



Right and Extended Right Hemicolectomy (Open, Laparoscopic)

56

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Indications

- Colon cancer
- Appendiceal cancer or neoplasm with unfavorable features
- Large colon polyps, not amenable to endoscopic removal
- Ileocolic Crohn disease
- Arteriovenous malformations, not amenable to endoscopic ablation
- Cecal volvulus
- Ischemia
- Right-sided diverticulitis

The extent and approach may vary depending on the nature and location of the target pathology, possible underlying risk constellations (hereditary cancer, inflammatory bowel disease), and the chosen technique (open versus minimally invasive).

Preoperative Preparation

- Review the patient's history, diagnosis, functional aspects, and appropriate indication for surgery (based on endoscopic, clinical, or radiographic means) as opposed to nonsurgical management (e.g., systemic chemotherapy).
- Ascertain the exact location of the pathology (endoscopy, imaging); if the location is uncertain or if there is potentially a chance for an endoscopic removal of the lesion, plan for a repeat colonoscopy with EMR, tattooing, or

consider a combined endoscopic-laparoscopic surgery (CELS).

- Colonoscopy to determine the nature of the pathology (benign vs malignant), assess whether it is amenable to endoscopic removal, and to exclude synchronous pathology.
- Cross-sectional imaging (CT/MRI): Assess resectability and rule out systemic disease.
- In patients on chemotherapy or immunosuppressants: Plan for optimal timing of surgery.
- Depending on the specifics (e.g., large tumor, severe inflammation): possible ureteral stent placement.
- Mechanical bowel preparation: Not mandatory but advantageous if intraoperative colonoscopy planned, or to do intracorporeal anastomosis.
- Antibiotic prophylaxis (versus treatment).

Pitfalls and Danger Points

- Oncologically inferior resection
- Injury to duodenum, liver, and gallbladder
- Injury to right ureter
- Hemorrhage: most dangerous from branches of the superior mesenteric vein or the mid colic artery
- Unplanned enterotomy or colotomy
- Retrorenal dissection
- Anastomotic leak, or twist
- Internal hernia

Operative Strategy

Localization of Target Lesion

For any colon resection, exact localization of the target lesion is of utmost importance. Some lesions are large enough that they can be identified on a CT scan or other radiological

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images. Other lesions are visible on the same colonoscopy image as definitive landmarks (ileocecal valve, appendiceal orifice). The remainder of lesions, however, requires preoperative localization and tattooing. The colonoscopic tattoos should be injected in three quadrants deeply into the bowel wall to be visible on the serosal side. It should be clearly documented where the tattoos are placed in relation to the lesion (distal, at the site, etc.). Further, endoscopic clip placement with immediate abdominal X-ray in the recovery room after endoscopy can be helpful in defining the tumor location.

Surgical Approach

Traditionally, colon surgery including right colectomy was approached and described as open surgery, for example, through a midline or a transverse incision. Minimally invasive approaches (laparoscopic or robotic surgery), however, have dramatically evolved and in many circumstances are considered the first choice.

Extent of the Resection

One of the first decisions to be made is to define the extent of the resection (Fig. 56.1a–c). In benign disease, the resection is directly related to the immediate extent of the pathology. In malignant or potentially malignant disease, quality parameters include (1) the proximal, distal, and circumferential margins, (2) an adequate lymph node harvest of at least 12 nodes per colon segment, and (3) inclusion of the respective omentum. The proximal resection is invariably at the ileum. The distal extent depends on the location of the tumor. For a cecal or ascending colon lesion, the resection should include the right branch of the mid colic artery (Fig. 56.2a); for hepatic flexure or transverse colon lesions, the base of the mid colic artery should be taken and the colon resection extended to the distal transverse colon or even the descending colon (extended right hemicolectomy) (Fig. 56.2b). The omentum should be resected to the same extent as the colon (Fig. 56.3).

Vascular Transection

A “high ligation” of the key vessels should be performed at their point of origin. This allows for maximal nodal tissue to be incorporated in the pathologic specimen. This remains one of the most dangerous portions of the case, and care must be taken not to lose control by poorly executed ligations or by injury to the superior mesenteric artery or vein.

Often—and particularly in the case of laparoscopic surgery—it is advantageous to take the vascular supply early in the case. That means that the knowledge of the anatomy in general and related to the specifics of the case needs to be crystal clear.

The right colon is supplied by the ileocolic and the middle colic artery; a formal right colic artery is present in some cases. The middle colic artery branches early into the right and left branches. The left branch forms the marginal artery that connects to the left colic artery at the splenic flexure. This is one of the known water-shed areas between superior and inferior mesenteric artery, but the adequacy of this collateralization is variable. Commonly, but not always, this redundant blood inflow allows the distal transverse colon to survive after transection of the middle colic artery. If not, the extended right colectomy needs to include the splenic flexure. Care must be taken not to damage the marginal artery during eventual anastomosis to ensure adequate oxygenation to the anastomosis from this now sole blood supply.

Special analysis and planning of the resection extent are necessary if the inferior mesenteric artery has been previously ligated (e.g., after repair of an infrarenal aortic aneurysm or a previous rectosigmoid resection) or is found to lack adequate blood flow at the time of surgery.

Colon Mobilization

In open surgery, the mobilization of the colon from retroperitoneal attachments is the first step; it starts at the white line of Toldt and progresses in a lateral to medial fashion. In contrast, laparoscopic and robotic surgeries preferably approach the dissection from a medial to lateral approach. This allows the lateral colon attachments to keep it up and out of the way, aiding in exposure of the vascular pedicle. A gentle anterolateral retraction of the colon can flatten out the redundant mesentery and create a roadmap of the vascular supply to the right colon. It is important to be mindful of the correct plane of dissection which should be largely avascular. Too posterior dissection may result in mobilization behind the kidney and increase the risk of duodenal and ureteral injury.

Colon Resection

After transection of the vascular pedicles and the mesentery up to the terminal ileum and the predetermined marking on the colon, the resection follows. Depending on the chosen approach this can be done on the exteriorized bowel or as an intracorporeal resection and anastomosis. In select cases, an anastomosis is either not possible or not advisable, and the terminal ileum is brought out as an ileostomy (*see* Chap. 50).

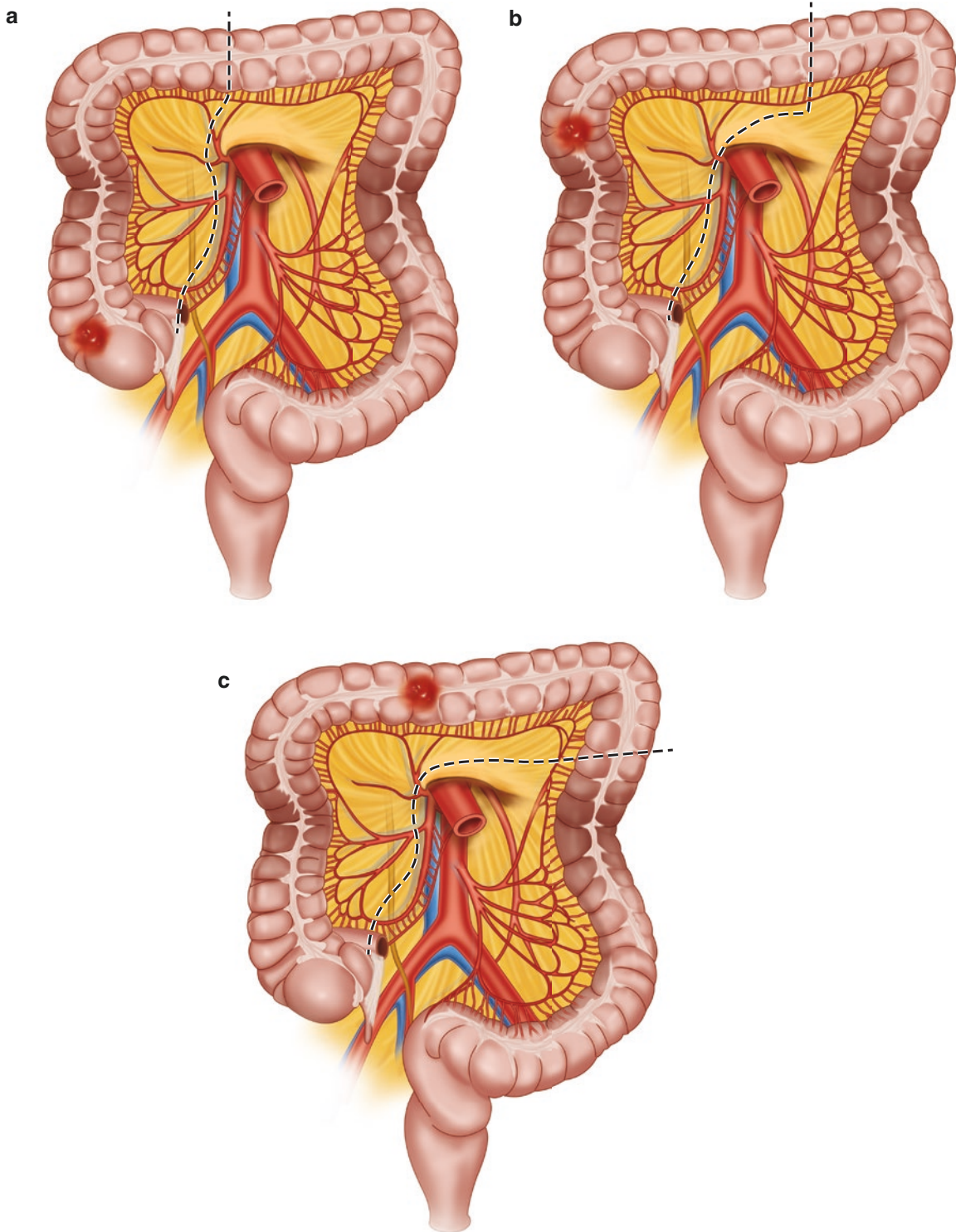


Fig. 56.1

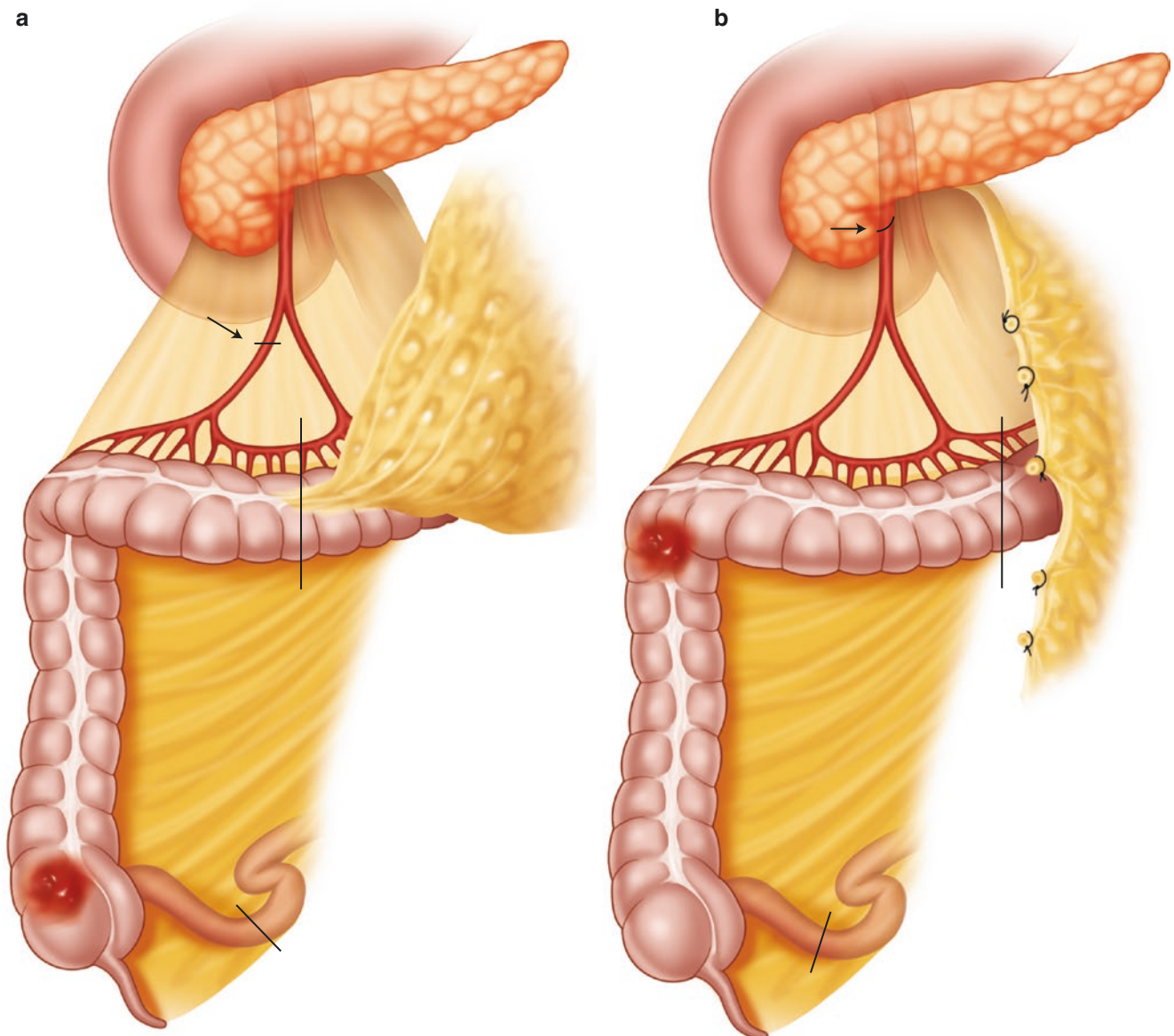


Fig. 56.2

Documentation Basics

Coding for surgical procedures is complex. Consult the most recent edition of the AMA's *Current Procedural Terminology* book for details (see references at the end). In general, it is important to document:

- Findings and indication
- Reasoning for choice and extent of surgical approach
- Surgical approach
- Blood vessels taken
- Type of anastomosis

Operative Technique

Positioning

Regardless of the approach, place and secure the patient in either supine position or in modified lithotomy on an anti-sliding system that allows for dynamic repositioning during the case. Preferably arms are to be tucked to allow best access. Place a urinary catheter to decompress the bladder and monitor intraoperative urine output. Prep and drape the patient. Monitors for laparoscopic surgery should be placed such that surgeon, target, and monitor form one line (Fig. 56.4).

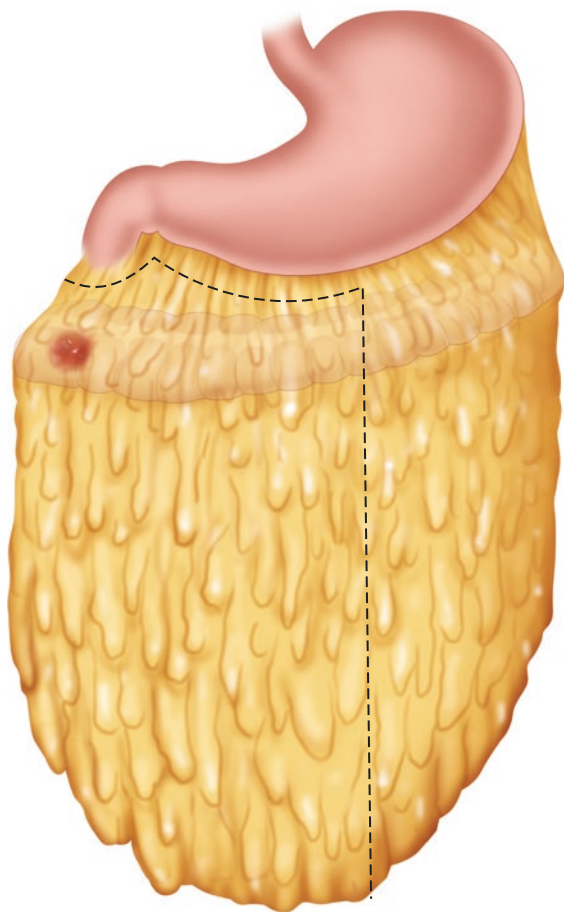


Fig. 56.3

Operative Approach and Incisions

Minimally Invasive Surgery

In regard to minimally invasive techniques, there are straight laparoscopic, single port, hand-assisted, or robotic approaches. Each platform employs a slightly different layout of their port placement. Depending on the past history, insert the first 10–12 mm trocar using the Hasson or the Veress needle technique. Insert all subsequent ports under visual control.

Pure laparoscopic techniques normally use 3–4 trocars. Insert a camera port at the umbilicus. You can later expand this incision to serve as an extraction site and to perform an extracorporeal anastomosis (unless you prefer a different location). Place 2–3 working ports that triangulate onto the ascending colon. Our preference is one in the suprapubic midline, one in the left upper quadrant, and the third one either in the left mid abdomen or in the right lower quadrant (Fig. 56.5a).

For single port or hand-assisted laparoscopy, the multi-access port and the hand port, respectively, are typically

placed at the umbilicus and later served as the extraction and anastomosis site.

Placement of the robotic trocars depends on the platform. For the most current generation of robots (the DaVinci Xi), they are placed on an oblique line from the suprapubic area to the left upper quadrant with an additional accessory port in the left lateral quadrant (Fig. 56.5b).

Open Approach

For an open approach, make a midline incision staying on the left side of the umbilicus, in the very rare event that an ostomy needs to be made. Start with a 10 cm incision and determine the individual anatomy. Depending on the needs of the variable anatomy, the incision can be left as that or be extended in one or the other direction. A wound protector is desirable.

Alternative incisions include a right transverse incision; occasionally, a right hemicolectomy is performed in conjunction with a liver resection and can typically be carried out through the hepatobiliary access.

Exploration

Once entry into the abdomen has been obtained (regardless of the platform), explore the abdomen. Perform a thorough examination of all quadrants and look for signs of tumor manifestations, for example, liver metastases, carcinomatosis, or Krukenberg tumors of the ovaries. Visualize or palpate the liver to assess for any metastatic disease. Carcinomatosis can be encountered in all quadrants but is particularly frequent in the pelvic cul-de-sac and the pericolic gutters. Next, find the site of the primary tumor, either by locating the tattoo or by gentle palpation through the colonic wall.

Identification of the Ureter

It is never wrong to look for the ureter, but not mandatory for the right hemicolectomy. If you carry out the dissection in the correct plane, the risk for a ureteral injury during a right hemicolectomy is much smaller than during a rectosigmoid resection. In patients without a lot of abdominal fat, the right ureter may be clearly visible upon entry into the abdomen. If it is not easily visible, you may find it where it is crossing the right common iliac artery near the bifurcation into the internal and external branches. If it is still not visible, the top layer of the peritoneum can be incised along planes that will be used for further steps in the surgery. Often the ureter can be seen peristalsing (“vermiculating”) in the retroperitoneal fat, particularly in response to a mechanical stimulus. In order to avoid injury throughout the rest of the case, you may

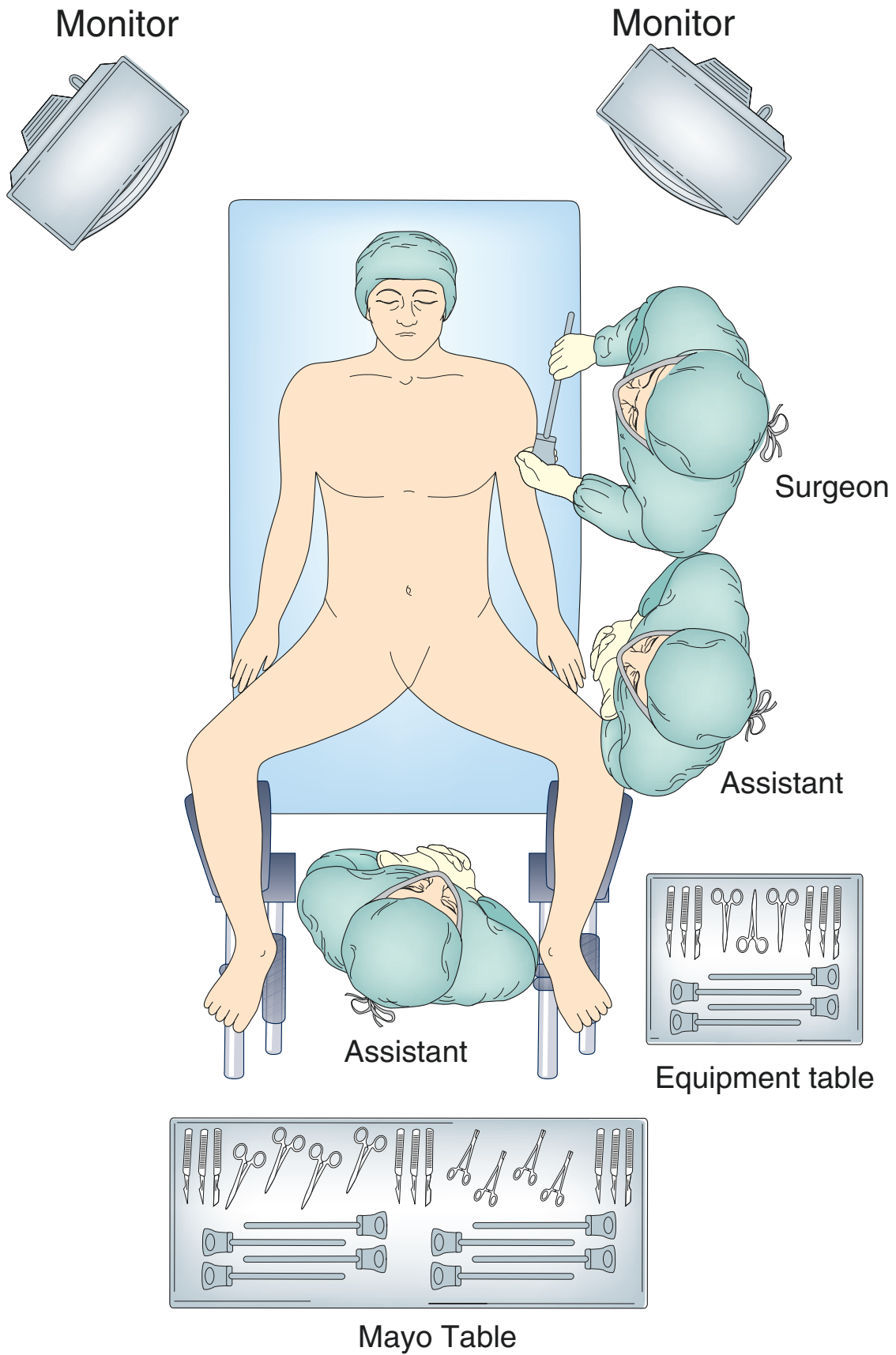


Fig. 56.4

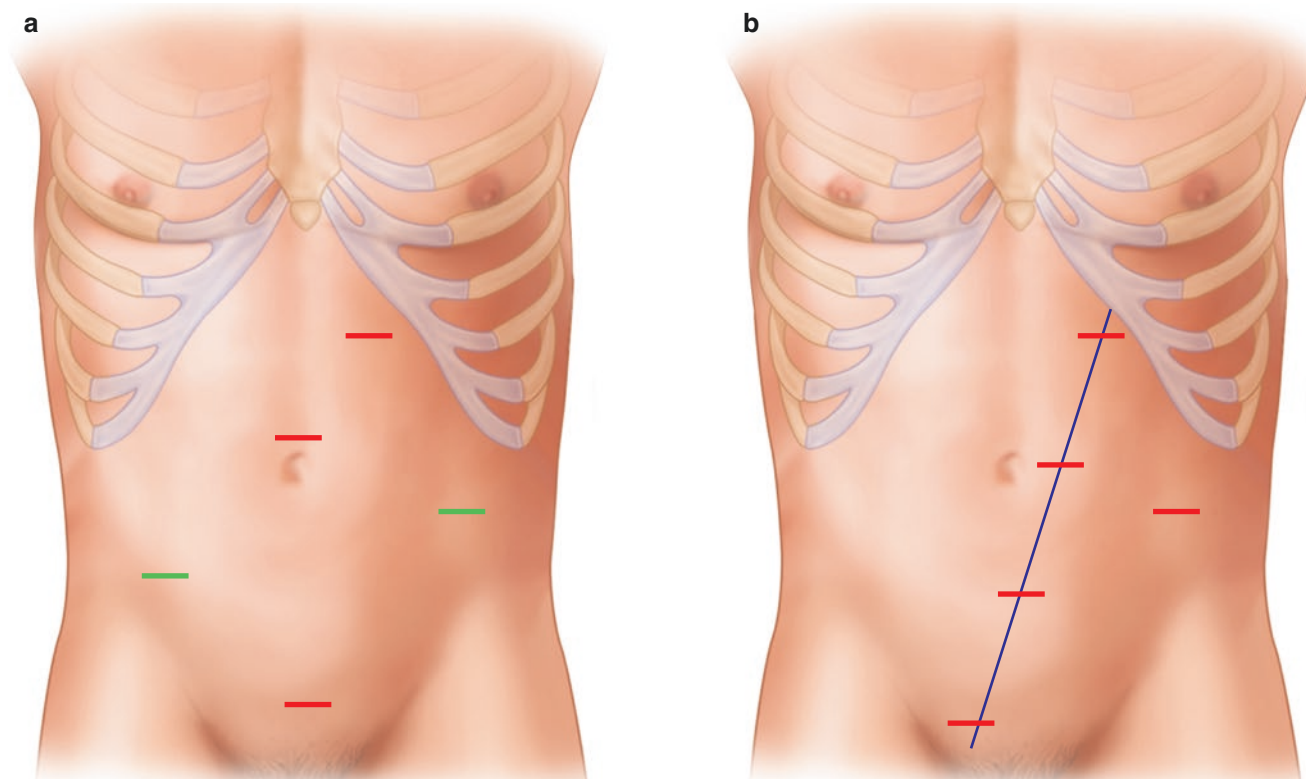


Fig. 56.5

keep the location of the ureter in the mind's eye or mark it for example by placing a clip to the fat just anteriorly to it.

Division of the Ileocolic Vessels

Grasp the mesentery at the ileocecal junction and elevate and retract it to the side. This maneuver will accentuate the ileocolic vascular pedicle. In order to increase the amount of lymphatic tissue in the specimen, plan on taking the ileocolic pedicle as close as possible to its point of origin from the superior mesenteric artery and vein without injuring either one. Score the serosa over the top at the base of it. Continue in cephalad direction to enter the retrocolic plane. Be mindful during this step that the inferior portion of the duodenum is often directly superior to the pedicle. Gently sweep the duodenum down and out of the surgical field. Complete a window around the pedicle. Sometimes, gentle dissection must be utilized to remove lymphatic and areolar tissue so that you can safely identify the vascular structures.

Transection of the ileocolic pedicle can be achieved in different ways: (1) by clamping, sharp dissection, and suture ligation; (2) isolation of each vessel, clipping, and sharp dissection; (3) vascular linear stapler; or (4) advanced energy devices (Fig. 56.6a, b). Whichever method you choose, make sure to have a clamp ready on the proximal side of the tran-

section to keep control of the vessel origin should the hemostasis not be perfect.

The next step before moving on to the colon itself entails dividing the mesentery to the terminal ileum, either by stepwise clamping and ligating or by using an advance energy device.

Colon Mobilization

Medial to lateral approach Leave the lateral attachments in place until the posterior mobilization is largely done. The attachments are a free assistant as they hold the colon up in place while you can work underneath. Once the serosa along the vascular pedicle is opened, you may elevate it and bluntly separate the colon along the avascular embryological planes. Again, pay attention to not injure the duodenum by rough movements or hot instruments. Continue until the lateral peritoneal reflection has been reached, at which point the lateral dissection is completed (Fig. 56.7a, b).

Lateral to medial approach Historically and still in open surgery, the mobilization of the colon starts at the white line of Toldt which is incised with cautery. Move your nondominant index finger underneath and retract the colon away from

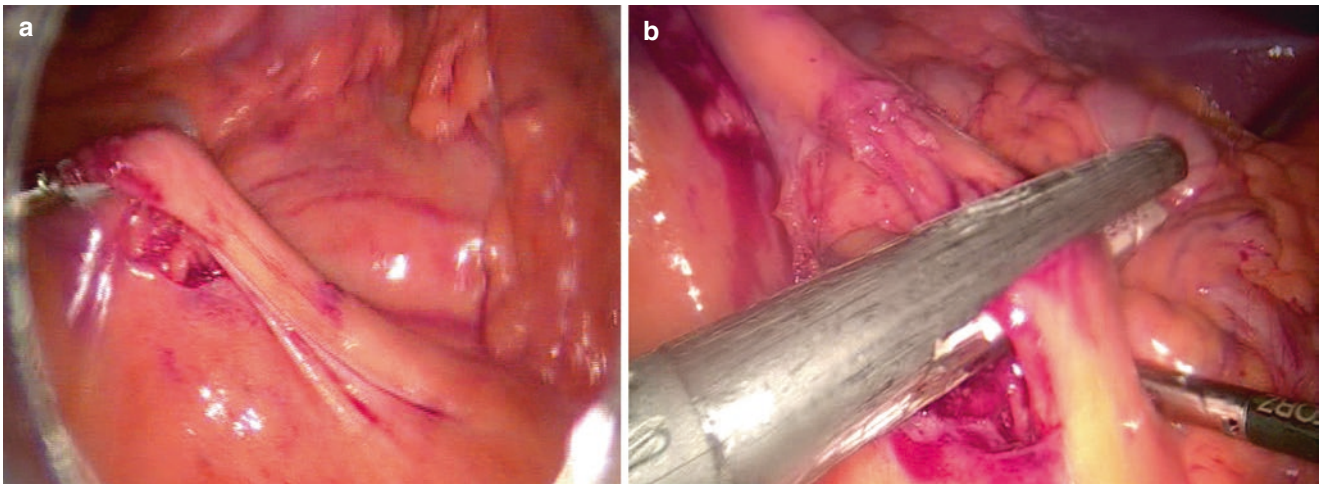


Fig. 56.6

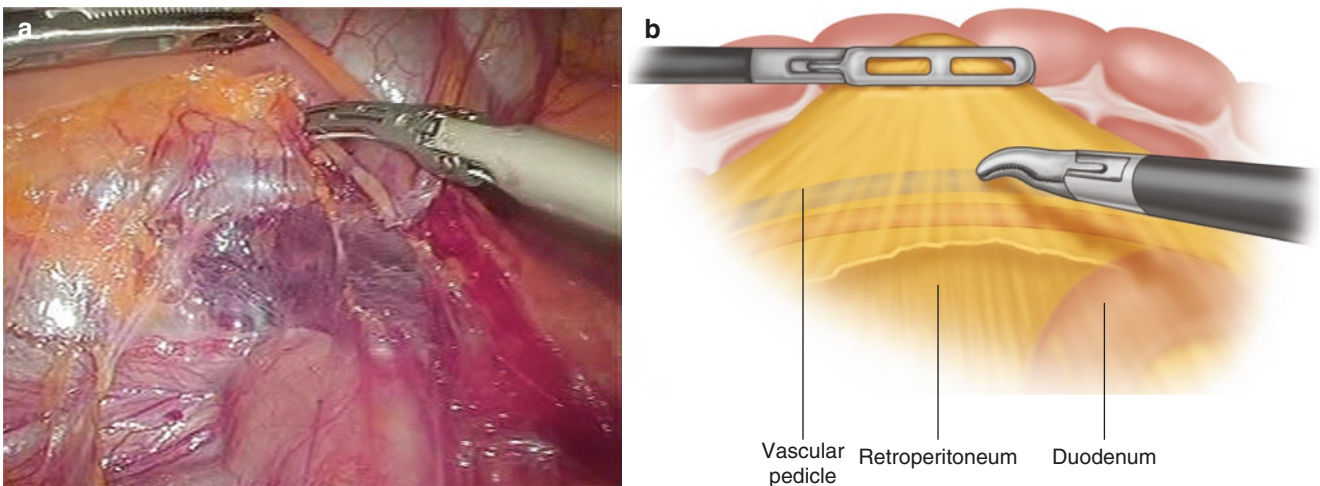


Fig. 56.7

the structures underneath. Continue incising the serosa close to the colon. Progress medially toward the pedicle (Fig. 56.8).

Division of the Middle Colic Vessels

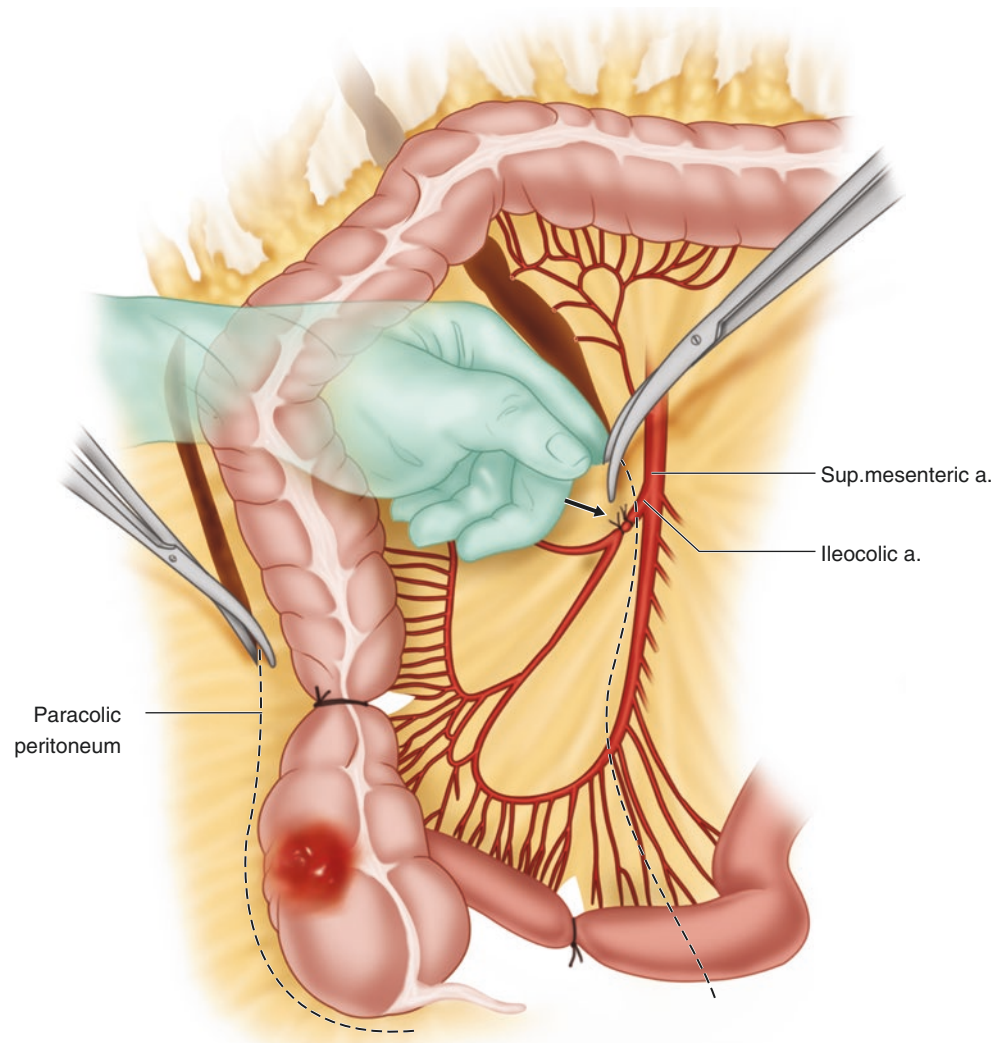
Lift the gastrocolic ligament and start dividing layer by layer until the avascular plane leading to the lesser sac is reached. Move from the mid transverse colon backward to and around the hepatic flexure and conjoin the lateral colon mobilization. Identify the mid colic vessels, that is, the main trunk and the right and left branch. For lesions in the proximal portion of the ascending colon, it suffices to divide the right branch of the middle colic artery. For lesions at the hepatic flexure or the transverse colon, the trunk of the middle colic vessel should be taken. This is a dangerous step! You need to avoid losing control. There may be dense attachments between the pancreas and the colonic mesentery that needs

to be divided. There are also collateral veins from the inferior pancreaticoduodenal vein to the middle colic vein that can cause considerable bleeding. Carefully create a window around the mid colic pedicle. Check that you are not including the superior mesenteric vessels to the small bowel mesentery. Divide the middle colic pedicle between clamps and secure both sides with suture ligatures, clips, or a stapler.

Mesentery and Omentum Roundup

Complete the division of the mesentery up to the point where you intend to resect the colon. For malignant disease, divide the omentum from its caudad free border perpendicular toward the intended site of bowel transection. You can do that either by stepwise clamp-clamp-cut-ligation or more conveniently with an advanced energy device. For benign disease, resecting the omentum is optional; if you elect to

Fig. 56.8



preserve the omentum, move it to the upper abdomen and carefully dissect it off the transverse colon by finding the avascular plane. It is often helpful to visualize the posterior side of the stomach to confirm that dissection is progressing in the correct plane.

Division of Ileum and Colon

Timing and type of bowel transection is less a question for open surgery. When using the minimally invasive platforms, the colon and ileum can be transected intracorporeally or extracorporeally. The areas of transection should have been identified earlier and the mesentery should have already been dissected off of them. Transection for the intestine is usually performed by a linear stapler device at this point. Before extraction of the colon/specimen, place a wound protector to decrease the risk of port-site recurrence and/or infection (Fig. 56.9).

Once division of the intestine has occurred, reexamine the blood supply. If this is in question, use a knife to make a nick in the bowel or mesentery to assess for bleeding. Alternatively, the minimally invasive platforms allow for injection of ICG and fluorescence imaging to assess the tissue perfusion. If the blood supply is insufficient or none, resect additional bowel until good blood supply is reached. When confident in the blood supply, verify and achieve hemostasis.

Ileo-colonic Anastomosis

Hand-Sewn End-to-End

Align the cut ends of the ileum and the transverse colon together. Make a diagonal incision in the ileum to compensate for possible size mismatch if needed (Fig. 56.10a, b). Approximate the two ends of the bowel with 3-0 Vicryl interrupted sutures. Attach hemostats to these two ends to flatten the bowel ends and make subsequent sutures easier.

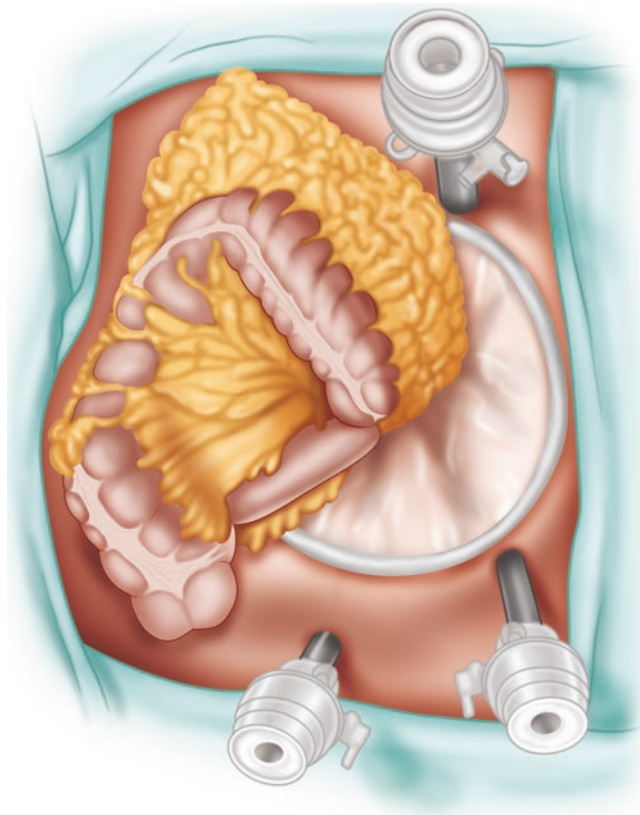


Fig. 56.9

Now place a posterior layer of interrupted seromuscular sutures in a linear fashion creating the back wall of the anastomosis. This can be achieved directly or by flipping the entire anastomosis for that step (Fig. 56.11a–c). For the mucosal anastomosis, use a double-armed 3-0 PDS to start in the middle of this back wall. With each needle, place a running suture in opposite directions. Place the full-thickness sutures to incorporate a small edge of mucosa and a larger edge on the serosal side. Once the back wall has been finished, continue these sutures along the anterior surface of the anastomosis (Fig. 56.12a–d). Add interrupted seromuscular 3-0 Vicryl sutures to complete the outer layer of the front wall (Fig. 56.13). Once all suture ends have been cut, gently palpate the anastomosis between thumb and index finger to assess potency and adequate size. Close the mesenteric defect with a running 3-0 Vicryl, making sure to take adequate but shallow bites of the mesentery to avoid injury to the mesenteric blood supply.

Stapled Functional End-to-End Anastomosis

Stapled anastomoses have become the most common technique because they are faster and convenient. Make sure that both ends are mobile and free of adhesions. Aligned the two bowel ends. You may place two holding stitches (optional) to aid with placement of the staplers. Using Mayo scissors, cut the tips of the staple line on the anti-mesenteric side and

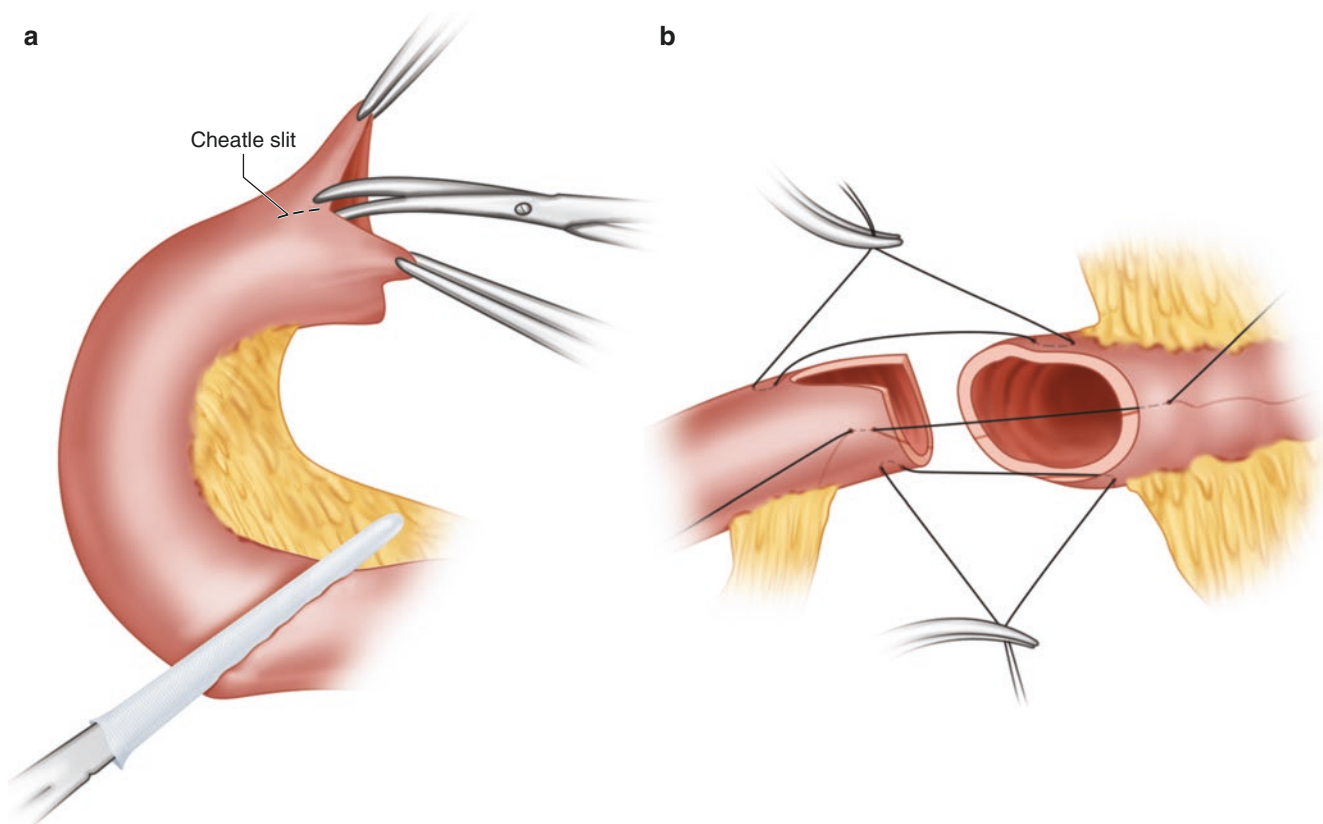


Fig. 56.10

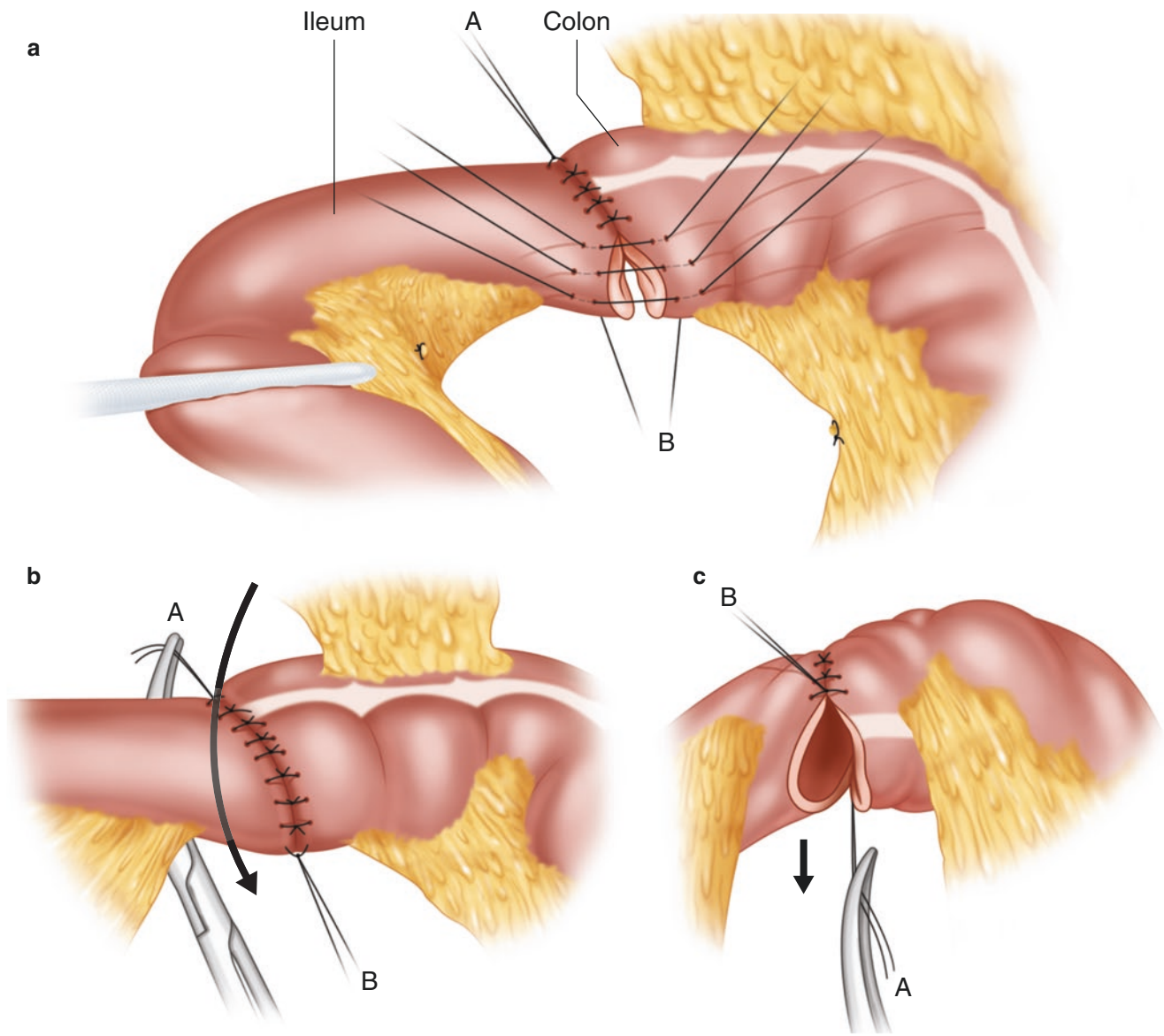


Fig. 56.11

ensure hemostasis (Fig. 56.14a). Insert one jaw of the linear stapler into either bowel and rotate the anti-mesenteric edges against each other. Check that the mesentery is not incorporated in the stapler jaws (Fig. 56.14b). Close and fire the stapler to create the common enterotomy. Place Allis clamps over the remainder of the defect ensuring that two staple

lines are shifted and are not directly opposing each other. Fire a second cartridge of the same cutting linear stapler or a non-cutting TA stapler in transverse direction to close the remaining defect (Fig. 56.15a–d). Using interrupted absorbable sutures, invert the ends of the staple lines in with Lemberting sutures. Loosely oversewing the entire anasto-

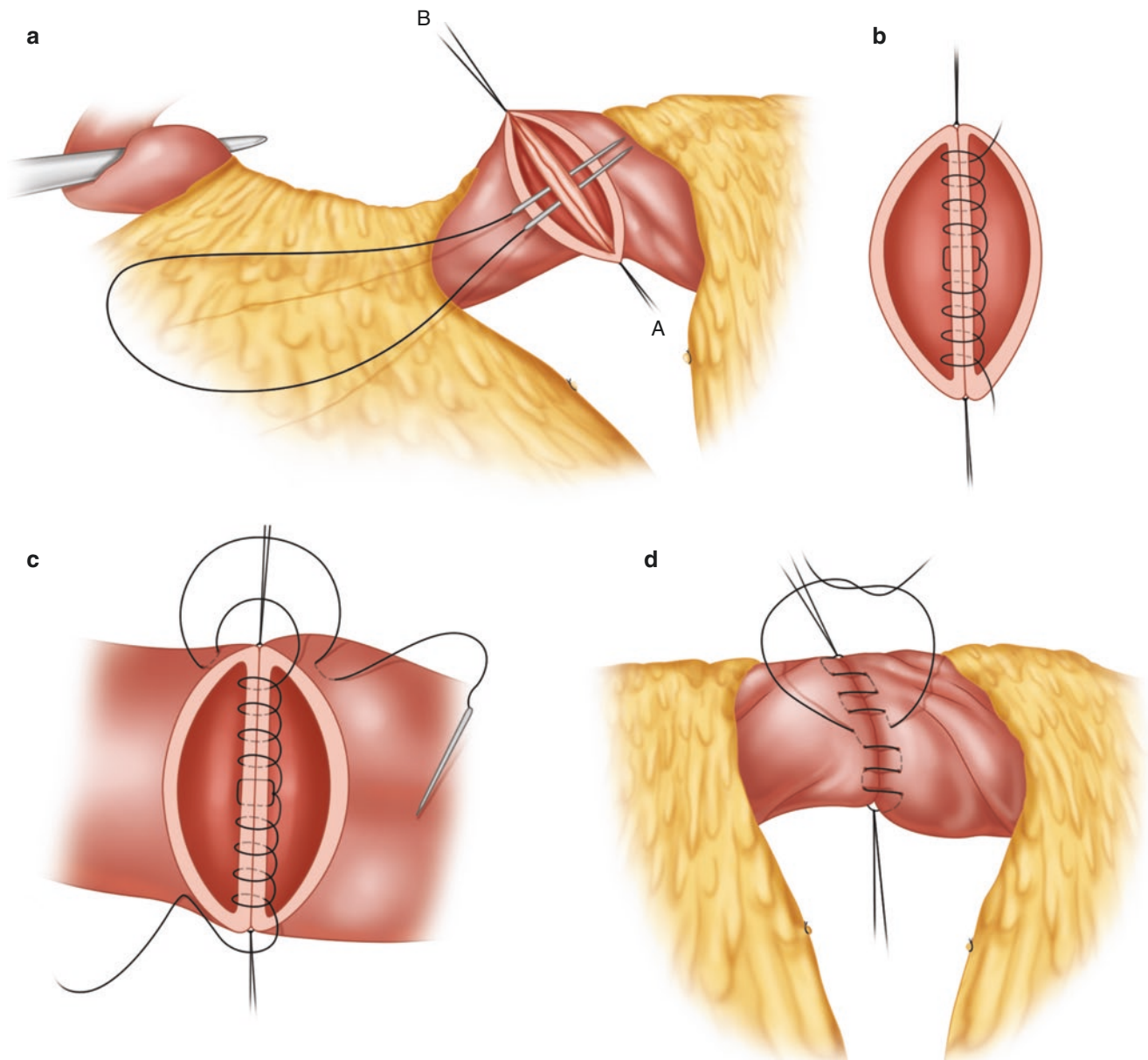


Fig. 56.12

mosis is optional but may take some tension of the staples. Close the mesenteric defect as described above.

Stapled Isoperistaltic Side-to-Side Anastomosis

Particularly with the onset of the robotic intracorporeal approach, the stapled isoperistaltic side-to-side anastomosis has gained popularity. Make sure that both ends are mobile

and free of adhesions. Align the two bowels to overlap for the length of a stapler cartridge. Place two holding stitches to aid with placement of the staplers. Using the scissors, cut a small enterotomy at the end of the small bowel and the directly adjacent area of the colon. Insert the laparoscopic/robotic linear stapler with one jaw into either bowel. Rotate the anti-mesenteric edges against each other. Visually check

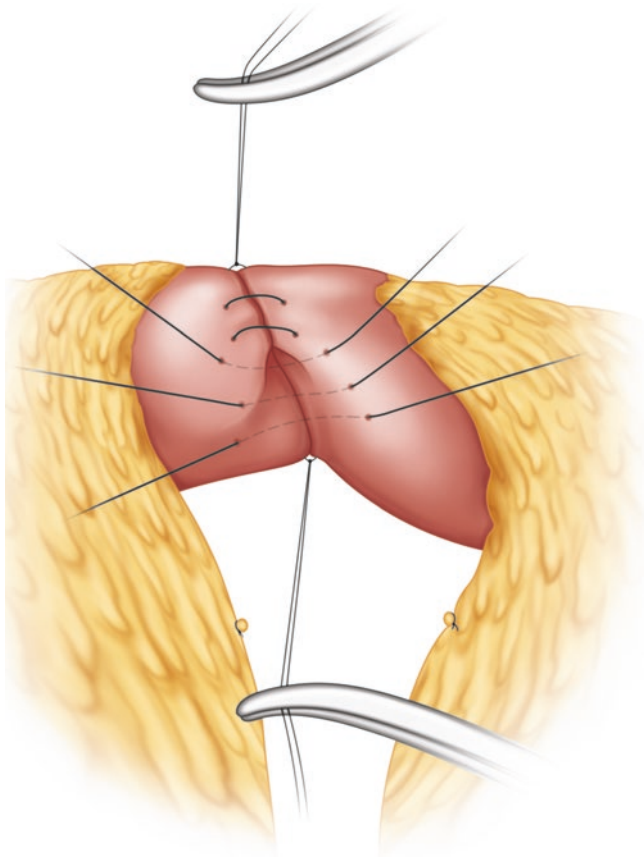


Fig. 56.13

that the mesentery is not incorporated in the stapler jaws. Close and fire the stapler to create the common enterotomy (Fig. 56.16a, b). Using laparoscopic/robotic instruments and technique, close the enterotomy in two layers using a running 3-0 PDS suture and oversew it with interrupted 3-0 Vicryl sutures.

Wound Closure

The operating team should discard soiled gloves and use new instruments to close the surgical wounds. If available, cover the anastomosis with the remaining omentum to aid in healing and deterrence of leak. Perform a last check of the abdomen. Remove the ports and/or close the fascia in routine fashion. Irrigate the wound before closing the skin.

Postoperative Care

- Antibiotics: Routine coverage for the perioperative 24-hour period. In case of an underlying infection/sepsis, continue respective therapeutic antibiotics for that indication.
- Intravenous fluids: Maintain adequate fluid until return of bowel function.
- Nasogastric tube: No routine use in elective cases; keep it in non-elective cases until evidence of return of bowel function.

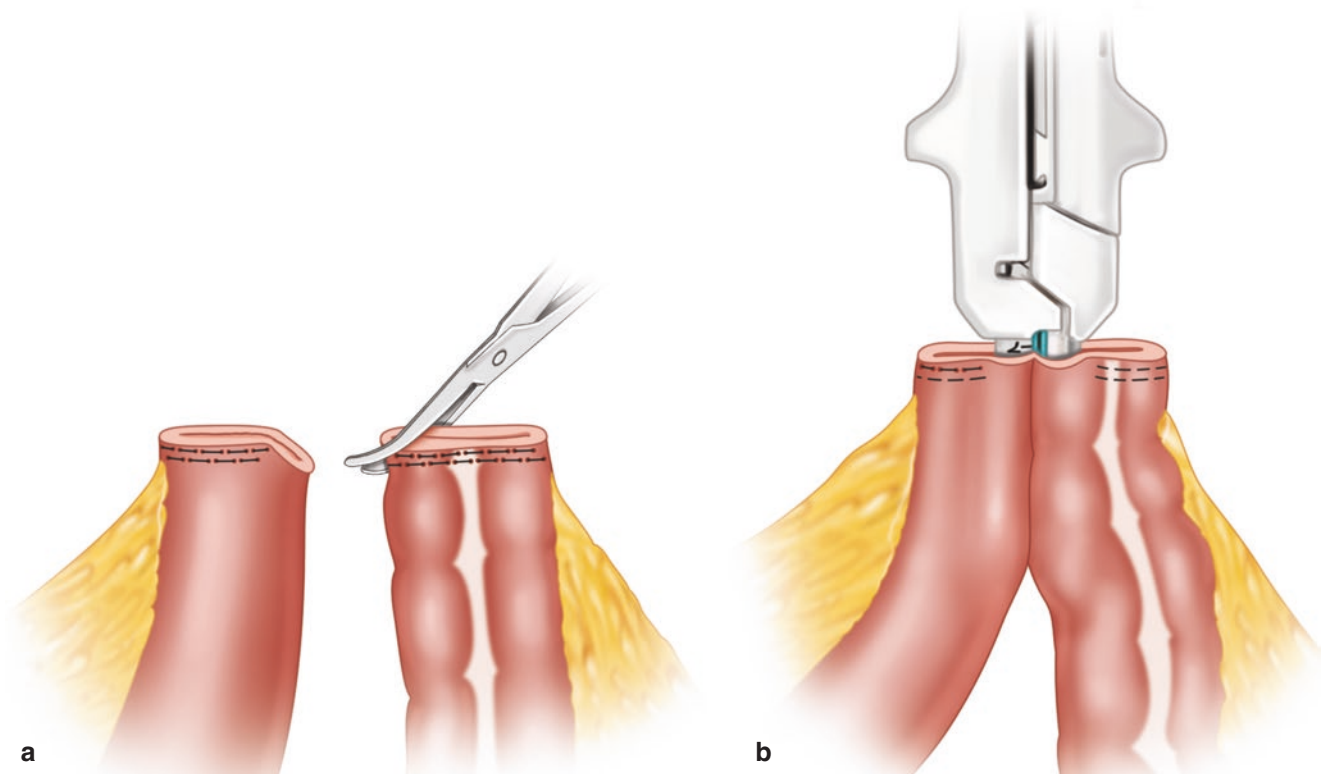


Fig. 56.14

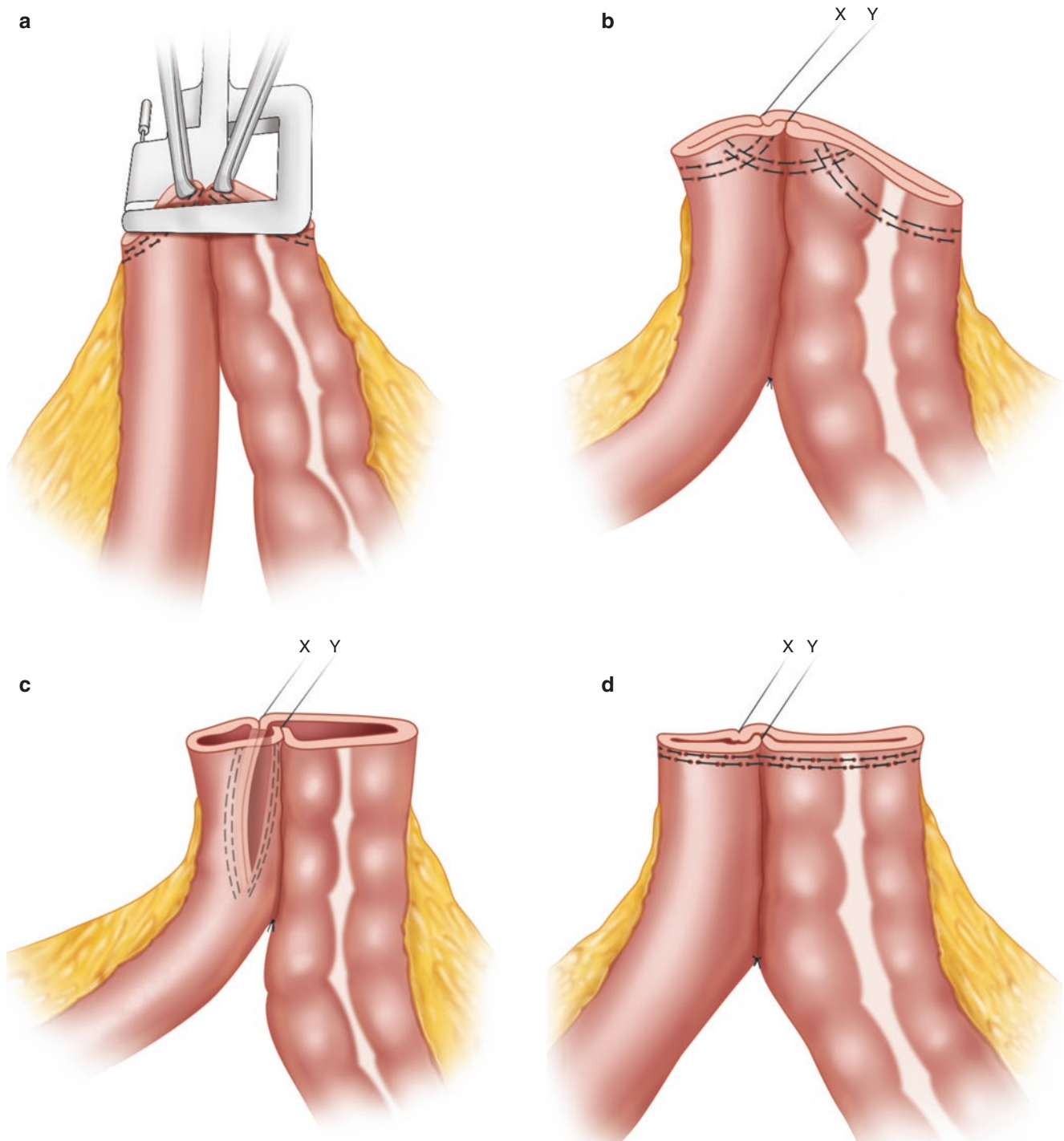


Fig. 56.15

- Enhanced recovery after surgery (ERAS) protocol: in elective cases, initiate oral intake on day of surgery and advance to solid food as patient demonstrates return of bowel function.
- Nutritional support: If a substantial portion of ileum has been removed or short-cut, plan for monthly intramuscular injections of Vitamin B12. If return of bowel function delayed by more than 5 days, initiate parenteral nutrition.
- Incentive spirometry and early ambulation should be encouraged.

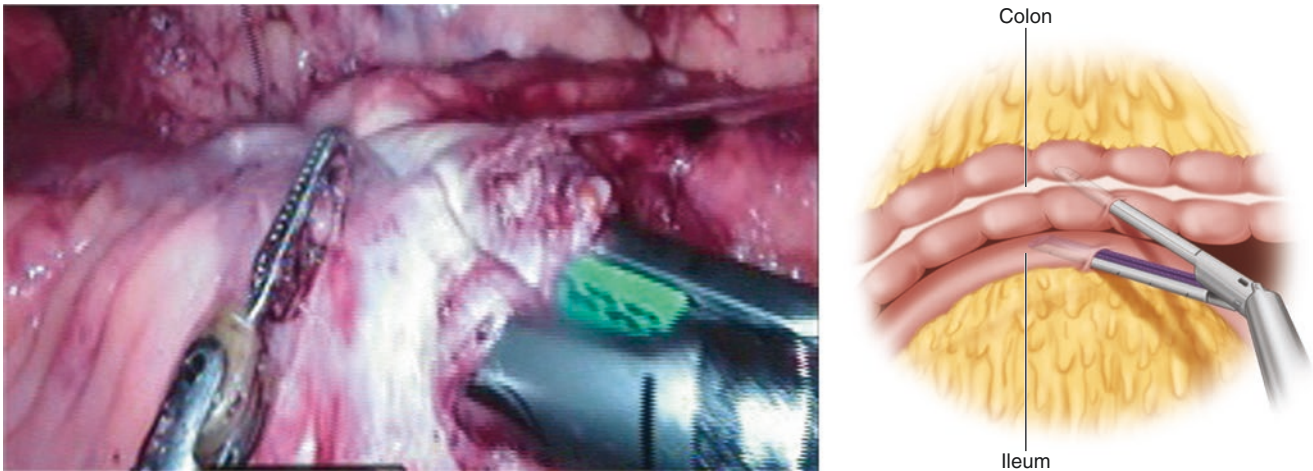


Fig. 56.16

Complications

- Anastomotic leak
- Small bowel obstruction
- Wound infection
- Port-site hernia
- Injury to superior mesenteric vessels with thrombosis or ischemia

Further Reading

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