

A new method of performing circular enterorrhaphy / by F.T. Paul.

Contributors

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Royal College of Surgeons of England

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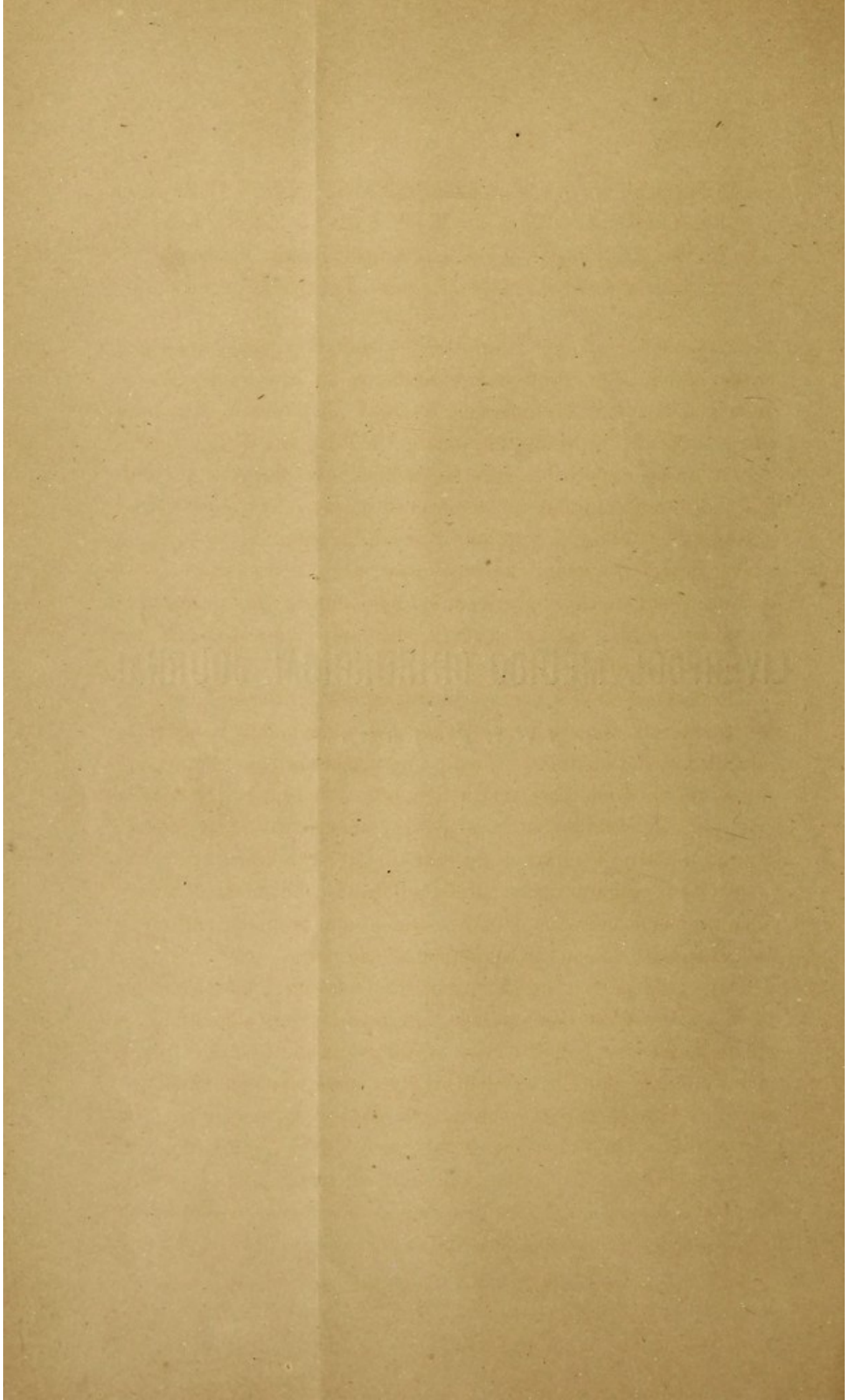
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A NEW METHOD OF PERFORMING CIRCULAR ENTERORRHAPHY.¹ By F. T. PAUL, F.R.C.S., *Surgeon to the Liverpool Royal Infirmary and Professor of Medical Jurisprudence, Victoria University.*

A YEAR and a half ago I applied for and obtained permission to try upon dogs some experiments as to the best plan of uniting a divided intestine end to end. The idea in my mind was to extend the principles involved in Professor Senn's operation of lateral apposition with decalcified bone-plates to a direct and continuous reunion of the severed bowel. That end-to-end is preferable to lateral reunion, if it can be obtained with equal safety, stands to common sense, and that Senn shares this opinion is sufficiently indicated by his offering an alternative operation of this nature, though decidedly more fatal in its immediate results.

The method that I desire to bring under notice is, I believe, less dangerous than either of Senn's, for it has not by itself been fatal in any dog operated upon. The operation is not suggested to replace the bone-plate method in any of those cases for which it is specially suitable, such as pyloric obstruction where lateral apposition is necessary, or in matting of the intestines with obstruction, when it is certainly advisable; but rather to replace previous methods of end-to-end union by invagination of the proximal into the distal portion of the bowel.

There can be no question that the bone-plate operation has proved a very marked success. It was evidently planned to meet the well-recognised causes of failure in stomach and bowel operations, the chief of which I take to have been (1) the time occupied, (2) the difficulty in securing safety from leakage, and (3) the laxity and mobility of the parts. Now, Senn's method shortens the time by about one-half, ensures such a perfect coaptation between the two portions of the bowel as almost to defy leakage; and during the continuance of the bone-plates the

¹ Read at Liverpool Medical Institution, April 9, 1891.

parts are kept supported and at rest as by a splint. Decalcified bone answers the purposes required of it in these respects remarkably well. Firm, elastic, and yet too soft to damage the bowel, maintaining its rigidity during the first day or two, then gradually dissolving and melting away. In my experiments I resolved that decalcified bone should be the supporting material, and have had every reason to be satisfied with it. I had a number of bone tubes made about 1 inch long and suitable for the calibre of dogs' intestine. These were prepared in accordance with Senn's directions. Altogether eleven experiments were made, of which the operation to be described was performed in eight consecutive cases.

Four were allowed to live for long periods, and four were killed at early dates; but none were injuriously affected by the operation.

Three dogs were operated upon with the object of elucidating points indirectly connected with the main subject. They all died in about thirty-six hours. In one the operation involved a partial resection of the coats of the intestine, which was followed by rapid sloughing and perforation. In another the mesentery was cut away from the colon for about 3 inches, and an enterorrhaphy done at the spot. The bowel became gangrenous, though all reasonable care had been taken to save the vessels as much as possible. This operation was done in view of the obstruction offered by the human meso-colon to invagination of that portion of bowel. In the third of these experiments the ileum was cut away from the cæcum and connected with the rectum, the isolated colon being closed by invagination at each end. Faecal matter contained in the colon was driven by peristaltic action to the lower end, when it formed a round ball which burst open the Lembert sutures and liberated the invagination. The sutures in the mucous membrane held but permitted the exudation of a little fluid from the intestine into the peritoneal cavity. This must have been rapidly fatal, for the dog was left well on the second night, and had been dead some hours when seen the next morning. The attachment of ileum to the rectum was going on quite satisfactorily.

I learnt from these three cases three facts of importance in operating on the human subject: *first*, that it would not be advisable to attempt any operation involving interference with the individual coats of the intestine; *second*, that while the mesentery might no doubt be safely separated to a slight extent from the bowel if nothing further was done, yet in conjunction with enterorrhaphy it would probably be fatal; and *thirdly*, that, if under unusual circumstances it became necessary to isolate a portion of the bowel, the lower end should be left open and attached to the wound.

I turn now to the eight experiments in which the operation I wish to recommend was performed. The first patient was a black-and-tan terrier. Under chloroform the abdomen was opened, and a piece of small intestine brought out. This was divided and the bleeding arrested. Next, a decalcified bone tube charged with chromic gut sutures in the middle of its length was inserted one-half into each end. The sutures were armed with sewing needles, by means of which the two ends of the bowel were at the same time sewn together and to the tube. The next thing to be done was to invaginate the bowel for about half an inch, which, though remarkably easy in the dead subject, proved quite the reverse in the living. However, with some roughness and much patience it was accomplished in the end, the parts being retained in position by three Lembert sutures. The bowel was then cleansed and returned, and the abdominal wound closed with chromic gut sutures. Considering the rough handling of the bowel, I fully expected some sloughing, and was agreeably surprised to find how well the dog appeared to be the next day. The diet was carefully restricted, only water and gradually increasing quantities of beef-tea being given during the first three days; on the fourth bread and milk was added, and all seemed to be going on remarkably well, when straining at stool caused the abdominal sutures to give way, and a piece of bowel escaped. Chloroform was administered, and though no great harm had been done, and the invaginated bowel appeared to be in perfect condition, it was judged right under the circumstances to kill the animal at once. At the

post-mortem examination the union at first sight appeared perfect, but closer inspection proved that the invagination had been incomplete on the mesenteric side of the bowel, and but for the attachment of the omentum there might have been some leakage. Also, it was seen that the distal end had been invaginated into the proximal instead of the reverse, a condition which would, I believe, by other methods have been almost necessarily fatal.

It was quite to be expected that in the first case, especially in the hands of a surgeon unaccustomed to operating upon small animals, things would not go perfectly smoothly. I could see three points required attention. *First*, the abdominal wound must be better sutured, and the subsequent substitution of silkworm for chromic gut removed that source of danger. *Second*, the bowel must be more carefully invaginated, special attention being paid to the mesenteric border. This, too, was satisfactorily accomplished in future cases. And *thirdly*, the actual process of invagination must be made more certain and easy, or the operation on the present lines would be extremely likely to break down from simple inability to accomplish the fundamental step.

Believing that experience would suggest some better method if the difficulty on further trial proved as serious, I shortly repeated the operation on a black rough-haired puppy. Invagination was again only accomplished with the same force and patient persistence. It seemed that the more one tried to push the proximal end of the bowel with the tube into the distal end, the more the latter contracted and resisted. Once, however, start the invagination, and it could be increased to any extent. Though the operation had been very severe, the puppy rallied well, and was soon quite lively. The same night only water was given him. The next day, one ounce of beef-tea; second day, two ounces of milk; third, four ounces of milk and one of beef-tea; bread and milk on the sixth day, meat on the eighth; on the eleventh, turned out of the laboratory, and put in charge of the porter.

In about a month's time the puppy had grown double its

previous size, and was fat and well, as it had been all along. It was therefore killed, and a *post-mortem* made. Externally the slight scar round the bowel was easily detected, especially as there was a little dilatation of the part just above it. Internally the calibre of the bowel appeared to be lessened by about one-half, owing to a ring or diaphragm of soft mucous membrane at the site of the invagination. In subsequent cases it was observed that this diaphragm tended to disappear, and, considering the nature of the operation, it could hardly be expected that the redundance of tissue constituting the invagination could atrophy in four weeks.

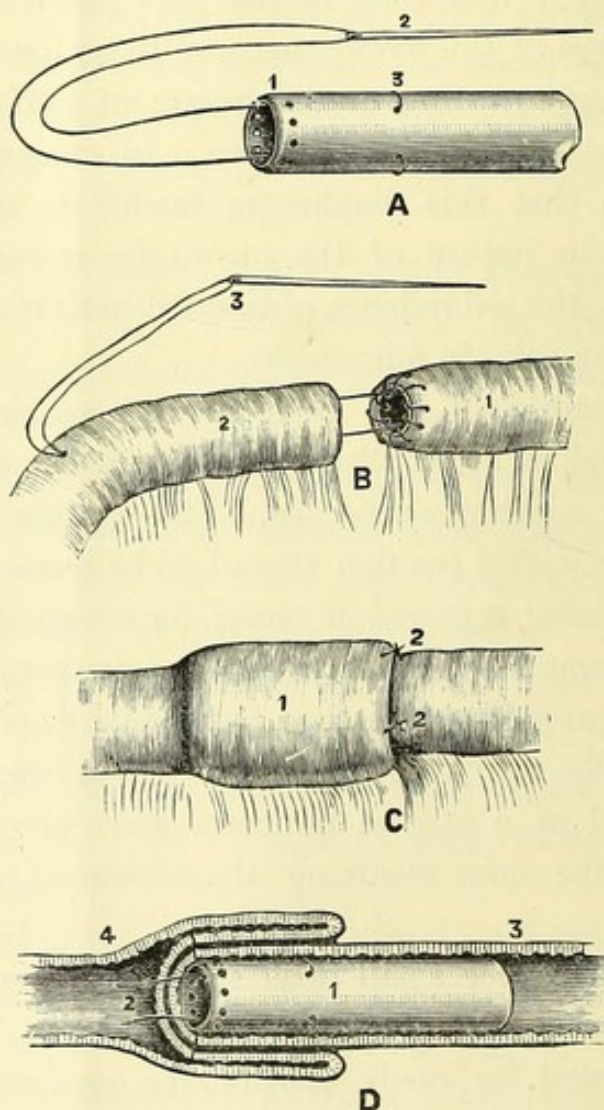
In the meantime I had been at work seeking for a more certain method of accomplishing the operation, and at last, by a very simple addition, succeeded. This consisted in supplying the bone tube with a traction thread to be passed through the wall of the distal segment of bowel, for an assistant to pull on whilst the operator manipulates the invagination. I had found the chromic gut sutures attached to the middle of the tube and their six needles very inconvenient, owing to their tendency to get entangled at a critical moment, and therefore discarded them, the tube now assuming the character shown in the engraving.

The tube itself, for small dogs, should be about 1 inch long by $\frac{3}{8}$ inch outside diameter, and $\frac{1}{16}$ inch thick. The lower end (1) is perforated for easily sewing the proximal end of the bowel to it, and the traction thread with its needle (2) is fixed well back in the tube (3), to make certain that it cannot break away. For the human bowel, I have had made¹ tubes $1\frac{1}{2}$ inch long, with diameters ranging from $\frac{1}{2}$ to $\frac{3}{4}$ inch, and $\frac{1}{8}$ inch in thickness.

The operation is now performed in the following manner:—The bowel being ready to receive the tube, its full length is introduced into the proximal end, the cut margin of which is sewn to the tube through the perforations with a fine continuous chromic gut suture (B). For this purpose a sewing-needle is used, which in passing is made to dip more deeply

¹ By Mr Reynolds, 9 Rodney Street, Liverpool.

into the mucous than the peritoneal coat. It is not sufficient to take the muscular and mucous coats only, as the attachment to the tube is not then sufficiently secure. When sewing the



- A, the decalcified bone tube. 1, the lower or distal end perforated for sewing to the bowel; 2, the traction thread armed with long sewing needle; 3, its attachment to the tube.
- B, a stage in the operation. 1, the proximal end of the bowel with the tube sewn in; 2, the distal end not yet sewn to the proximal end, but with the traction thread 3 passed.
- C, the operation completed. 1, the sheath or intussusciens of the invagination; 2, the Lembert sutures for retaining the parts in position.
- D, the parts dissected. 1, the tube in situ; 2, the traction thread cut short; 3, the proximal end of bowel entering the intussusception; 4, the distal end supplying the returning and ensheathing layers.

mesenteric border of the bowel to the tube, care should be taken to pick up the severed edges of the mesentery with the point of the needle, as this is the part most likely to give way,

and the mesentery should not be allowed to drag in the least degree from the cut edge of the bowel. Next, the needle of the traction thread is slipped along a director, about 3 inches down the distal segment of the bowel, and pushed through its wall. Then the distal is sewn to the proximal end by a chromic gut suture all round, the needle piercing the musculo-serous coats only. Again, great care is taken to fix the mesenteric edge securely, and, with the same thread, the opening in the mesentery is drawn together. Now an assistant takes the traction-threads and steadily resists the operator as he draws the distal end of the bowel back over the tube, thus invaginating the proximal end and producing the appearance seen in figure C. The parts are retained in position by a few Lembert sutures, one on either side of the mesentery, and others as they appear necessary. Lastly, the traction-thread is pulled tight and cut off short, the small opening caused by it requiring no further attention. The operation is completed by cleansing the intestine and closing the abdomen in the usual way. The special part of the operation may be said to involve three stages: *first*, to introduce the bone tube into the upper or proximal end of the bowel, and sew it there; *second*, to pass the traction-thread and attach the distal and proximal ends together; *third*, to produce the invagination, retain it in position by a few Lembert sutures, and cut off the traction-thread. With no unusual difficulty, each stage ought only to occupy a few minutes. I operated in this way upon six more dogs, and they all did remarkably well. Three I killed, at short intervals after the operation, to examine the condition of the bone tubes and the stages of repair. They were in excellent health at the time of being killed, it having been arranged beforehand how long each dog was to live after the operation. This was carried out in all but one, which should have been killed on the third instead of the fourth day.

These dogs were allowed more food than the first two, bread and milk being given the day after operation. Nearly all passed a motion daily, showing that the tube offered little or no obstruction to the passage of food. They were not tied up,

but left loose in the laboratory, jumping and playing about appearing to do them no harm. Indeed, there was nothing in their manner to indicate that they had been submitted to an operation. Those killed were destroyed at the end of twelve hours, two days, and four days respectively. At the end of the twelve hours, I found the parts much as I left them, except that the irregularities were smoothed over with lymph and the peritoneal surfaces of the invaginations were adherent. The bone tube had practically undergone no change. From the dogs that died in the experiments previously referred to, I learnt that the tube was present at thirty-six hours, but much softened. At forty-eight hours it is quite soft, and probably collapsed; but the union strong. After this the tube disappears, and at first the lumen of the bowel partly closes with swollen mucous membrane; but it gradually enlarges again as the swelling goes down and the excess of tissue caused by the invagination atrophies.

Of the dogs that lived some time, one was killed at the end of two months in perfect health. There was still a slight, thin diaphragm at the site of operation, but offering much less impediment, if any now, to the passage of the intestinal contents. One is still living in Manchester, the domestic pet of a friend of the porter, and is reported in its usual health just twelve months after the operation. The other is also living, and very fat and hearty, three months after the operation.¹

I was particularly struck in all these latter cases with the, to me, extraordinary absence of any sign of pain or illness after the operation. I attribute it to the absolute security from leakage, owing to the firm and close approximation of the parts by this method of operating. It is not altogether due to the

¹ This dog was shown at the meeting, when it was suggested by the President, Mr Mitchell Banks, that the Society should have an opportunity of inspecting the condition of the bowel at its next meeting. Accordingly, on April 23, the animal having been killed, Dr Ross opened it, in the presence of the Members, and examined the bowel. The site of operation was indicated by a circular scar, about $\frac{1}{16}$ inch broad, and quite soft. There was no trace of roughness or adhesion to omentum or other parts, and there was no obstruction whatever, the bowel above having exactly the same diameter as below, and the calibre at the site of the scar being the same as elsewhere.

nature of the dog as compared with man, for, in the faulty operations, the dogs, in my opinion, failed more quickly and completely than a man would have done under the same circumstances. Like children, they recover rapidly; but stand shock badly, and collapse at once if anything goes wrong.

In conclusion, I wish to point out that, should any surgeon think sufficiently well of this operation to make use of it in the human subject, it should, in the first place, be limited to quite suitable cases, in which it is necessary to divide or excise a portion of small intestine. I have had only the opportunity of trying it in a case of malignant stricture of the colon, in which, owing to the shortness and inflexibility (due to fat) of the mesentery, a satisfactory invagination could not be produced, another plan having to be substituted in its place. I think this would often be the case with human colon. Sometimes, in spare subjects and children, especially in the region of the sigmoid flexure, it could easily be accomplished; but in sigmoid colotomy I have found difficulty in simply invaginating the lower end of the bowel when the mesentery was short and fat, though this form of invagination is the easiest one could have to do. That the mesentery is the source of difficulty I believe there can be no doubt. It was on this account that the experiment of cutting away the dog's meso-colon was made, with the discouraging result of gangrene of the bowel. It seems to me that injury of the small intestine, whether direct or the result of internal or external strangulation, or any disease requiring excision of a portion, will form the class of cases most suitable for a trial. In such it will be at least no longer than Senn's operation, and decidedly more secure than either his invagination or bone-plate process. When properly done leakage is impossible for about thirty-six hours in the dog, and, I should say, for at least double that time in man, as the tubes can be made much thicker and digestion is less vigorous. Another advantage of this method is that, so long as the tube is sound liquid food may be given with impunity. During the first two days, the most important time of all, there is no occasion to withhold nourishment. On the third or fourth day the

tube will probably be collapsing and the lumen of the bowel partly blocked. It would, therefore, be wise to somewhat restrict the diet at this time, but not to limit it, as has been too much the practice, to a little water and meat extract, for good, sound, rapid healing cannot take place in a starving body. The success or failure of the operation will not, however, rest upon minor details of treatment, but upon the broad lines of the facility or otherwise with which it can be put into practice, and the nature of the union affected by it. I am now only awaiting a suitable case of the kind indicated to put this operation into practice and report on the result.

Table of Invagination Experiments.

Animal.	Operation.	Result.
1. Black - and - tan terrier.	Invagination of small bowel on tube without traction thread.	Killed fourth day, on account of rupture of abdominal wound. Bowel invaginated wrong way, but well united, except one spot on mesenteric side covered by omentum.
2. Rough-haired black puppy.	Do.	Killed one month. Grown double size. Calibre of bowel at site of operation lessened by circular fold of mucous membrane.
3. Scotch terrier.	Invagination with tube and traction thread.	Killed two months. Perfect health. Still partial diaphragm at site of operation, but offering no obstruction to fæces.
4. Young brown terrier.	Do.	Killed three months. Grown, and in vigorous health. Union perfect. No obstruction whatever.
5. Fox terrier.	Do.	Still living twelve months after operation, and in usual health.
6. Small fox terrier.	Do.	Killed twelve hours. Tube unchanged. Invagination adherent by recent lymph.
7. Fox terrier.	Do.	Killed forty-eight hours. Doing very well. Bowel firmly united. Tube soft and collapsed.
8. Fox terrier.	Do.	Killed fourth day. Tube gone. Bowel well united. Lumen much closed by folds of recent invagination. (This dog was to have been killed on third day).

Table of other Experiments.

Animal.	Operation.	Result.
1. Large rough-haired terrier.	Tube operation with resection of coats of bowel.	Sloughing, and death in about thirty-six hours.
2. Fox terrier.	Colon separated from mesentery for about 3 inches, and enterorrhaphy done at the spot.	Gangrene of bowel, and death in about thirty-six hours.
3. Fox terrier.	Implantation of ileum in rectum. Invagination of each end of isolated colon.	Lower end of colon partly opened up. Extravasation. Collapse and death in about thirty hours.

Date	Place	Remarks
1891. 1. 1.	London	Arrived at 10.30. Found Mr. ...
1891. 1. 2.	London	Visited the ...
1891. 1. 3.	London	Visited the ...