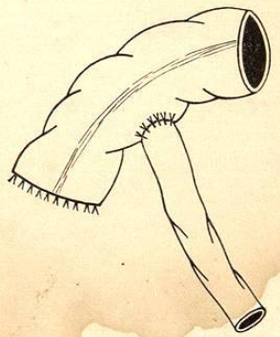
ridge disappears, but in the first few days after operation it may produce a relative stenosis. If both intestinal ends are cut obliquely, the lumen at the suture will be slightly increased thereby and immediate or later stenosis prevented.

FIG. 220.




Resection of intestine. Circular suture. (Hartmann.)

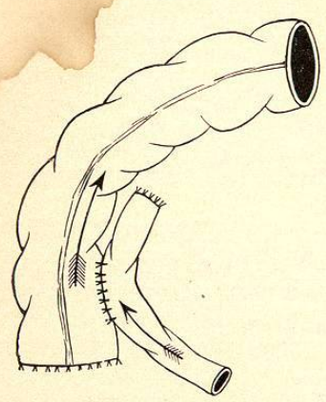
FIG. 221.



Lateral implantation.

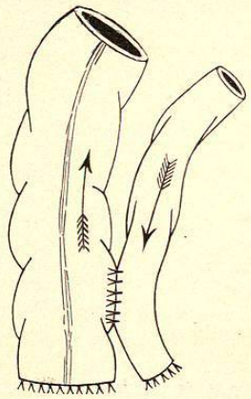
**Lateral Implantation, or End-to-side Anastomosis.**—This method of anastomosis is an imitation of the natural connection between the small intestine and the large intestine. It is rarely employed except in cases in which there is considerable difference in the lumina of the two portions of the intestine. This anastomosis may be carried out with a suture or with a button. The open ends of the intestine are closed blindly by suture. (Fig. 221.)

FIG. 222.



Isoperistaltic lateral apposition.

FIG. 223.



Antiperistaltic lateral apposition.

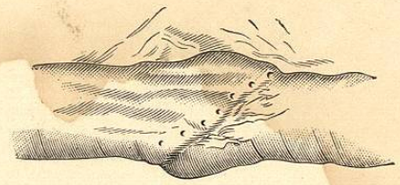
**Lateral Apposition, or Side-to-side Anastomosis.**—This form of anastomosis is carried out according to the simple principles given on page



398. It is equally efficient whether the two portions of intestine have the same or different lumina.

The apposition may be isoperistaltic or antiperistaltic. (Figs. 222 and 223.) The objection to the latter method is that it leads to an accumulation of feces in the blind end of the lower bowel. Therefore when conditions permit the surgeon to choose freely, he will decide on isoperistaltic anastomosis. In many cases it is impossible to arrange the portions of intestine in this manner without prolonging the operation unduly. Under such circumstances an antiperistaltic union should be effected, the practical results of which method are sufficiently good. Frey's experiments upon animals show that an isoperistaltic lateral anastomosis smoothes itself out in the course of a few months so that it appears almost like an oblique circular anastomosis. (Fig. 224.)

FIG. 224.



Isoperistaltic lateral apposition after a period of six months. (Frey.)

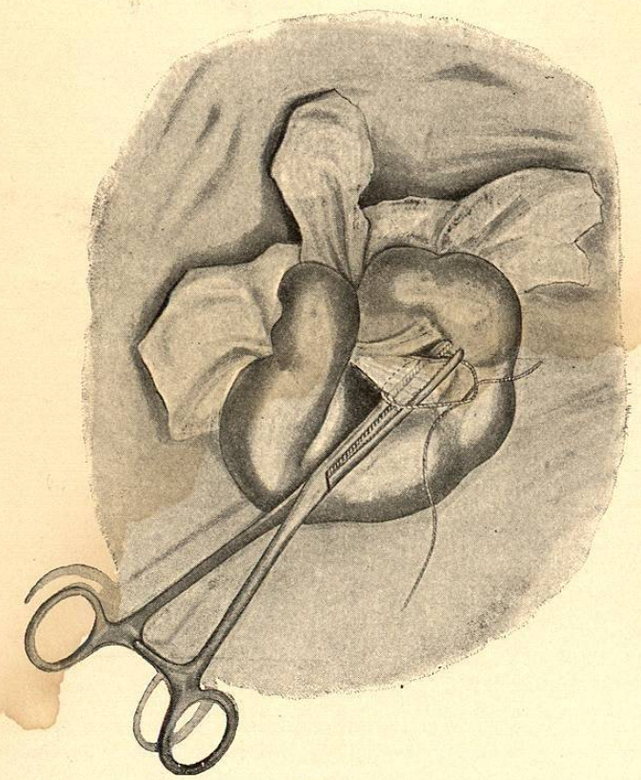
**Intestinal Resection with Circular Anastomosis.**—The site of the skin-incision is determined by the portion of intestine to be resected. If there is no counterindication, the incision for resection of small intestine or transverse colon is made in the centre of the median line. The length of the cut varies from 12 to 20 cm. (4.8 to 8 inches). After the peritoneal cavity is opened, the portion of intestine resected is brought as far out of the peritoneal cavity as possible and separated from it by a careful tamponade. (Fig. 59.)

The mesentery is next separated from the portion of bowel to be resected. First a small opening is made in the mesentery near its attachment to the bowel, and then a second one 2 or 3 cm. (0.8 to 1.2 inches) from the first. The portion of mesentery between these two openings is clamped and a slender thread is passed, as shown in Fig. 225. This ligature crosses the jaws of the clamp and is gradually drawn taut as the clamp is withdrawn; thus it comes to lie in the groove made by the pressure of the clamp. Another clamp is applied between the ligature and the bowel, and the mesentery cut between them. In this manner the mesentery is tied and divided step by step. If the mesentery contains little or no fat, it is unnecessary to press into it with clamps before drawing the ligature taut.

Some surgeons prefer to cut the intestine away from the mesentery with a scalpel or a pair of scissors, sewing each bleeding vessel as it is divided. This method takes longer and causes a greater loss of blood. Another method is to cut out a wedge-shaped piece of mesentery with

the intestine. This plan is inadvisable because the collateral circulation is unnecessarily sacrificed. It has to be adopted, however, in case of a carcinoma of the intestine with secondary infection of lymph-glands situated in the mesentery.

FIG. 225.



Ligation of the mesentery.

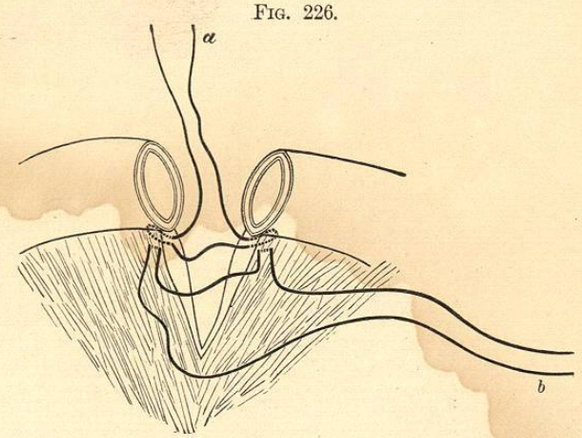
The portion of intestine is stripped of its contents and is shut off from the rest of the bowel by intestinal clamps (Fig. 215) or a temporary ligature, or by the fingers of the assistant. Two or 3 cm. (0.8 to 1.2 inches) within the point selected for the incision the affected loop of bowel is firmly clamped or ligated. It is then cut through with straight scissors, not transversely, but at a slight angle, so that a little more of the free border of the intestine is removed than of the portion which is attached to the mesentery. (Fig. 219.) The division of intestine must exactly coincide with its separation from the mesentery. If any bowel projects beyond the mesentery which remains, its nutrition is endangered.

The ends of the bowel are united by a suture or Murphy button. The small intestine is completely surrounded by serosa with the exception



of a portion 2 or 3 mm. (0.1 or 0.2 inch) in width where it is attached to the mesentery. As the success of the suture depends chiefly upon the exact approximation of serous surfaces, the point in the suture-line where the mesentery is attached to the bowel is a weak one and requires especial attention. Mikulicz first inserts an intramesenteric suture (Fig. 226, *a*), which approximates the tissues of the mesentery between its two serous layers and also the muscular coats of the intestine. He next inserts two perimesenteric sutures, which approximate the serous surfaces of the mesentery in accordance with Lembert's principle. One

FIG. 226.




Suture of the mesentery in circular resection of the intestine as practised by Mikulicz: *a*, intramesenteric suture; *b*, paramesenteric suture.

of these stitches is placed on either side of the mesentery. For the sake of clearness only one appears in the illustration. (Fig. 226, *b*.) The ends of the intramesenteric suture are cut short while the ends of the perimesenteric sutures are left long. He next inserts a continuous suture from within the intestine passing through all of its coats. (Fig. 107.) This suture begins at the mesenteric attachment and extends through nearly half the circumference of the bowel. It is then recommenced at the mesenteric attachment and extends as far in the other direction as possible. The gap which of necessity remains is closed by two or three interrupted sutures tied externally. The usual continuous serous suture completes the operation. The ends of this suture are fastened to the perimesenteric suture on either side. When the suture is finished, the parts are cleansed with a weak antiseptic solution and the suture-line is dusted with iodoform. The gap in the mesentery is closed by a continuous suture in order to prevent incarceration of intestine within it. The needle should not be inserted deeply lest some mesenteric vessel be included in the suture.

**Lateral Implantation and Lateral Apposition.**—The blind end of intestine is closed by a purse-string suture. The enterotribe is pressed across the bowel about 1 cm. (0.4 inch) from the point to which the

mesentery has been separated from it so as to facilitate inversion of the same. The portions of intestine are sutured in much the same manner as in circular resection, with the exception of the intramesenteric suture. The technic of lateral apposition is the same as that of entero-anastomosis. The operation is usually simpler if the portion to be resected is first removed and the blind end of the bowel is closed before the anastomosis is made. The length of the blind sac should not be too great lest feces accumulate in it. But it must not be so short as to threaten the integrity of the anastomosis. If only a narrow portion of intestine is left between the two sutures, it may easily necrose. If a Murphy button is employed, the technic is similar to that given on page 405. Closure of the abdominal cavity following intestinal resection is discussed on page 480.

**Intestinal Resection performed in Steps.**—In the methods of intestinal resection hitherto described the free ends of intestine are immediately brought together by suture or the Murphy button. Such a method is by far the best in the case of the small intestine, which is completely surrounded with peritoneum. Technically the same methods of operating are applicable to the large intestine, especially to the transverse and the sigmoid colon. In the rest of the large intestine resection with immediate suture is possible by a method of lateral implantation or lateral apposition. Circular suture is not practical on account of the absence of the peritoneum over a considerable circumference of the bowel. While the completion of an operation is therefore possible at one time, it is not advisable, and in certain cases is distinctly dangerous. There are several reasons for this. The wall of the large intestine varies in thickness in different places and the appendices epiploicæ add to the difficulties of suture. The wall of the large intestine is not so well supplied with vessels as that of the small intestine, and the reactive changes which are necessary for the perfect sealing of the suture-line are not so satisfactory as in the case of the small intestine. The thick character and slow movement of the contained feces, and the greater virulence of the bacteria within the large intestine, are additional reasons why immediate suture of this portion of the intestine entails a greater risk. The use of the Murphy button, which in the case of the small intestine frequently leads the operator out of difficulty, is in the case of the large intestine absolutely counterindicated. In view of these facts Mikulicz does not employ immediate resection and suture of the large intestine except in unusual circumstances.

When the small intestine is to be united to the large intestine—for example, in resection of the cæcum—the operator will have to choose between the various methods. If the local and general conditions are satisfactory, the operation may well be completed at once. If any doubt exists, it is safer to operate in the manner described below.

Resection of the large intestine is performed as follows:

1. The portion of intestine to be resected, together with the tumor or other diseased tissues—for example, the lymph-glands—is separated from the mesentery to a distance of 3 or 5 cm. (1.2 to 2 inches) from



the tumor and brought out through the abdominal incision. The gap or rent in the mesentery is closed by suture and the two portions of bowel which form the spur are brought together by a continuous serous suture.

2. The peritoneal cavity is then closed by suture and the skin is sutured to the projecting intestine. The affected bowel may then be cut away either immediately or after twelve or twenty-four hours. At a later period the spur between the afferent and efferent portions of bowel is destroyed, and still later the artificial anus is closed.

The advantages of this plan of procedure are:

1. Infection of the peritoneal cavity due to opening the lumen of the intestine is absolutely avoided, since the peritoneal cavity is closed by suture and adheres before the intestine is cut into.

2. The stenosis of the intestine which is so frequently the chief indication for resection has often produced ulcers in the portion of intestine to be resected. Therefore unless a considerable portion of bowel is removed the suture will be made through badly nourished tissue. The success of an immediate operation may also be defeated by sluggish circulation due to the paralytic condition of the bowel. If suture is postponed to a time in which the intestine is completely empty and its tone is restored, the suture is much more likely to succeed.

3. The nutritive condition of a patient who has for some time been suffering from stenosis of the intestine is usually bad, and he is therefore not in a condition to outlive even a mild infection. The contents of the intestine are besides made more than usually virulent by such stagnation. Most of the patients are of advanced age.

4. By means of an operation in several steps portions of intestine can be united whose immediate union by suture would be impossible or dangerous on account of too great tension. This disadvantage can be avoided in an immediate operation by establishing an anastomosis between distant portions of the intestine in place of suturing the cut ends of the bowel. For example, the transverse colon or cæcum or small intestine may be united with the sigmoid flexure, but such an operation is a much more serious procedure than simple resection in several steps.

5. The operative shock of resection in steps is less and the time required for operation is less than for an immediate resection and suture.

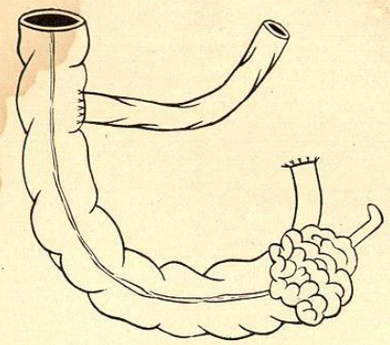
The chief objections which have been made to intestinal resection in steps are that the period of convalescence is prolonged, and that the patient has to pass through an unpleasant stage of artificial anus. These objections are scarcely sufficient to counterbalance the advantages given above. Therefore the operation in several steps must be considered the normal procedure for extirpation of tumors of the large intestine and for the cure of extensive ulcers. It is also a satisfactory method to pursue when volvulus or invagination makes resection necessary. In case of carcinoma complicated by ileus this method of

operation is too severe for the patient to endure. It is better to establish a simple artificial anus, and to leave the resection to a subsequent period when the local and general condition may be more favorable.

Intestinal resection in several steps is not a new operation. For many years it has been practised by surgeons in cases of necessity. In 1892 it was first performed by Block as an operation of choice. He recommended it, however, only in cases in which the mesocolon was sufficiently long to permit the tumor to be brought out of the abdominal wound without dividing the mesocolon. There are comparatively few such cases.

Operation in steps may be carried out in a different way. An artificial anus may be established above the affected portion of intestine, and at a later date the intestinal resection and suture may be performed as a single operation. This plan of procedure has little to recommend it since the second operation carries with it the chief dangers of suture of the large intestine. Mikulicz adopts the plan of a preliminary artificial anus in case of acute ileus, but the subsequent resection of the affected portions of intestine is even then made in steps, as above described.

FIG. 227.



Partial elimination of the intestine, with suture of the upper end of the eliminated portion. (Wölfler.)

There is still another method of operating in steps. An entero-anastomosis may be established above and below the portion of intestine which is to be resected; at a later date the resection is performed and the cut ends of the bowel are closed blindly. This method has the great advantage that the patient is not subjected to the annoyance of a temporary artificial anus, but it is not wholly free from the risks of a complete operation carried out at one time.

**Elimination of the Intestine.**—By elimination of a portion of intestine is meant its separation from the rest of the alimentary canal so that it takes no part in digestion although it remains in the abdominal cavity. If it is the seat of malignant growth, the latter may be removed at a later date; if the trouble is benign, this is unnecessary.



A simple anastomosis usually eliminates a portion of the intestine, which is thereby cut off from the fecal stream even though there is no mechanical obstruction. This is especially true of a gastro-enterostomy, but for the sake of clearness the portion of the bowel cut off by a simple anastomosis will not be described as eliminated.

Elimination may be partial or complete. In the former case only one end of the portion of intestine in question is cut loose from the alimentary canal (Fig. 227), whereas in total elimination both ends are cut off from the alimentary canal.

The various forms of partial and complete elimination are as follows:

1. Partial elimination of intestine with—
   *a*. Suture of the upper end, or
   *b*. Suture of the lower end; and
2. Total elimination of intestine with—
   *a*. Suture of both ends either together so as to form a ring, or separately;
   *b*. With suture of one end, the other one forming a fistula;
   *c*. Each end forming a fistula;
   *d*. With closure of both ends when a fistula already exists.

**Partial Elimination of Intestine.**—Although simple anastomosis relieves a portion of intestine of most of the fecal stream, yet because some of the intestinal contents find their way into this portion it may be desirable to eliminate it. Furthermore, in gastro-enterostomy the flow of bile through the pylorus into the stomach may make it desirable to effect a mechanical obstacle by a suture at the pylorus or upper part of the duodenum. Thus Billroth's second method of pyloric resection and the various modifications are forms of partial elimination. Closure of the lower end of the eliminated bowel while the upper remains open is usually unnecessary and may be dangerous. In such a cul-de-sac feces or intestinal secretion may collect to an unpleasant extent.

The operation for partial elimination is as follows: Anastomosis is performed as usual and the upper or lower end of the affected intestine is cut transversely and closed blindly by suture. This step in the operation may precede the anastomosis. A variation of this procedure is the lateral implantation of the intestine above the obstruction into the intestine below the obstruction and blind suture of the upper end of the eliminated portion. (Fig. 227.)

**Total Elimination of Intestine.**—The method previously followed of closing both ends of the eliminated bowel blindly or of suturing one to the other so as to form a ring has proved somewhat dangerous. Normal intestine thus treated will give no trouble, but diseased intestine continues to secrete fluid, especially if it contains ulcers, while its power of resorption is diminished. Under such circumstances distention may increase until the bowel bursts. In a normal bowel secretion and resorption are about equal and the mucous membrane gradually atrophies. A safe plan to follow under such circumstances is to