OBSERVATIONS AND EXPERIMENTS

ON

INTESTINAL AND GASTRO-INTESTINAL ANASTOMOSIS

(FROM THE BROWN INSTITUTION)

BY

WALTER EDMUNDS, M.C.,

AND

CHARLES A. BALLANCE, M.S.

Received March 20th—Read May 12th, 1896.

SYLLABUS.

I. Intestinal anastomosis.
   - A. Side to side.
   - B. End to end.
   - C. End to side

   Choice of operation for:
   - A. Artificial anus.
   - B. Gangrenous hernia.
   - C. Malignant disease of bowel.
   - D. Intussusception and volvulus.

II. Gastro-enterostomy.

III. Physiological observations.
   1. Shortening of blind ends in lateral anastomosis.
   2. Short circuiting experiments.
   3. Changes in the mucous membrane.
   4. Implantation experiments.
   5. Reversal experiments.

IV. List of experiments.

V. References.

THE object of the experiments here given was to determine the best method of uniting either two parts of intestine together, or the stomach to intestine.

According to Senn, Maisonneuve was the first to attempt to make a fistulous opening between two portions of bowel,—that is to say, an intestinal anastomosis between a portion of bowel above, and another below the seat of obstruction. Unfortunately both Maisonneuve's cases were unsuccessful.

From time to time the subject was touched on by surgeons, but it is to Senn's numerous experiments, and his energetic advocacy (in 1887) of these operations in competent hands, that the recent progress in this department is chiefly due.

I.—Intestinal Anastomosis.

There are three main methods of uniting two pieces of intestine, namely,

(A) **Side to side** (by lateral openings),

(B) **End to end,** or

(C) **End to side,** *i. e.* by the implantation vertically of one piece of intestine into another—this last being useful in the treatment of cases where the obstruction cannot be removed.

All our experiments were made on dogs. It will, no doubt, be objected that the dogs were in good health, and not suffering from the effects of intestinal obstruction, and that the intestines to be united were healthy, and not affected either with distension from obstruction or with inflammation.

These objections are no doubt to some degree valid, but with respect to both obstruction and inflammation it must be remembered that it is not imperative in most cases in man to perform a primary anastomosis.

It will further be objected that the dog's intestine is so different from that of man as to vitiate any cross-inferences from experiments. Figs. 1 and 2 show transverse sections of human and dog's small intestine. They are the same magnification, and it will be noticed that the dog's intestine is more muscular, but that the submucous coat is about the same in both. This submucous

coat is very important on account of its strength, and it is in it that Halsted insists that the sutures should get their hold.

The submucous coat is important in surgery in another way, for it is of it that catgut for surgical purposes should almost exclusively consist. Lister, in his account of the

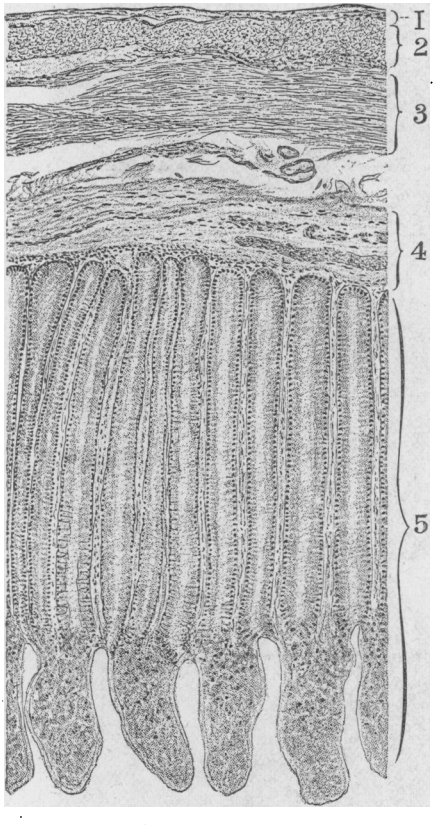

FIG. 1.—Transverse section of human small intestine. (×100.)

1 = Peritoneum.
2 = Longitudinal muscular coat.
3 = Circular muscular coat.
4 = Submucous coat.
5 = Mucous membrane.

Between 3 and 4 is some loose tissue, allowing of some gliding movement.

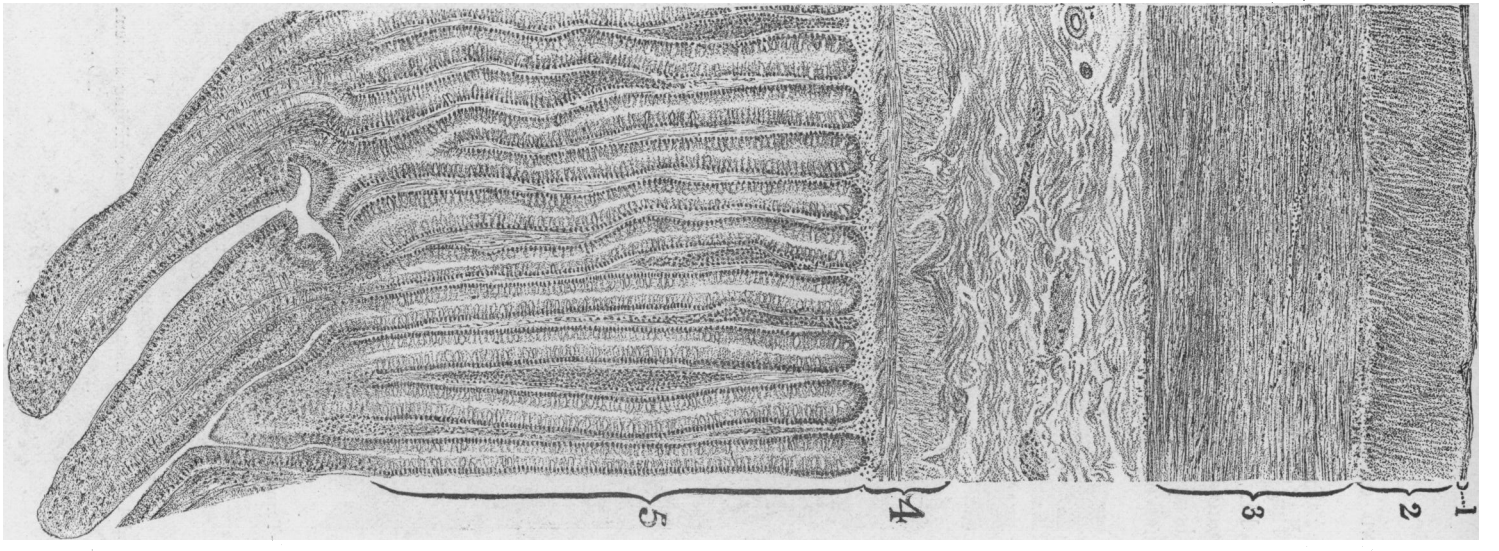

FIG. 2.—Transverse section of small intestine of dog. (× 100.)

1 = Peritoneum.
2 = Longitudinal muscular coat.
3 = Transverse muscular coat.
4 = Submucous coat.
5 = Mucous membrane with villi.

Between 3 and 4 is some loose tissue, allowing of some gliding movement.

preparation of catgut, relates how the sheep's intestine is spread out, the mucous membrane scraped off, and the muscular coat also removed, and thus the submucous coat alone is left.[1] All catgut, however, is not prepared

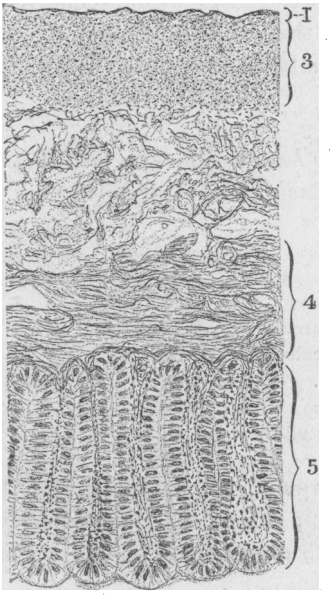

FIG. 3.—Transverse sections of the human large intestine : × 100. It will be noticed that the submucous tissue is particularly thick. As the section is not made through a band there are no longitudinal fibres shown.

1 = Peritoneum.
3 = Circular muscular fibres.
4 = Submucous coat.
5 = Mucous membrane.

[1] The method of preparation of catgut is thus described by Lister:—"Catgut, as you are doubtless all aware, is prepared from the small intestine of the sheep. The gut is treated in what seems an exceedingly rude manner for so delicate a structure. It is scraped with some blunt instruments, such as the back of the knife, over a board; and by this means, as the people express it, the dirt is scraped out. That which these people call the dirt is the exquisite and complicated structure of the intestinal mucous membrane. But while the mucous membrane is scraped out from within, there is also

in this way, for on microscopic examination of some of it the mucous membrane can be seen.[1]

Fig. 3 shows a transverse section of human large intestine. The section is not carried through a band of longitudinal fibres; the submucous coat is decidedly thicker than in the small intestine.

The following table gives the thicknesses of the various coats:

Measurements in hundredths of a millimetre. The specimens had previously been hardened for microscopic purposes:

	Small intestine, dog.	Small intestine, human.	Large intestine, human.
Peritoneum . . .	1 ...	1 ...	1
Longitudinal muscular coat	12 ...	5 ...	—
Transverse muscular coat .	27 ...	10 ...	12
Loose tissue . . .	(25) ...	(5) ...	(20)
Submucous tissue . .	10 ...	10 ...	15
Mucous without villi .	70 ...	50 ...	32

It must, however, be admitted that as the subject of surgery is man, man is, scientifically speaking, the proper animal to experiment on—and this is what practi-

scraped off from without the circular coat of muscular fibres. The result comes to be that the intestine is converted into a comparatively unsubstantial material consisting of two parts or bands, one more slender than the other. When the mesentery is stripped off by the butcher the peritoneal covering of the gut shrinks into a narrow strip, and this, with some longitudinal fibres, constitutes the more slender of the two parts to which the intestine is reduced by this process of scraping. The other part is the essential material from which the catgut is prepared, and this is neither more nor less than the submucous cellular coat of the intestine. When I first visited a catgut manufactory I was astonished to find that after this scraping process the intestine could be blown up still as a continuous tube, as you see can be done with this specimen, which has been treated in the manner I have described. This exquisitely delicate structure is a beautiful anatomical preparation of the submucous cellular tissue, though made in so rude a fashion. This coat of the intestine, which in the sheep has this extraordinary toughness, is the material out of which the catgut is prepared."—'Lancet,' Feb. 5th, 1881.

[1] See Ballance and Edmunds, 'Ligation in Continuity,' 1891, p. 249, fig. 105.

cally we should be left to if there were no experiments on animals; but as by the latter more strictly scientific methods can be followed, the progress of our knowledge

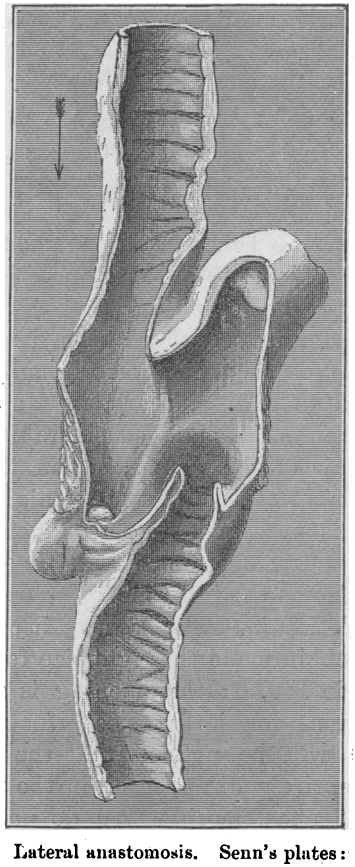

FIG. 4.—Dog. Lateral anastomosis. Senn's plates: 63 days. The arrow indicates the direction of the flow through the bowel. It will be noticed that the anastomosis still remains lateral. One blind end—that of the upper bowel—has contracted more than the other. ($\times \frac{2}{3}$.)

is more rapid. Indeed, the great advance of recent years in intestinal surgery is to be attributed to the experimental method.

A. Lateral anastomosis.—Various aids, in the shape of plates (Senn, Davis, Littlewood, &c.), bobbin (Mayo Robson), mechanical button (Murphy), are in use; or the operation can be carried out by suturing, and of sutures a large variety has been devised. Of these methods we will consider Senn's plates, Robson's bobbin, Murphy's button, and Halsted's method of suturing.

Senn's plates.—This method is so well known that it does not require description. The plates were cut to a size suitable for a dog's intestine, and the operation was carried out as now recommended by Senn, a continuous or interrupted suture being finally applied externally all round. The results of two of these operations are seen in Figs. 4 and 5. It will be noticed that the blind ends are short (much shorter, indeed, than at the time of operation), and that the anastomosis, which was originally quite lateral, has become end to end. Nature, in fact, in the short space of two months has made considerable progress, not only in the repair of the wound, but in the direction of the re-establishment of the original straight condition of the bowel. This process is further advanced in Fig. 5 than in Fig. 4. The opening, it will be seen, is of full size, the same size as the intestine.

Mayo Robson's bobbin.—This we used in one experiment, having had a bobbin made the right size for a dog. The result is shown in Fig. 6: the opening is small; it was, however, sufficient for its purpose, for the dog was quite well. It will be noticed that the valvulæ conniventes have entirely disappeared in the portion of the bowel above the anastomosis. We do not wish to infer too much from one experiment, and the successful employment of the bobbin combined with the continuous suture in its inventor's hands is well known to us. The small opening following the use of the bobbin is easily explained by the collapse of the bobbin shortly after the operation, and as only incisions have been made in the bowels, the edges come in contact, and heal except for the small opening.

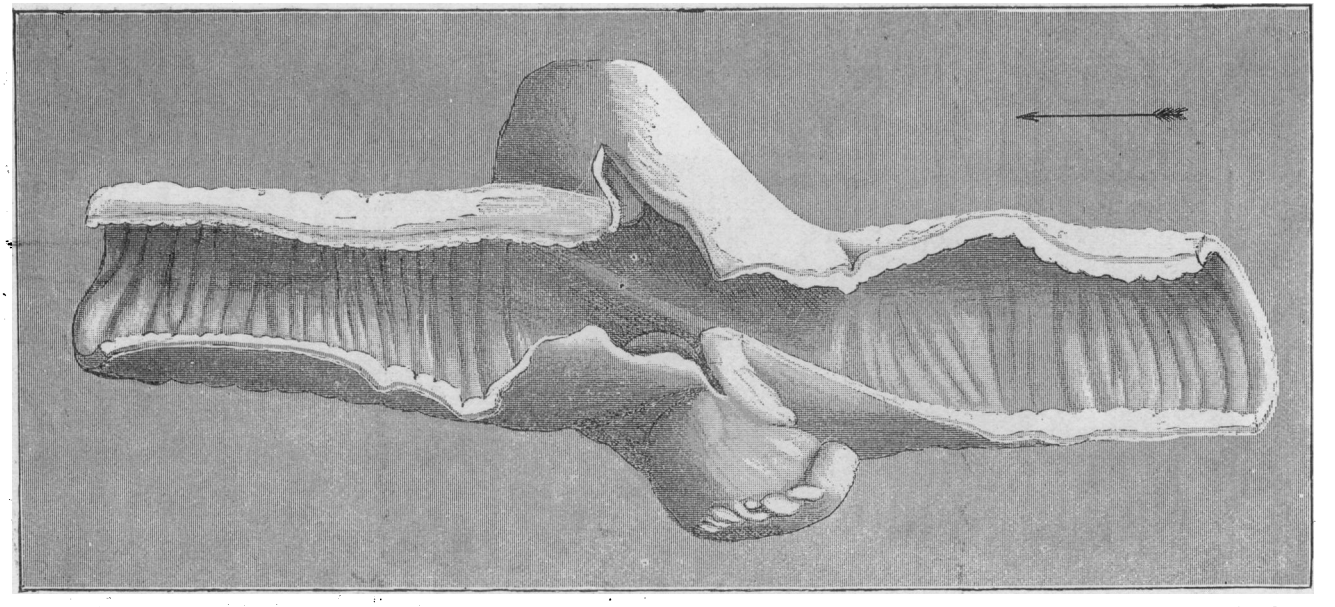

FIG. 5.—Dog. Lateral anastomosis. Senn's plates: 68 days. The arrow indicates the direction of the flow through the bowel. It will be noticed that although the anastomosis was originally completely lateral, the direction is now nearly straight; the two blind ends have become shorter. No trace of the plates. (Nat. size.)

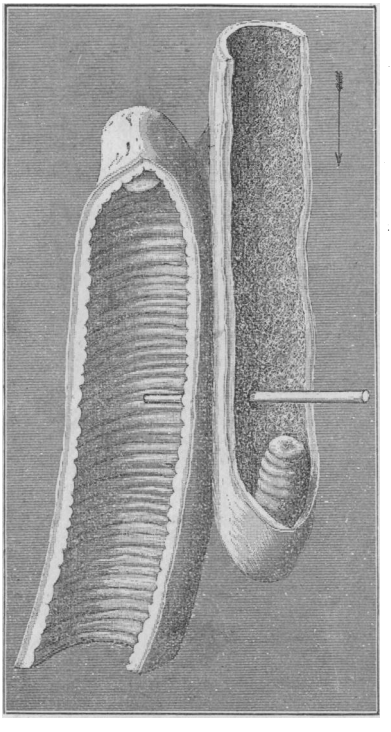

FIG. 6.—Dog. Lateral anastomosis. Mayo Robson's bobbin: 33 days. The arrow indicates the direction of the flow through the bowel. The anastomosis is quite lateral; the opening is small. A style is passed through opening. The blind end of upper bowel more shrunk than that of lower. ($\times \frac{1}{2}$.)

Murphy's button.—We tried this in one case, but the button we used, and which had been especially made for us for dogs, was somewhat too large, and this, therefore, cannot be considered a fair test; leakage occurred at the seat of union, and death ensued.

Pure suturing.—Finally, by this two anastomoses were made; the method of suturing used was Halsted's: both the animals did well. (See Figs. 43, 44, and 45.)

B. End to end junction.—Of the methods of end to end juncture, we tried Jessett's tubes, Paul's tube, pure

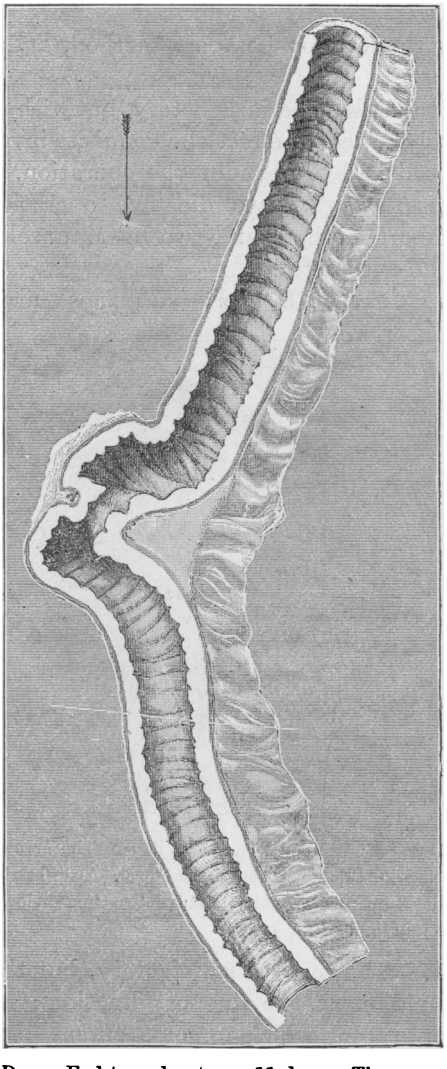

FIG. 7.—Dog. End to end suture: 11 days. The arrow indicates the direction of the flow through the bowel. The lumen of the bowel is considerably encroached upon at the point of suture; much more than in specimens obtained at a later date after operation. There is also a kink, due probably to excessive number of sutures at the mesenteric border, placed there to prevent leakage at a particular weak spot. Valvulæ conniventes alike above and below line of union. ($\times \frac{4}{5}$.)

suturing by the Czerny-Lembert method, and Maunsell's method.

Jessett's tubes seemed satisfactory, but with *Paul's* tube we completely failed to effect the requisite invagination of the bowel, and had to abandon the operation.

With *pure suturing* we did five operations by the Czerny-Lembert method, and two by Maunsell's method; these were all successful.

The five *Czerny-Lembert suturings* are seen in

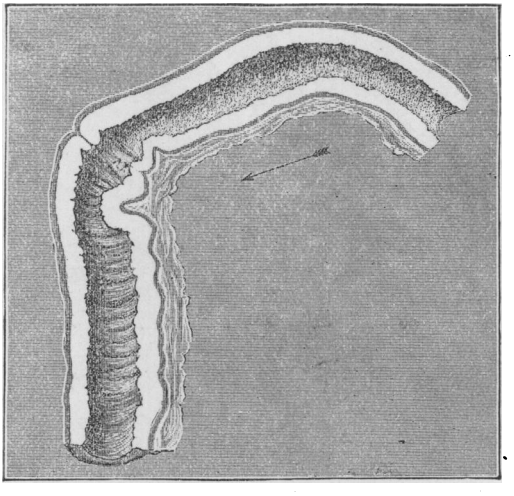

FIG. 8.—Dog. End to end suture: 18 days. The arrow indicates the course of the flow through the bowel. A slight ridge partly occludes lumen. Valvulæ conniventes seen below, but not above junction. (× ⅔.)

Figs. 7—11. They are all satisfactory, but they all have a circular ridge at the line of junction; this constistutes a diaphragm, which to some extent diminishes the lumen of the bowel.

In some of these cases the continuous suture was used for the mucous membrane, so that the operations were not all true Czerny-Lembert's.

There can be no doubt that the continuous suture is more rapid than the interrupted, but if the needles for

the latter are previously threaded, the difference in time need not be much; the objection, of course, to the con-

FIG. 9.

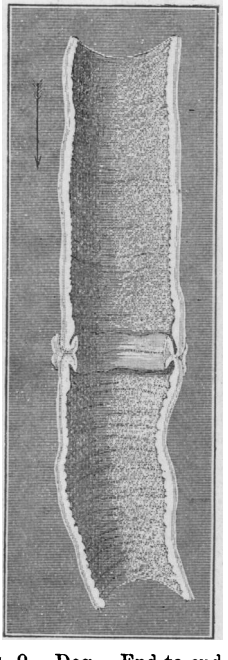

FIG. 10.

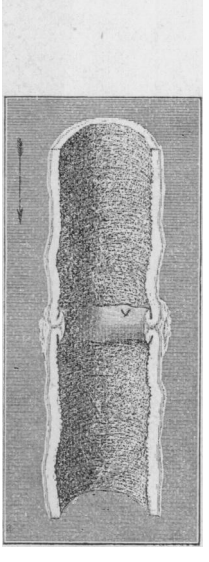

FIG. 9.—Dog. End to end suture: 21 days. The arrow indicates the direction of the flow through the bowel. The union is satisfactory; the lumen of the bowel is slightly encroached upon; there is some supporting tissue also externally. The two ridges formed by the incurving of the upper and lower portions of the bowel by the Lembert sutures are well seen. Valvulæ conniventes seen below, but not above line of junction. ($\times \frac{1}{2}$.)

FIG. 10.—Dog. End to end suture: 35 days. The arrow indicates the direction of the flow through the bowel. The union is satisfactory; the lumen of the bowel is slightly encroached upon; there is some supporting tissue also outside; the incurving of the coats by the outer row of (Lembert's) sutures is well seen. ($\times \frac{1}{2}$.)

tinuous suture is that it is not so easy to apply accurately, while with a Lembert stitch it is difficult to go wrong.

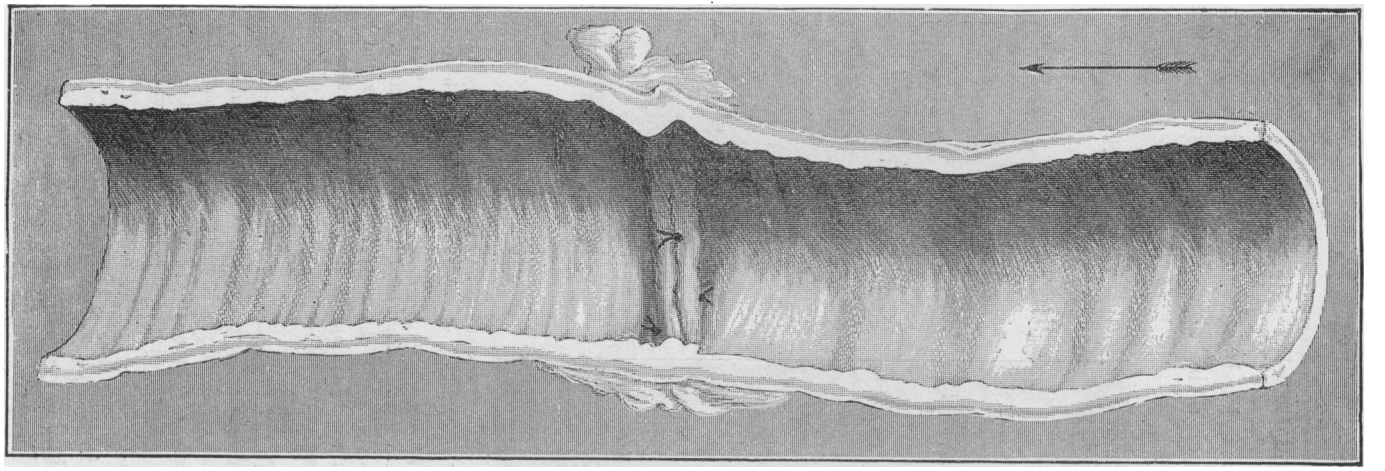

FIG. 11.—End to end sutures: 42 days. The arrow shows the direction of the flow through the bowel. The union is perfect; there are two slight ridges encroaching on the lumen, one on each side of the line of junction. Externally there is some organised lymph round the bowel. Three of the Lembert's stitches are seen working their way inwards towards the interior of the bowel. Valvulæ conniventes more marked below than above line of junction. (Nat. size.)

Lembert sutures of silk work inwards, and are discharged into the bowel, as was seen in some of the experiments, and is shown in Fig. 12.

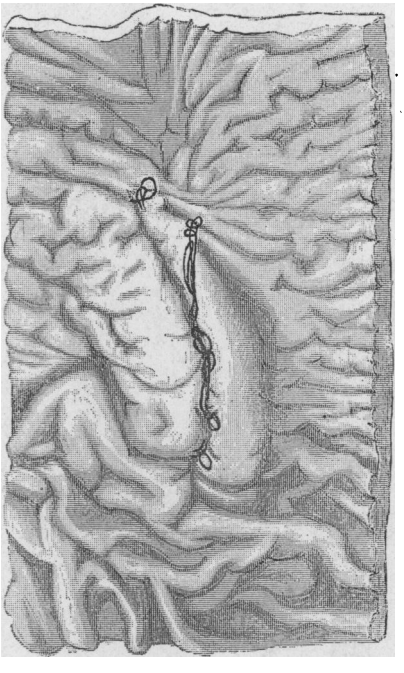

FIG. 12.—Reunion of a longitudinal incision in the large intestine of a woman æt. 35, for removal of fæcal concretion. Silk Lembert sutures were used. They are seen working out on the inner surface of the bowel six weeks after the operation. (Nat. size.)

Maunsell's operation, see Figs. 13, 14, and 26—29.—After this operation there is no diaphragm; indeed, it is quite difficult to recognise the line of circular junction: it contrasts markedly with the ridge which is seen at the site of the longitudinal incision which has been closed by Lembert sutures only.

C. Implantation of end of intestine into side.—This operation we performed twice, in both cases by pure

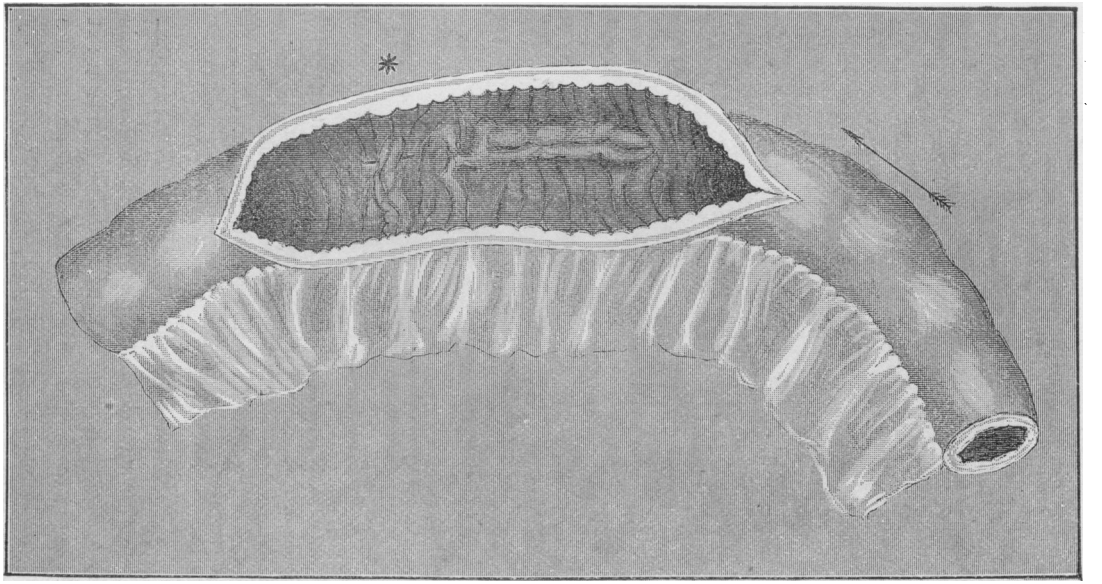

FIG. 13.—Dog. End to end union by Maunsell's method: 30 days. The arrow indicates direction of flow through the bowel; the asterisk the line of junction. This is extremely neat; there is scarcely any ridge within, and no new tissue without. This contrasts markedly with the line of union produced by Lembert sutures. The opening in the bowel made after death is lateral in order to show the median longitudinal incision, where there is now a considerable ridge produced by the Lembert sutures. Four Lembert's sutures were applied externally at the line of circular union (see abstract of experiments, No. 14). (Nat. size.)

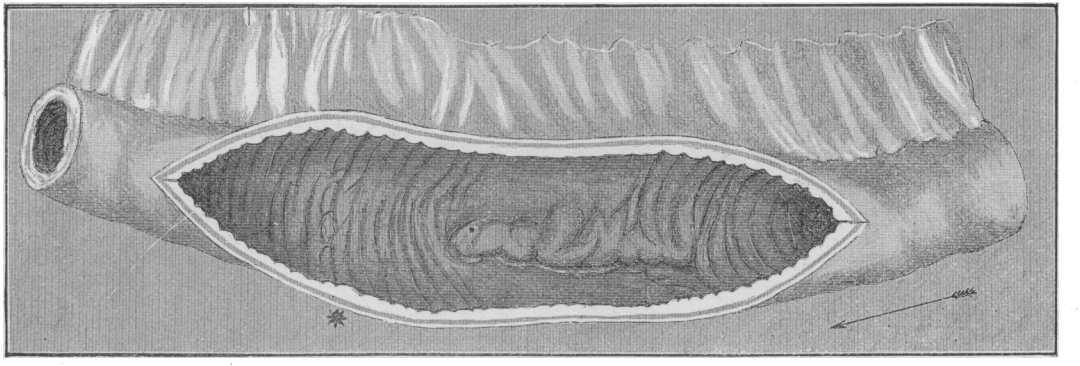

FIG. 14.—Dog. End to end suture by Maunsell's method: 78 days. The arrow indicates direction of flow through bowel. The bowel is opened at the side to show the median ridge caused by the suturing of the longitudinal incision with only Lembert stitches. At this level the bowel is now of smaller calibre than above or below (3 mm. less in circumference). At this level, too, the valvulæ conniventes are absent. The circular junction marked by an asterisk is almost invisible, there being no encroachment on the lumen of the gut. Several Lembert sutures were applied externally at line of circular union (see abstract of experiments, No. 15). ($\times \frac{3}{4}$.)

suturing ; they both did well. Vertical implantation is a form of short circuiting; the choice between it and lateral anastomosis must be decided by the individualities of the case, such as the length of bowel available : in lateral anastomosis a complete diversion of the chyme can

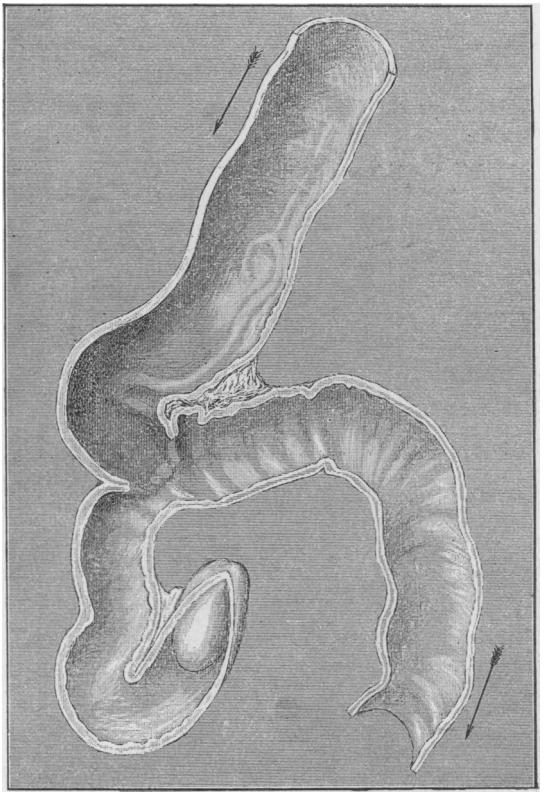

FIG. 15.—Dog. Implantation of upper into lower part. The arrow indicates the direction of the flow of the contents of the bowel. It will be noticed that although the anastomosis was vertical, yet the direction of the flow is now nearly straight. The blind end is small in comparison with that in Fig. 16, in which the anastomosis was made in the reverse way. Specimen obtained after 84 days. ($\times \frac{4}{5}$.)

be effected if desired by the division of the bowel, and the inversion and suturing of the ends.

Fig. 15 shows implantation of the upper end of the divided bowel into the side of the lower; Fig. 16 shows

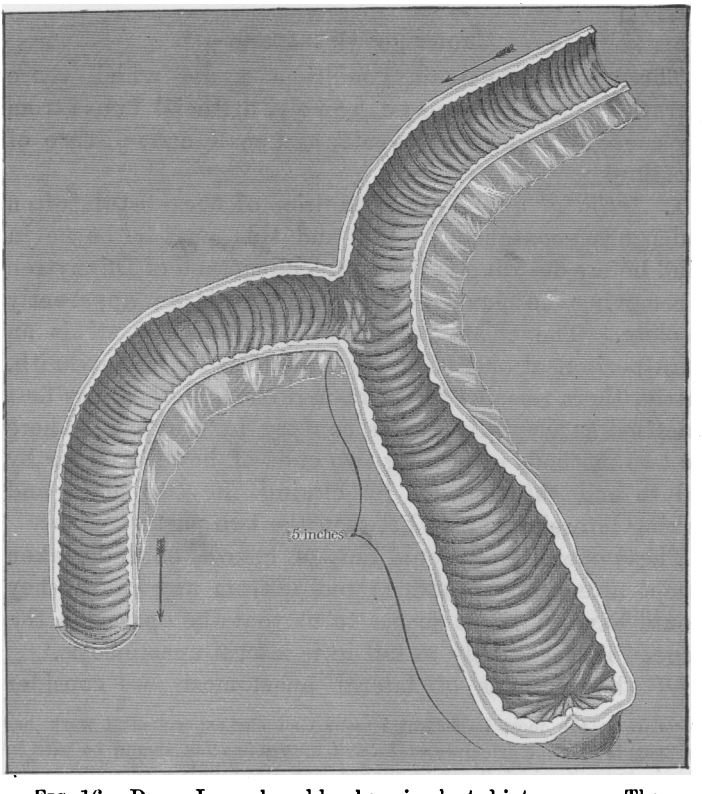

FIG. 16.—Dog. Lower bowel has been implanted into upper. The arrows indicate direction of flow through bowel. The blind end is five inches long, the same length as originally; it is distended, its wall hypertrophied, as are also the valvulæ conniventes. Specimen obtained in 126 days. Note distension of the blind end in connection with the direction of peristalsis. ($\times \frac{1}{2}$.)

implantation of the lower end of the divided bowel into the side of the upper.

With regard to intestinal clamps, although several

ingenious forms have been devised, we have not seen any reason to be dissatisfied with the use of a piece of rubber tube passed through a hole in the mesentery, and tied with a single hitch; the bowel is thus perfectly occluded and not injured.

Choice of Operation.

There are three main conditions under which these operations may be required, namely, artificial anus (from any cause), gangrenous hernia, and malignant disease of intestine.

A. *Artificial anus.*—The condition of fæcal fistula often undergoes spontaneous cure, and this must be borne in mind before deciding to operate. The method of Dupuytren of removing the spur with the enterotome is now apparently obsolete. The next method that suggests itself is an extra-peritoneal operation, as described by Greig Smith. Lastly, there remains the intra-peritoneal methods, as first practised successfully in this country by Makins. There are two methods of uniting two ends of bowel; either by end to end suturing, or by closing the two ends, and making lateral openings between the two parts.

These operations should not, of course, be undertaken except after some practice; but if from any cause they should have to be, it seems to us that the operation the surgeon is least likely to fail in is lateral anastomosis.[1]

Of the methods of lateral anastomosis we consider

[1] "One of the most important lessons that our experimental work has taught us is that the principle of *lateral approximation* should be used in every instance in which it can be applied. In itself it is a very simple and easy operation, and can generally be completed in from ten to fifteen minutes. In not a single case did we lose a dog on which we had performed a lateral approximation of two loops of the small intestine with or without resection, except when we experimented with the cut ends after resection. Such has been, to a great extent, the experience of all operators. The principle of lateral approximation may be carried out almost *ad infinitum*. If two sections of the small intestine are to be joined, a lateral approximation should be made; if the small intestine and the stomach are to be brought together, the union should be by lateral approximation; if the small and large intestine are the parts to be dealt with, still a lateral approximation is the operation of choice: indeed, this method should be practised if any of the other hollow

Halsted's superior to Senn's, and indeed to all methods in which plates, bobbins, or other mechanical aids are relied on. Figs. 16—22 will remind the reader of the details of Halsted's operation.

One objection to all mechanical aids is that it is possible that the surgeon will not have the right sized plate or bobbin at hand; it is often claimed that these shorten the time of operation, but if Lembert sutures are placed round the plates, the time is not much shortened; further, we are aware of cases in which, with plates and buttons, leakage and death have occurred. Halsted's operation need not take long if the following details are attended to:—more than sufficient needles should be ready threaded: the needle we prefer is No. 8 straw needle; the silk should be sufficiently thick not to cut the intestine; No. 0 silk is the size we have used.

We found it much better to have two needles on each suture, one at each end; by this means the operation can be more rapidly performed, for it is much easier for the surgeon to pass all the needles in the same way, than to have to pass each needle back again in the reverse direction; further, if one needle is passed only half through at first, it acts as a splint, and steadies the bowel for the next needle, and so on. In some experiments we united with a few stitches the two cut edges of mucous membrane.

Figs. 23 and 24 show the result of a Halsted operation on the human subject by one of us. An account of another of our cases will be found in the 'Clinical Society's Transactions' for 1894.

Of the methods of end to end anastomosis we again

viscera are to be united. So thoroughly are we convinced of the greater safety of this operation over any of the other methods, that with our present experience we would not dare to attempt an end to end approximation or an invagination on the human subject in cases in which we had the choice. Our mortality from the end to end approximation after resection amount to more than 30 per cent. Brokaw in his experiments had a mortality of 50 per cent., and other experimenters have shown no better results, whatever method was employed."—Ashton and Baldy, *Experimental Studies in Intestinal Surgery*, 'Medical News' (U.S.A.), Feb. 28th, 1891.

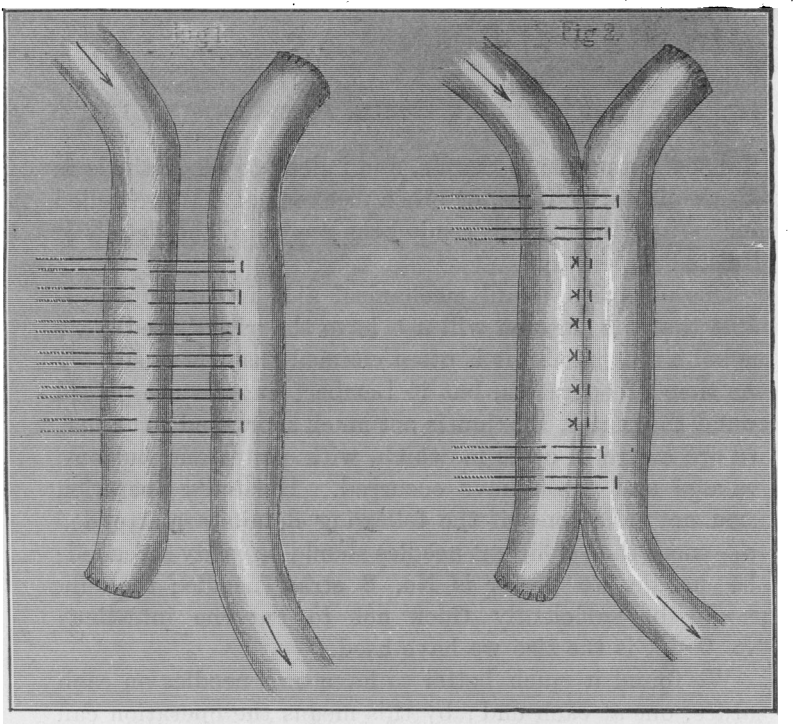

FIG. 17. FIG. 18.

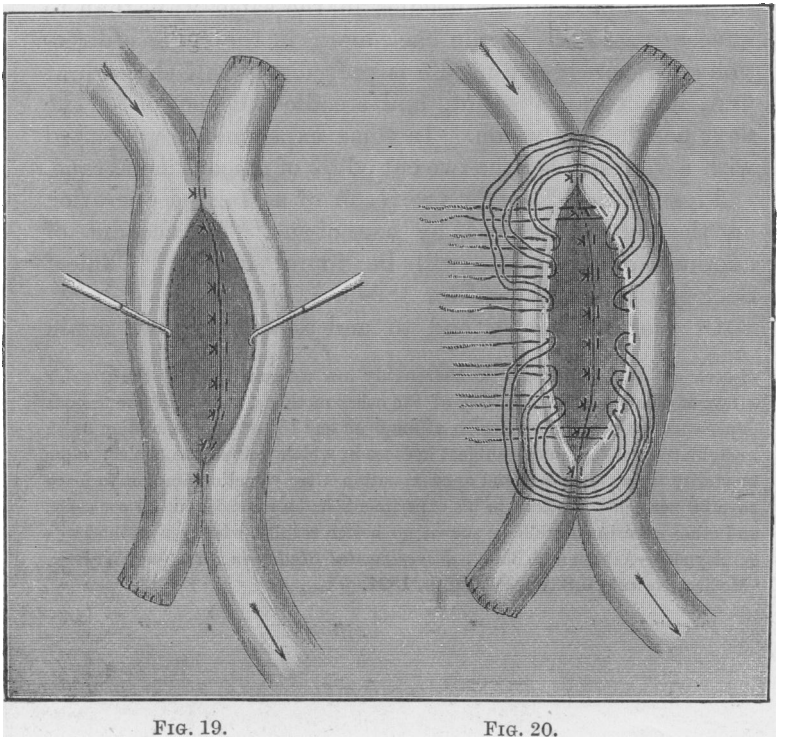

FIG. 19. FIG. 20.

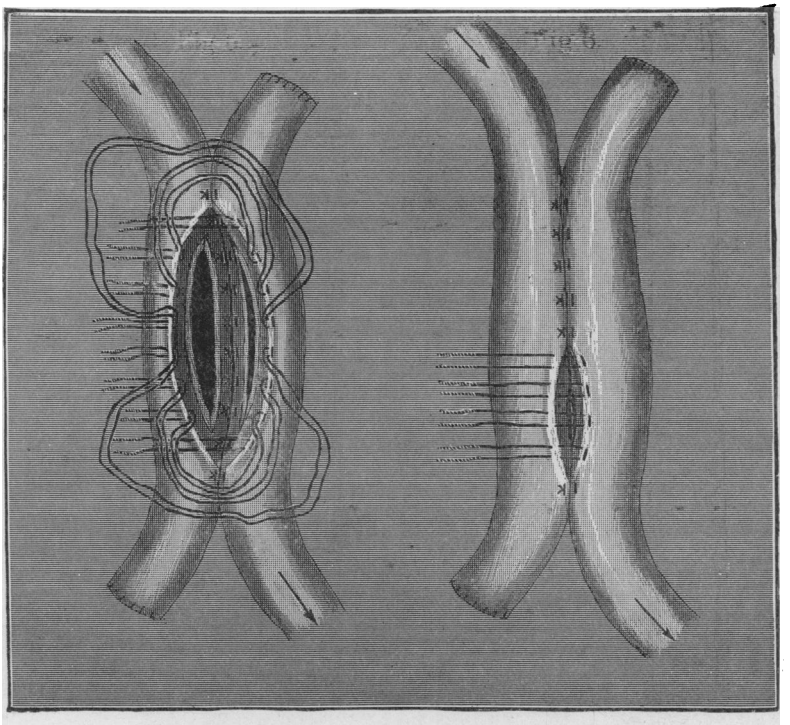

FIG. 21. FIG. 22.

HALSTED'S OPERATION (after Halsted).

FIG. 17.—1*st stage.* Posterior row of sutures applied.

FIG. 18.—2*nd stage.* Posterior row of sutures tied. Lateral sutures applied but not tied.

FIG. 19.—3*rd stage.* Posterior and lateral sutures tied.

FIG. 20.—4*th stage.* Anterior row of sutures applied and drawn aside. Intestine not yet incised.

FIG. 21.—5*th stage.* Intestine incised.

FIG. 22.—6*th stage.* Anterior row of sutures. Four tied and four not tied.

prefer simple suturing to the use of any form of supporting apparatus such as recommended by Paul, Jessett, and others.

Of these mechanical devices, some (as Robson's bobbin) are not attached to the bowel; these seem to us much better than those which are either attached by sutures to the bowel, as Senn's plates and Paul's tube, or, as in the

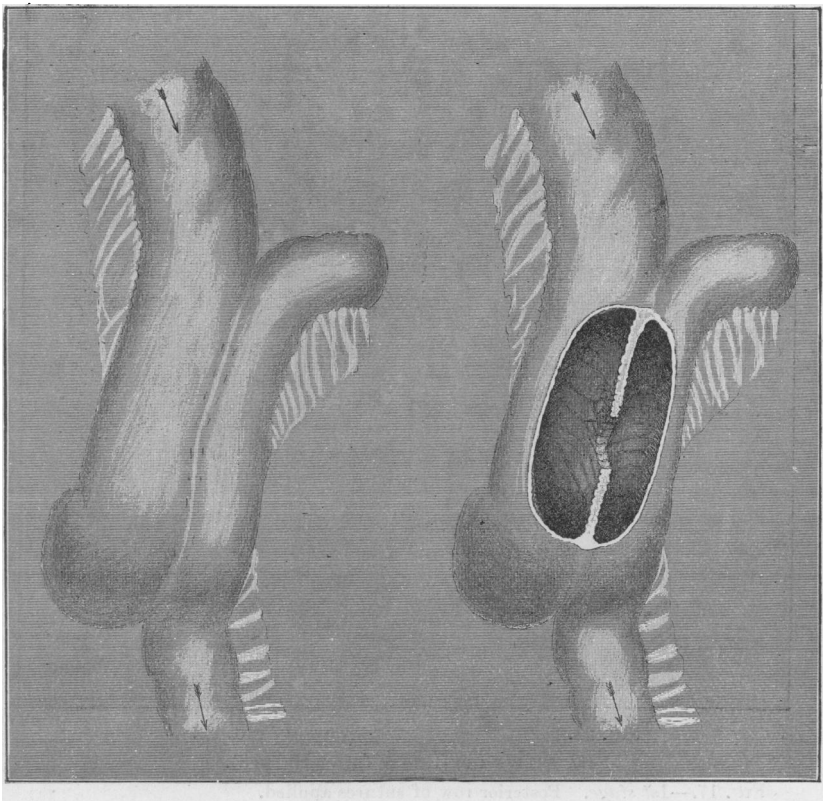

FIG. 23. FIG. 24.

Gangrenous hernia treated by Halsted's operation. Woman æt. 56. Small intestine strangulated in an umbilical hernia. Patient was the subject of huge fibroma of ovary, which caused intestinal obstruction and death fifth day after operation. The union was complete, and withstood high water pressure. Specimen in St. Thomas's Hospital Museum. ($\times \frac{1}{4}$.)

case of Murphy's button, are attached by compression to the bowel, the included portion of which is to become gangrenous.

The results of direct suture by the Czerny-Lembert method are shown in the accompanying drawings. Most care has to be taken at the mesenteric border, and here the

sutures should be applied first; the eversion of the mucous membrane in the small intestine is so great that the inner row of stitches merely results in the apposition of mucous membrane to mucous membrane, and the integrity of the junction depends solely on the Lembert sutures (see Fig. 25).

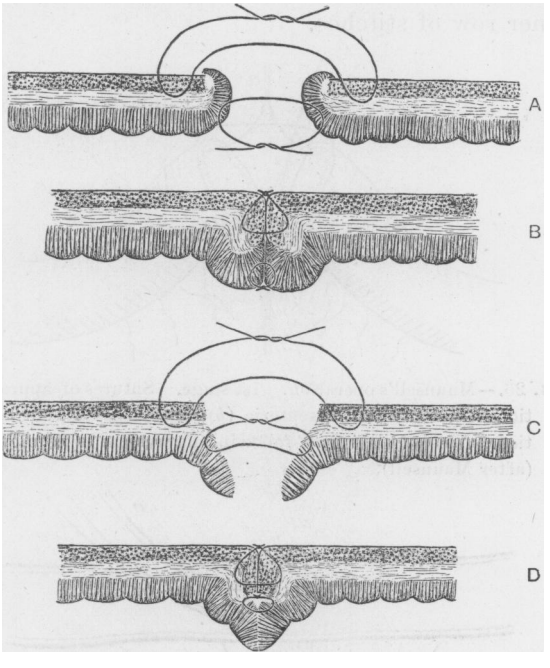

FIG. 25.—**A shows the way in which intestine is often brought together by the Czerny-Lembert method; mucous surface being brought to mucous surface. B shows the sutures in fig. A tightened. C shows sutures applied so as to bring raw surface of mucous membrane to raw surface of mucous membrane—a method which can be often practised in the large intestine. D the sutures shown in fig. C tightened and the bowel brought together.**

The result of this is the ridge which remains at the line of junction, sometimes seriously contracting the lumen. The temptation is to put in a second or even third row of Lembert sutures, and thus to run the risk of occluding

the bowel. The employment of the bobbin prevents this form of obstruction at least for the short time it retains its shape. The eversion of the mucous membrane does not occur to the same extent in the large intestine, and therefore the raw surface of the mucous membranes and of the muscular coat can be brought into apposition by the inner row of stitches.

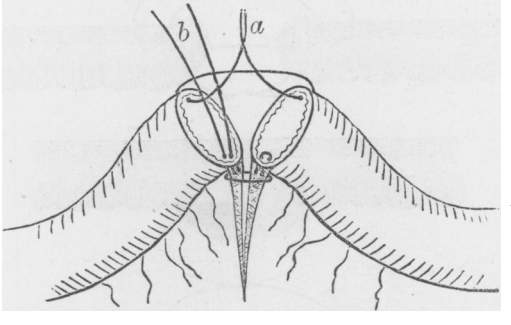

FIG. 26.—Maunsell's operation. 1st stage. Sutures of approximation in free (*a*) and mesenteric (*b*) borders passed, but neither tied. This and the three following figures are by Stanley Boyd (after Maunsell).

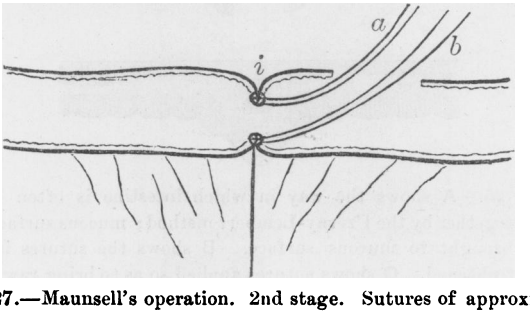

FIG. 27.—Maunsell's operation. 2nd stage. Sutures of approximation tied, and their ends (*a* and *b*) passed through a cut in the free margin. *i*. Line of section.

This objection does not apply to Maunsell's method (Figs. 26—29); it causes very perfect union of the two parts of bowel; raw surface of mucous membrane is brought to the same, muscular coat to muscular coat, and peritoneum to peritoneum. The result is an almost per-

fect union, the site of which has to be looked for to be detected (see Figs. 13 and 14). The circular union con-

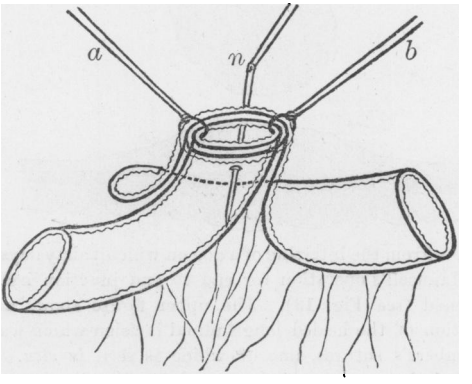

FIG. 28.—Maunsell's operation. 3rd stage. Traction has been made on *a* and *b*, producing an invagination, the layers of which are visible (dark lines = serosa, wavy = mucosa). *n*. A needle passed through all four layers of bowel.

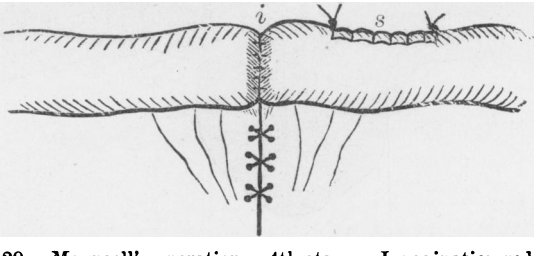

FIG. 29.—Maunsell's operation. 4th stage. Invagination reduced. *i*. Line of union. *s*. Wound in free margin closed by continuous suture. Mesentery has been sutured by interrupted stitches.

trasts markedly with the union by Lembert sutures of the longitudinal incision (Figs. 30 and 31). A possible objection to Maunsell's operation is that the sutures pass completely through the bowel, and may thus lead to leakage. In both our experiments we thought it necessary to place additional Lembert sutures at line of circular union (see abstract of experiments).

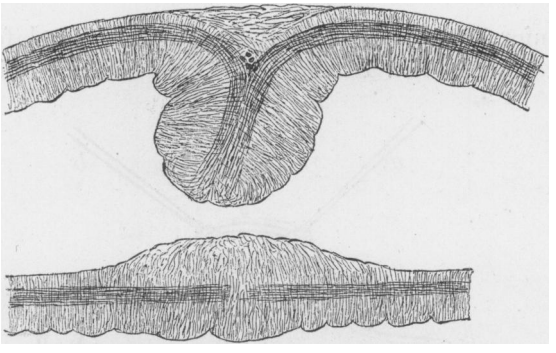

FIG. 30.—From the intestine of a dog on which thirty days previously a Maunsell's operation for end to end junction had been performed (see Fig. 13). The upper figure shows a transverse section of the healed longitudinal incision which was closed by Lembert's sutures, one of which is seen *in situ*. The lower figure is a section of the healed circular line of union. The figures show well the internal ridge formed by the Lembert sutures alone, as contrasted with the absence of obstruction to the bowel in the part united by Maunsell's method of suturing. (× 4.)

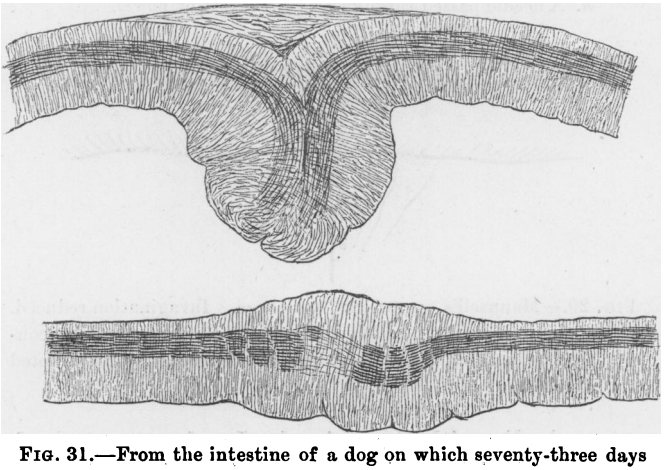

FIG. 31.—From the intestine of a dog on which seventy-three days previously a Maunsell's operation for end to end junction had been performed (see Fig. 14). The upper figure shows a transverse section of the healed longitudinal incision which was closed by Lembert sutures. The lower figure is a section of the healed circular line of union. The figures show well the ridge formed by the Lembert sutures alone, as contrasted with the absence of obstruction to the bowel in the part united by Maunsell's method of suturing, although additional Lembert sutures were used. (× 4.)

B. With regard to *gangrenous hernia*, the present tendency of surgery seems to be towards excision and primary suture, and the remarks already made will apply to this.

C. As to the treatment of *malignant disease of bowel*, if the growth can be removed, it of course should be, and the intestine will be either at once or subsequently united. As new growth generally occurs in the great bowel, and the small intestine is only rarely affected, the question will be one of union of great bowel either to itself or with small bowel. In the case of great bowel to great bowel there will probably not be sufficient length of intestine left after excision of growth to do a lateral anastomosis or Maunsell's method, and therefore the surgeon is restricted to another form of end to end junction, or to an implantation.

The following figures (32—36) illustrate the treatment of a case of malignant disease of the sigmoid by one of us.

In the case of uniting small bowel to large bowel (as after removal of a growth in the cæcum) the choice of operation is possibly wider, and lateral anastomosis and Maunsell's operation are practicable, or an implantation can be done; this latter would seem proper, owing to the difference in size of the two portions of bowel. It is probable that the safest and easiest operation—where possible—would be lateral anastomosis by Halsted's method; where not possible, as sometimes when junction is made with the rectum, a large Murphy's button could be used, as in a successful case under the care of one of us, in which the sigmoid was opened into the rectum for the cure of artificial anus. Where the growth cannot be removed and obstruction exists there are only two things the surgeon can do—either to make an artificial anus above, or to make an artificial opening between the bowel above the growth and that below. By the latter method there will be a choice between (*a*) simple lateral anastomosis, (*b*) lateral anastomosis after division of the bowel above

the tumour, and (*c*) implantation after division of the bowel. The best operation will depend partly on the case and partly on the surgeon, but the last two methods

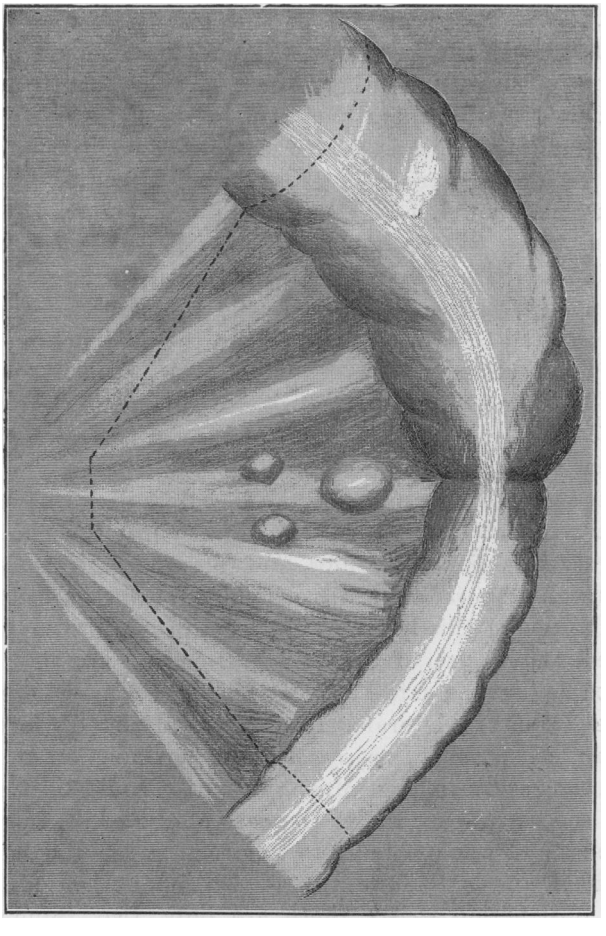

FIG. 32.—Drawing shows a case of carcinoma of sigmoid flexure with glands in mesentery. Patient a woman æt. 48. The dotted line shows the line of section by which the tumour was removed. There was considerable obstruction and much distension of abdomen. Both ends of bowel brought out and subsequently reunited (see Figs. 33 and 34). ($\times \frac{1}{4}$.)

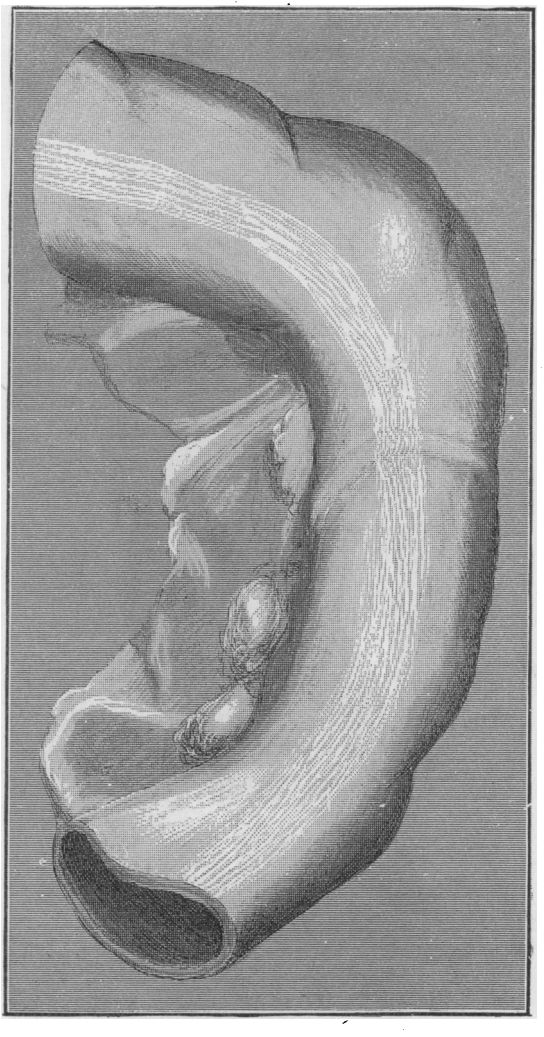

FIG. 33.—Two months after reunion of sigmoid (as mentioned in description of Fig. 32) patient died, and specimen figured obtained. It will be noticed that the direct line of the bowel was re-established. Only a line marks the site of reunion. ($\times \frac{2}{3}$.)

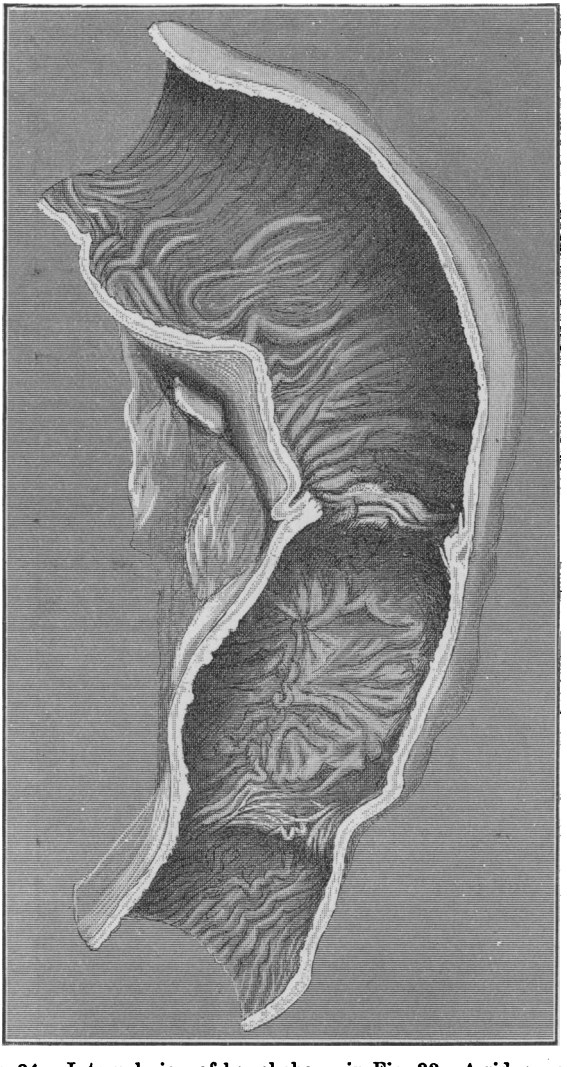

FIG. 34.—Internal view of bowel shown in Fig. 33. A ridge marks the line of union, the suturing being Czerny-Lembert. The raw surface of mucous membrane was stitched to the same (not mucous surface to mucous surface). ($\times \frac{2}{3}$.)

will have the advantage of preventing the passage of fæces over the growth; this diverting of the fæces not

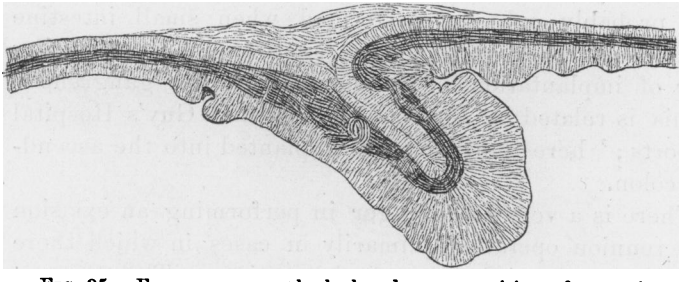

FIG. 35.—From a woman who had undergone excision of a portion of the sigmoid flexure for carcinoma (see Figs. 32—34). The divided ends were subsequently reunited. The figure shows a section of the circular line of union and of the diaphragm caused by the Czerny-Lembert suturing. (×3.)

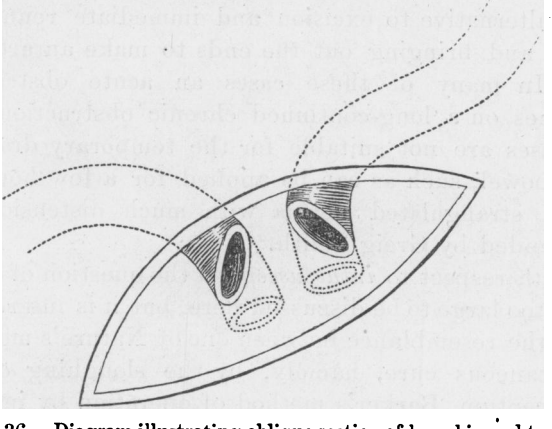

FIG. 36.—Diagram illustrating oblique section of bowel in end to end anastomosis for the cure of artificial anus. The advantages of the oblique section are (1) larger lumen to suture, and (2) angle at the mesenteric border is lessened or abolished. The method was adopted in the operation for the cure of artificial anus in the case illustrated in Figs. 32—35. This section might not be advisable in a recent case, or at least care should be taken not to interfere with the blood supply to the bowels.

merely stops any irritation of the growth by them, but also possibly causes some retardation of the rate of

growth comparable to the atrophy of bowel which occurs in short-circuiting experiments even where the passage of the chyme is not completely stopped. Implantation can probably only be performed when small intestine forms the upper part of the junction. An interesting case of implantation for artificial anus after gangrenous hernia is related by Davies-Colley in the 'Guy's Hospital Reports;' here the ileum was implanted into the ascending colon.

There is a very real danger in performing an excision and reunion operation primarily in cases in which there is even a minor degree of obstruction. The pent-up liquid fæces may pass in considerable quantity over the fresh wound, and this, together with the muscular action of the bowel, make most unfavourable conditions for union.

The alternative to excision and immediate reunion is excision and bringing out the ends to make an artificial anus. In many of these cases an acute obstruction supervenes on a long-continued chronic obstruction, and these cases are not suitable for the temporary drainage of the bowel, such as can be applied for a few hours in cases of strangulated hernia with much distension, as recommended by Greig Smith.

D. With respect to *intussusception* the question of treatment is too large to be discussed here, but it is interesting to note the resemblance between one of Nature's methods of spontaneous cure, namely, by the sloughing of the intussusceptum, Barker's method of operation by incising the bowel and amputating the intussusceptum, and finally Maunsell's operation for reunion, in which an intussusception is first produced. If a total excision is thought advisable, the surgeon must decide according to the case between lateral and end to end anastomosis.

Volvulus, especially that chronic form of it which occurs in the omega loop of the sigmoid flexure, occasionally requires operation: hitherto relief has generally been sought by an artificial anus; but it suggests itself that

a better result might be obtained by a large Halsted lateral anastomosis between the two lower arms of the large loop—in some cases it might be advisable to make in addition an artificial anus in the loop (Fig. 37). The advantage of the anastomosis is that the loop might be expected to atrophy from disuse—in fact, by precisely the reverse process to that which had produced it.

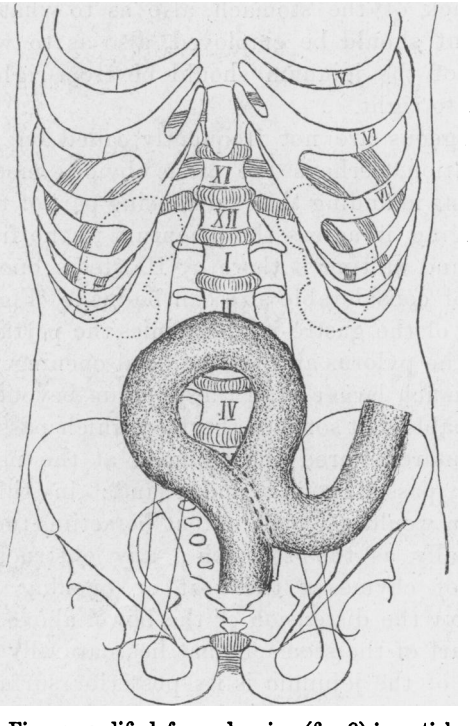

FIG. 37.—Figure modified from drawing (fig. 9) in article by von Samson on variations of the sigmoid flexure in Langenbeck's 'Archiv für klin. Chirurgie,' vol. xliv, p. 386 (1892). In the modified drawing the enlarged and distended sigmoid flexure is represented as united at the base of the omega by a Halsted's anastomosis. It is suggested that the bowel should be thus short-circuited, and that the loop would then gradually undergo atrophy from partial disuse.

II. Gastro-enterostomy.

It is still a moot point how best to perform gastro-jejunostomy for the relief of pyloric obstruction due to malignant disease or other cause ; even if pylorectomy is thought advisable it may be best to perform gastro-jejunostomy first. There has been some discussion as to whether the intestine should be attached to the front or to the back of the stomach, also as to what method of attachment should be employed, also as to whether the direction of the jejunum should be from right to left or from left to right.

As surgeons are not frequently called on to perform this operation, perhaps the most obvious mode is best : this consists in finding the commencing part of the jejunum and bringing it across the omentum to the front of the stomach and uniting it there by Halsted's operation ; an opening of considerable size can be made (Figs. 38—40).

In one of the gastro-jejunostomies the portion of bowel between the pylorus and the artificial opening was dilated and was much larger than the jejunum beyond (Fig. 39). It is probable that some of the food which passed through the pylorus re-entered the stomach at the new opening, and thus passed round and round : in this way the duodenum would to some extent be acting the same part mechanically as the stomach : any obstruction to the passage of chyme at the seat of opening would also account for the distension of the bowel above it.

The part of the stomach that lies naturally nearest the first part of the jejunum is its posterior surface, and the least disturbance of relations would be obtained by attaching these together : this method has been strongly advocated by Paul, who uses an ivory ring to effect the attachment; Fig. 41 illustrates the result of this operation in a dog. Paul further claims for this method that the opening will not spontaneously close, as seemed to have happened in several cases in which the anterior operation was performed with plates or bobbins. With Halsted's

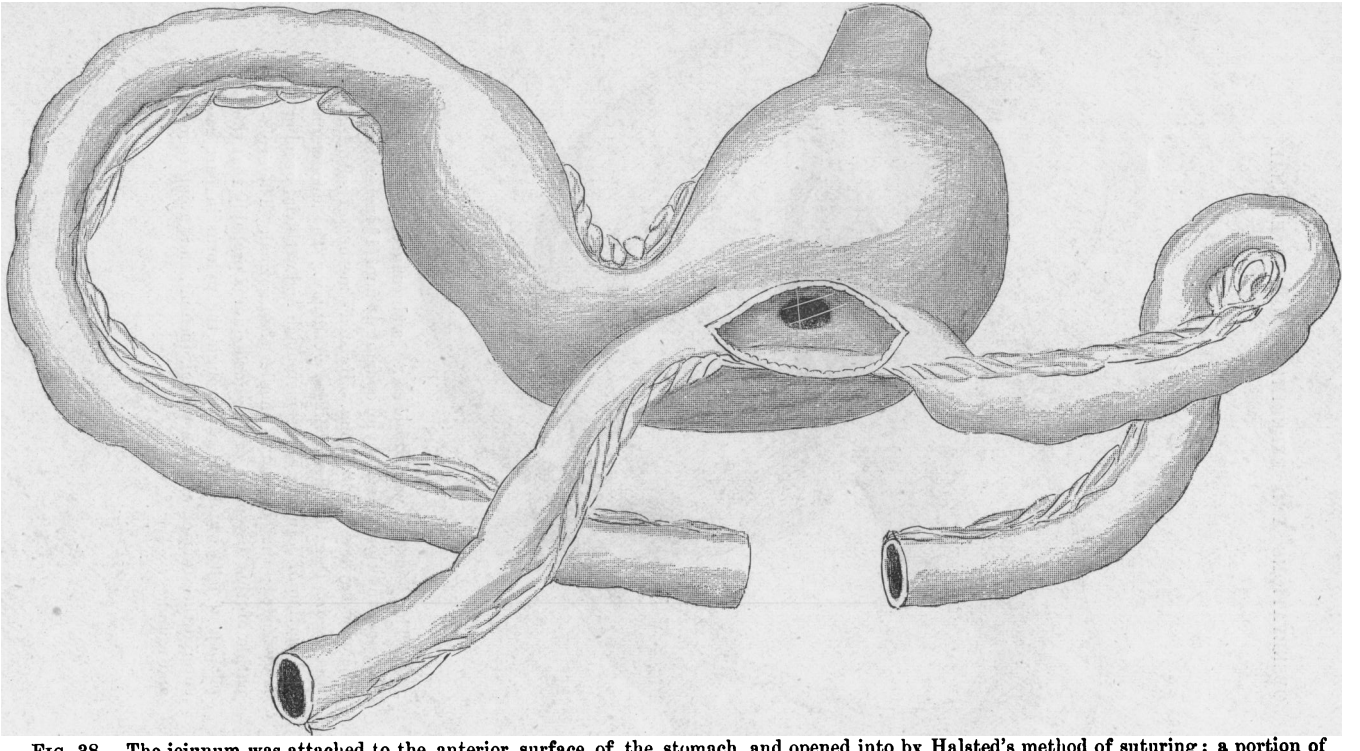

FIG. 38.—The jejunum was attached to the anterior surface of the stomach and opened into by Halsted's method of suturing; a portion of the mucous membrane of the stomach was cut away. Animal killed on 63rd day. The pylorus is not distended, nor is the bowel between it and the artificial opening (as in Fig. 39). The anastomotic opening has contracted to about half its original dimensions; it is now 10 × 7 mm. The opening in the duodenum was 27 inches below the pylorus. ($\frac{2}{3}$ scale.)

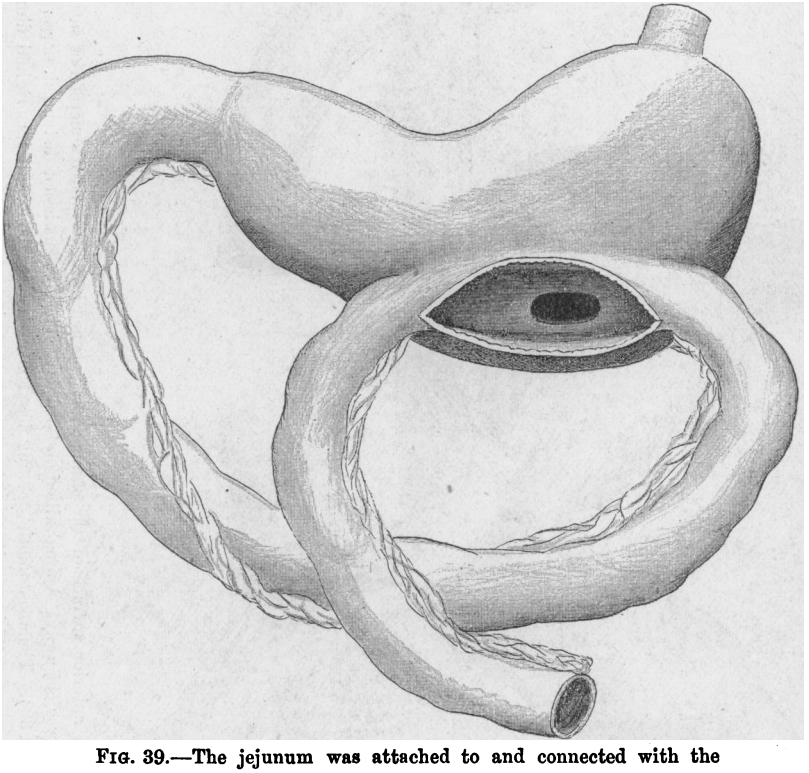

FIG. 39.—The jejunum was attached to and connected with the stomach (anterior surface) by an opening 42 mm. (1¾ inches) long. The opening now is 18 × 7 mm. Halsted's method of suturing was used. Dog lost flesh; killed 70th day. The duodenum and portion of jejunum between stomach and artificial opening is distended; that beyond is smaller than normal. The explanation of this distension of the duodenum is probably that the portion of food which passed through the pylorus in part re-entered the stomach at the artificial opening, thus going round and round. (× ½.)

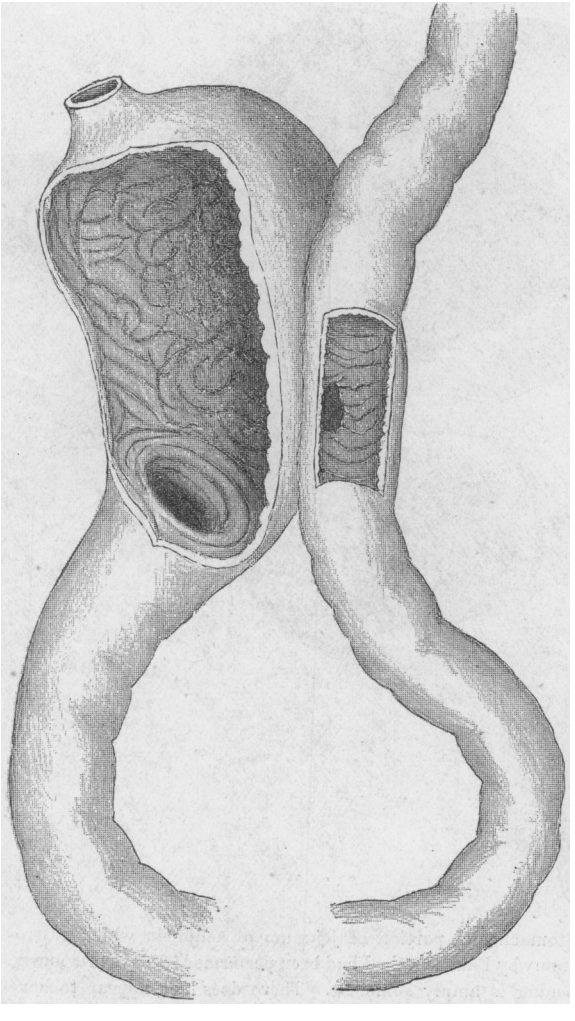

FIG. 40.—Stomach and portion of ileum united: the ileum had been brought up to the anterior surface of the stomach, sutured, and opened into it by Halsted's method. The dog did well, and was killed the 76th day. The artificial opening is free. In this case it will be noticed that the ileum was attached from right to left. ($\times \frac{2}{3}$.)

operation, however, the size of the opening is within the surgeon's control. Paul attaches great importance to the

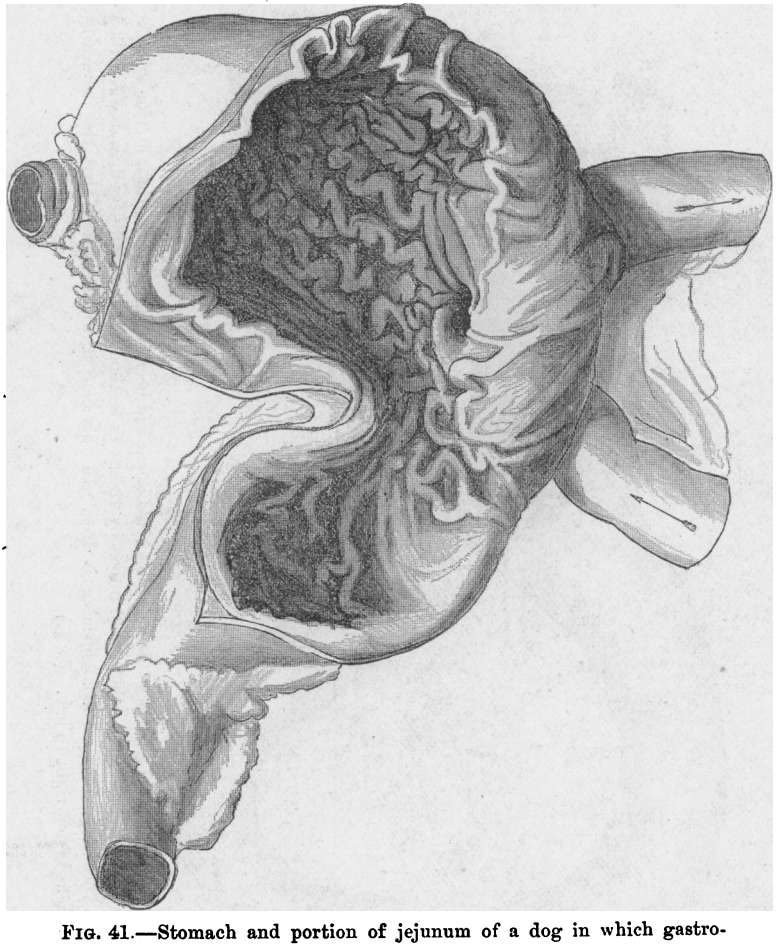

FIG. 41.—Stomach and portion of jejunum of a dog in which gastro-jejunostomy by Paul's method had been performed 97 days previously. The opening is amply sufficient. There does not appear to have been any contraction. The opening is on the posterior surface of the stomach. (Scale $\frac{2}{3}$.)

strangulation and death of a small portion of the walls of stomach and intestine which occurs in his operation as

preventing the tendency to contract. In Figs. 38—40 are shown gastro-jejunostomies by Halsted's method in which a portion of the prolapsing mucous membrane of the stomach was excised. It is obvious that by any method a portion of the whole thickness of the stomach wall can be excised if that is thought essential to ensure the opening remaining patent.

It is probable that it makes no material difference in which direction the jejunum is attached to the stomach, that is to say, whether from right to left or left to right; according to physiology it should be from left to right, for the direction of the peripheral current of food in the stomach is said to be towards the pylorus.

For pyloric obstruction not due to malignant disease it may be advisable to merely divide a band or to perform pyloroplasty, or in some cases gastro-jejunostomy.

In grafting the jejunum on to the front wall of the stomach it is obvious that care must be taken to avoid any twisting of the mesentery or any kinking of the intestine. Gastro-jejunostomy can also be performed by means of Maunsell's operation, as can also the reunion after pylorectomy—as described and figured by Wiggin after Maunsell. It suggests itself that it would be better for the artificial opening to be in what is ordinarily the most dependent part of the stomach; but the muscular contraction of the stomach would probably empty the organ wherever the artificial opening is situate. The pylorus itself is not dependent.

III. Physiological Observations.

1. In *lateral anastomosis* it is interesting to notice that the blind ends become shorter (see Figs. 4 and 5)—atrophy in fact—and would probably in time entirely disappear; further, the lateral opening after a time ceases to be lateral and tends to become more and more terminal or in the axis of the bowel; thus in time it is to be expected that the normal condition would be restored and all trace of

the operation lost. It would seem that the less specialised a part is the more perfect is repair.

2. In *short-circuiting* experiments the loop which is partly excluded diminishes markedly, both in length and diameter: in one case in 78 days it had diminished in length from 7 to 3¼ inches, that is to say reduced to 46 per cent. of its original length. The same atrophy is observed when the large intestine is totally excluded by an artificial anus in the ileum. This would seem to

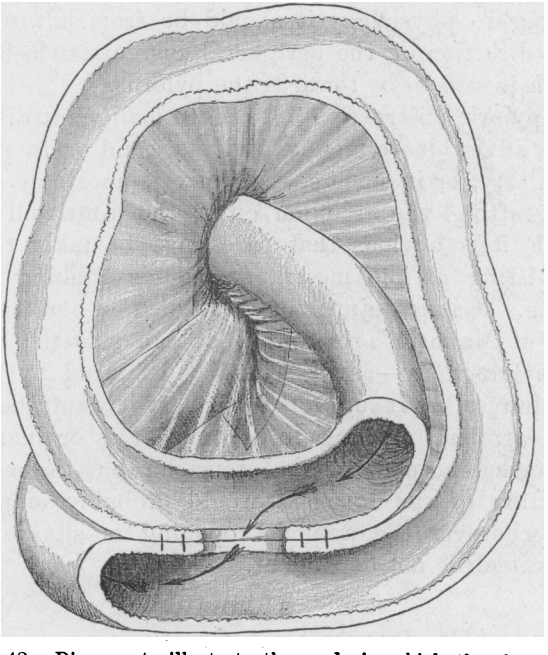

FIG. 42.—Diagram to illustrate the mode in which the short-circuiting of the small intestine of the dog was performed by Halsted's operation of lateral anastomosis. See Figs. 43—45.

show that the continued discharge of function is a necessary condition to the continued existence of the structure of the part—in fact, that without physiology there could be no anatomy. Fig. 42 illustrates the plan

adopted in these short-circuiting experiments. Figs. 43—45 are drawings of short-circuited portions of intestine for from 78 to 165 days after operation.

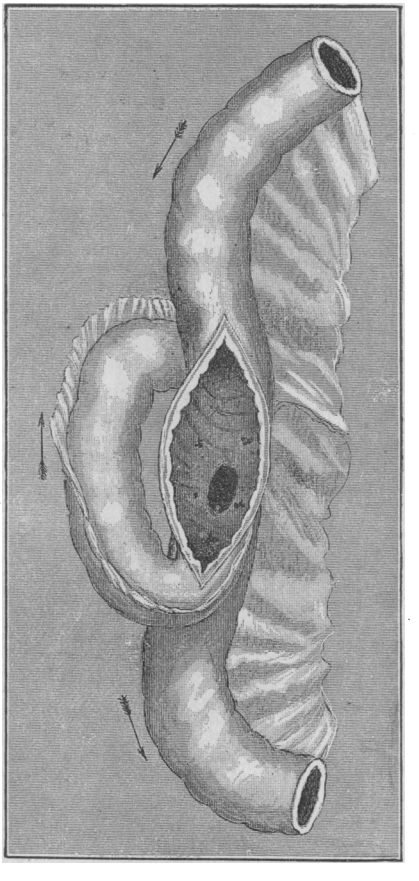

FIG. 43.—Small intestine was short-circuited by Halsted's method. Specimen obtained after 78 days. The excluded loop is seen to be diminished in diameter; it has also become reduced in length from 18 cm. to 8 cm. The artificial opening measures 7 mm. in its long diameter. The Halsted sutures are seen to be working their way to the interior of the bowel. In the abdomen the excluded loop lay transverse to the long axis of the bowel made by the upper and lower ends. ($\times \frac{5}{6}$.)

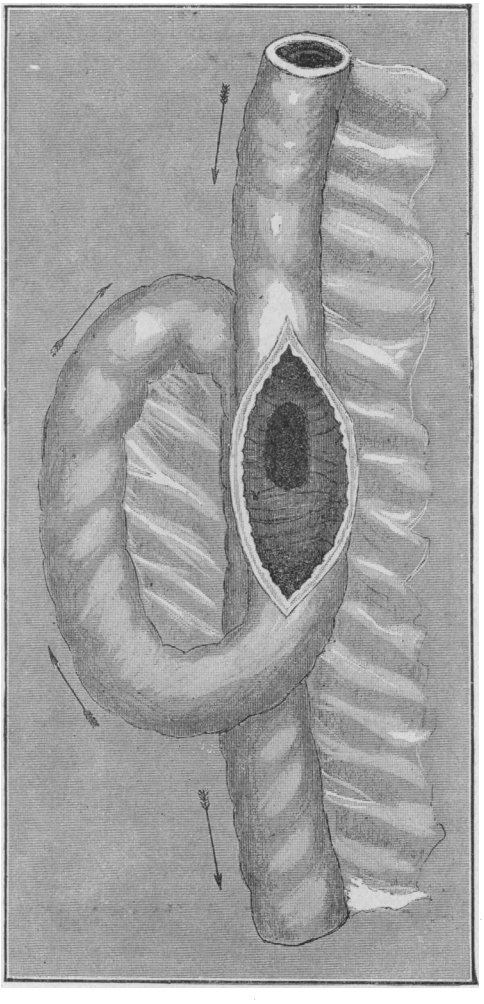

FIG. 44.—A portion of small intestine was short-circuited, an artificial opening between two loops being made by Halsted's method. Specimen obtained at the end of 134 days. The arrows indicate the direction of the intestinal flow. The excluded loop is seen to be diminished in diameter; it was also diminished in length from 20 cm. to 16 cm. The opening was 14 mm. in diameter. ($\times \frac{5}{6}$.)

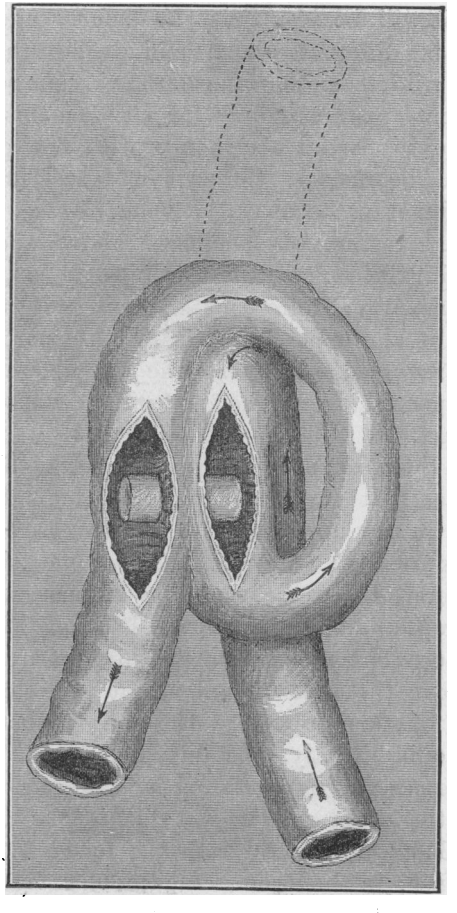

FIG. 45.—Short-circuiting of bowel by Halsted's anastomosis. The arrows indicate the direction of the flow. The upper end is bent by adhesions just before reaching the anastomosis. A style is placed through the artificial opening, which is oval, and measures 8 mm. in its long diameter. The partially excluded portion of bowel is seen to be slightly diminished in diameter. The dotted outline shows the true position of upper end. The opening has much contracted, and this is possibly due to the bend in the upper end not favouring passage through the opening. Specimen obtained after 165 days. ($\times \frac{5}{6}$.)

3. *Changes in the mucous membrane.* On inspection of the figures it will be seen that the mucous membrane of the bowel is different above and below the seat of anastomosis; it is smoother above, the valvulæ conniventes disappear, but apparently only for a time; this change is possibly due to partial obstruction with the consequent pressure and distension; the part of bowel immediately above the junction becomes, in some degree, the large intestine and rectum of the bowel above, and like the large intestine has no valvulæ conniventes.

This explanation, unfortunately, will not agree with our figures of the experiments in which a portion of the bowel was reversed; in these the valvulæ conniventes have disappeared from the normal bowel below the reversed part.

In both these experiments there was a collection of hardened fæces at the upper junction, indicating apparently that, in the upper part of the reversed portion at least, the peristalsis in what has become the reverse direction persisted at the time the animals were killed. Also in Maunsell's operation it will be seen, Figs. 13 and 14, that there is no such marked disappearance of the valvulæ above the seat of union, but that there is some diminution of them opposite the longitudinal incision, which no doubt slightly contracted the bowel.

4. In the case of *implantation* it is to be noted that it makes all the difference whether it is the upper part of bowel that is implanted into the lower or the lower into the upper; in the former case the blind end atrophies, as the peristaltic action tends to empty it; in the latter the peristaltic action in the cul-de-sac is towards its blind end, and consequently this artificial cæcum elongates and its walls become hypertrophied (see Figs. 15 and 16).

In the appendix of man the peristalsis is towards the cæcum; this may explain the smallness of the appendix in man. It will be remembered that in certain pathological conditions which cause obstruction of the appendix, it elongates and its walls become hypertrophied.

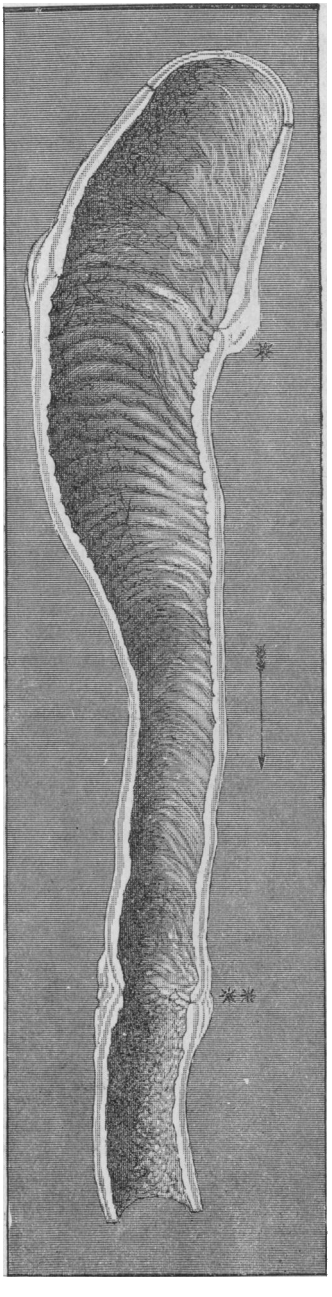

FIG. 46.—Reversal of portion of small intestine, 9½ inches long before division. The reversed portion is now 6 inches long; there was a small collection of fæces at the upper junction, but intestine not distended. Specimen obtained at end of 32 days. ($\times \frac{2}{3}$.)

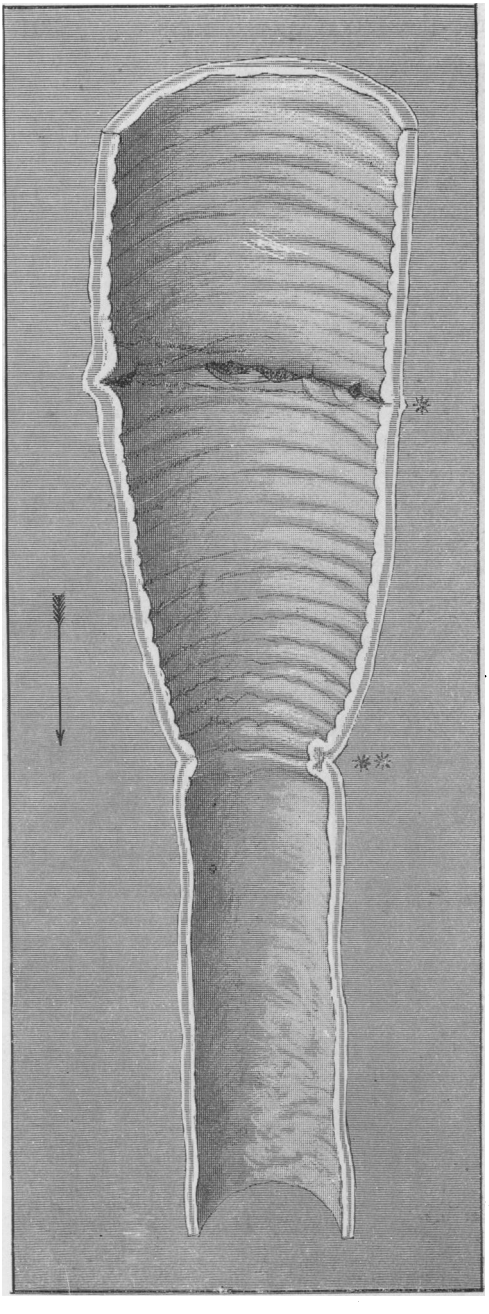

FIG. 47.—67 days. The bowel is distended at upper line of suture, where a mass of hardened fæces was blocked; ulceration along upper line of sutures. The reversed portion has contracted from 5 to 3¼ inches. Lower line of suture perfect. ($\times \frac{2}{3}$.)

5. *Reversal experiments.* In the case of a portion of the intestine being reversed, the reversed portion shortens considerably; in one experiment, at the end of 32 days 9½ inches were reduced to 6 inches (see Fig. 46); in another, at the end of 67 days 5 inches had contracted to 3¼ inches (see Fig. 47).

It is interesting that an animal can live quite well after a length of intestine has been reversed. The difficulty (already referred to) in the upper portion of the reversed part taking up the chyme coming down from above must be due to the nervous mechanism being at fault, continuing possibly the peristalsis in the old way and not adapting itself to the new conditions caused by the operation. This, however, was not sufficient, at least in one of our experiments, to interfere with the enjoyment of good health.

In conclusion, we wish to express our indebtedness to Professor Sherrington, late Professor Superintendent of the Brown Institution, for his suggestions and kind interest in our work.

IV. Abstract of Experiments.

I. Intestinal Anastomosis.

A. *Lateral Anastomosis.*

Exp. 1. *Senn's plates,* 63 *days.*—Small intestine divided; two cut ends inverted and sutured; intestines incised longitudinally, plates inserted and tied, and continuous suture applied externally. Animal recovered without bad symptoms. Killed 63 days (see Fig. 4).

Exp. 2. *Senn's plates,* 68 *days.*—Small intestine divided; two cut ends inverted and sutured; intestines incised longitudinally, plates inserted and tied, and Lembert's sutures applied externally. Animal recovered. No bad symptoms. Killed 68 days (see Fig. 5).

Exp. 3. *Mayo Robson's bobbin* (*made for dogs*), 33 *days.*—Small intestine, division, inversion and suture of both ends, intestines incised longitudinally, bobbin inserted. Lembert suture externally. Animal recovered, but became thin. Killed 33 days.

Post-mortem.—Small opening. Upper end distended, valvulæ conniventes absent in upper intestine; in lower well marked. No trace of bobbin (see Fig. 6).

Exp. 4. *Davis's catgut plates.*—Experiment attempted and abandoned.

Exp. 5. *Littlewood's bone plates.*—Experiment attempted and abandoned.

Exp. 6. *Murphy's button.*—Leakage and death ensued.

Exp. 7. *Halsted's method of suturing.*—Operation successful; dog did well. Killed 25th day, opening not measured post mortem.

Exp. 8. *Halsted method.*—Operation successful; dog did well. Killed 28th. Opening not measured post mortem.

B.—*End to End Junction.*

Exp. 9. *End to end junction,* 11 *days.*—Small intestine divided, cut ends sewn together by Czerny-Lembert sutures; no bad symptoms. Animal killed 11 days.

Post-mortem.—Lumen more encroached upon than in later specimens (which see). It will also be noticed that here the valvulæ conniventes are equally marked above and below junction, instead of only below as in later specimens (see Fig. 7).

Exp. 10. *End to end suture,* 18 *days.*—Small intestine divided, two cut ends sewn together, mucous membrane to mucous membrane by Czerny sutures, and outer coats to outer coats by Lembert sutures. No bad symptoms. Animal killed 18 days.

Post-mortem.—A slight ridge at line of union; valvulæ conniventes more marked below than above junction (see Fig. 8).

Exp. 11. *End to end suture,* 21 *days.*—Small intestine divided; two cut ends sewn together by Czerny-Lembert sutures. No bad symptoms. Animal killed 21 days.

Post-mortem.—Satisfactory union; slight ridge within bowel; the incurving of outer coats produced by the Lembert sutures is well seen (see Fig. 9).

Exp. 12. *End to end suture,* 35 *days.*—Small intestine divided; two cut ends sewn together; *interrupted sutures in mucous membrane* and *Lembert sutures* in outer coats going down to and through submucous coat (Czerny-Lembert sutures). No bad symptoms. Animal killed 35 days.

Post-mortem.—Satisfactory union. Slight ridge within and supporting tissue without. The incurving of the

coats by the Lembert stitches was well seen (see Fig. 10).

Exp. 13. *End to end suture, 42 days.*—Small intestine divided; two cut ends sewn together end to end; the *mucous membrane by continuous suture,* and one or two additional single sutures; the outer wall of bowel sutured with *Lembert sutures* carried through submucous coat (as recommended by Halsted). No bad symptoms. Animal killed 42 days.

Post-mortem.—Satisfactory union. Slight ridge at line of union (see Fig. 11).

Exp. 14. *End to end suture by Maunsell's method, 30 days.*—Small intestine divided and reunited by Maunsell's method with horsehair stitches. *Four additional Lembert stitches were subsequently applied externally.* The longitudinal incision was made above the junction. It was closed by Lembert's stitches. No bad symptoms. Animal killed 30 days.

Post-mortem.—Good union. The line can be with difficulty recognised, while the longitudinal incision (closed with Lembert's sutures) is shown by a very obvious ridge (see Fig. 13).

Exp. 15. *End to end suture by Maunsell's operation, 78 days.*—Small intestine divided and cut ends united. *The junction produced was by no means perfect, and mucous membrane could be seen externally; therefore several Lembert sutures inserted.* The longitudinal incision also closed by Lembert's sutures. No bad symptoms. Animal killed at end of 78 days.

Post-mortem.—Line of union perfect; considerable ridge at longitudinal incision (see Fig. 14).

Exp. 16. *Jessett's tubes.*—Operation apparently satisfactory, but the dog same day died of another cause.

Exp. 17. *Paul's tube.*—Operation abandoned.

C.—*End to Side Junction.*

Exp. 18. *Implantation of bowel, upper into lower, 84 days.*—Small intestine; intestine divided; upper end of lower bowel inverted and sutured; the end of upper bowel implanted laterally into the side of the lower bowel; Czerny-Lembert sutures. Dog did well and was killed at the end of 84 days.

Post-mortem.—There were some adhesions of the bowel to neighbouring structures; intestine as figured (see Fig. 15).

Exp. 19. *Implantation of bowel, lower into upper, 126 days.*—Small intestine; intestine divided; upper end of bowel inverted and sutured; the end of lower bowel inserted into upper five inches from its inverted end. Dog did well. Killed in 126 days.

Post-mortem.—The anastomosis is free, the blind end being five inches long, the same length as at time of operation; it is also distended, its walls and valvulæ conniventes hypertrophied. Externally sutures in position, the opening not quite full size of bowel (see Fig. 16).

II. Gastro-enterostomy.

Exp. 20. *Gastro-jejunostomy by Halsted's method, 63 days.*—Jejunum found and united, and opened into stomach by Halsted's method, using double-threaded needles which can all be passed in the same and most convenient direction. A portion of the mucous membrane of the stomach was cut away. The cut edges of stomach and jejunum were joined by four additional single sutures. The opening measured 18 × 12 mm. Animal did well, and was killed at the end of 63 days.

Post-mortem.—Firm adhesion between stomach and jejunum; opening measured 10 × 7 mm. Opening between stomach and duodenum not distended: it is not clear how much food passed through the artificial opening. The fact that the opening is smaller now than

at time of operation is explained by the healing of the wound, and there seems no reason to suppose that there would be any further contraction (see Fig. 38).

Exp. 21. *Gastro-jejunostomy, 70 days.*—A gastro-jejunostomy was performed by *Halsted's method;* a linear opening between stomach and jejunum was made, 42 mm. long. Animal did only fairly well; on the 43rd day it was noted that he was well and lively, but extremely thin; on the 70th day he was in better condition; killed that day.

Post-mortem.—A length of jejunum firmly adherent to stomach; intestine between stomach and artificial opening distended; beyond the opening the intestine is rather small; opening between stomach and jejunum measures 18 × 7 mm.; free communication.

Remarks.—It seems probable, owing to the large size of the communication, that some of the food passing along the duodenum re-entered the stomach, and thus circulated round and round; in this way the duodenum would become part of the stomach, and its upper part dilated, the food loitering about there as in the stomach; in this way the existence of the stomach in animals would be due to the presence of a pylorus (see Fig. 39).

Exp. 22. *Gastro-enterostomy by Halsted's method, 76 days.*—A portion of intestine was taken and brought forward, and attached to and opened into the front wall of the stomach by Halsted's method of suture; the dog did well, and was killed at the end of 76 days.

Post-mortem.—It was found to be the ileum which had been attached; the opening was satisfactory, and shows no sign of contraction.

It is noteworthy that in this case, and also in No. 23 experiment, although the route out of the stomach *viâ* the pylorus was quite open, yet there was no sign of contraction of the artificial opening, and also that no regurgitation of any consequence seems to have taken place,

for the animals were quite well, and had no vomiting (see Fig. 40).

Exp. 23. *Gastro-jejunostomy, Paul's method, 97 days.*—The abdomen was opened, the jejunum found, and a site selected, an incision made, and the ring inserted and needles passed; the omentum and transverse colon were then turned back, and a site selected on the back of the stomach; on the front of the stomach a vertical incision was made so as not to cut the branches of the gastro-epiploic artery; the needles were then passed at selected site into the interior of stomach and the sutures tied; the portion of stomach included in the ring was *not* divided.

The animal did well, and was killed at the end of 97 days. There was a good-sized opening between stomach and jejunum, showing no signs of contraction. Nothing was seen of the rings. The ivory ring used was kindly sent to us by Mr. Paul (see Fig. 41).

III. Physiological Observations.

Exp. 24. *Short circuiting, 78 days.*—A portion of small intestine was short-circuited by Halsted's method. The length of intestine thus treated was 7 inches (18 cm.). Animal did well, and was killed at the end of 78 days.

Post-mortem.—The short circuited loop is now only 3¼ inches (8 cm.), less than half what it was before. The loop is also diminished in diameter. The position of the loop in the abdomen rather favoured the passage of the chyme through the opening. The artificial opening measured 7 mm. in diameter. When water is injected through intestine, pinching the loop makes no difference in the outflow (see Fig. 43).

Exp. 25. *Short circuiting, 134 days.*—A portion of small intestine is short-circuited, an artificial communication being made by Halsted's method. The length of

short circuited portion was 8 inches (20 cm.). Dog did well, and was quite well when killed at the end of 134 days.

Post-mortem.—Seat of operation readily found. Excluded loop is diminished in length and diameter. Its length is now 6¼ inches (16 cm.). The artificial opening is 14 mm. in its longer diameter. On obstructing loop water flows freely through artificial opening (see Fig. 44).

Exp. 26. *Short-circuiting, Halsted's anastomosis,* 165 *days.*—Small intestine short-circuited, opening being made by Halsted's operation; the animal did well, and was killed at the end of 165 days.

Post-mortem.—Short-circuited portion readily found. On injecting water from upper end it flowed partly round the circuit, and partly through the artificial opening. The diameter of the "excluded" part is slightly diminished. The opening measures 8 mm. in its long diameter (see Fig. 45).

Exp. 27. *Reversal of bowel,* 32 *days.*—Small intestine; reversal of intestine; recovery, dog did well. Killed 32nd day.

Post-mortem.—Before division of bowel portion reversed was 9½ inches long, at time of death 6 inches long. Small collection of fæces at upper line of sutures, but intestine not distended: dog quite well when killed (see Fig. 46).

Exp. 28. *Reversal of bowel,* 67 *days.*—A portion of small intestine was divided in two places: the portion thus isolated was, after division, 5 inches long; it was then joined to the intestine again, but in the reverse direction, the lower end being sutured to the upper end, and *vice versâ;* this necessitated a half-turn in the mesentery. The animal did well, bowels acted third day. On the 67th day animal weak and ill, therefore killed.

Post-mortem.—The reversed portion is now 3¼ inches long. A mass of hard fæces at upper junction, causing ulceration of mucous membrane along line of suture (see Fig. 47).

The drawings are by Mr. Lapidge.

V. References.

Ashton and Baldy.—'Medical News,' U.S.A., Feb., 1891.

Barker.—'Lancet,' Jan., 1892, and 'Proc. Roy. Med. and Chir. Soc.,' New Series, vol. ii, p. 257, 1887.

Boyd, Stanley.—'Med.-Chir. Trans.,' vol. lxxvi, 1893.

Davies-Colley.—'Guy's Hospital Reports,' vol. xlviii, 1891.

Greig-Smith.—'Abdominal Surgery,' 5th edit., and private conversations.

Halsted.—'Bulletin of the Johns Hopkins Hospital,' Jan., 1891.

Jessett.—'British Medical Journal,' July, 1889.

Littlewood.—'Lancet,' April, 1892.

Makins.—'Resection of Small Intestine,' 'St. Thomas's Hospital Reports,' 1884.

Maunsell.—'Transactions Intercolonial Med. Congress of Australia,' 1889. (His first operation was in 1886.)

Murphy.—'Medical Record,' (U.S.A.), Dec., 1892.

Paul.—'Liverpool Med.-Chirurgical Journal,' July, 1892.

Robinson.—'Annals of Surgery,' Feb., 1891.

Robson, Mayo.—'Med.-Chir. Trans.,' vol. lxxv, 1892.

Senn.—'Ninth International Medical Congress,' 1887, and 'Intestinal Surgery,' 1889.

Wiggin.—'New York Medical Journal,' Dec., 1895.