

Anastomosis with EEA Stapler After Anterior Colonic Resection*

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The end-to-end anastomosis by stapling for left colonic and rectal resections is proving to be a relatively safe and fast procedure. Results of a survey of the American Society of Colon and Rectal Surgeons reveals 15.1 per cent intraoperative complications, 3.7 per cent early postoperative complications, 0.5 per cent deaths, and 13.8 per cent late complications. The majority of late complications, stenosis and incontinence, were either subclinical or transient for most patients. Technique and prevention of complications are stressed. [Key words: Anastomosis, left colon, end-to-end, stapled; Complications, colon surgery; Surgery, colon]

Even though staples have been used for bowel anastomoses in the United States for a decade, an end-to-end anastomosis (EEA) stapler was not available for general use until 1978. An EEA stapler has been in use in Russia for more than a decade, but it was not introduced to this country until the early 1970s by Dr. S. N. Fain.¹ Using the Russian model EEA in 62 patients, Goligher recently reported a lower leak rate than in handsewn anastomoses.² Furthermore, he suggested that six low anastomoses performed with the EEA could not have been handsewn. The Russian model 249 EEA stapler employs a single layer circle of staples. Currently, the United States Surgical Corporation (USSC) markets an EEA that creates an inverted, two-layer circular anastomosis (Fig. 1).

A poll of the American Society of Colon and Rectal Surgeons has been taken to evaluate experiences with the EEA stapler. Data from the Society are presented below. In addition, technical details in the use of the EEA and a discussion of prevention of complications is presented, based on the use of the EEA at the Uniformed Services University of the Health Sciences (USUHS) in 50 patients and collective comments for Society members.

The opinions and assertions contained herein are the private ones of the author and are not to be construed as official or reflecting the views of the Department of Defense.

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Method

Members of the American Society of Colon and Rectal Surgeons were polled by mail. Four hundred twenty-five (50 per cent) responded to the questionnaire. The questionnaire addressed morbidity, mortality, and economy of time. In addition, comments were solicited regarding technical details in its use and the prevention of complications.

Results

Two hundred forty-three surgeons utilized the EEA stapler 3,594 times. Intraoperative complications were encountered in 543 (15.1 per cent) cases; these are summarized in Table 1. Anastomotic leak was the most common intraoperative complication. It was reported in 352 (9.8 per cent) patients and accounted for 65 per cent of all intraoperative complications. Complications associated with extraction of the instrument were second most common. Sixty-eight tears occurred during extraction and the anvil could not be withdrawn in 43. Together these represented 20 per cent of the intraoperative complications.

Postoperative complications were reported in 134 (3.8 per cent) patients. These are summarized in Table 2. Pelvic abscesses were reported in 90 (2.5 per cent) and pelvic hematomas in 27 (0.8 per cent). Information regarding management of the pelvic abscesses and hematomas is not available. The mortality rate in the collected series was 0.5 per cent. Sepsis accounted for nearly half of the deaths; other causes included myocardial infarction, pulmonary embolus, aortic occlusion, and mesenteric venous thrombosis.

Late complications were reported in 496 (13.9 per cent); these are summarized in Table 3. Stenosis was reported in 315 (8.8 per cent) patients; however, only

14 required operative correction. Incontinence was encountered in 124 (3.5 per cent) patients; only five patients were incontinent of stool. Nearly all cases of incontinence were transient, and none required surgical correction. Anastomotic recurrence of tumor was reported in 54 (1.5 per cent); this number is likely to be higher with longer follow-up. Rectovaginal fistulas were noted in three patients; it is not clear in these whether the primary resection included removal of a portion of the vagina.

One hundred thirty-two surgeons (65 per cent) reported 15–60 minutes were saved per case. Fifty-two (26 per cent) found stapled and handsewn anastomosis times were identical, and only 18 (9 per cent) found stapling to require more time.

Discussion

There are many difficulties with data generated from questionnaires. For example, the levels of resection were not defined, yet certainly influence the morbidity, if not the mortality rates. However, since large series reporting experience with the EEA stapler are not available, the data presented in this paper outline some basic problems. Technical details to avoid some of these problems will be enumerated below.

Preparation: Passage of the EEA stapler through the rectum is a potential source for contamination. The colon must be entirely clean: both mechanical and antibiotic preparation are essential. The 90 pelvic abscesses and eight septic deaths testify to the importance of adequate preparation of the colon. The preoperative preparation of the patient at USUHS includes a combination of purgatives, enemas, and oral antibiotics as described by Nichols *et al.*³

At operation the patient is placed in the lithotomy position with the buttocks extending well over the end of the table to facilitate sigmoidoscopy and manipulation of the stapler handle (Fig. 2A and 2D). Sigmoidoscopy is performed early in the operation to verify adequate preparation of the colon. Often a pool of liquid stool is present; this can be removed with suction. In addition, after clamping the proximal colon, a providone iodine cleansing solution is instilled through the sigmoidoscope and removed by suction (Fig. 2B). This is repeated until the colon is cleaned of all visible fluid. Prior to opening the colon, the pelvis should be isolated with laparotomy sponges to protect exposed tissue from soilage.

Surgeon instrument check: Prior to the procedure, the anvil and cartridge should be inspected to ascertain that all parts are present. Specifically, each staple, the knife, and the teflon ring, which serves as a “cut-

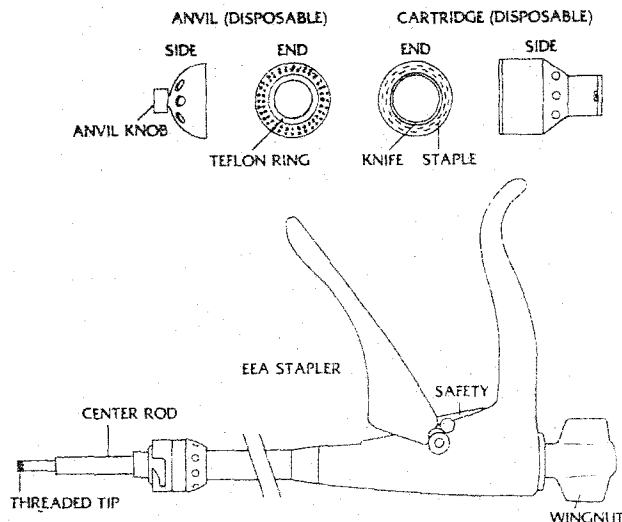


FIGURE 1. STAPLER, ANVIL, AND CARTRIDGE

ting board,” should be examined. Staples are difficult to see; thus some surgeons include a magnifying glass in their instrument set to facilitate the inspection. An incomplete instrument contributes to leaks and failures of the anastomosis as well as problems associated with extraction of the instrument after completion of the anastomosis.

A spur or barb of metal may form on the tip of the stapler center rod after repeated uses. In order to mount the cartridge in proper position on the center rod, it must be pushed with some force. The pusher rod in the cartridge which drives the knife and staples can be hung on a metal spur causing inadvertent firing. Since the staples are made of fine wire, the loss might not be noted. Thus if metal spurs are found on the center rod, they should be filed.

TABLE 1. Intraoperative Complications in 3,594 Stapled Anastomoses

	Number of Cases	Per Cent
Anastomotic leak	352	9.8
Tear during extraction	68	1.9
Anvil not extractable	43	1.2
Complete anastomotic failure (Conversion to another technique)	33	0.9
Instrument failure	28	0.8
Knife absent	25	
Teflon ring absent	2	
Staples absent	1	
Bleeding	19	0.5
TOTAL	543	15.1

TABLE 2. *Early Postoperative Complications after 3,594 Stapled Anastomoses*

	Number of Cases	Per Cent
Pelvic abscess	90	2.5
Hematoma	27	0.8
Deaths	17	0.5
Sepsis	8	
Myocardial infarction	4	
Pulmonary embolus	2	
Aortic thrombosis	1	
Mesenteric venous thrombosis	1	
Pulmonary failure	1	
	134	3.8

Manipulation of the instrument by inexperienced operating room personnel without the stapler safety being locked (Fig. 1) may also result in inadvertent firing of the staples.

Mobilization: Adequate mobilization is essential not only to obtain adequate tumor margins but also to prevent tension across the anastomosis. At least 3 cm of colon must be mobilized below the distal line of resection. In cancer surgery, a margin of resection below the lesion must be added to insure the best chance for cure and avoidance of suture-line recurrence. The 3 cm margin distal to a tumor may be adequate for cure; however, this is a point that needs to be analyzed in three years. The puborectalis muscle is the key to continence. Mobilization or anastomosis at this level may result in some degree of incontinence. Mobilization of the splenic flexure might be necessary to alleviate tension across the anastomosis.

Metal clips used for hemostasis near the anastomosis or wire suture placed in an oversewn Hartmann's pouch can interfere with proper crimping of the staples and knife cutting of redundant enfolded tissue. In general metal should not be used

TABLE 3. *Late Complications following 3,594 Stapled Anastomoses*

	Number of Cases	Per Cent
Stenosis	315	8.8
Incontinence	124	3.5
Gas	79	
Liquid	40	
Solid	5	
Anastomotic recurrence	54	1.5
Rectovaginal fistula	3	0.1
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TOTAL	496	13.9

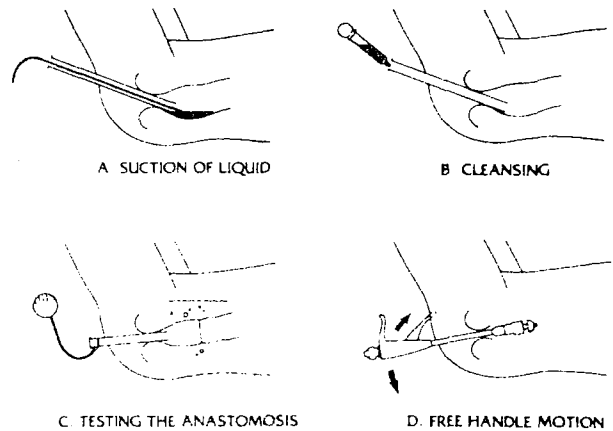


FIGURE 2. PERINEAL MANIPULATIONS

within 2 cm of the anastomosis if the EEA stapler is to be used at that procedure or in a subsequent surgery.

The EEA stapler introduced through the rectum has facilitated finding the oversewn rectum fixed in scar deep in the pelvis. Rather than mobilizing the rectum, only a 4 cm diameter circle on its anterior wall needs to be cleared. The center rod of the EEA can be introduced via the rectum through a stab wound in the center of the cleared space and the anvil screwed in place from the abdominal side. The anvil is then passed into the proximal bowel, the proximal purse-string tightened and tied, and the anvil closed onto the cartridge. With this technique, a distal purse-string suture is not necessary (Fig. 3).

Purse-string suture: Properly applied and tied purse-string sutures on the proximal and distal ends of the bowel are keys to the successful operation of the EEA stapler. Monofilament suture such as 3-0 nylon is preferable to braided suture. Braided suture does not slide or cut cleanly. If the suture becomes caught between the knife and teflon ring when the EEA stapler is fired and is not completely cut, the stapler cannot be removed without risk of tearing the attached tissue.

If the purse-string suture is begun on the anterior aspect of the bowel, it can be pulled and tied under direct vision (Fig. 4). The suture should include all layers of bowel; needle bites should be placed 6 mm from the edge and 6 mm apart. If only mucosa is included, the anastomosis will likely break down. If wider bites are made, gaps are created when the anvil and cartridge are approximated, resulting in leaks (Fig. 5). If bites are taken too far from the cut edge, folds of tissue thicker than the staples will be included between the closed anvil and cartridge. Across the thick walls, staples may close incompletely or pull through, resulting in the "eversion leak" shown in

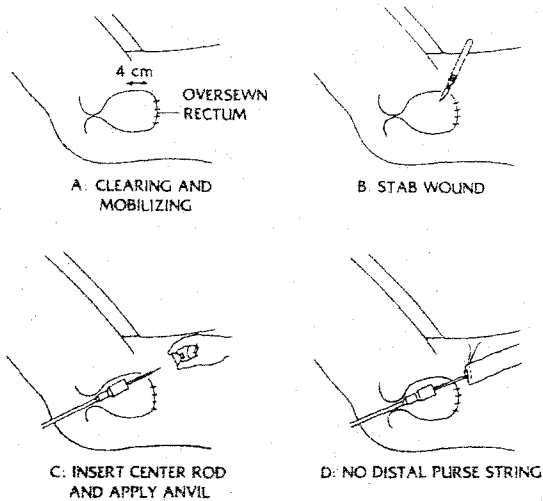


FIGURE 3. DELAYED ANASTOMOSIS OF AN OVERSEWN RECTUM

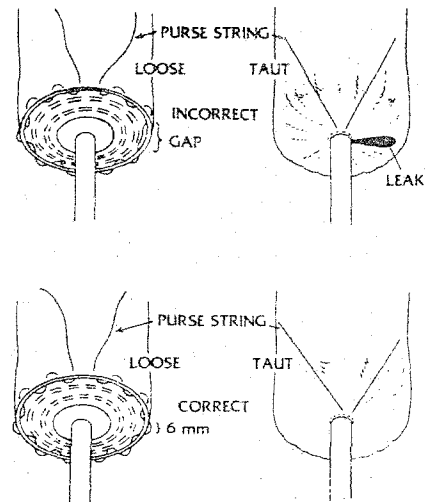


FIGURE 5. PURSE STRING

Figure 6. Obtaining a tight purse-string closure when anastomosing the rectum is difficult because of the discrepancy in lumen size. The temptation to place needle bites farther apart around the wider lumen should be avoided. An over-and-over suture technique which allows tight closure of the tissue on the center rod is shown in Figure 7. The purse-string must be taut against the center rod. If the suture is loose and lies outside the circular knife, a leak is imminent.

The purse-string instrument marketed by USSC has not been uniformly successful. In the pelvis there is not adequate space to accommodate the instrument end to end with the length of the straight needle. If the instrument can be used, the straight needle is best passed prior to transection of the colon. The cut margin can slip through the instrument and not be included in the purse-string. Also the colon should be

cut with a curved scissor rather than a knife which shaves the bowel too close to the suture allowing it to tear through when pulled tight.

Insertion: The EEA stapler with the anvil closed against the cartridge is introduced through the anus by the perineal operator. The abdominal operator directs the insertion and manipulation of the instrument until the knob at the tip of the anvil becomes visible at the transected end of the distal segment. At this point the anvil is extended and separated from the cartridge by turning the wing nut counterclockwise (Fig. 8). The space between the anvil and cartridge is necessary to allow room to tighten and tie the purse-string sutures around the center rod.

The proximal bowel is placed onto the anvil by triangulating the cut end with instruments, such as Allis clamps. Two clamps are placed posteriorly and one

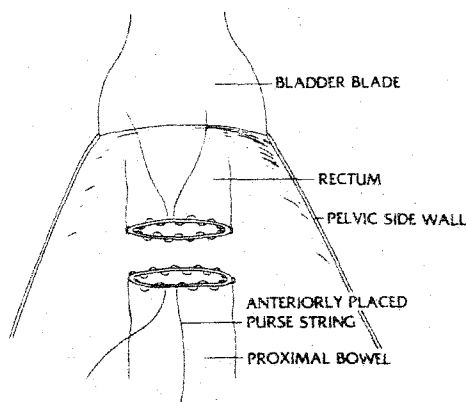


FIGURE 4. START PURSE STRING SUTURE ANTERIORLY FOR EASIER TYING

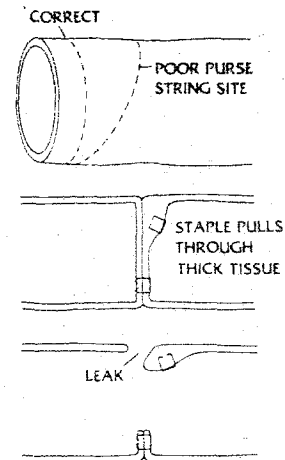


FIGURE 6. EVERSION LEAK

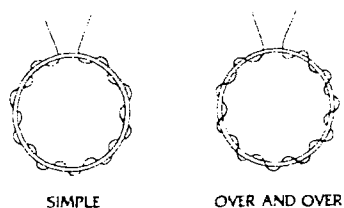


FIGURE 7. PURSE STRING SUTURE

anteriorly (Fig. 9). The posterior aspect is pulled over the anvil first, followed by the anterior margin.

Often the proximal line of resection is situated at the sigmoid colon, the narrowest portion of the colon. It can be difficult to fit this segment over the anvil especially if it is in spasm. One hundred forty-four (59 per cent) surgeons polled reported difficulty with this step. The manufacturers have tried to alleviate this problem by producing smaller cartridges. Thus there are 25 mm and 28 mm sizes in addition to the standard 31 mm. The sizes which accompany the cartridges can be used as dilators to allow use of larger cartridges. Two other alternatives for a small proximal colon include resection back to colon of larger diameter or the use of glucagon. An intravenous injection of 1 mg of glucagon can be given five minutes prior to placing the proximal colon over the anvil.⁴ Its use, however, should be avoided in patients with insulinoma or pheochromocytoma.

An alternative technique to introduce the EEA stapler is to place it via a proximal colotomy and to direct the anvil into the distal segment (Fig. 10). The advantages of this technique are that a perineal surgeon is not necessary and extraction of the anvil might be easier. The disadvantages are that the sutured (or stapled) colotomies might further narrow the lumen of the proximal bowel, or may rupture in

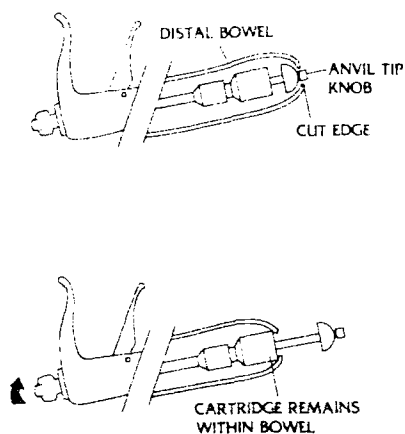


FIGURE 8. INTRODUCTION OF ANVIL INTO PELVIS

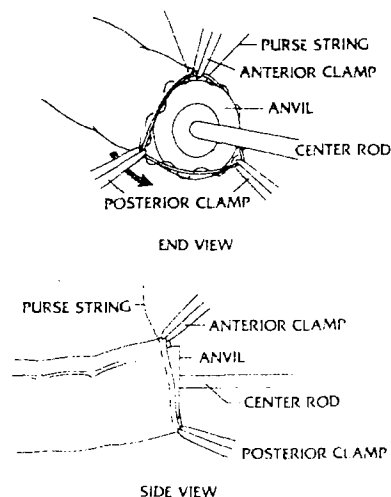


FIGURE 9. ADVANCEMENT OF BOWEL OVER THE ANVIL BY TRIANGULATION OF THE CUT EDGE

the postoperative period. With this technique, it is still recommended that sigmoidoscopy be done prior to anastomosis to cleanse the bowel and that it be done to evaluate the stapled anastomosis.

Firing: After tightening and tying the purse string sutures, the space between the cartridge and anvil is closed by turning the wing nut on the instrument clockwise. A hand should be placed behind the anastomosis to prevent extraneous tissue from becoming entrapped (Fig. 11). Additional tissue caught within the anastomosis can prevent proper closure of the staples and cause a leak. Pressure on the handles of the instrument should be firm but smooth to achieve well-crimped staples and a complete cut.

Extraction: The anvil is separated from the cartridge by turning the wing nut counterclockwise. The tissue is freed from the parts by rotating the handles right and left in increasing increments, from 30° to 60° to 90° to 180°. Usually the anvil can be seen or palpated to ensure it is free from the anastomosis. If the excess tissue has not been cut completely and is caught in the

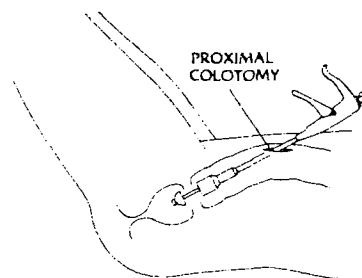


FIGURE 10. INSERTION, PROXIMAL TO DISTAL

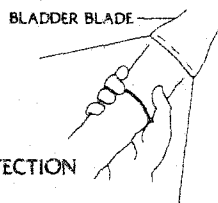


FIGURE 11. HAND PROTECTION AGAINST ENTRAPMENT OF ADJACENT TISSUE DURING FIRING

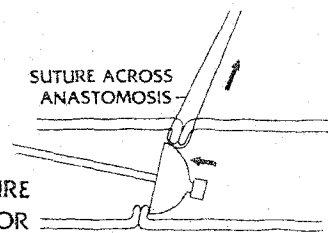


FIGURE 13. SUTURE PULL OF ANTERIOR STAPLED ANASTOMOSIS TO FREE ANVIL

instrument, extraction can result in tearing of the anastomosis and a leak. If one lip of the anvil can be slipped through the anastomosis, the rest will slide easily. The original method used for extraction was like a "tug of war"; the perineal operator pulled the stapler one way and the abdominal operator pulled the colon the other way. It is safer to have the abdominal operator manipulate the anastomosis with one hand, and while reaching between the legs, extract the instrument (Fig. 12). The contaminated glove and gown can be changed. Tears are frequent at the time the anvil is pulled through the anastomosis since the diameter of the anvil measures 31 mm and the lumen is 21 mm. When the anvil will not slide through, place three sutures at half-centimeter intervals on the anterior surface across the anastomosis. Sometimes the anterior lip can be pulled over the anvil with this maneuver (Fig. 13). If the anvil is hopelessly trapped, a proximal colotomy is necessary to unscrew and extract the anvil. Should rings of tissue not be cut free, these can be excised with a curved scissor through the same colotomy.

Evaluation of the Anastomosis: Scrutinize the anastomosis by first examining the rings of tissue removed from the cartridge, being careful to preserve orientation proximal to distal and anterior to posterior. A break in the continuity of the rings should prompt an

examination for a leak at a specific point. Intact rings are referred to as "rings of confidence" (Fig. 14). Next, the anastomosis should be evaluated by sigmoidoscopy if it is within viewing distance. Care must be taken not to force the scope through the anastomosis causing disruption. Hemorrhage from the anastomosis can be managed by coagulation or, if possible, by suture ligation. Tightness of closure can be tested and leaks detected by clamping the proximal colon, filling the pelvis with saline, and insufflating air per rectum to distend the closed bowel. Leaks can be localized by the escape of bubbles of air from the anastomosis (Fig. 2C). Localized leaks can be managed by full thickness suture repair. Leaks involving more than half the circumference of the anastomosis might be better managed, if possible, by re-resection and restapling. Very low anastomosis with a large leak may require an abdominoperineal resection or oversewing of the rectal stump. However, a restapling technique has been described by Goligher.⁵ In his technique the distal purse-string suture is placed from below through an operating anoscope (Figs. 15 and 16). The suture tails can be passed to the abdominal operator for tying. In these cases, a proximal diverting colostomy is recommended. In addition to restapling, a pull-through procedure might be achieved with additional mobilization and suture from the perineal position.

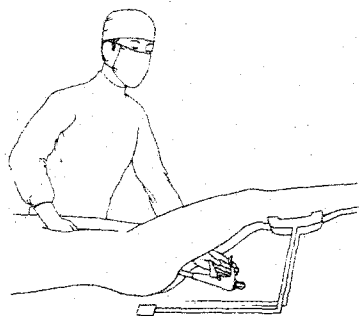


FIGURE 12. COORDINATION OF HANDLE PULL AND ANASTOMOSIS MANIPULATION AT EXTRACTION

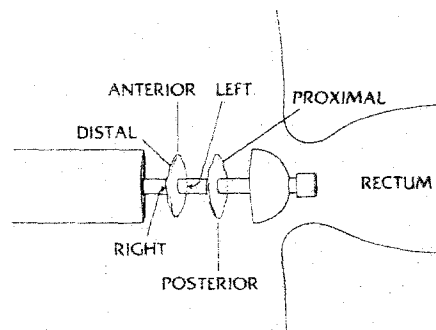


FIGURE 14. ORIENTATION OF "RINGS OF CONFIDENCE"

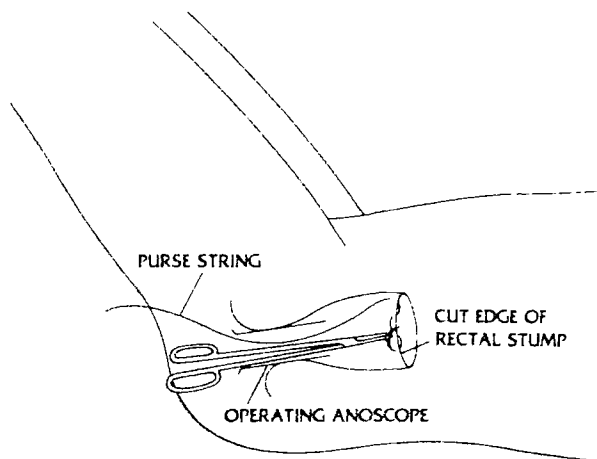


FIGURE 15. TRANSANAL PURSE STRING

Colostomy and Drainage: A proximal, diverting colostomy should be utilized to protect those anastomoses with poor blood supply or questionable construction. If blood does not flow from transected bowel, it should be trimmed back to good blood supply prior to anastomosis. Drains are not routinely used at USUHS.

Follow-up: Regularly scheduled sigmoidoscopy is essential in these patients to detect stenosis or tumor recurrence at the anastomosis. Stenoses are seldom of

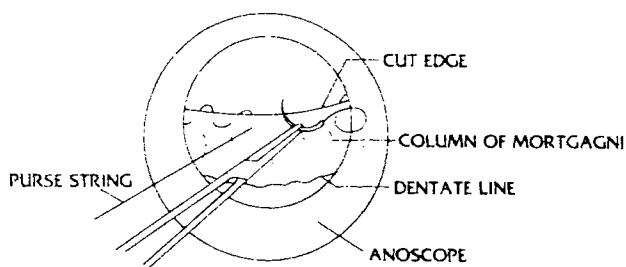


FIGURE 16. ANOSCOPIC VIEW OF TRANSANAL PURSE STRING

clinical significance; only 14 of 315 stenoses required reoperation. Generally, anastomotic strictures can be managed with graduated dilators if the anastomosis is low. The reason for stenosis is not readily apparent. The probable pathogenesis is ischemia.

The role of computerized axial tomography (CT scan) in rectal cancer follow-up is still being defined. The pelvis is the commonest site of recurrence, and the pelvic CT scan may allow earlier detection. However, staples or any metal cause a "starburst effect" to appear on the film, which render it useless as a diagnostic tool.

Conclusion

The mortality rate of 0.5 per cent in this survey series of 3,594 high and low anterior anastomoses with the EEA stapler compares favorably with other types of anastomosis.

The EEA stapler requires attention to detail to ensure success. The technique is best learned on high anterior anastomoses under direct vision; thus the difficult low anterior anastomosis can be undertaken with confidence later.

The late and postoperative morbidity rate of 17.5 per cent in this series compares favorably with other techniques of anastomosis and offers the possibility of lower anastomoses in less time.

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