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Operative Techniques in
General Surgery

Stapled Small Bowel Anastomoses

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Numerous surgical conditions require the resection of bowel segments and the creation of reliable anastomoses. As such, anastomotic techniques have been central to the development of modern surgical practice. Traditionally, a wide variety of suture materials have been used to create hand-sewn anastomoses. Although surgical stapling devices have existed since the early 20th century, their use in routine gastrointestinal surgery has not been widespread until approximately 30 years ago when their design became much more efficient and convenient. Today, stapled anastomoses are an integral part of most major abdominal operations.

Numerous studies have compared the clinical and laboratory features of hand sewn and stapled anastomotic techniques. Although it is beyond the scope of this article to review this body of literature, certain principles are worth mentioning. Most importantly, the indications, pitfalls, complications, and surgical principles associated with stapled and hand-sewn anastomoses are identical. Undoubtedly, two of the most significant complications related to intestinal anastomosis remain dehiscence and leakage. Indeed, breakdown of an anastomosis is associated with considerable perioperative morbidity and mortality. That being said, the odds of creating a safe and reliable anastomosis can be greatly increased if certain surgical tenets are respected. These include meticulous technique, avoidance of tension at the anastomosis, maintenance of good tissue vascularity, perioperative nutritional optimization, avoidance of concomitant systemic illnesses, perioperative optimization of medical comorbidities, and avoidance of certain drugs such as steroids and vasopressors. Intestinal anastomoses can nevertheless leak despite optimal conditions, hence the need for dependable and consistent methods. In this context, the current review focuses on operative techniques for stapled small bowel anastomoses. This is undoubtedly one of the most frequently encountered areas of elective and emergent general abdominal surgery. Excellent technique in stapled anastomoses of the small bowel is of paramount importance to both practicing surgeons and trainees.

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Operative Technique

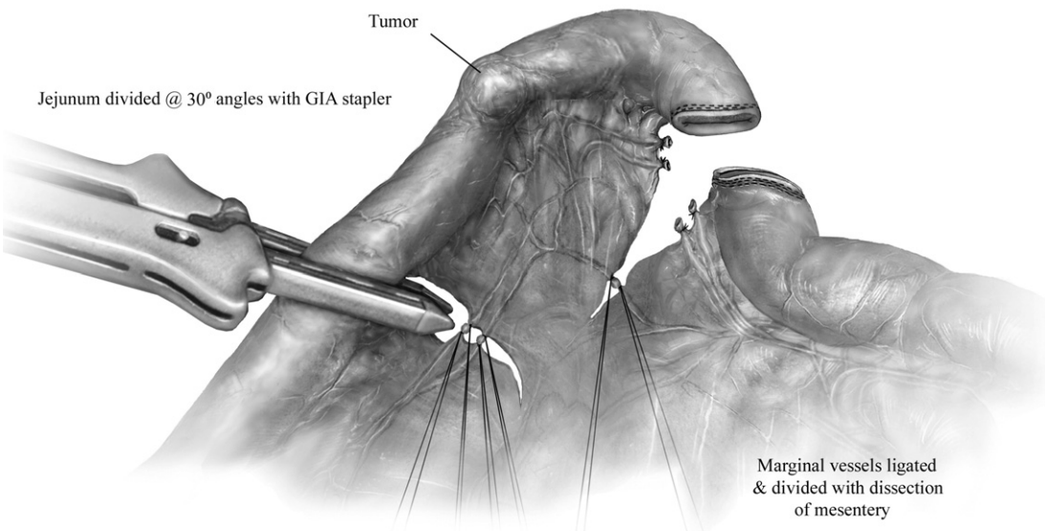

Figure 1

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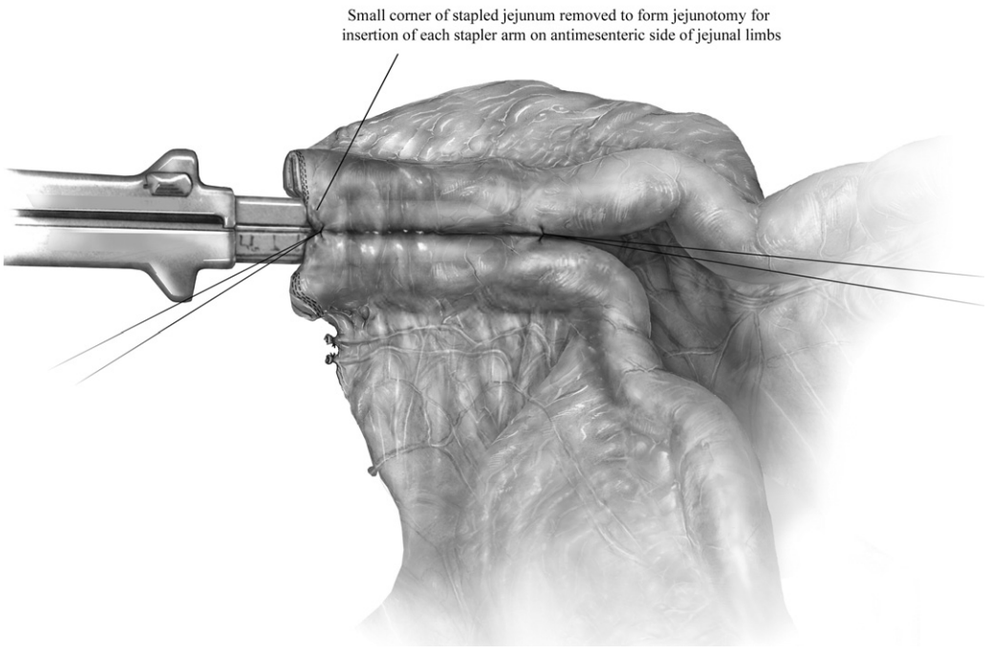

Figure 2 Creation of a functional end-to-end small bowel anastomosis. The two segments of transected small bowel are brought together, with their two antimesenteric surfaces lying closely parallel to one another. Serosal traction sutures can be placed near the two parallel staple lines and approximately 10 cm further along the bowel length. Alternatively, the surgeon's assistant can hold up and approximate the two bowel segments. A Babcock clamp can then be placed carefully on the antimesenteric corner of each staple line, taking care to apply only a single "click" when locking the clamp. Using curved Mayo scissors, the surgeon can then cut out the corner of the staple line of each bowel segment. A pool suction may need to be inserted in the enterotomies to avoid spillage of enteric content. Blunt atraumatic bowel clamps can also be placed across the bowel. Holding the corner of the enterotomy with a Babcock instrument to provide counter traction, the jaws of a GIA stapler can then be inserted into each bowel segment. Extreme care must be taken to avoid perforating the small bowel with the pointed distal ends of the stapler's jaws. The bowel ends must then be positioned properly such that the GIA will close around the two parallel antimesenteric bowel walls. As well, one should ensure that the stapler's jaws are inserted completely into the bowel ends, so as to create as large a common lumen as possible. However, care must be taken not to insert the bowel past the length markings designated on the instrument by the manufacturer. At this point, the GIA stapler can be approximated, but the surgeon should check one more time that no mesentery has been inadvertently incorporated in the anastomosis by sweeping a finger underneath the two bowel ends. The GIA can then be fired and removed from the common lumen. All instruments having come into contact with enteric contents should be considered contaminated and removed from the sterile operative field. Before closing the remaining enterotomies, the internal staple lines should be inspected for bleeding using three Babcock clamps to manipulate the bowel. If bleeding is encountered, the internal staple lines should be everted over using sequential grasping with the Babcock clamps. The areas of bleeding along the staple lines can then be over sewn using 3-0 Vicryl (Ethicon, Somerville, NJ) figure-of-eight stitches. Once this maneuver is completed, the staple lines should be delicately inverted back into their original position.

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Figure 1 Small bowel transection. The segment of diseased small bowel is transected using two firings of the GIA stapler. To do so, the small bowel and its mesentery are held up by the surgeon's assistant, so as to expose the window created in the mesentery. Note that this window should be as close as possible to the mesenteric aspect of the small bowel wall, so as to avoid stapling any mesentery. The inferior jaw of the GIA stapler is then passed through the defect in the mesentery, while the superior jaw is passed over the antimesenteric aspect of the bowel segment. The jaws are then closed around the proximal small bowel end, making sure not to clamp and lock the instrument until optimal positioning has been achieved. A 30-degree angle should be obtained with the longer edge located on the mesenteric aspect of the remaining healthy bowel. This position maximizes blood flow to the staple line and ensuing anastomosis. Both ends of the stapler can then be approximated and fired, completing the transection of the proximal bowel end. The same process can then be repeated at the distal bowel end using a reload cartridge for the GIA linear cutter.

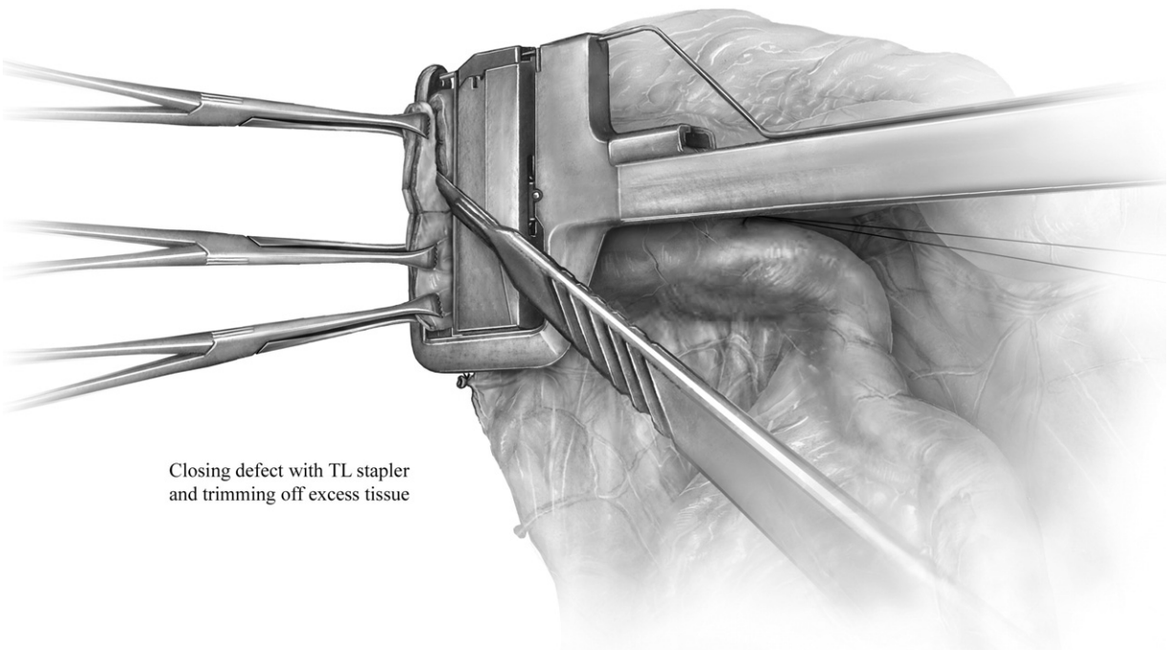

Figure 3 Closure of a functional end-to-end small bowel anastomosis. Four to six Allis clamps are delicately applied across the original staple lines and held up so as to seal off the enterotomies created previously. The original GIA staple lines should be offset before doing this. A TA linear stapler is then positioned and tightened just distally to the tips of the Allis clamps. Care must be taken to avoid incorporating staples within the TA stapler. The surgeon should also ensure that little intestinal tissue is taken so as to avoid overly narrowing the common bowel lumen within the anastomosis. The TA stapler can then be fired, closing the remaining defect. Using curved Mayo scissors or a scalpel, the surgeon then proceeds to cut off the excess bowel tissue, making sure to use the cutting groove on the TA stapler as a guide. The stapler is then released, and the new anastomosis examined. The bowel should look pink and healthy, with possible mild oozing from the newly applied staple line. If this bleeding appears too brisk or fails to diminish on its own, it may be advisable to over sew the new staple line using an interrupted or a running 3-0 Vicryl suture with a gastrointestinal needle. In addition, the dimension of the anastomosis should be palpated through the bowel wall for patency. Two 3-0 Vicryl seromuscular stitches should also be placed to reinforce the crotch of the anastomosis. Finally, the mesentery should be assessed for hemostasis, and any bleeding should be controlled using sutures. Mesenteric defects can be closed to avoid internal herniation by approximating the peritoneum using 3-0 Vicryl sutures. Many surgeons choose not to close this opening and accept this defect.

Figure 4 Creation of a side-to-side small bowel anastomosis. The general principles of this anastomosis are very similar to that of functional end-to-end small bowel anastomoses. The surgeon begins by identifying the segment of small bowel targeted for resection. As in Fig 1, the small bowel mesentery must first be taken down at the proximal and distal resection margins, using serial clamping, cutting, and tying of vascular pedicles. Then, the surgeon must position the bowel segments to be anastomosed in a parallel or side-to-side fashion, with both antimesenteric surfaces opposing one another. Stay sutures can be applied at the crotch of the proposed anastomosis. Two transverse enterotomies are then created in the bowel wall using electrocautery. Care must be taken to avoid spillage of enteric content. The arms of a GIA stapler are then inserted through each enterotomy, pointing away from the loop of bowel being resected. Once the surgeon is satisfied that no mesentery has been inadvertently incorporated between the two bowel segments and that the GIA stapler is properly positioned, the stapler is closed and fired. The GIA can then be released and carefully removed from the bowel segments. The common lumen of the anastomosis is then examined carefully for hemostasis, as described earlier.

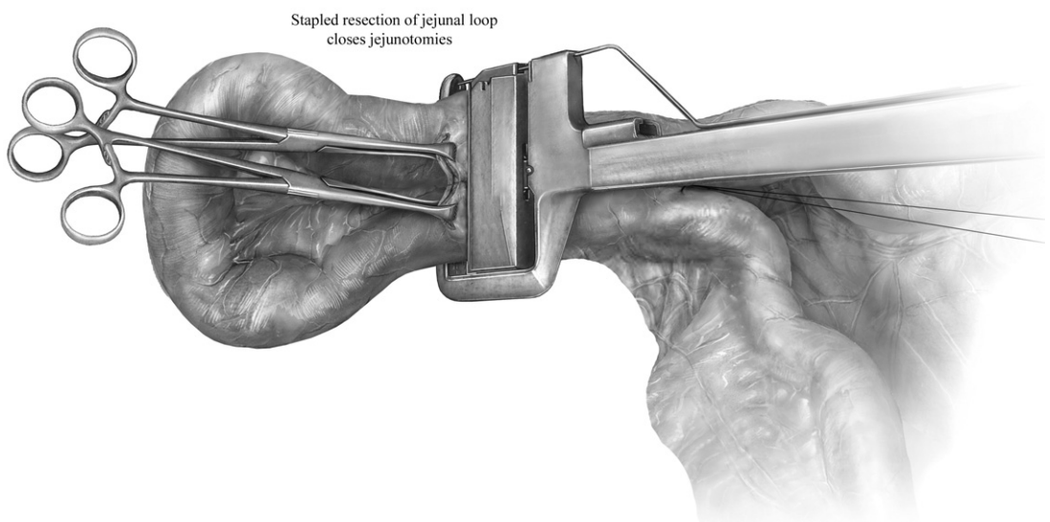

Figure 5 Closure of a side-to-side small bowel anastomosis. Two Allis clamps are applied across the small bowel enterotomies created earlier. The bowel loop targeted for resection, along with its mesentery, is then held up by the surgeon's assistant. A large TA stapler is then positioned across the diseased bowel loop, just distal to the newly created anastomosis and proximal to the two enterotomies. Once the surgeon is satisfied that the TA is positioned safely, the latter is closed and fired. The bowel loop intended for resection can then be cut off from the anastomosed bowel using the knife or curved Mayo scissors on the distal side of the TA stapler. As previously described, the surgeon should now inspect the anastomosis for hemostasis, and consider closing small to medium-size mesenteric defects.

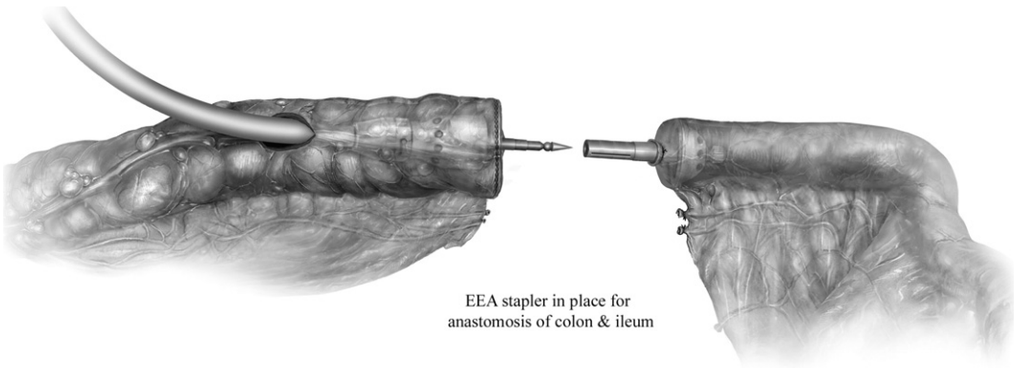

Figure 6 Creation of an end-to-end ileocolic anastomosis. The segment of diseased ileocolic bowel is mobilized and resected in the usual fashion. The colon is transected using a GIA stapler, whereas the ileum is cut using a TA stapler. On the ileal side, the stapled portion of bowel is taken away with the specimen, whereas the open ileum remains at the proximal end. Again, the surgeon may need to utilize the pool suction to avoid contamination of the field by enteric contents. It is wise to isolate this portion of the operation from the sterile field with laparotomy sponges. A purse string 2-0 Prolene (Ethicon, Somerville, NJ) suture can then placed at the distal end of the ileum. The anvil of the EEA stapler is then inserted into the distal ileum, and the purse string tied off around its rod so as to secure it in place. A colotomy must then be created in the colonic segment using electrocautery, approximately 5 to 10 cm from the staple line. It is best to make this opening along one of the teniae, making sure to create an opening long enough to accommodate the wide distal end of the stapler. The EEA circular stapler is then inserted through the colotomy, and its integral trocar allowed to pierce through the colonic staple line. The rod and integral trocar are then inserted and locked into one another, and the circular stapler tightened and fired. Again, care must be taken to align the antimesenteric surfaces of both ileal and colonic segments, and to verify that no mesentery is inadvertently incorporated into the stapler at the moment of firing. Once the anastomosis is created, the EEA stapler should be withdrawn through the colotomy, and its donuts verified for completeness. Finally, the colotomy must be closed with a running 3-0 Vicryl or PDS (Ethicon) suture with a gastrointestinal needle, or using a single firing of TA stapler. Care must be taken not to narrow the colonic lumen excessively to avoid causing an iatrogenic stricture. Often, the defect can be closed transversely so as to prevent compromise of the lumen. Mesenteric defects can be closed as for simple small bowel anastomoses.

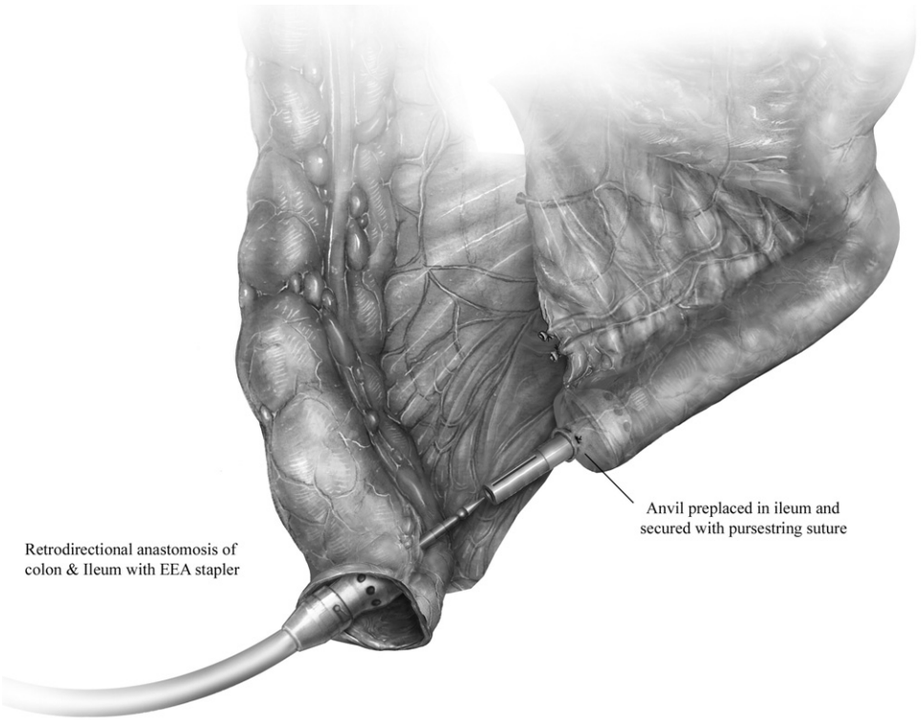

Figure 7 Creation of an end-to-side ileocolic anastomosis. This anastomosis proceeds in a manner very similar to the end-to-end ileocolic anastomosis, except that in this case both the colon and ileum are transected using a TA stapler. Again, the anvil of the circular stapler can be positioned in the lumen of the distal ileum using a purse string suture. After transection, the colonic segment is maintained open using Babcock bowel clamps, so as to allow the EEA stapler to be inserted through this opening in a retrograde direction. The integral trocar must then pierce through one of the teniae, the goal being to select the proper antimesenteric orientation for the colonic end of the anastomosis. The trocar and anvil can then be connected, and the EEA stapler closed and fired. The remainder of the anastomosis proceeds as described earlier for end-to-end ileocolic anastomoses. The colotomy in this case is best closed using a TA stapler, ensuring that the size of the blind end created is not too large.

A small bowel anastomosis begins by resecting a segment of small intestine. The area intended for resection is first identified by thoroughly running the bowel along its length. The surgeon must first fully expose the targeted bowel loop and its associated mesentery. Adhesions may have to be taken down for this to be possible. A window is then created at the bowel-mesentery junction using a combination of sharp and blunt dissection in an area of normal appearing proximal small bowel. The exact margin required depends on the indication for resection. A similar window is also created at the distal margin of the bowel segment. Both the proximal and distal mesenteries are then taken down in a V fashion by sequentially clamping, cutting, and tying off vascular pedicles running within the mesentery. Alternatively, this can be performed using clips or newer hemostatic technology such as high-frequency ultrasonic dissection or the electrothermal bipolar vessel sealer. This is performed to fully mobilize the segment of small bowel intended for resection. The small bowel segment of interest can then be transected using the gastrointestinal anastomosis (GIA) stapler (Fig 1).

After resection of the diseased small bowel segment, an anastomosis can be performed in a variety of fashions. The creation of a stapled functional end-to-end anastomosis (Figs 2 and 3) is the most commonly used and simplest method in small bowel surgery. This technique involves the creation of a common lumen between the proximal and distal small bowel segments using one firing of a GIA stapler. Then, the enterotomies created to fashion the common anastomotic lumen are closed off using one firing of the thoracoabdominal (TA) stapler. Although this technique is undoubtedly the most prevalent one, other important methods include side-to-side anastomoses (Figs 4 and 5), end-to-end anastomoses based on TA stapler triangulation, as well as end-to-end anastomosis (EEA) circular stapler insertion through a separate enterotomy. Note that this method is similar to a technique of ileocolic anastomosis presented in Fig 6.

Small bowel surgery, particularly ileal procedures, often requires concomitant cecal or right colonic resection. For this reason, techniques of stapled ileocolic anastomosis must also be reviewed. For the majority of patients, such anastomoses can be performed in a functional end-to-end fashion, using the principles described in Figs 1 to 3 for small bowel resections. However, some surgeons prefer to use different methods, including side-to-side (Figs 4 and 5) and end-to-end or end-to-side (Figs 6 and 7) ileocolic anastomoses with or without the EEA circular stapler. In the case of end-to-end anastomoses, the colonic dissection is performed in the usual fashion, whereas the colonic transection requires one firing of a large GIA linear cutter. On the other hand, the ileal transection is done using a TA stapler, allowing the creation of a purse-string suture around an EEA stapler's anvil at the proximal ileal end. The circular anastomosis is performed by creating a colotomy distally to the colonic staple line, through which the EEA stapler can be inserted. On the other hand, end-to-side anastomoses require that both ileum and colon be transected using TA staplers. Again, the anvil is inserted into the proximal ileal segment. However, for this anastomosis, the EEA stapler is inserted directly through the open distal colonic segment and allowed to pierce through one of the teniae to meet with the anvil. The remaining defect is finally closed with a TA stapler.

Conclusion

Intestinal anastomoses are commonly performed surgical procedures. Within this group, small bowel cases account for an important proportion of both elective and emergent anastomoses. Stapled small bowel anastomoses have become an integral part of routine surgical practice. Commonly used techniques of functional end-to-end and side-to-side small bowel anastomosis, as well as end-to-end and end-to-side ileocolic anastomosis have been reviewed, including appropriate instrumentation, pitfalls, and operative suggestions.[1-10]

Suggested Readings

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