Minimally Invasive Small Bowel Resection

15

Ciro Andolfi and Konstantin Umanskiy

Indications

The laparoscopic technique has been adapted to essentially all operative approaches for small bowel resection. Specific indications include isolated small bowel Crohn's disease, ischemia or gangrenous segment of bowel, diverticula, benign strictures, vascular malformations, and neoplasms [1]. Approximately 75% of small intestinal tumors are malignant, with carcinoid tumors being the most common histological type, followed by adenocarcinoma, gastrointestinal stromal tumors (GIST), and lymphomas; altogether, these account for nearly 98% of all small bowel tumors [2].

Preoperative Work-Up and Perioperative Preparation

The preoperative work-up is guided by the underlying etiology and presenting symptoms. Imaging can help establish the diagnosis and provide a "road map" for planned surgical intervention. An upper gastrointestinal series with small bowel follow-through (UGI-SBFT), computed tomography (CT), or magnetic resonance (MR) enterography can be quite useful as initial studies. An esophagogastroduodenoscopy (EGD) or colonoscopy with intubation of the terminal ileum can be beneficial to further characterize the lesion in question and obtain biopsies. Small bowel segments beyond the proximal jejunum and terminal ileum that are not easily accessible by conventional colonoscopy or EGD can be evaluated with double-balloon enteroscopy. Further imaging studies depend on the initial findings and may include ultrasound, positron emission tomography (PET), octreotide scan, or capsule endoscopy [2].

Mechanical bowel preparation and oral antibiotics may be administered preoperatively but are not essential unless colon resection is planned. A chlorhexidine shower is recommended the night before and the morning of the operation. Deep venous thrombosis prophylaxis with both sequential compression devices and subcutaneous heparin is advisable. Preoperative antibiotics are administered within an hour of initial incision using a first-generation cephalosporin and metronidazole; gentamicin and clindamycin are prescribed in patients with beta-lactam allergies [2, 3].

Electronic supplementary material The online version of this chapter (https://doi.org/10.1007/978-3-030-18740-8_15) contains supplementary material, which is available to authorized users.

C. Andolfi · K. Umanskiy (✉)
Department of Surgery, The University of Chicago Pritzker School of Medicine, Chicago, IL, USA
e-mail: candolfi@surgery.bsd.uchicago.edu; kumanskiy@surgery.bsd.uchicago.edu

J. Kim, J. Garcia-Aguilar (eds.), *Minimally Invasive Surgical Techniques for Cancers of the Gastrointestinal Tract*, https://doi.org/10.1007/978-3-030-18740-8_15

Patient Positioning and Room Setup

The procedure is performed under general anesthesia. A nasogastric or orogastric tube and urinary catheter are placed following induction of anesthesia. The patient may be placed in either supine, split leg, or low lithotomy position with the arms padded and out or tucked by the patient's sides to allow more ergonomic positions for the surgeons, especially if two operators need to stand side-by-side. The surgeon usually stands across the table from the lesion, e.g., on the patient's right side for lesions in the patient's left abdominal cavity or for lesions involving the proximal bowel, and the surgeon stands on the patient's left side for lesions in the patient's right abdominal cavity or for lesions involving the terminal ileum. The camera operator stands on the same side as the surgeon. The assistant surgeon stands on the opposite side of the surgeon (Fig. 15.1). At least two monitors are required – one on each side of the patient. They should be easily movable toward the head and foot of the patient, as to be in line with the operating surgeon's direction of work. An ultrasound machine with laparoscopic probe may be needed in certain circumstances, such as intestinal ischemia or with neoplasm requiring hepatic assessment. Intraoperative endoscopy is occasionally needed to localize the lesion in question.

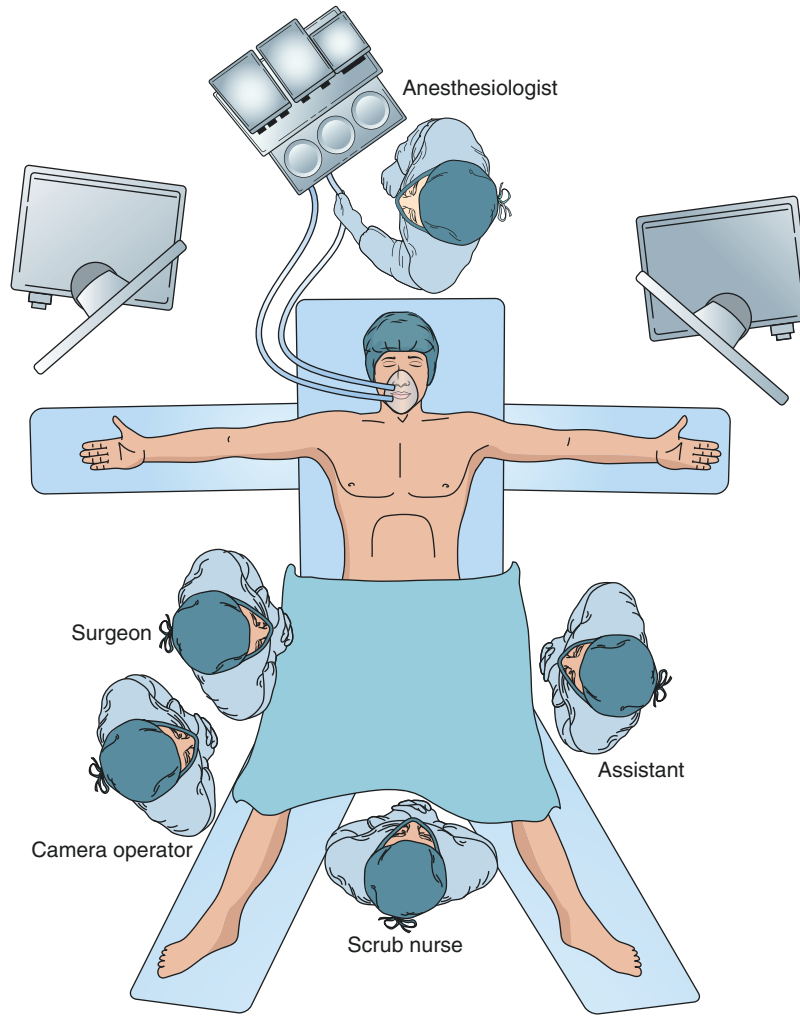

Fig. 15.1 Patient positioning and operating room setup for minimally invasive small bowel resection

Port Placement and Instrumentation

The first port is placed above or below the umbilicus to insufflate the abdomen and to introduce a laparoscope. The open Hasson technique is the preferred method to gain entry into the abdomen. Alternatively, the Veress needle and a trocar with Optiview technology can be used. An initial survey of the abdominal cavity is performed to evaluate the intestine and, if lesion is readily identified, additional port placement is planned accordingly. An angled (30 ° or 45 °) laparoscope provides the optimal view of the small bowel and its mesentery and is preferred over a 0 ° scope. The working ports should be positioned at the corners of an equilateral triangle across from the site of pathology with 8–9 cm length on each side (Fig. 15.2). In most circumstances, three ports are sufficient to accomplish the procedure. A fourth port in the supra-pubic area may be helpful for retraction or exposure. The size of trocars can be 5 mm or 10–12 mm depending on the instruments used during the case. Table 15.1 illustrates specific instruments recommended for laparoscopic small bowel resection, including atraumatic graspers, and laparoscopic linear staplers. Mesenteric vascular control may be accomplished by vascular endoscopic staplers, clips, or bipolar energy devices. The choice of the device largely depends on individual surgeon's preference and experience. Laparoscopic scissors with monopolar cautery are helpful in performing enterolysis and fine dissection [3].

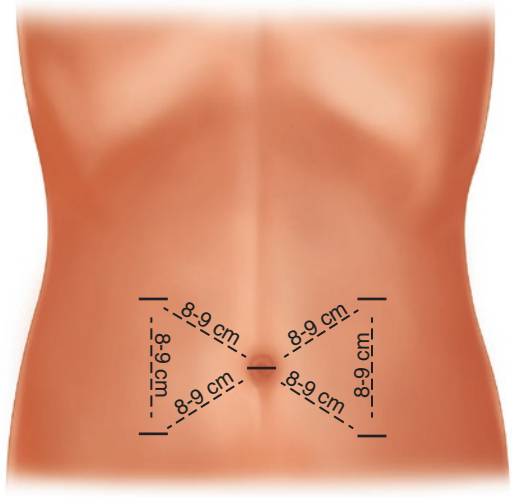

Fig. 15.2 Trocar/port placement for minimally invasive small bowel resection

Table 15.1 Instruments recommended for laparoscopic small bowel resection

No.	Instrument type
3–5	Trocars (10–12 mm and 5 mm)
2	Needle holders (optional)
2	Laparoscopic graspers
1	Laparoscopic dissector
1	Laparoscopic scissors
1	Laparoscopic vessel sealing device
1	Laparoscopic intestinal stapler
1	Laparoscopic vascular clips

Techniques of Small Bowel Resection

Because of the potential for multifocal lesions or unsuspected disease in other parts of the abdomen, small bowel resection should be preceded by a thorough exploration and visualization of abdominal organs, particularly the liver, and the entire small bowel. If preoperative studies clearly localize the lesion, and there are extensive adhesions that preclude "running" the entire small bowel, then this recommendation may not apply [4, 5].

Laparoscopic-Assisted Small Bowel Resection

Video 15.1

The small bowel is typically evaluated laparoscopically, with the use of atraumatic graspers, from proximal to distal by placing the patient in slight reverse Trendelenburg position, with the left side elevated. This maneuver displaces the small bowel into the lower abdomen. The colon can be lifted cephalad, thereby exposing the ligament of Treitz. Beginning at the Treitz, the bowel is run by "hand over hand" technique. Once the proximal jejunum is evaluated, the patient's position

is progressively changed to Trendelenburg position, with right side elevated to evaluate the distal half of the small intestine. Alternatively, a distal to proximal evaluation of the small bowel can be performed. Once the segment to be resected is identified, it can be marked and suspended by traction sutures on both sides of the lesion. It is helpful to use a 2-0 Prolene suture with a straight needle. The needle is passed through the tissue to be suspended, and the two ends of the suture are held together outside the abdominal wall with a small clamp. It is advantageous to divide the mesenteric vessels before exteriorization of the specimen through the abdominal incision using either an endoscopic linear stapler or a bipolar vessel sealer. This may be especially helpful in a patient with a thick abdominal wall. Once the specimen is fully mobilized, an incision measuring 3–5 cm is made in order to accommodate the section of the small intestine that will be resected. Depending on the size of the specimen, the location of the segment of the small bowel, and mobility of the mesentery, either a Pfannenstiel or a periumbilical midline incision is preferred. The wound is protected using a plastic wound protector, and the loop of the intestine with the lesion is drawn out through the incision. The exteriorization of the bowel before resection allows the palpation of the small bowel so that more subtle disease is not missed and avoids the contamination of the abdominal cavity. The resection and anastomosis are then performed in a standard extracorporeal fashion, by either hand-sewn or stapled method. The mesenteric defect can be left open or closed with a running absorbable suture either through the incision or intracorporeally after reestablishment of pneumoperitoneum. The abdomen is then copiously irrigated with warm sterile saline solution through the incision. After irrigation of the peritoneal cavity, the abdominal wall is closed. The peritoneal cavity can be finally inspected laparoscopically to assure hemostasis [6].

Technical tips for laparoscopic-assisted small bowel resection:

1. Evaluation of proximal small bowel
   (a) Surgeon and camera holder stand on the patient's right side.
   (b) Allow gravity to assist with retraction. Place patient in reverse Trendelenburg position. Small intestine will fall down to pelvis, away from the transverse colon.
   (c) Lift transverse colon to identify the ligament of Treitz.
   (d) Run the small intestine between a pair of atraumatic bowel clamps or endoscopic Babcock clamps.
2. Evaluation of distal small bowel
   (a) Small bowel is grasped by the assistant at the midpoint of its course.
   (b) Both surgeon and camera holder switch to the patient's left side to complete evaluation of the small bowel to the level of the ileocecal valve.
   (c) Identify the segment with the disease. Lyse adhesions to surrounding loops of bowel if necessary.
3. Prepare for bowel resection
   (a) Mark and suspend the section of bowel by placing traction sutures.
   (b) Use cautery to score the peritoneum overlying the mesentery on the side facing the surgeon along the line of intended resection. This outlines the V-shaped segment of small bowel and mesentery that is planned for resection. Make the V large enough for the intended purpose: for example, wide mesenteric excision is appropriate when operating for cancer but unnecessary when a resection is performed for a benign stricture.
   (c) Divide the mesentery using clips, staplers, or a bipolar energy device (Fig. 15.3).
4. Bowel resection
   (a) Make an incision (3–5 cm) to exteriorize and resect the bowel segment. Use wound protector.
   (b) Divide the bowel at the sites of the divided mesentery using a standard extracorporeal technique.
   (c) Remove the specimen.
5. Anastomosis
   (a) Construct the anastomosis extracorporeally using a standard technique (hand-sewn or stapled method).
   (b) Close the mesenteric defect (optional) extracorporeally or intracorporeally.

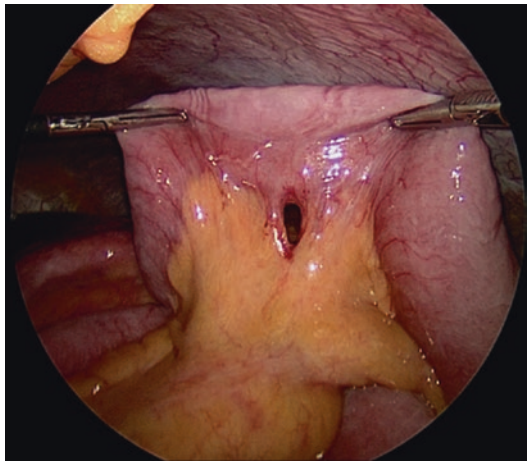

Fig. 15.3 Dissection to produce mesenteric defect in preparation for bowel resection

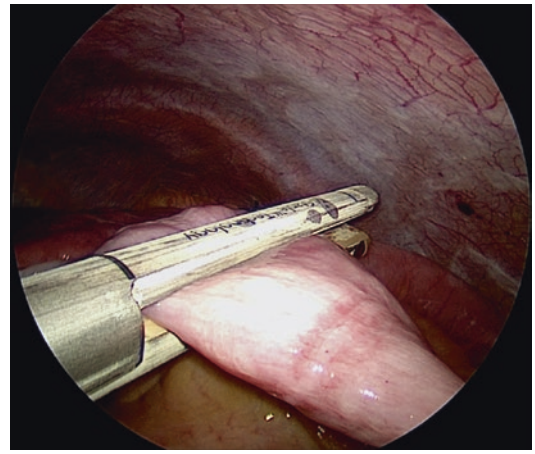

Fig. 15.4 Bowel resection using a laparoscopic linear stapler

(c) Return the anastomosed bowel to the peritoneal cavity.
(d) Close the small incision in layers, reestablish the pneumoperitoneum, confirm hemostasis, and inspect the bowel anastomosis.

Totally Laparoscopic Small Bowel Resection

The laparoscopic technique is similar to the laparoscopic-assisted technique described above except that resection and entero-enteric anastomosis is performed entirely intracorporeally [7].

1. Laparoscopic preparation for small bowel resection is outlined in steps 1 through 3 of the laparoscopic-assisted section.
2. Bowel resection
   (a) Divide the bowel at the sites of the mesenteric division using an endoscopic stapler (Fig. 15.4).
   (b) Make an incision (usually around 4 cm) to allow removal of the resected bowel segment.
3. Intracorporeal anastomosis
   (a) Align the divided bowel ends with stay sutures placed through the anti-mesenteric border of the bowel. The anastomosis can be constructed either in antiperistaltic (side-to-side, functional end-to-end) or iso-peristaltic (side-to-side) fashion.
   (b) Create an enterotomy in both limbs of the bowel close to the antimesenteric borders (Fig. 15.5) with monopolar scissors or hook cautery, and then pass the limbs of the endoscopic gastrointestinal stapler into each enterotomy, approximating the segments. Close the stapler and verify the correct alignment (Fig. 15.6).
   (c) Fire and remove the stapler.
   (d) Use the traction sutures to inspect the anastomotic staple line for bleeding. The incidence of bleeding can be minimized

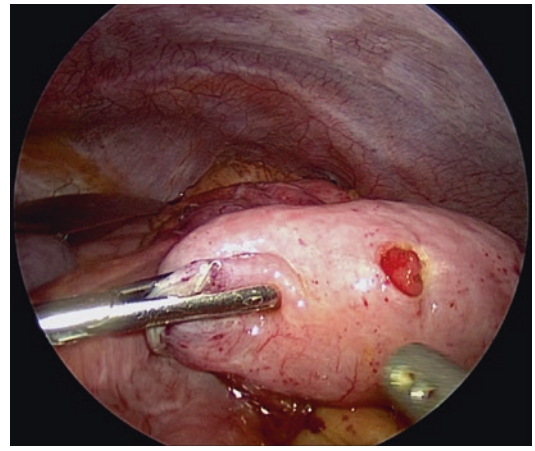

Fig. 15.5 Creation of enterotomy on the antimesenteric border of the small intestine

by ensuring that the antimesenteric sides of each limb are used to construct the anastomosis. Control any bleeding sites. Bleeding areas at the staple line can be controlled with sutures or clips.

4. Closure of the enterotomies with stapled technique
   (a) Place three traction sutures (one at each end and one in the middle) to approximate the enterotomy defect and elevate the edges.
   (b) Place an endostapler (3.5 mm) or an Endo GIA with Tri-Staple technology (tan or purple) through a 12-mm port, just beneath the cut edges, and close it transversely. Be certain to ensure that both edges are completely enclosed within the stapler, but avoid including excessive amount of bowel.
   (c) Fire the stapler, and use scissors to remove excess tissue from the staple line.
5. Alternatively, a closure of the common enterotomy with intra-corporeal running V-Loc suture can be performed (Fig. 15.7) [8].

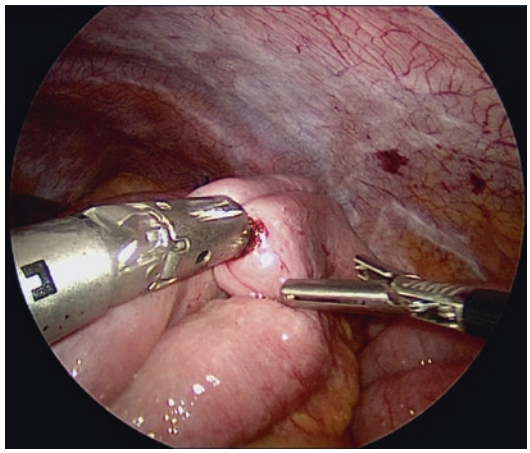

Fig. 15.6 The stapler is inserted into the two limbs of small for side-to-side functional end-to-end anastomosis

Complications

Anastomotic Leak

One of the most serious complications of any bowel anastomosis is anastomotic leak. Compared to the large intestine, the small bowel has a much lower leak rate. In fact, as long as the segments of bowel for anastomosis are well vascularized and the anastomosis is free of tension, small bowel leaks are exceedingly rare. Leaks in small bowel anastomosis most frequently result from technical error, excess tension on the anastomosis, or poor blood supply. A gross technical error can contribute to anastomotic leak, such as incomplete closure of the enterotomy with the linear stapler or if the enterotomy is hand-sewn and the sutures are not placed accurately.

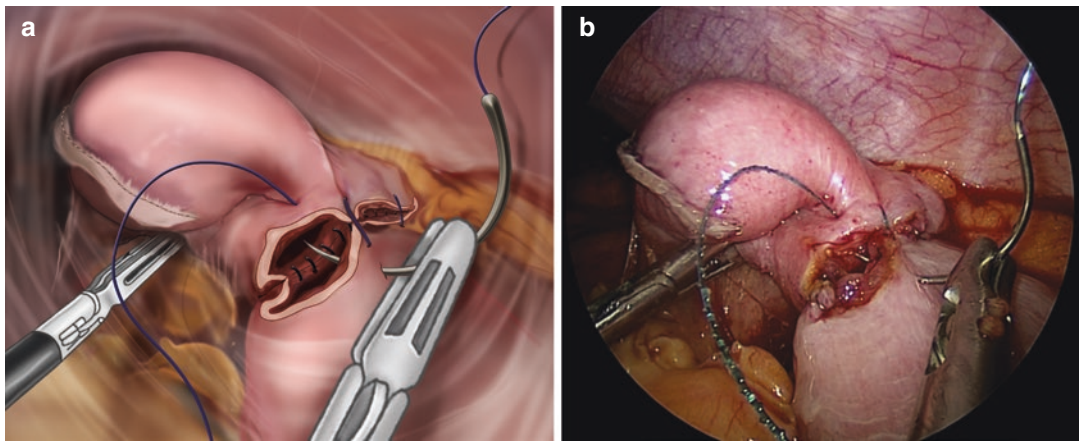

Fig. 15.7 (**a**) Illustration showing closure of the common enterotomy with laparoscopic suturing. (**b**) Paired intraoperative image showing laparoscopic suturing of the common enterotomy with V-Loc barbed sutures

If an anastomotic leak does occur, it may present with peritonitis, necessitating re-exploration, or the leak may decompress through the skin as an enterocutaneous fistula. An enterocutaneous fistula typically presents a few days after resection with what initially appears to be a wound infection. Once wound discharge becomes enteric, the diagnosis of enterocutaneous fistula can be established with certainty. Some enterocutaneous fistula will close spontaneously, although it may take several weeks of bowel rest and parenteral nutrition for complete resolution.

Anastomotic Stricture

The three factors thought to cause anastomotic stricture are technical error, ischemia, or tension on the anastomosis. The technical errors that most frequently result in anastomotic stricture include creation of an inadequate size opening (i.e., using short staple load), incorporating excess bowel wall in a stapled enterotomy closure, and bleeding with hematoma at the anastomotic site. Tension on the anastomosis may result in leakage or complete disruption. Occasionally, subclinical anastomotic leaks may result in anastomotic scarring and narrowing of the lumen.

Recognition of intraoperative technical errors is critical. If an error is recognized, it is highly recommended to redo the anastomosis. When anastomotic strictures are recognized during the postoperative period, the severity of the obstructive symptoms dictates whether reoperation and revision of the anastomosis is indicated. In some circumstances, anastomotic strictures can be dilated endoscopically.

Small Bowel Obstruction

Abdominal adhesions are one of the most common causes of postoperative small bowel obstruction. Even though adhesions can occur after any intra-abdominal operation, they tend to be less common following laparoscopic surgery. It is unknown why some patients form diffuse adhesions, while others remain adhesion-free even after multiple laparotomies. While there is no certain way to avoid this problem, limiting the amount of dissection and intraoperative hemorrhage may limit the extent of postoperative adhesions. Early postoperative small bowel obstruction after laparotomy should initially be managed with bowel rest, nasogastric tube decompression, and intravenous fluid support. Although cases of small bowel obstruction following laparoscopic surgery are rare, conservative management is not advised, as many of the cases are caused by a single adhesive band resulting in angulation or kinking of the bowel [9, 10]. Reoperative laparoscopic surgery is advised for early postoperative small bowel obstruction after laparoscopic surgery.

Prolonged Postoperative Ileus

Some degree of postoperative ileus is expected after small bowel surgery, but the minimally invasive approach often shortens its duration. The signs and symptoms of postoperative ileus may include a lack of intestinal peristalsis, abdominal bloating and distention, nausea, and vomiting. Prolonged postoperative ileus should raise the suspicion of a postoperative intra-abdominal infection, particularly an anastomotic leak. The condition must be differentiated from mechanical obstruction with physical examination and radiographic imaging (abdominal X-ray or computed tomography). Treatment for ileus is nonoperative and consists of intravenous fluids and bowel rest until bowel function resumes [11].

Short Bowel Syndrome

Short gut syndrome may develop as a result of excessive resection of the small bowel, leading to a malabsorptive state. The minimum length of bowel necessary to prevent short bowel syndrome is approximately 2 m, but this varies

significantly among individuals. Children can adapt better than adults in tolerating massive bowel resection, since over time intestinal adaptation can occur allowing relatively normal intestinal function. A shorter length of small bowel can be tolerated if the ileocecal valve and pylorus remain intact. Tailored enteral diets have been created to maximize digestion, and total parenteral nutrition (TPN) can be used to supplement oral intake.

Conclusion

Small bowel resections are very common in the adult and pediatric general surgery practice. The reasons for performing a small bowel resection are numerous and include bowel obstruction, vascular damage, hemorrhage, neoplasms, inflammatory diseases, fistulas, and congenital anomalies. In spite of the numerous indications, the approach is generally similar for each situation. We usually prefer a totally laparoscopic approach. However, the main disadvantages of a complete laparoscopic small bowel resection are (1) the unavoidable contamination of the abdominal cavity when the bowel is transected, (2) the slightly longer operative times, and (3) the limited tactile feedback and intraluminal surveillance of the staple line for hemostasis.

References

1. Adams S, Wilson T, Brown AR. Laparoscopic management of acute small bowel obstruction. Aust N Z J Surg. 1993;63:39–41.
2. Bowles TL, Amos KD, Hwang RF, et al. Small bowel malignancies and carcinoid tumors. In: Feig BW, editor. The MD Anderson surgical oncology handbook. 5th ed. Philadelphia: Lippincott Williams & Wilkins; 2012.
3. Duh QY. Laparoscopic procedures for small bowel disease. Baillieres Clin Gastroenterol. 1993;7:833–50.
4. Lange V, Meyer G, Schardey HM, et al. Different techniques of laparoscopic end-to-end small-bowel anastomoses. Surg Endosc. 1995;9:82–7.
5. Schlinkert RT, Sarr MG, Donohue JH, et al. General surgical laparoscopic procedures for the "non-laparologist". Mayo Clin Proc. 1995;70:1142–7.
6. Scoggin SD, Frazee RC, Snyder SK, et al. Laparoscopic-assisted bowel surgery. Dis Colon Rectum. 1993;36:747–50.
7. Soper NJ, Brunt LM, Fleshman J Jr, et al. Laparoscopic small bowel resection and anastomosis. Surg Laparosc Endosc. 1993;3:6–12.
8. Waninger J, Salm R, Imdahl A, et al. Comparison of laparoscopic handsewn suture techniques for experimental small-bowel anastomoses. Surg Laparosc Endosc. 1996;6:282–9.
9. Chopra R, McVay C, Phillips E, et al. Laparoscopic lysis of adhesions. Am Surg. 2003;69:966–8.
10. Ibrahim IM, Wolodiger F, Sussman B, et al. Laparoscopic management of acute small bowel obstruction. Surg Endosc. 1996;10:1012–5.
11. Soybel DI, Landman WB. Ileus and bowel obstruction. In: Mulholland MW, Lillemoe KD, Doherty GM, Maier RV, Simeone DM, Upchurch GR, editors. Greenfield's surgery scientific principles and practice. 5th ed. Philadelphia: Lippincott Williams & Wilkins; 2011.