31 Pearls for the Small Bowel and Colon That Will Not Reach

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Introduction

Colorectal operations involve two phases: resection of target pathology and then reestablishment of gastrointestinal continuity. When intra-abdominal continuity cannot be fully established, stomas are constructed. In either scenario, surgeons may face a stressful situation in which the small bowel or colon "just does not reach," either to the distal end for an anastomosis, or to the skin, to construct a stoma. This chapter will describe the techniques and operative pearls on making difficult reconstructions possible.

We can classify most colorectal operations by their levels of resection and matching reconstruction (Table 31.1). Most reconstruction problems occur after very distal rectal resections. For example, a low anterior resection almost always requires, at the very least, mobilization of the descending colon from the retroperitoneum and splenic flexure for a tension-free colorectal anastomosis. A right colectomy, on the other hand, does not require extensive mobilization of the ileum or transverse colon to create the ileo-transverse anastomosis because the mesentery at both ends is not retroperitoneal.

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Perhaps the most critical point when dealing with the bowel that "does not reach" lies with preemptive planning. For any colorectal operation that will require reestablishment of gastrointestinal continuity, the surgeon should have a preoperative plan of what needs to be done for reconstruction after the specimen is resected. Patients should therefore be positioned to enable splenic flexure mobilization, for example, along with having the necessary equipment for mobilization maneuvers no matter the approach (open, hand-assisted laparoscopy, or purely laparoscopic). These strategies should be conveyed to both the patient and the surgical team so that any unexpected surprises can be mitigated.

Anatomic Constraints

The primary concern in difficult bowel reconstruction is a tenuous and unsafe anastomosis. Multiple studies have demonstrated both "local" and "systemic" factors that contribute to poor anastomotic healing [1–4]. During an operation, the surgeon has immediate control of the local factors and a tension-free anastomosis with adequate blood supply is the most critical technical point that needs to be achieved to decrease the risk of anastomotic leak. Successful mobilization of the small bowel and colon to create tension-free anastomoses or stomas requires a clear understanding of their anatomic attachments. These attachments include (1) embryonic fusion planes, (2) peri-organ "ligaments," and (3) vascular pedicles that can be ligated to maximize

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Table 31.1 Classic colorectal operations and reconstruction techniques

	Reconstruction
Segmental resection	
Proximal	
Small bowel resection	Enteroenterostomy
Ileocecectomy	Ileo-ascending colostomy
Right colectomy	Ileo-transverse colostomy
Middle	
Right extended colectomy	Ileo-transverse colostomy
Transverse colectomy	Colocolostomy
Left extended colectomy	Colocolostomy
Distal	
Left colectomy	Colocolostomy
Sigmoidectomy	Colorectostomy
Low anterior resection	Colorectostomy
Proctectomy	Coloanal anastomosis
Nonsegmental resection	
Subtotal colectomy	Ileo-sigmoid colostomy
Total abdominal colectomy	Ileorectostomy
Total proctocolectomy	Ileo-anal anastomosis

mobility while preserving necessary blood supply (Fig. 31.1).

The small bowel is tethered to the posterior abdomen in an obliquely arranged mesentery that runs diagonally from the ligament of Treitz in the left upper quadrant to the right lower quadrant. The small bowel mesentery is usually very mobile with retroperitoneal fixation only at the ligament of Treitz and near the terminal ileum as it joins the retroperitoneal cecum and right colon. The right colon mesentery posteriorly abuts the right kidney, right ureter, and duodenum. After turning at the hepatic flexure, the transverse colon emerges from the retroperitoneum and its mesocolon is usually mobile before fixation into the splenic flexure. At this juncture, the left colon becomes retroperitoneal and its mesentery posteriorly abuts the left kidney. The splenic flexure is additionally fixated by the greater omentum and several peri-organ "ligaments" (splenocolic, renocolic, pancreatocolic, and phrenocolic ligaments). The sigmoid colon is nonperitonealized and usually held by a few lateral attachments as its mesentery courses over the left ureter and gonadal vessels. As the tenia disappears, the rectum begins intraperitoneally at the sacral promontory before traveling under the peritoneal reflection with its mesorectum to the pelvic floor and anorectal junction.

While mobilizing the small bowel and colon from the retroperitoneum and peri-organ attach-

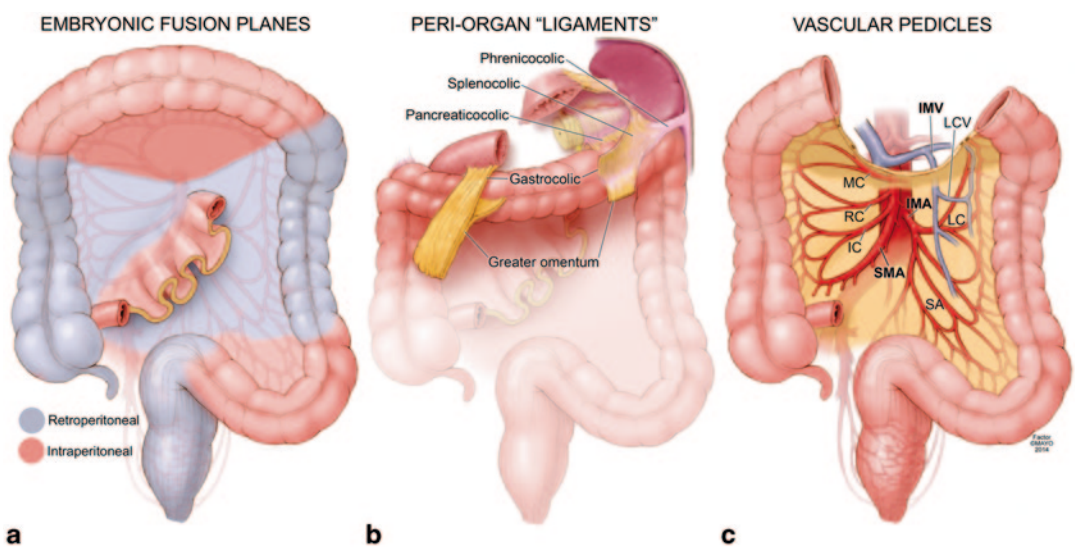

Fig. 31.1 Anatomic constraints within the abdomen. *Highlighted* are the embryonic fusion planes (**a**), peri-organ ligaments (**b**), and vascular pedicles that are the targets of primary and secondary mobilization techniques (**c**). *SMA* superior mesenteric artery, *IMA* inferior mesenteric artery, *IMV* inferior mesenteric vein, *IC* ileocolic artery, *RC* right colic artery, *MC* middle colic artery, *LC* left colic artery, *SA* sigmoid arteries, *LCV* left colic vein. © Mayo Clinic

Table 31.2 Mobilization techniques for difficult reconstructions

Maneuvers	Goals of maneuver	Examples
Primary	Separation of embryonic fusion planes	Cattell and Mattox maneuvers
	Division of peri-organ "ligaments"	Splenic flexure mobilization
Secondary	Ligation of vascular pedicles	Ligating the ileocolic artery during IPAA
	Preservation of collateral blood supply	Preserving the middle colic artery to supply ileal pouch
Tertiary	Extended resection to mobile proximal bowel	Completion colectomy
	Stoma construction	End ileostomy or colostomy

ments such as the spleen and omentum is often sufficient to provide needed reach, these "first-line" maneuvers simply free, but preserve embryonic planes. Secondary and more advanced maneuvers exploit the vascular tethers within the mesentery. These vessels include the superior mesenteric artery (SMA) and its branches (the ileocolic, right colic, and middle colic artery), the inferior mesenteric artery (IMA) and its branches (the left colic, sigmoid, and superior rectal artery), and the inferior mesenteric vein (IMV). Thoughtful and directed transection of these vessels while relying on collateral blood flow can provide significantly more reach while maintaining a tension-free anastomosis with adequate blood supply.

Diagnosing the Problem

Surgical trainees are taught that a successful anastomosis is one that is tension-free and well-vascularized. But is there a way to quantify how much tension is allowable for an anastomosis to be safe? Is there a way to quantify if adequate blood supply is reaching an anastomosis? These are critical questions that are always asked during mortality and morbidity conferences when presenting an anastomotic leak case, but unfortunately our ability to answer these questions with objective data is limited. On the contrary, we often rely on past experience and make clinical judgments when making these decisions.

Probably the simplest way to ask if an anastomosis is under tension is to lay the proximal and distal bowel ends in the field without any pulling or pushing. If the ends overlap each other by at least 5 cm, one can presume that there will be minimal to no tension on the anastomosis. When we need to pull inferiorly on the proximal end, or superiorly on the distal end, there will be problems and further mobilization needs to be performed. Similarly, during ileal-pouch anal anastomoses (IPAA), we use the inferior edge of the pubis symphysis as a rough estimate of adequate length if the apex of the pouch can reach it without tension.

Blood supply can be initially assessed with the gross appearance of the proximal and distal ends of the bowel. Completely ischemic tissue will have an obvious black-blue, discolored appearance, but this assessment is easiest at the extreme end of ischemia. In reality, bowel ends could be bruised, or "dusky," and a clinical judgment needs to be made on its viability. In these cases, we observe whether there was bleeding at the anastomotic line during transection or use the Doppler to assess for blood flow. While somewhat rudimentary, we find these methods useful in those moments of doubt. Future diagnostic tests may include using intraoperative indocyanine green (ICG) angiography, which shows promise in distinguishing anastomotic ends with poor perfusion [5].

Specific Techniques: Making It Reach

When presented with the bowel that cannot reach, mobilization should begin in a sequential and logical fashion that uses defined technical principles to remove anatomic constraints (Table 31.2). **Primary** maneuvers include (1) mobilizing embryonic planes and (2) dividing peri-organ "ligaments" or attachments. **Secondary** maneuvers include directed ligation of vascular pedicles that restrict the mobility of the corresponding proxi-

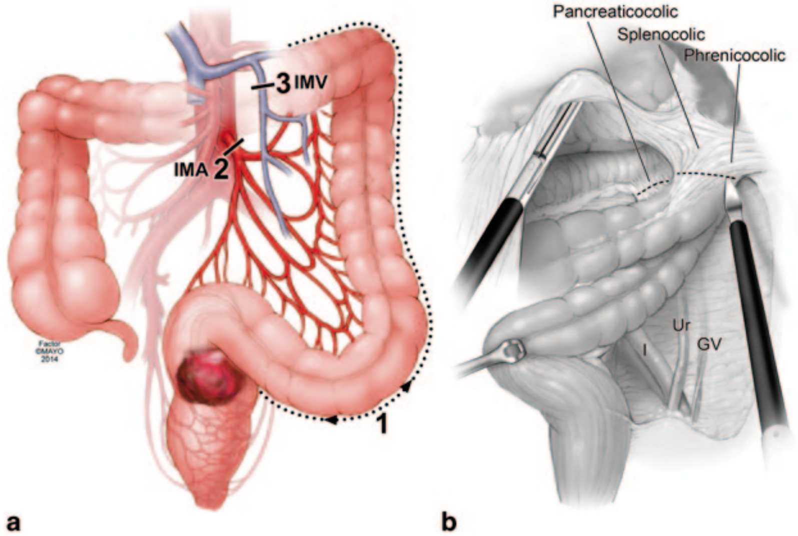

Fig. 31.2 Overview of primary and secondary maneuvers for colorectal and coloanal anastomoses. **a** Lateral-to-medial dissection proceeds with (*1*) mobilizing the line of Toldt and splenic flexure, (*2*) high ligation of the inferior mesenteric artery (*IMA*), and (*3*) high ligation of the inferior mesenteric vein (*IMV*) to provide maximum bowel length for a colorectal or coloanal anastomosis. A medial-to-lateral dissection proceeds in another order with (*2*) high ligation of the IMA, (*3*) high ligation of the IMV, and finally (*1*) mobilization of the retroperitoneal embryonic plane. **b** Critical retroperitoneal structures that can be identified during mobilization of the left colon are illustrated including the left iliac artery (*I*), left ureter (*Ur*), and left gonadal vessels (*GV*). Splenic flexure mobilization involves ligating the splenocolic, phrenicocolic, and pancreaticolic ligaments. © Mayo Clinic

mal bowel. Often, these vascular ligations are already part of the oncologic resection. **Tertiary** maneuvers include more extended bowel resections to reach a mobile proximal portion of bowel versus the construction of a stoma if no tension-free option is possible. To illustrate these principles, we describe several challenging operative situations in which multiple strategies may be necessary to achieve intestinal continuity.

Colorectal and Coloanal Anastomosis

Primary reconstruction of the distal gastrointestinal tract after resection of the left colon, sigmoid, and/or rectum requires a colorectal or coloanal anastomosis. The construction of a tension-free anastomosis requires significant mobilization for the proximal bowel to reach into the pelvis and can be performed using open or minimally invasive techniques.

Primary maneuvers separate the left colon from its retroperitoneal and peri-organ attachments. This maneuver can be done using a lateral-to-medial or medial-to-lateral approach (Fig. 31.2). Either approach is effective and depends on the surgeon's experience, training, and comfort level. The medial-to-lateral approach immediately identifies and ligates vascular pedicles such as the IMA and IMV before dissecting "underneath" the retromesenteric plane to the lateral line of Toldt and splenic flexure. The lateral-to-medial approach is more classically taught and equally effective, and both techniques have been thoroughly described before [6–8]. As such, we will go over general principles and add our specific commentary and operative pearls.

Lateral-to-Medial Approach

For a lateral-to-medial approach, we first open the line of Toldt at the pelvic brim to enter the retromesenteric space (Fig. 31.2). With firm counter-traction on the colon medially, the white, wispy, and avascular fibers marking the embryonic, retromesenteric fusion plane can be visualized and dissected bluntly, sharply, or with electrocautery. The retroperitoneum, gonadal vessels, and left ureter remain undisturbed posteriorly and the dissection is continued superiorly toward the splenic flexure. One of the teaching points during this maneuver is to keep closer to the colon edge and to avoid laterality once the line of Toldt is incised. If the latter is done, then the dissection will actually come around the retroperitoneum rather than the colon mesentery, and the left kidney will be elevated. The colon mesentery will often maintain a sheer glistening layer of parietal peritoneum that can be used to distinguish from the underlying fat of the retroperitoneum.

As the surgeon works superiorly, the left kidney will be encountered posteriorly with its overlying Gerota's fascia. The kidney should remain undisturbed, and any bleeding suggests that the wrong plane has been entered. With firm medial and inferior traction on the colon, the splenic flexure can be approached laterally while staying close to the colon to avoid "wandering off" into the more lateral retroperitoneum and sometimes thick omental attachments. Tension lines should be demonstrated and sharply cut, cauterized, or divided with energy devices. The goal is to enter the lesser sac which would signify the surgeon coming "around the bend" of the splenic flexure. Often there is abundant omentum that will need to be dissected free from the distal transverse colon and its epiploica. If there is difficulty freeing the splenic flexure with a lateral, counterclockwise approach, then the surgeon should switch to a medial, clockwise approach by flipping the omentum superiorly and detaching the inferior omental leaflet from the mid-transverse colon to enter the lesser sac. Once the lesser sac is entered, then the surgeon can approach the splenic flexure medially to join the lateral dissection.

Mobilizing the splenic flexure is an important first step in distal reconstructions such as colorectal or coloanal anastomoses. Cadaveric studies have shown that an additional 10–28 cm of colonic length can be gained with mobilization of the splenic flexure and distal transverse colon [9, 10]. Some surgeons advocate splenic flexure mobilization at the very beginning of the operation to avoid any future debate at the end of a long resection, while others advocate selective use of the technique on an as-needed basis depending on colon redundancy [9]. It is our routine practice to mobilize the splenic flexure preceding an anticipated mid-rectal to coloanal anastomoses.

If the proximal colon cannot reach the distal rectum or anus for a tension-free anastomosis after splenic flexure mobilization, then secondary mobilization techniques are employed (Fig. 31.3). These maneuvers involve ligating the vascular pedicles on the left colon/rectal mesentery including the IMA and the IMV. During oncologic resections, these vessels are usually taken anyways as part of the specimen, but in benign indications such as diverticular disease, these vessels may have been preserved.

Ligation of the IMA and IMV provides significant additional length to the left colon for distal anastomoses (Fig. 31.3). Cadaveric studies have shown that after primary mobilization of the left colon and splenic flexure, "high ligation" of the IMA 1 cm from the aorta and "high ligation" of the IMV superior to its junction with the left colic vein (usually at the inferior border of the pancreas) provide up to 19.1 ± 3.8 cm of additional colon length [11]. In contrast, "low ligation" of the both the IMA and IMV at the level of the left colic artery releases only 8.8 ± 2.9 cm of colon length. Ligation of the remaining left colic artery then provides an additional 8.2 ± 2.7 cm of length for a 17 ± 3.1 cm total mean gain in colon length. Ligation of the vascular pedicles at these locations can thus provide significant mobility for low pelvic anastomoses with the caveat that blood supply to the remaining colon relies on collateral supply from the middle colic and marginal arteries.

Medial-to-Lateral Approach

The medial-to-lateral approach, often used during laparoscopic approaches, begins with identification of the IMA as the sigmoid colon is held under ventral and lateral tension (Fig. 31.2). The IMA appears as a bow string in the fold of the sigmoid mesocolon. The peritoneum at the base of the mesentery is scored above and parallel to

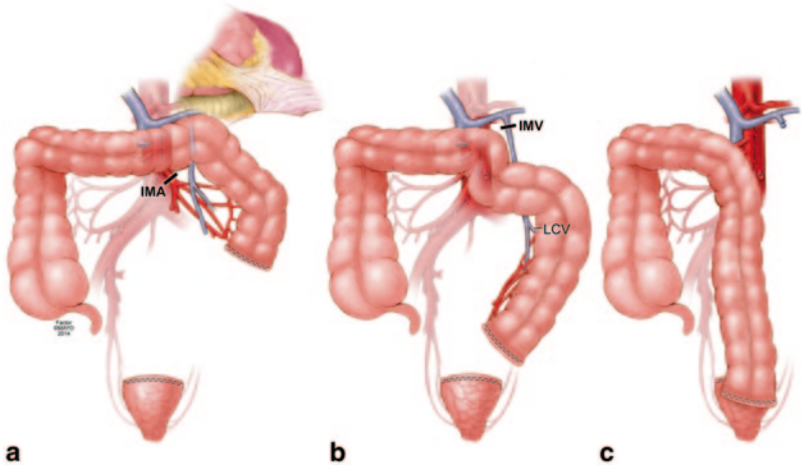

Fig. 31.3 Increasing colon length with primary and secondary maneuvers. **a** Primary maneuvers such as splenic flexure mobilization provide additional reach for the proximal colon, but maximal reach is restricted by the inferior mesentery artery (*IMA*). **b** After high ligation of the IMA, the colon is further restricted by the inferior mesenteric vein (*IMV*). Transection of the IMV must be performed proximal to the confluence of the left colic vein (*LCV*). **c** Ligation of the IMV proximal to the LCV provides maximum colon reach to the pelvis for tension-free colorectal or coloanal anastomoses. © Mayo Clinic

the aorta beginning at the sacral promontory. An avascular plane should be found that stays above the aorta/hypogastric nerves and under the IMA/superior rectal artery as it courses into the pelvis. This plane is carried superiorly to the base of the "bow string" as the IMA takes off from the aorta. Both sides of the base of the IMA are developed, and the IMA can be then be divided using suture, clips, staplers, or with energy devices.

While the left colon mesentery is held under tension, the retromesenteric plane is bluntly developed from the medial side. The left ureter and gonadal vessels are left posteriorly in the retroperitoneum. As this plane is dissected, the IMV should become identifiable as it courses superiorly before slipping under the pancreas. If the retromesenteric plan is correctly developed, the IMV will be elevated off the retroperitoneum. Both sides of the IMV can then be opened and the vessel ligated at the inferior border of the pancreas and superior to its junction with the left colic vein. At this point, the surgeon continues dissecting laterally underneath the left colon mesentery until the lateral border is reached. This approach continues up to the splenic flexure and at any time, the surgeon may also choose to work from a lateral approach by incising the lateral attachments to connect with the medial approach after the IMA and IMV have been ligated.

The end result of a medial-to-lateral approach is the same as a lateral-to-medial one, and the same primary and secondary mobilization techniques are utilized to maximize the bowel length necessary for a colorectal or coloanal anastomosis. The anastomotic technique will not be discussed in detail in this chapter, but can be performed with hand-sewn or stapled techniques. It should be noted that stapled techniques require additional bowel length as the proximal and distal ends need to be "purse-stringed" or closed over the stapling device head/spike and anvil. Hand-sewn techniques utilize the edge of the bowel ends and thus can preserve some bowel length in those difficult reconstructions.

Ileal-Pouch Anal Anastomosis (IPAA)

Surgeons who perform IPAA know that a tension-free pouch anal anastomosis is a challenge due to the anatomic constraints of the ileal mesentery, which is anchored by the SMA. To determine if a tension-free anastomosis will be possible, a somewhat crude estimate for adequate length is to see if the base of the pouch reaches the *inferior* portion of the symphysis pubis without tension. It is important to emphasize that there can be a 2–4-cm difference between the superior and inferior border of the pubis. Cadaveric studies by Smith et al. estimate that the total length from the SMA origin to the dentate line is 34.5 cm (range, 28–36 cm) but only 31.2 cm (range, 28–33 cm) to the inferior border of the pubis [12]. Thus, there is a gap of 3.3 cm that needs to be accounted for when constructing an IPAA. Interestingly, Smith et al. observed that if the base of the pouch can reach 6 cm below the pubis, then the pouch will reach to the dentate line 100 % of the time without tension. If the pouch reaches to 2 or 4 cm below the symphysis, then the pouch will reach without tension 33 and 55 % of the time, respectively. In our experience, pouches often do not reach easily and additional mobilization techniques are always required.

As described previously, primary maneuvers mobilize the embryonic fusion planes. The first step in creating more reach, therefore, is to mobilize the small bowel mesentery off the retroperitoneum to its mesenteric root as the SMA emerges from the inferior border of the pancreas and duodenum (Fig. 31.4). Further mobilization of the SMA over the head of the pancreas can yield 2–3 cm of additional length. Horizontal stepwise scoring of the peritoneum and avascular portions of the small bowel mesentery can provide upward of 2–3 cm of additional mesenteric length for an ileal pouch [13–15]. Typically, at least three to six relaxing incisions are made. This simple maneuver is particularly useful for mesenteries foreshortened by peritoneal fibrosis and/or adhesions from prior operations (Fig. 31.4c).

Secondary maneuvers, which can provide significant additional length, involve ligation of the ileocolic artery [16], distal SMA [17] or, less commonly, individual ileal mesenteric vessels [18]. There is still debate on which vessel should be ligated to provide the greatest gain in length, but the average additional gain ranges from 4 to 7 cm in any of the three techniques with no observed differences in morbidity [15]. The first pedicle we prefer to ligate is the proximal ileocolic artery (Fig. 31.4d). In thin patients, this blood vessel can be directly visualized by splaying out the mesentery under the bright, overhead lights. In the obese patient with mesenteric fat, these vessels are much harder, if not impossible, to visualize and palpation or Doppler devices may be needed to verify collateral circulation.

In one cadaver study, ligation of the ileocolic artery provided an additional 3 cm of pouch reach as compared to 6.5 cm in additional reach with ligation of the distal SMA (inferior to the takeoff of the ileocolic artery) [16, 17]. In rare cases, the distal SMA, not the ileocolic artery, creates the most amount of tension when the mesentery is pulled caudally to the pelvis. In this circumstance, if appropriate collateral circulation exists from the ileocolic artery, the distal SMA can be ligated. If there is concern about collateral blood supply, trans-illumination of the mesentery should be done and a bulldog vascular clamp can be used to temporarily occlude the distal SMA. If adequate collaterals exist, no signs of ischemia will be seen in the distal ileum.

Proponents of “first-line” ligation of the SMA, with preservation of the ileocolic artery, suggest employing this technique when a significant discrepancy in pouch reach is assessed at the beginning of the case [15]. In general, and as confirmed by cadaveric studies [19], significantly increased mesenteric length can be achieved with ligation of the distal SMA. The benefit of length, however, is tempered by the risk of ligating the major inflow to the distal small bowel. No study has demonstrated increased morbidity with distal SMA ligation, but these studies are all small, retrospective, and limited by selection bias [17, 20], and we would caution surgeons when using this particular vascular technique.

When a severely shortened ileal mesentery is noted at the time of initial exploration, another advanced secondary technique can be considered. If this approach is to be used, it must be considered while the colectomy is being done because it requires preservation of the middle colic, right colic, ileocolic, and intervening marginal artery (Fig. 31.5). Upon completion of the colectomy,

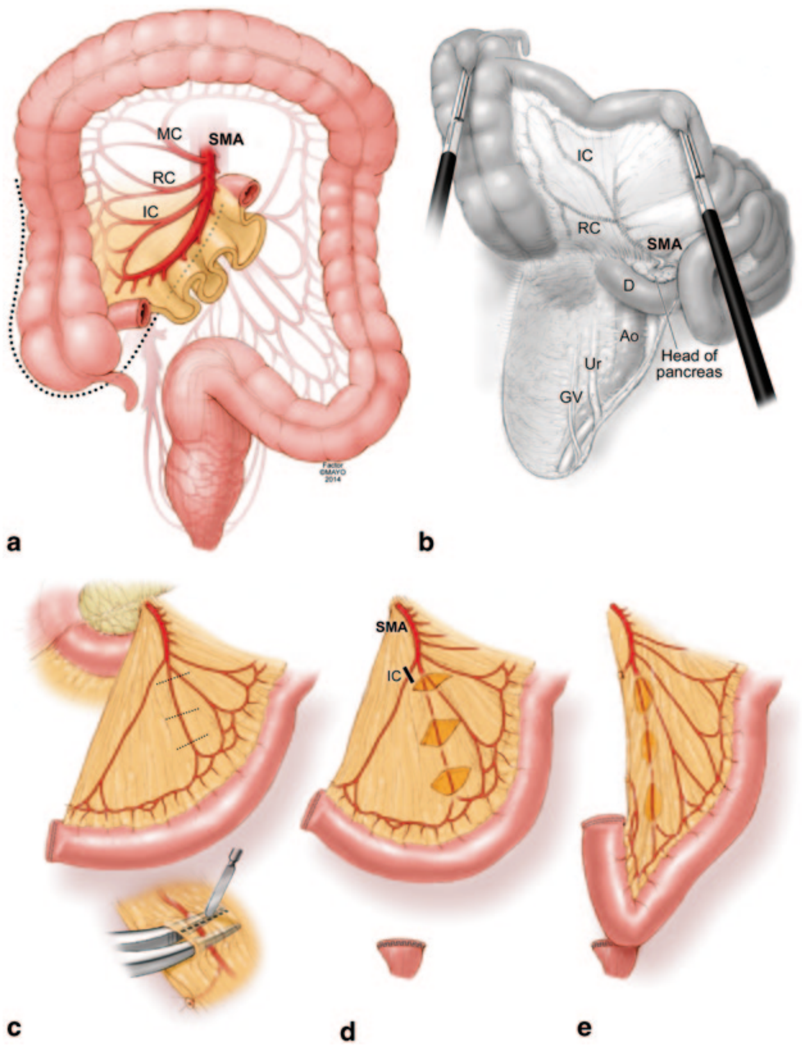

Fig. 31.4 Ileal-pouch anal anastomosis (*IPAA*) reconstruction. **a** Primary maneuvers mobilize the small bowel mesentery off the retroperitoneum to its mesenteric root as the superior mesenteric artery (*SMA*) emerges from the inferior border of the pancreas and duodenum. *IC* ileocolic artery, *RC* right colic artery, *MC* middle colic artery. **b** Critical retroperitoneal structures that can be identified during mobilization of the small bowel mesentery include the aorta (*Ao*), right ureter (*Ur*), right gonadal vessels (*GV*), and duodenum (*D*). **c** After resection of the colon, the terminal ileum is prepared by exposing the root of the SMA and then scoring the peritoneum stepwise over the path of the SMA under tension, which provides additional length for the ileal pouch. **d** and **e** Ligation of the IC, with preservation of the distal SMA, is a secondary maneuver that provides significantly more reach for the ileal pouch. © Mayo Clinic

the distal ileum, at approximately 8 cm from the transected ileum, is pulled caudally toward the pubis putting tension on the ileal mesentery. A series of sequential vessel ligations are then performed until adequate length is reached. The first vessel to be ligated is the right colic artery followed by the ileocolic artery if more length is needed. If tension is still a concern, the distal SMA can be ligated to generate maximum length. These series of ligations can be safely performed because of the preserved retrograde collateral circulation from the middle colic and right colon

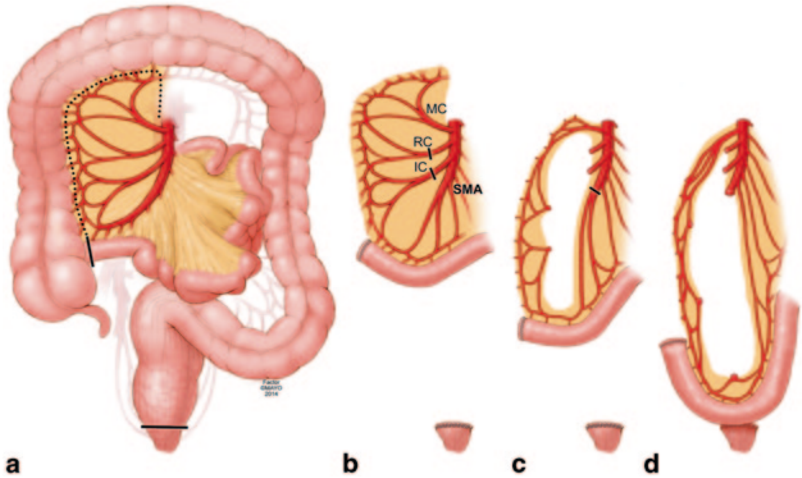

Fig. 31.5 Advanced ileal-pouch anal anastomosis (*IPAA*) reconstruction**. a** Overview strategy showing the correct line of transection during the colectomy to preserve the critical mesenteric vessels including the superior mesenteric artery (*SMA*), ileocolic artery (*IC*), right colic artery (*RC*), and middle colic artery (*MC*). **b** Ligation of the RC and IC preserves blood flow from the preserved MC via the right marginal arteries and provides additional length in pouch reach. **c** and **d** Ligation of the distal SMA provides the final and most significant gain in length for the construction of a tension-free IPAA with critical blood supply from the MC. © Mayo Clinic

marginal artery to the ileal pouch (Fig. 31.5). An additional reach of 11.2 cm has been estimated in cadaveric studies with this technique [21]. The authors have experience using this technique in three cases, all of which did well and achieved a successful tension-free anastomosis.

Whether or not an IPAA is hand-sewn or stapled significantly impacts how much length of ileal mesentery will be needed to perform a tension-free anastomosis. Because a stapled anastomosis joins the pouch to a rectal cuff at the level of the pelvic floor, there is approximately 2–4 cm less reach required as compared to a hand-sewn anastomosis to the dentate line. In addition, we routinely orient the J-pouch so that its mesentery lies posteriorly within the hollow of the pelvis, which has been reported to provide an additional 0.5–1 cm of reach [15]. Finally, in our practice, we always construct a J-pouch. Cadaveric studies have shown that a pouch configured in an "S-shape" reaches 2 cm or further than a J-pouch [16]. However, due to poor functional results observed in some S-pouches, we only consider this approach if the J-pouch cannot reach despite employing all the above mobilization maneuvers.

Stomas that Do Not Reach

The same principles for mobilizing small bowel and colon for distal anastomoses apply to mobilizing sufficient mesentery for construction of tension-free, well-vascularized stomas. The construction of an end colostomy during a Hartmann procedure, for example, may require both primary and secondary mobilization techniques. This strategy is especially relevant in obese patients that have a stoma sited in the left upper quadrant of the abdomen. In these situations, we begin with primary maneuvers by incising the line of Toldt along the left colon and freeing its mesentery from the retroperitoneum. The splenic flexure is then mobilized. If the proximal colon still does not reach the stoma site, secondary mobilization techniques are employed including ligation of the IMA and IMV. The collateral circulation to the stoma is the marginal artery supplied by the middle colic artery.

For the difficult end ileostomy that does not reach the skin, we begin with primary maneuvers by mobilizing the small bowel mesentery from the retroperitoneum to the ligament of Treitz,

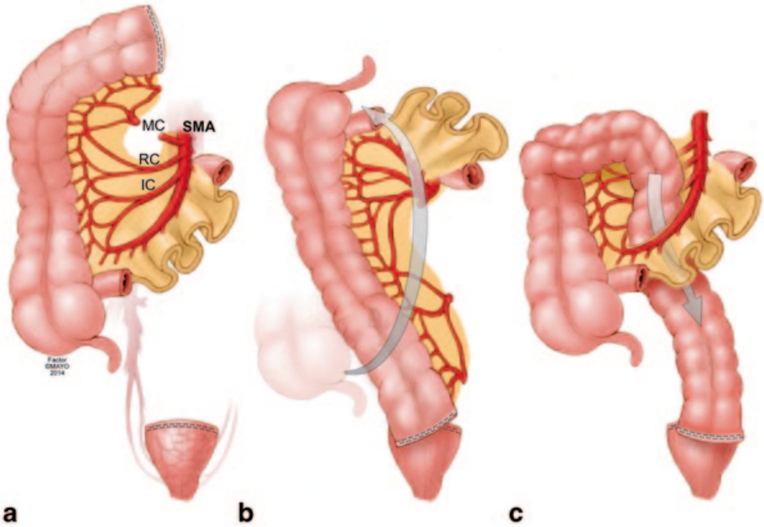

Fig. 31.6 Tertiary or Bailout Maneuvers. **a** Resection of colon to the proximal transverse colon and ligation of the middle colic artery prepares for two maneuvers that allow for a tension-free, low anastomosis. *SMA* superior mesenteric artery, *IC* ileocolic artery, *RC* right colic artery, *MC* middle colic artery. **b** Deloyers procedure. Counterclockwise rotation of the remaining right colon around the axis of the SMA may allow for a tension-free low pelvic anastomosis. **c** Retroileal reconstruction. Tunneling the remaining right colon through the ileal mesentery may allow for a tension-free low pelvic anastomosis. © Mayo Clinic

similar to IPAA reconstruction. Careful stepwise scoring of the peritoneum on the mesentery can provide additional length when the end ileostomy is held under tension. There may also be circumstances when the fixed, cut edge of the mesentery creates more tension than the mesentery of the bowel 4–6 cm proximal to the cut edge, and construction of an end-loop ileostomy, rather than an end ileostomy, makes the better tension-free stoma. In the unusual circumstance that primary maneuvers or the end-loop conversion fail to provide enough mesenteric length, then secondary maneuvers, including ligation of vascular pedicles such as the ileocolic artery, can be performed after ensuring adequate collateral circulation to the distal bowel edge.

Bailout Maneuvers—It Just Does Not Reach

There will be very rare situations when the small bowel or colon will not reach the distal bowel for an anastomosis despite all the above primary and secondary maneuvers. At this juncture, there are a few remaining tertiary, or bailout, maneuvers within the surgeon's armamentarium.

In the rare situation when primary and secondary maneuvers fail to deliver enough colon length for a low colorectal or coloanal reconstruction, a technique called the Deloyers procedure involves additional resection to the proximal transverse colon and then counterclockwise rotation of the remaining right colon, around the axis of the SMA, to construct a tension-free anastomosis (Fig. 31.6a, b) [22]. Besides requiring complete mobilization of the right colon, this maneuver also requires ligation of the middle colic artery, but good clinical outcomes have been reported [23]. Blood to the remaining colon flows from the SMA through the right colic, ileocolic artery, and marginal artery arcades. Alternatively, there have also been case reports of orienting the remaining right colon behind the ileal mesentery to construct a retroileal colorectal anastomosis after left colectomy (Fig. 31.6c**)** [24, 25].

If the above maneuvers are not possible, a completion colectomy to the terminal ileum might be justified depending on the indication for the operation. The terminal ileum can then be used for a distal anastomosis (ileorectostomy or IPAA). In every situation, if a safe anastomosis is in serious doubt, the surgeon should consider construction of a stoma to establish a dependable gastrointestinal outlet.

Conclusions

Reestablishment of gastrointestinal continuity is a technically challenging but rewarding part of abdominal surgery. Undoubtedly, surgeons will encounter situations when the bowel does not easily reach for an anastomosis, but if these situations are approached in a deliberate fashion, the techniques illustrated in this chapter can be used to allow construction of a safe anastomosis or stoma in almost all circumstances.

Key Points on How to Avoid the Complication

1. A detailed understanding of embryologic planes and gastrointestinal vascular anatomy is essential to be technically proficient in employing advanced anastomotic techniques.
2. If a patient has had prior bowel surgery, operative notes should be obtained to clearly define the patient's current anatomy and remaining blood supply as it may impact intraoperative decisions in advanced reconstruction options.
3. If the patient has had a previous bowel resection in which key vessels were ligated that may be necessary for a second resection and reconstruction, alternative strategies will have to be considered. An angiogram in some circumstances may be necessary to clarify a patient's gastrointestinal vascular anatomy.
4. During colorectal or coloanal anastomoses, the proximal bowel end should easily reach the distal end without any pulling or tension. If a tension-free configuration is not achieved, there is high risk for anastomotic complications and further mobilization needs to be performed.
5. During IPAA, use the inferior edge of the pubis symphysis as a rough estimate of adequate length if the apex of the pouch can reach it without tension.

Key Points on Diagnosing/Managing the Complication

1. Intraoperative techniques to assess blood supply, such as mesenteric trans- illumination and handheld Doppler probes, can facilitate decision making regarding safe vascular ligation and adequate perfusion to an anastomosis.
2. Primary maneuvers to provide additional bowel length should be employed first and include mobilizing embryonic planes and dividing peri-organ "ligaments" or attachments.
3. Secondary maneuvers include directed ligation of vascular pedicles that restrict the mobility of the corresponding proximal bowel. Often, these vascular ligations are already part of the oncologic resection.
4. Tertiary mobilization techniques should only be considered in those rare circumstances when primary and secondary maneuvers fail.
5. Externalizing the bowel as a stoma is better than leaving a high-risk anastomosis that could lead to significant intra-abdominal sepsis and death.

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