

Experience with Intestinal Plication and a Proposed Modification *

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Intestinal Plication

RECURRENT intestinal obstruction due to adhesions has long presented a difficult problem in abdominal surgery. In cases where infection or abraded peritoneum are present in the abdominal cavity, fibrous bands are formed which tend to cause intestinal obstruction. Re-operation often leaves further areas of abraded bowel, and an unhappy sequence of events familiar to every surgeon ensues.

Numerous attempts have been made to discover a substance which would prevent the formation of adhesions. These have met with minimal success. In 1937, Noble³ described an original operation for plicating loops of bowel in cases where adhesions were inevitable, so that they would form in a controlled rather than an uncontrolled manner. His original technic was to suture the involved leaves of mesentery with a continuous catgut suture, beginning at the root of the mesentery. The suture continued up the mesentery to the bowel wall, was locked, and then continued along the walls of the adjacent loops of small bowel. He plicated all of the involved small bowel in separate "wings," approximately eight inches in length. This technic is illustrated in Figure 1, taken from an article by Poth, Lewis, and Wolma.⁸ Noble emphasized the importance of freeing all of the adhesions prior to plication, and plicating all the involved

bowel. Noble⁴⁻⁷ published further experience with the procedure in 1939, 1942, 1943, and 1945. In these articles he broadened the indications for the procedure, but did not change the basic technic.

Lord² was one of the early advocates of the procedure. He reported several cases in 1949. He emphasized that sutures should be interrupted and of nonabsorbable material.

Another author who reported favorably on intestinal plication was Seabrook,⁹ who reported several cases in 1949. By 1954, Seabrook and Wilson¹⁰ had collected considerable experience with the procedure, and reported 54 cases. This article made two important contributions. The first was to report that "fiddle string" adhesions may form where sutured loops pull apart, if interrupted sutures are used. This is illustrated in Figure 2C. They also emphasized that the suture line should be placed half way between the mesenteric and anti-mesenteric borders of the bowel wall. If the bowel is sutured at the mesenteric border, loops may fall over and become acutely kinked at the mesenteric border. This is illustrated in Figure 3. If the bowel is sutured at the anti-mesenteric border, and distention occurs, the previously described "fiddle string" adhesions may form where distention exerts force on the suture line. These fiddle string adhesions may actually pull out pieces of bowel wall.

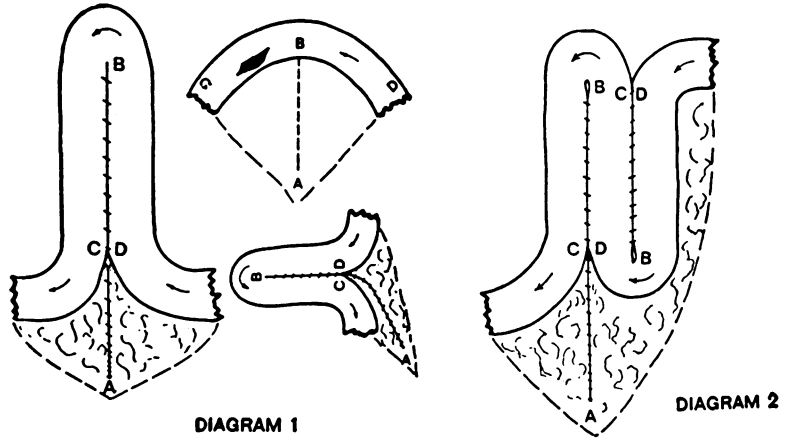
Other authors who have reported favorably on this procedure have been Poth, Lewis and Wolma in 1953,⁸ Robert Smith in 1951,¹² Gordon Smith¹¹ in 1955, and Foster and Childs in 1950.¹

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FIG. 1. The original plication technic as described by Nobel. From Poth, Lewis and Wolma, *Am. Surgeon*, 19:24, 1953.



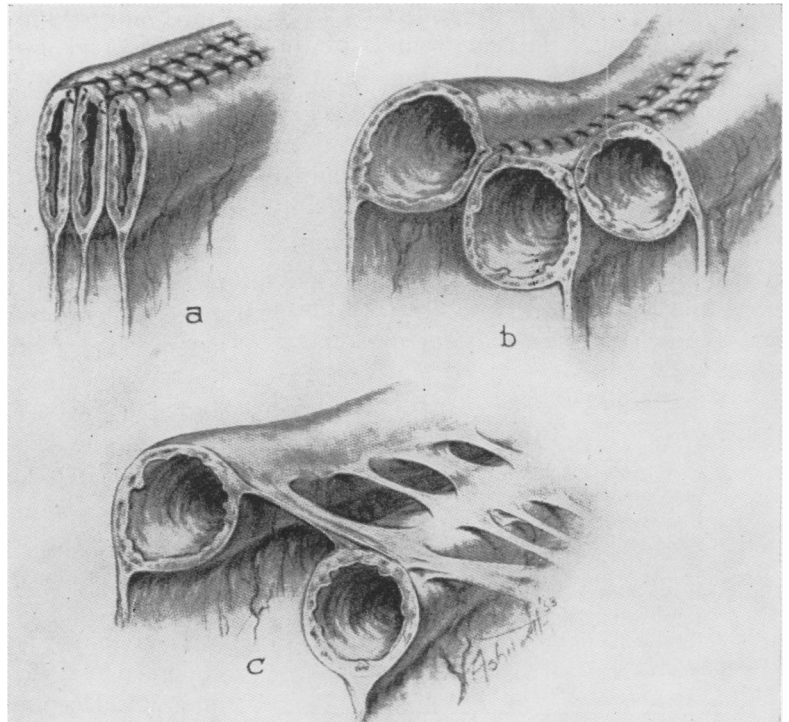
Materials and Methods

Our experience with intestinal plication began in 1949. The first case was that of a man who had had chronic intestinal obstruction, and after lysis of adhesions had a badly abraded bowel in numerous skip areas. He was plicated as a matter of desperation. When he did quite well, we were encouraged to use the procedure in other cases. By 1955, we had accumulated a series of fifteen patients with total plica-

tion of the small intestine. We have excluded from our series many cases of partial plication because of the various factors involved in an accurate analysis. Our 15 cases have now been followed for a period varying from four to ten years.

The technic used in these 15 cases varies little from that originally described by Noble, except that in many instances a continuous silk suture was used instead of catgut. In several cases the sutures were placed

FIG. 2. From Seabrook and Wilson, *Am. J. Surg.*, 88:186, 1954. It illustrates the technic of suturing at the antimesenteric border. C. shows the "fiddle string" adhesions which may occur as the bowel distends when sutures are placed in this area.



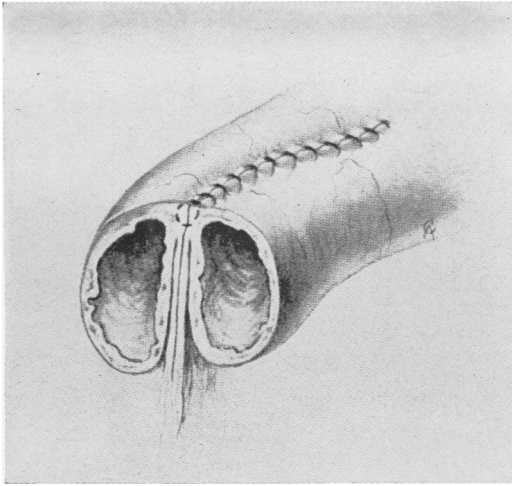


FIG. 3. From Seabrook and Wilson, *Am. J. Surg.*, 88:186, 1954. This illustrates the manner in which loops of bowel may fall over and become entrapped between adjacent loops if the sutures are placed at the mesenteric border.

at the mesenteric border. We have not tried to correlate these minor variations in technique with the results in our patients because the number of patients in each group would not be sufficiently significant. The original injury or operation which initiated the series of events leading to plication is listed in Table 1. As might be expected in a Veterans Hospital, missile wounds of the abdomen led the list. Operation for carcinoma of the colon was also a common offender in our series. In most cases there was some factor in the history of the initial injury or operation leading to massive contamination of the peritoneum. For example, the ruptured urinary bladder actually ruptured into the peritoneal cavity. The number of previous operations for obstruction

TABLE 1. *Initial Injury or Operation*

Missile wounds of abdomen	4
Carcinoma of colon	3
Stab wounds of abdomen	2
Cholecystectomy	1
Chocystojejunostomy	1
Diverticulitis	1
Nephrectomy	1
Ruptured appendix	1
Ruptured urinary bladder	1
	—
	15

is shown in Table 2. A total of 32 operations had been performed on these 15 patients, exclusive of their original injury or operation.

Results

There were no operative deaths from plication. Four patients died from carcinoma at periods varying from six months to three years following plication. None of these patients had symptoms of obstruction prior to his death. One patient was lost to follow up shortly after his operation. Another was lost to follow up three years after plication, but when last heard from, he was symptom free and working in the oil fields.

Two patients have required re-operation for obstruction. The first of these was a 23-year-old white man whose initial injury was a gunshot wound of the abdomen in Korea in 1951. He had splenectomy and partial small bowel resection at that time. He underwent lysis of adhesions and total plication on April 13, 1953. Following this operation he was admitted several times to the Grand Junction V.A. Hospital with intermittent intestinal obstruction which subsided on gastro-intestinal suction. He finally developed a complete intestinal obstruction on December 15, 1953. He was reoperated upon at the Grand Junction V.A. Hospital. At that time the surgeon reported that there were numerous fistulae between loops of small bowel. At least one of these had perforated spontaneously, with contamination of the peritoneal cavity. He was again plicated using interrupted cotton sutures in the mesentery at the mesenteric border of the bowel. A recent follow up revealed that he has gained weight, is working, and has had only two bouts of abdominal pain which have responded to antacids. He has had no symptoms suggestive of recurrent obstruction.

The second patient requiring re-operation was a 40-year-old white man whose original injury was a stab wound of the abdomen in 1953. He entered the Albuquerque V.A. Hospital with intestinal obstruc-

tion from adhesive bands, and was plicated on May 5, 1955. He was readmitted with abdominal pain in 1957, but had no evidence of obstruction by x-ray. On December 1, 1958, he developed complete intestinal obstruction and was again operated upon. Many sutures from the previous plication had pulled loose, and adhesions had formed in an uncontrolled manner. A plication was done using a new technique of the authors. This will be described later in this paper. This patient has maintained his weight since replication and has had no further evidence of obstruction.

Nine of our patients are still available for follow up, including the last two discussed. Seven of these patients state that they have had some form of abdominal pain since their operation. Four have had pain requiring hospitalization, including the two patients who were re-operated upon. Seven are working, and the two who are not working have some other illness which accounts for their inability to work. Five have gained weight. None reports excessive weight loss. All nine state that operation has relieved them of the major portion of their abdominal complaints. The follow up on these patients is summarized in Table 3.

Our experience with intestinal plication shows that it definitely has a place in the management of chronic or recurrent intestinal obstruction due to massive adhesions. The fact that these 15 patients had had a total of 32 operations for obstruction prior to their plication, and only two operations collectively since their plication, lends objective support to our conclusion. These patients almost universally complain of a minor, crampy abdominal pain on occasion. This is indeed a small price to pay for freedom from repeated abdominal operations.

In spite of the fact that this has proved to be a valuable operation, we have found three major disadvantages to the procedure as it is now commonly employed. The first is the occurrence of fistulae between plicated loops of small bowel. This is illustrated in our series by the first patient dis-

TABLE 2. *Operations for Obstruction Since Initial Procedure*

One operation	4 patients
Two operations	6 patients
Three operations	4 patients
Four operations	1 patient
	—
	15 patients

cussed. It is mentioned by almost every author who writes about plication. The danger to the fistula formation occurs if obstruction develops. As the small bowel distends the fistulae may be torn apart, with spillage of intestinal content into the peritoneum. The second disadvantage is the length of time necessary to suture the entire length of small bowel and its mesentery. This type of patient is often not in ideal condition for surgery, and time may be a lifesaving factor. The third disadvantage is the minor, crampy type of abdominal pain which is so common in these patients following their surgery.

Experimental: For several years the senior author had attempted to devise an operation which would help overcome these disadvantages. The most likely way to avoid fistula formation would seem to be some way which would avoid the actual placing of sutures in the bowel wall, i.e. a mesenteric type of plication. To overcome the time factor, it seemed advisable to devise some method using a suture which could plicate more than one loop of small bowel at a time. A technic was finally developed using a long needle similar to

TABLE 3. *Results of Follow-up on Original Plication Procedure*

	Yes	No
Any abdominal pain since operation	7	2
Pain requiring the services of a doctor	6	3
Pain requiring hospitalization	4	5
Working steadily	7	2
Lost weight since operation	3	6
Surgery has relieved the major portion of symptoms	9	0

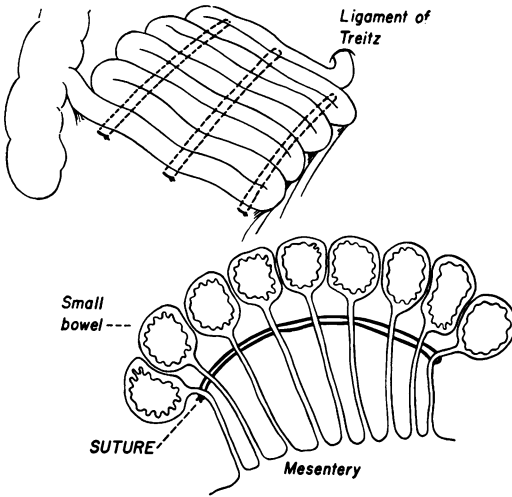


FIG. 4. An artist's conception of the modified plication procedure. It can be seen from the top drawing that if the sutures are placed near the bowel wall very little of the blood supply to the small bowel is actually occluded. The bottom illustration is a cross sectional view of the completed suture.

a knitting needle* and a heavy black silk suture. The adhesions are freed from the entire small bowel as originally described by Noble. The mobilized bowel is then arranged in loops approximately eight inches in length. The long needle bearing the No. 2 black silk is then threaded through the mesentery of each loop of bowel at a point about three mm. from the bowel wall. After passing through the mesentery of each loop, the suture is then reversed and threaded back through each leaf of mesentery to a point about three cm. from its starting point. It is tied loosely to avoid any possibility of strangulation, although this has not seemed to be a problem. In general three of these sutures are used. One is placed at either end of the loops of bowel and at least one in the middle. The total time necessary to plicate the entire small bowel using this technic should be about ten minutes. This is in contrast to as much as an hour or more using the standard methods. Figures 4 and 5 are artists' drawings of the procedure. Note that by placing the

sutures in the mesentery close to the bowel wall, the sutures include only a proportionately small amount of the blood supply to the small intestines. As an additional safeguard, the sutures are tied loosely so that the vessels are not actually occluded. Figure 6 is a photograph of the technic as used on an experimental animal. Figure 7 is a photograph taken during an operation on a patient.

In order to determine the safety and effectiveness of this operation a series of animal experiments was done on young hogs. These animals were operated upon in our animal laboratory, their courses observed, and their weights recorded. When it was determined that they were doing well they were boarded at a farm until their death or sacrifice. A total of 11 pigs was successfully operated upon. These animals all did well in our laboratory and had a normal weight gain. One animal died during the course of his stay at the farm. At autopsy, death was found to be due to a tootpick perforation of the small bowel. The perforation, however, was not in relation to any acute angulation of the bowel from the plication. The remaining pigs continued to gain weight normally and were sacrificed at approximately six months following operation. In four of the earlier pigs operated upon, several of the end loops had escaped the

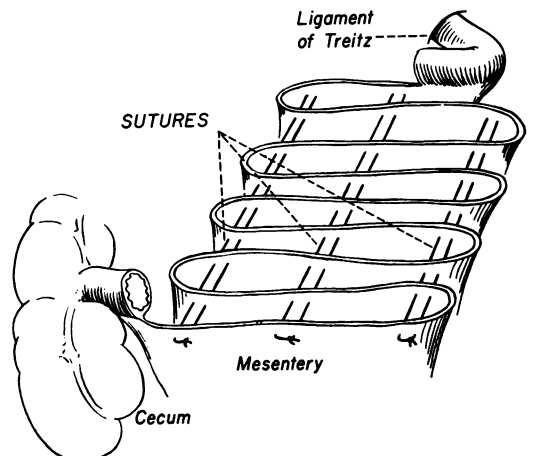


FIG. 5. Another artist's conception showing the completed sutures through the mesentery.

* The needle may be obtained from V. Mueller and Co., Chicago, Ill.



FIG. 6. This was taken during an operation on a pig showing the partly completed suture.

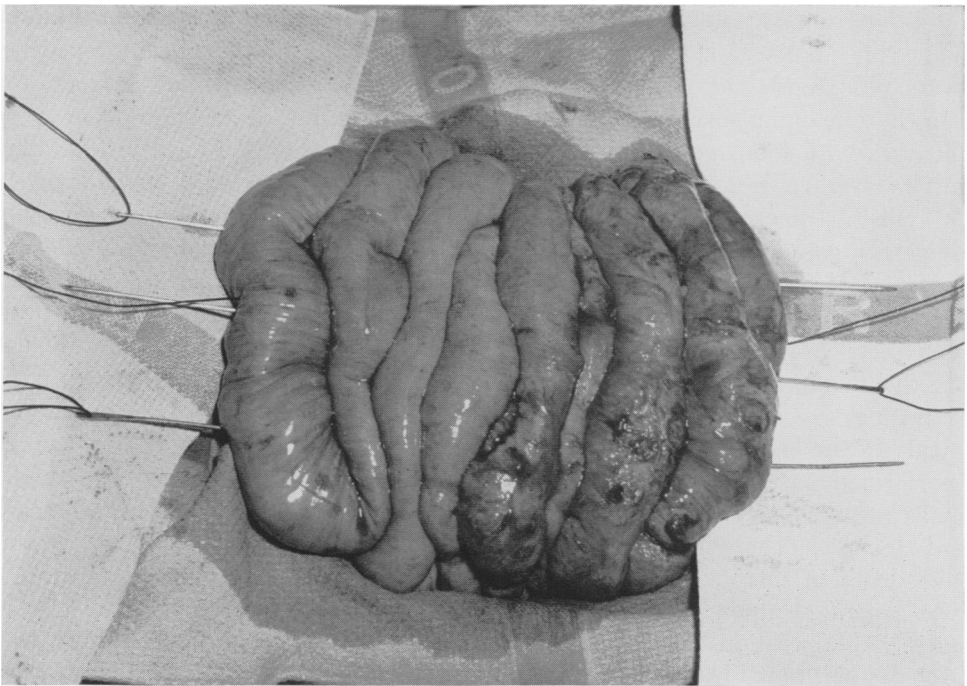


FIG. 7. A photograph taken 4/16/57 after modified plication operation on a patient with obstruction due to adhesions. The two side needles are placed first and the central suture is placed after the side sutures have been tied.

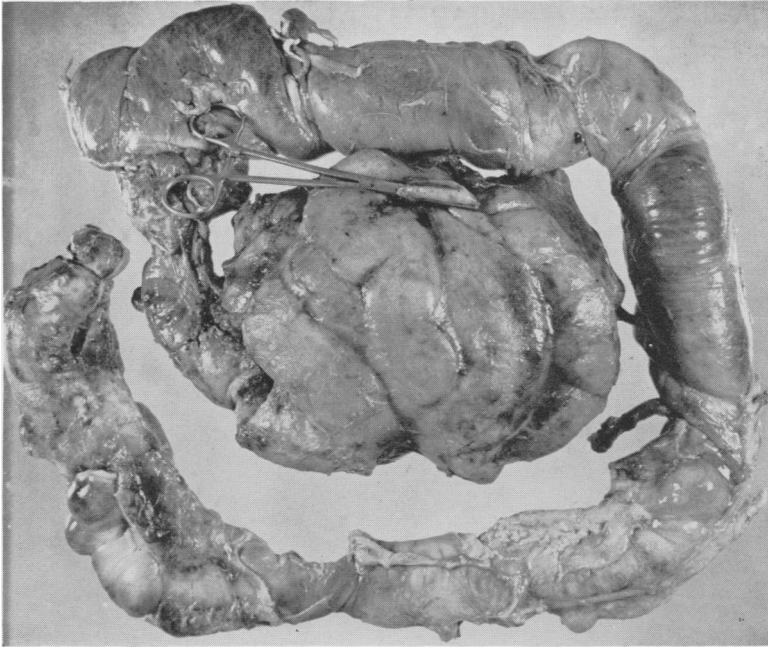


FIG. 8. A photograph taken of a plicated small intestine removed at autopsy.

plicating suture. No ill effect seemed to result from this. Escape of loops was apparently related to the fact that early in the experiment we were using very small pigs. These pigs have a gossamer-thin mesentery. Following this observation, the later pigs used were older and had heavier mesenteries. In the remaining seven pigs, we had no difficulties with loops escaping the plication. The average weight gain was 120 pounds, which corresponded to the expected weight gain of a normal pig in a similar period of time.

As a result of our animal experiments, we were convinced that this would be a safe and effective means of plicating the human small intestine.

Clinical: In the last eighteen months we have performed seven total plications of the small intestine in patients, using this modified technic. There was one postoperative death in this group in a patient who was operated upon for generalized peritonitis. At operation, no cause was found for the peritonitis but sections of the tissues showed massive involvement with lymphosarcoma. Death occurred on the

twenty-sixth postoperative day from the primary condition, with massive gastrointestinal hemorrhage. At autopsy, the plication was intact, and there was no evidence of intestinal obstruction. Figure 8 is a photograph of the plicated specimen at autopsy. A second patient, who was operated upon for obstruction from a pelvic abscess, developed a fecal fistula following operation. This closed spontaneously in three months, and was presumed to be due to an anastomotic leak from one of the several anastomoses. There were no other complications, and the patients have all done well to date. Our past experience has shown us that a longer follow up is necessary to properly evaluate this operation, but these patients have had fewer complaints than those done by the older method. The small, crampy pain after eating has been much less prominent.

Summary and Conclusions

The history of intestinal plication has been reviewed. A study of 15 patients with total plication of the small intestine using standard technics has been made. While

intestinal plication of the Noble type appears to be an effective tool in the treatment of chronic or recurrent intestinal obstruction, three disadvantages have become apparent in the technic as it is now commonly employed. The first of these is fistula formation between plicated loops of small bowel. These fistulae may perforate if the bowel becomes distended. The second is the length of time it takes to plicate the entire small intestine in a group of patients in whom time is often an important factor. The third is the frequent occurrence of an annoying type of crampy abdominal pain, without evidence of obstruction. A modified operation, in which the mesentery is rapidly plicated, has been proposed to overcome these disadvantages. The results of this operation in a series of experimental animals have been reported. Seven patients have now been operated upon using this new technic. The results so far have been encouraging, although a long term follow up of these patients will be necessary for final evaluation. This operation, of course, is done only for massive adhesions.

In summary, our approach to a patient with intestinal obstruction is to first correct any electrolyte or fluid deficiencies. Then, at operation, an attempt is made to free the adhesions from the entire length of small intestine. When this is accomplished the extent of the abraded peritoneum is assessed. If the area involved is limited to one localized segment that can be easily resected, this is considered the procedure of choice. Multiple resections can be done if the disease process is well localized to several segments. If the abraded area is extensive, so that it is not feasible to resect all of the disease, the patient is then considered a candidate for plication. If the bowel is freed of adhesions distally from the ligament of Treitz, and proximally from the ileocecal valve until a large, matted area of bowel remains, it may be practical to resect this portion without taking the

time to free all of the adhesions. The remaining bowel can then be plicated.

We do not consider intestinal plication the answer to all cases of intestinal obstruction due to adhesions, but in our hands it has been a valuable tool for the desperate case of truly massive adhesive disease.

Acknowledgment

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