10 Anastomotic Complications

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Key Concepts

- Patients who develop diffuse peritonitis after intestinal resection with anastomosis should undergo prompt exploratory laparotomy.
- Colorectal anastomoses should be routinely tested prior to abdominal closure.
- Hemodynamically unstable patients who develop a leak after sigmoid resection should undergo a Hartmann procedure.
- Late anastomotic leaks commonly present with subtle and insidious symptoms such as failure to thrive.
- Endoscopic balloon dilation is the procedure of choice for short anastomotic strictures.
- Most cases of anastomotic bleeding resolve with conservative measures.
- Persistent anastomotic bleeding should be treated by colonoscopy with epinephrine injection and/or endoscopic clips.

Anastomotic Leak

Overview

Anastomotic leak is perhaps the most feared and dreaded complication after bowel resection [1]. The consequences of a failed intestinal anastomosis can be devastating to the patient, family, and surgeon alike. Management of an anastomotic leak typically necessitates a lengthy hospitalization with considerable morbidity, suffering, as well as the very real possibility of breathtaking cost and resource utilization [2]. This can include a prolonged stay in the intensive care unit, reoperations in a hostile and hazardous environment to control sepsis, and creation of an intestinal stoma when none was initially expected or planned [3]. Patients often require repeated imaging studies, a wide variety of invasive interventions, and many complex decisions surrounding the necessity, timing, and risk/benefit ratio of the pertinent diagnostic and therapeutic interventions.

Despite the serious and overwhelming burden that can be imposed by an anastomotic leak, we often do not know why the leak occurred in any particular patient or circumstance. There are a wide variety of factors that have been associated with an increased risk of anastomotic dehiscence, some of which may be at least partially remediable [4–10]. In general, sicker patients with more comorbidities are at higher risk. But we seldom know which of the associated factors are actually causative and particularly worthy of focus, since so many of them cluster together in the same patient. For example, patients with Crohn's disease may be considered to be at increased risk for anastomotic complications; but these patients may also be on steroids, other immunomodulatory agents, have preexisting local sepsis, and suffer from hypoproteinemia preoperatively [11].

Despite the critical importance of preventing leaks and understanding the pathophysiology of this potentially devastating problem, relatively little is known about why they actually occur. Avoiding tension on the anastomosis and assuring adequate perfusion to the two ends of the intestine to be joined remain valid and fundamental surgical principles; optimization of comorbid conditions and suspected risk factors is also of value [12]. But leaks often occur when no technical error, defect in surgical judgment, or patient-specific factor can be readily identified. Since we cannot confidently discern the causative element(s) that produced the leak, we are commonly unable to identify opportunities for improvement and devise a strategy to protect the next patient from this complication and its consequences. In short, it seems clear that our present concepts regarding the causes and prevention of anastomotic leak are lacking at best. New paradigms and avoidance strategies are badly needed.

Scope of the Problem

The reported incidence of anastomotic leakage after bowel resection varies from one to more than 20 %, based on the definitions used, location of the anastomosis, and length of

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follow-up [13–21]. A leak rate in the 5–8 % range is perhaps the most commonly reported incidence. Generally speaking, small bowel anastomoses have the lowest leak rate, and low colorectal or coloanal anastomoses carry the highest risk. The importance of definitions and the criteria utilized for diagnosis of a leak when assessing clinical data cannot be overemphasized; standardization of nomenclature across institutions would enable the more robust interpretation of incidence reporting for this key patient outcome. "Anastomotic leak" can signify anything from an apparently trivial, clinically meaningless radiologic finding to a profound septic insult causing a rapid decline, multiorgan failure, and death. In a systematic review, Bruce noted that there were 56 different definitions of "leak" used in the 97 constituent studies of gastrointestinal anastomoses that were reviewed [22].

It seems clear that there is a spectrum of radiologic findings and infectious complications in patients who have undergone an intestinal anastomosis that might reasonably be described as a leak. There is little question about the proper term or diagnosis in a patient who develops peritonitis after bowel resection and is found at laparotomy to have a dehiscence of their anastomotic site. But how should we classify patients who develop an intra-abdominal abscess after surgery? Should the patient who has an abscess around their anastomosis, but no contrast extravasation on an initial imaging study, be considered to have suffered a "leak"? What if a follow-up CT scan now reveals a communication from the abscess to the colorectal anastomosis: did an occult leak cause the abscess or did the abscess erode into the anastomosis? There are countless permutations on this theme, where reasonable surgeons might disagree; in truth, the precise pathophysiology of infectious events after an anastomosis in many patients may be uncertain. This makes comparative analysis of reported outcomes between different studies difficult to interpret.

We have described a spectrum of clinical entities with distinct clinical consequences that can complicate low pelvic anastomoses, for example [23]. These include "free" leaks, anastomotic sinuses, peri-anastomotic abscesses, and fistulas. Interestingly, even patients with "simple" fluid alone in the pelvis on a CT scan without any other evidence of a leak appeared to have impaired long-term function. Anastomotic infectious complications may be divided into leak, surgical site infection (SSI) organ space, and SSI deep. One can reasonably disagree about which category an individual postoperative complication may belong to. But a composite measure such as this may enable meaningful conclusions and avoid the largely arbitrary exercise of trying to distinguish between all of the nuanced findings that the surgeon may encounter in patients who develop an infectious complication associated with an intestinal anastomosis.

Consequences

An anastomotic leak is a potentially life-threatening complication, with a reported mortality in the 10–15 % range [24–29]. Most of these deaths occur in association with sepsis and progressive multiorgan failure, especially for the leaks that present early on in the postoperative course. For this reason, timely diagnosis and treatment prior to the onset of advanced organ dysfunction has been emphasized as a key factor in reducing the mortality rate for anastomotic leaks. However, patients with a more indolent course may also succumb to venous thromboembolic or other indirect complications owing to the prolonged hospital stay, limited mobility, and persistent inflammatory state that commonly occurs in patients who have leaked.

As noted earlier, patients with an anastomotic leak often require difficult and complicated reoperations in a hostile local environment, with considerable additional postoperative morbidity. Lengthy hospitalizations, the need for an intestinal stoma, repeated imaging studies, and trips to interventional radiology for catheter placement/replacement are commonplace [30]. True functional, physical, emotional, and psychological recovery is often measured in months or even years, especially when one considers the need for additional procedures such as stoma reversals even after the acute phase has resolved. Prolonged wound care, ventral hernias, bowel obstructions, and management challenges associated with gastrointestinal adaptation to the altered anatomy may continue to be active considerations for long periods of time, consume an enormous amount of resources, and delay return to the patient's "normal" lifestyle. Further, for many patients, an intestinal stoma is a permanent consequence of the leak [31].

In addition, local sepsis may lead to an impaired functional result, especially after low pelvic anastomosis, where fibrosis can markedly impair the reservoir function of the neorectum and/or be associated with a rigid and unyielding anastomotic stricture [32]. The adverse relationship between anastomotic leak and local recurrence after rectal resection for cancer is intriguing and may have several contributing explanations [33–36]. The leak may impair local and/or systemic immunity or may simply serve as a surrogate for a more aggressive tumor, suboptimal operation, or other host-/tumor-related factors that remain to be fully defined.

Prevention

As in almost any disease process or postoperative complication, prevention is always better than treatment. Unfortunately, we still do not know why most anastomotic leaks occur, and therefore we remain limited in our ability to prevent many of them. Nonetheless, even among high-volume surgeons, significant differences may be found in leak rates, suggesting that technical and/or judgment errors play a causative role in at least some leaks [37]. Time-honored principles such as avoidance of tension on the anastomosis and assuring adequate blood supply to the two ends remain pertinent and important considerations. The role of intraoperative assessment of anastomotic blood supply has received renewed interest in recent years.

Table 10-1. Reported risk factors for anastomotic leak

Patient factors
Overall physiological status
Steroids
Need for low rectal/anal anastomosis
Immunomodulators
Malnutrition/weight loss
Emergency surgery
Obesity
Male gender
Advanced age
Alcohol use
COPD
Cigarette smoking
Previous radiation
Prior abdominal surgery
Right vs. left colon (left increased)
Primary disease (e.g., Crohn's disease, diverticulitis)
Surgeon factors
Length of surgery
Blood loss
Use of pelvic drain
Bowel preparation
Use of vasopressors
Proximal diversion
Blood supply

Many patient- and surgeon-specific factors have been associated with an increased risk of an anastomotic leak (Table 10-1). However, many are simply markers for a sicker patient or serve as surrogates for various disease processes and/or a compromised host. So, it is unclear how many of the factors on this lengthy list are simply associated with a leak versus actually contributory, and how much effort or emphasis should be placed on trying to remediate them. Further, many factors (e.g., gender, age, disease process) are immutable and just a fact of life. Nonetheless, attention to controlling certain risk factors does seem prudent and worthwhile. These would include smoking cessation, optimization of nutritional status, and weight loss if possible [37–44].

Anastomoses should be tested intraoperatively when feasible, as occult disruptions may be identified and definitively treated [45–47]. A systematic review of the intraoperative assessment of colorectal anastomotic integrity documented an impressive reduction in anastomotic complications when the anastomosis was tested during surgery [11]. When a leak is identified intraoperatively, a sober and disciplined approach is required. Sometimes there is a focal, well-defined defect in an otherwise healthy-appearing anastomosis that can be readily repaired with a suture. However, in other circumstances, such as when there is concern about the blood supply, the defect is poorly visualized or there is a major disruption, it is best to start over, redo the anastomosis entirely, and retest. There is no sense trying to "perfume the pig" by placing a series of sutures into a poorly exposed, amorphous mass of tissue in the hope that the defect will be adequately addressed. With distal anastomoses, this will often include adding a proximal loop ileostomy. Mature surgical judgment, sometimes including intraoperative consultation with an experienced colleague, can enable optimal and objective decision making.

Intriguing work regarding the relationship of the microbiome and anastomotic leak has been reported by Alverdy and coworkers [48, 49]. It may be that the local microbial environment plays a critical role in anastomotic healing. Specific bacteria that produce locally destructive collagenolytic proteins (e.g., certain *Enterococcus*, *Pseudomonas*, or *Serratia* species) may be an important cause of anastomotic leaks, and perioperative suppression/eradication of these microbes may reduce leak rates. A large multicenter trial is underway to further explore this hypothesis.

Diagnosis

Perhaps one of the biggest fallacies perpetuated over the years about anastomotic leaks is that the diagnosis is typically straightforward and clinically obvious. This misconception is commonly exacerbated by surgical morbidity conferences where these cases are often reviewed. All attendees know or strongly suspect the patient in question suffered a leak (since it is being presented at a complication conference) and are often quick to suggest the diagnosis at the first mention of an abnormal vital sign, laboratory value, or upon review of radiologic studies.

Certainly, there are patients who present in the first few days after surgery with excruciating abdominal pain, hemodynamic instability, diffuse peritonitis, and a rapid and dramatic change in their clinical course; the diagnosis is often plainly evident and requires few if any ancillary studies (even in retrospect). However, in the nuances of actual clinical practice, medical decision making in the setting of a real patient where anastomotic leak is considered is usually far more difficult since, unfortunately, most leaks actually present in a more subtle and insidious manner [50, 51]. We reviewed the clinical course of 452 consecutive patients who had a bowel resection with anastomosis. Even in "uncomplicated" recoveries, tachycardia and tachypnea were almost routine, occurring in more than ½ of the patients frequently throughout the postoperative course. Hypotension, fever, and leukocytosis, factors commonly cited with the benefit of hindsight as reliable evidence of a leak, were also remarkably common in all patients and were poor indicators of a leak. The predictive value for abnormal vital signs or leukocytosis ranged from only 4 to 11 % [52].

Similarly, radiologic findings are often ambiguous and equivocal, commonly requiring careful and considered correlation with the clinical picture. On the one hand, the sensitivity for contrast radiography and CT scan in the setting of a leak has been reported to be in the range of 50 %, so a high index of suspicion must be maintained even when the imaging study appears to be negative [53]. On the other hand, Power has highlighted the broad overlap of radiologic findings in

FIGURE 10-1. CT scan in a patient with anastomotic leak after low anterior resection.

postoperative patients with or without a leak. For example, free air was seen on CT scan up to 9 days after surgery and localized extraluminal air up to 26 days postoperatively in patients without a leak. Of the many and varied radiologic findings that are often considered to be indicative of a leak, only loculated fluid with air (Figure 10-1) was observed more commonly in patients with an anastomotic leak [54].

With the foregoing as a background, it perhaps should not be surprising that the diagnosis of an anastomotic leak, in its many varied forms and presentations, is often quite delayed. In our review of 1223 patients undergoing an intestinal resection with anastomosis, the leak rate was 2.7 %. Of note, 14/33 leaks were only diagnosed upon readmission to the hospital, and 12 % were identified more than 30 days after surgery. The positive predictive value of CT scan was 89.5 % versus 40 % for contrast enema. However, these studies were used in somewhat different clinical settings, and the CT scans were often thought to be suggestive of a leak, rather than truly definitive [55]. Categorizing CT scans dichotomously into "positive" or "negative" can often seem to be a somewhat contrived exercise, in light of the open-ended and ambiguous terms that are often utilized to describe the radiologic findings.

So, the broad overlap in vital signs, clinical and radiologic findings between patients who have an uncomplicated postoperative course and those who are diagnosed with a leak, and the similarities in presentation between a leak and other common postoperative complications often make the diagnosis challenging in many clinical settings. The fact is that surgeons often worry or even agonize when things turn out to be fine and are commonly led astray by "reassuring" clinical data when patients have actually suffered an anastomotic leak. More reliable clinical, laboratory, and radiologic tools would be of great utility.

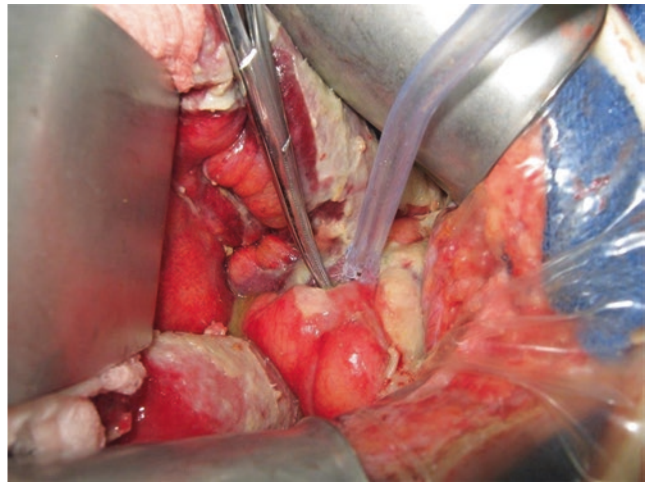

FIGURE 10-2. Diffuse peritonitis after major anastomotic disruption.

Treatment

Many factors need to be considered when deciding on the most appropriate management option for a patient with an anastomotic leak [56]. These include patient-specific factors such as the degree of hemodynamic derangement, physiologic reserve, nutritional status, comorbid complications, initial surgical indications/goals, and the potential need for additional treatments (e.g., chemotherapy for a malignant diagnosis). Similarly, features of the leak such as location (e.g., intraperitoneal vs. extraperitoneal), size of the defect, and the presence of concomitant tissue ischemia also play a major role in the surgeon's decision-making process.

Perhaps the most useful classification in outlining the principles of management is early versus late presentation. Patients with an early leak classically present in the first week after surgery with signs and symptoms of peritonitis, organ dysfunction associated with sepsis, and hemodynamic instability. In this clinical setting with a profoundly sick patient, the diagnosis is generally quite evident, and prompt return to the operating room is required (Figure 10-2). Radiologic studies are often unnecessary and may provide a false sense of reassurance as described above; hoping against hope it will just delay treatment and allow the septic picture to progress. The operating room is often the only place where this pivotal question can be definitively answered and addressed.

However, it bears repeating that even in the early postoperative period, patients with an anastomotic leak will often present with signs and symptoms that lead the surgeon astray and suggest other serious postoperative complications such as a pulmonary embolism, cerebrovascular event, or acute coronary syndrome. This is because patients with a leak will often appear short of breath and develop mental status changes, and the basic acute work-up will commonly reveal an abnormal chest X-ray or EKG. The surgical team must maintain a high index of suspicion for a leak in this setting and remain wary of alternative diagnoses.

Once the diagnosis is established in the first few days after the initial surgery, most patients will require operative exploration. Intravenous antibiotics and close observation may be appropriate in a few highly selected patients with small, contained leaks that otherwise appear reasonably well; most commonly, these are patients who have undergone a low colorectal anastomosis, especially if they have a proximal diversion. Otherwise, at reoperative surgery, the peritoneal cavity is thoroughly irrigated and appropriate cultures obtained. In general, patients with a small bowel to small bowel or ileocolic anastomosis are best treated with resection and repeat anastomosis. Patients who are hemodynamically unstable may be treated with an ileostomy and end-loop stoma, where the distal end is brought out through the same aperture as the ileostomy (Figure 10-3a–c). This markedly simplifies later reconstitution of the gastrointestinal track, which may be done without the need for laparotomy. This "minor" maneuver at the end of a taxing operation may be the difference between later stoma takedown and a permanent ileostomy, as many patients who are candidates for a stoma takedown will not be good candidates for another major laparotomy after a leak. Anastomosis with proximal loop ileostomy is another alternative to address this situation where primary anastomosis alone is deemed unwise.

When a colo-colic anastomosis breaks down, dividing the anastomosis and creating an end colostomy is usually the most appropriate option. Resection with anastomosis and proximal loop ileostomy is another option for hemodynamically stable patients. Performing an anastomosis without diversion in a hemodynamically unstable patient may greatly complicate diagnosing another leak after reoperation, and the second insult may prove too much for the patient to safely tolerate.

A leak after low anterior resection may create some challenging management decisions. If the anastomosis is divided and a colostomy created, then going back months later to attempt another low pelvic anastomosis to a short Hartmann stump may be a formidable endeavor; a pull through with hand-sewn coloanal anastomosis is often required. When there is no ischemia and the leak is relatively small and contained, loop ileostomy and drainage of the anastomosis is usually most appropriate. In stable patients with major disruptions, resection with anastomosis and proximal diversion may also be an option.

Although there is no hard and fast cutoff from "early" to "late" leaks, the management of anastomotic leaks diagnosed beyond the first week to 10 days postoperatively usually differs in many important regards from its earlier counterpart. These patients most commonly have a more insidious, subtle, and nonspecific presentation. Clinical features commonly include a poor appetite, low-grade fever, incomplete resolution of a postoperative ileus, and a generalized failure to thrive. Careful imaging including a CT scan of the abdomen and pelvis with intravenous and enteric (including rectal) contrast is typically the key to diagnosis and treatment planning. Reoperative surgery is usually unnecessary

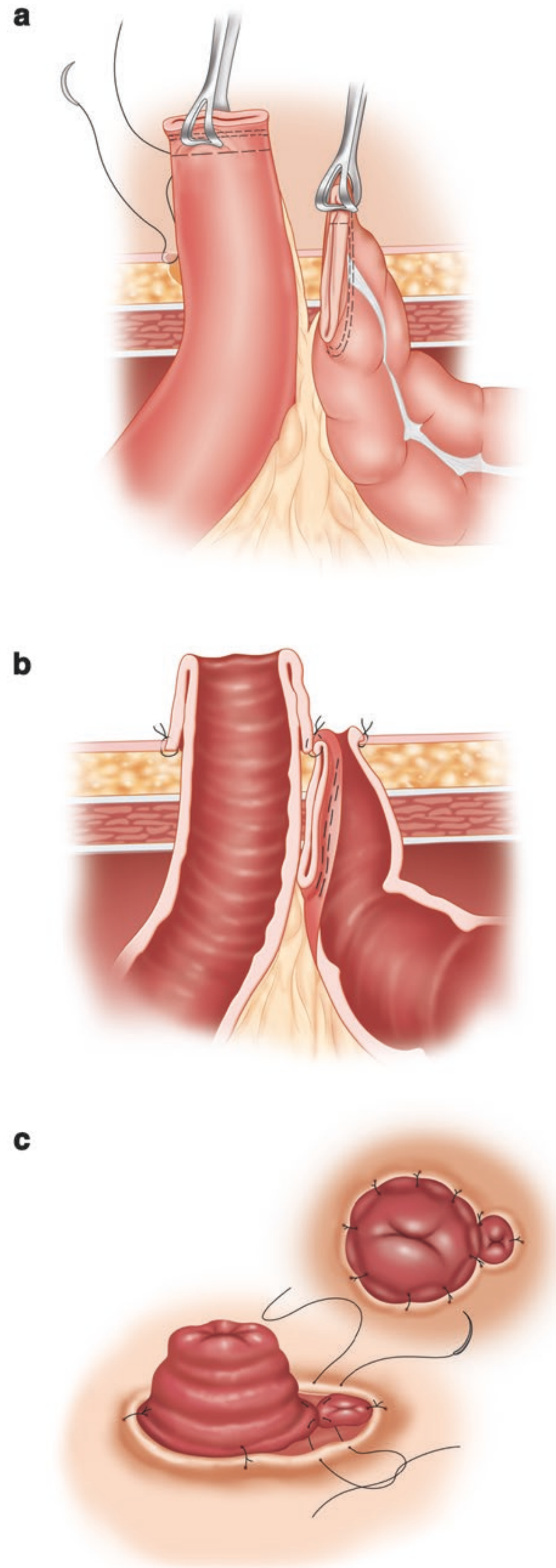

FIGURE 10-3. End-loop stoma. (**a**) The bowel is divided and each end is brought up through the opening. (**b**) The proximal portion is completely matured, while the distal end has only a corner matured. (**c**) Side and top view of the matured stoma.

and will quite often make things worse. Beyond a week to 10 days, patients will commonly have an obliterative peritoneal reaction, making dissection difficult and fraught with the danger of extending the damage to adjacent loops of small intestine as well as making the local situation worse. Adhesions are commonly dense and tenacious, leading to prolonged dissection, bleeding, and the need to anastomose, repair, or exteriorize fixed and friable bowel. If surgery is truly needed to control sepsis, the operation must be very carefully planned, focused, disciplined, and goal directed.

Most patients with late presentations are most often best managed by patience, antibiotics, and percutaneous drainage. Even in the presence of a demonstrable leak, percutaneous drainage alone may allow for complete resolution of the local sepsis and ultimate healing of the anastomosis. Unfortunately, this is commonly a slow process, requiring patience, serial imaging, and repeat percutaneous interventions. Both covered stents and vacuum-assisted devices have been used with anecdotal success [57–59].

Nutritional support, using the enteral route whenever possible, should not be neglected. Although patients are commonly restricted to clear liquids or nothing by mouth for prolonged intervals based on surgical custom, it is not at all clear that this enables healing of the anastomosis and may often exacerbate patient discomfort (physical and psychological) and diminish their ability to tolerate a prolonged recovery with repeated imaging studies and invasive interventions.

Anastomotic Stricture

Anastomotic stricture is a relatively common complication of colorectal or pouch-anal anastomosis, occurring in 3–30 % of cases [60], less commonly so following anastomosis elsewhere in the large intestine. The exact pathophysiology underlying anastomotic strictures remains unknown. Ischemia, incomplete "doughnuts" from stapled anastomotic reconstruction, anastomotic leakage, hemorrhage, and radiotherapy are probably contributing factors to this [61–66]. An anastomotic stricture may be defined as a chronic narrowing or obstruction to the flow of intestinal contents resulting in clinical signs or symptoms of complete or partial bowel obstruction [62]. Symptoms most commonly associated with rectal strictures are increasing constipation and partial large bowel obstruction. Other symptoms may include change in stool caliber or overflow diarrhea.

Asymptomatic patients with a stricture and diverting stoma can be identified based on digital rectal examination or upon radiographic or endoscopic evaluation prior to stoma reversal. Diagnosis is typically made by imaging (i.e., contrast enema) or endoscopically—the inability to pass a 12-mm-diameter sigmoidoscope through the anastomotic narrowing [60]. Anastomotic strictures frequently manifest at some delayed interval after surgery, except for cases associated with early postoperative anastomotic edema.

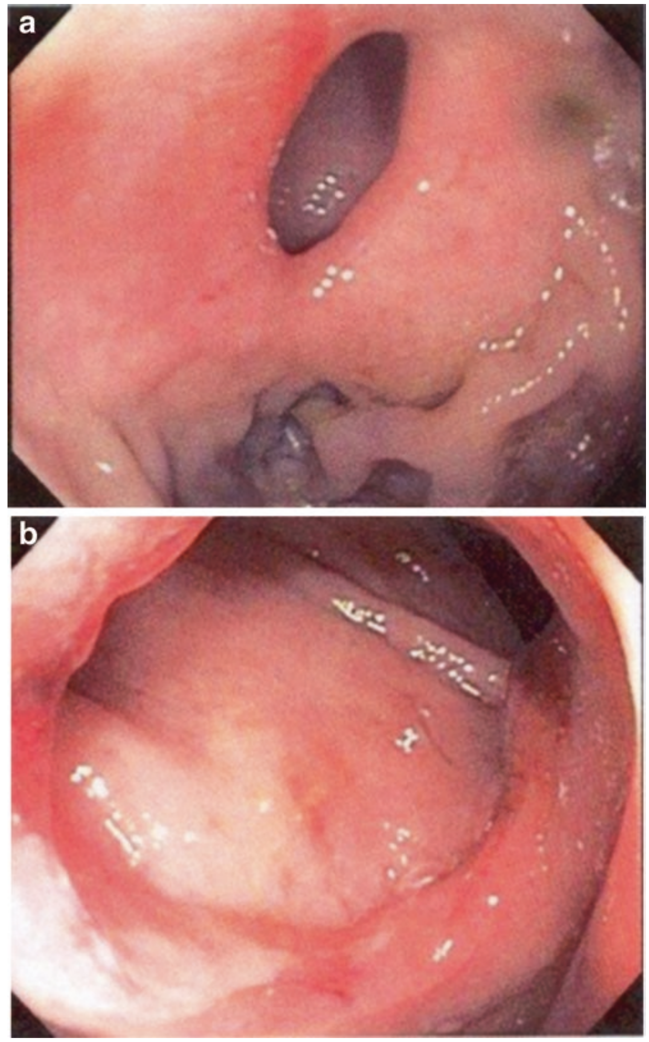

FIGURE 10-4. (**a**) Colorectal anastomotic stricture, before dilation. (**b**) Anastomosis after through the scope balloon dilation.

Luchtefeld [60] found that the stenosis was diagnosed at 1–6 months after surgery in 66 (54 %) of 123 patients, and at more than 6 months after surgery in 17 patients (14 %). Schlegel reported a series of 27 patients with a median time to diagnosis of 7.2 months [62]. Therefore, patients must be followed not only immediately after surgery but the diagnosis must be kept in mind for some time thereafter. Recurrent cancer must be considered as a cause of stricture prior to deciding on the treatment approach.

Short strictures in low colorectal, coloanal, and ileoanal pouch anastomoses can be treated by simple digital dilation, commonly performed in the outpatient setting or under anesthesia. Narrow distal strictures that do not admit the tip of the examining finger can be dilated with Hegar dilators, which are effective in achieving a sufficiently patent anastomosis with a low rate of restenosis.

Endoscopic balloon dilatation is highly effective, and the most commonly used method for treatment of short (<1 cm) colonic and colorectal anastomotic strictures (Figure 10-4a, b).

Several studies of balloon dilation of colonic anastomotic stricture reported success rates that range from 86 to 97 % [5–7]. Two types of balloon can be used for dilation: over the wire (OTW) and through the scope (TTS). The mechanical principles of these techniques are similar resulting in the dilating force being delivered radially and over the entire length of the stricture. Successful dilation is defined as an anastomotic lumen becoming wide enough to allow passage of a standard 12-mm diameter colonoscope and post-procedural relief of obstructive symptoms. Additional dilations may be required if the structure recurs.

The less frequently used method of bougie dilation of anastomotic stricture is accomplished by the radial vector of an axially directed force. Werre [67] treated 15 patients with a benign stricture after low anterior resection by using polyvinyl bougies (Savary-Gilliard). After a mean follow-up of 19 months, normal defecation was restored in ten patients; in five patients, there was only partial improvement, but only three required another form of treatment. No complications were reported. In a case study, Pietropaolo [68] found balloon dilation more effective than bougie dilation with respect to the proportion of patients successfully treated in a single session (76.9 % vs. 51.8 %).

Recurrent cicatricle strictures may be treated with the combination of incision plus balloon dilation [69]. Endoscopic stricturotomy with neodymium-yttrium aluminum garnet laser together with balloon dilation were performed by Luck in ten patients [70]. Treatment was successful, without recurrence or complication, in nine patients (median follow-up 82 months). In the remaining patient, the stricture recurred after 6 years. Brandimarte [71] treated 39 consecutive patients with an anastomotic colorectal stricture endoscopically by making six radial incisions electrosurgically with a precut papillotome. In all cases, satisfactory dilation of the stricture was obtained without complication, and no recurrence was identified at a mean follow-up of 25 months. Complications of electrocautery and laser strictureplasty are very low, with only one group reporting a 2.7 % technical failure rate [72]. Alternatively, transanal endoscopic microsurgical approach (TEM) strictureplasty with electrocautery or laser can be used. Endoscopic, TEM, or strictureplasty approach has been described as effective in 90–100 % of patients with a mean follow-up of 6–92 months [69, 70, 72–74].

Anastomotic strictures that are irregular, markedly angulated, fixed, or longer than 1–2 cm in length, may not be amenable to endoscopic treatment. In the ASCRS survey, surgery was required in 34 patients (28 %), including resection in 18 patients and permanent colostomy in 13 patients [60]. Reoperative rectal dissection in the presence of scarring from previous operations or from ongoing local sepsis is technically demanding and should not be underestimated. Shleigel [62] reported a series of 27 patients who underwent surgical correction of anastomotic stenoses. The authors performed seven colorectal anastomoses for upper rectal anastomotic strictures and 20 coloanal anastomoses for middle and lower rectal strictures (19 Soave's procedures and one colon J-pouch-anal anastomosis). Intestinal continuity was restored in all cases.

In long segment distal rectal strictures or after failure of local therapy, immediate or delayed coloanal anastomosis through a combined abdominal and perineal approach is recommended [75]. A less invasive technique using an end-to-end anastomosis (EEA) stapler may be applied to correct mid- to proximal rectal strictures without the need for laparotomy. Prior to stapling, the rectal anastomotic stricture is dilated and assessed by rigid sigmoidoscopy. Both the anvil and the rod of the circular stapler are introduced transanally, and the instrument positioned until the mural portion of the rectal stricture is caught between the anvil and the rod. The EEA is then fired so that a crescent-shaped rim of the stricture is stapled and resected. The biggest drawback to this method is its inability to treat any tight stricture that would not allow the anvil of the EEA to pass through its opening. An alternative method involves a laparotomy- or laparoscopy-guided approach to introduce the anvil of the stapler from above, via a small colostomy, and inserting the EEA stapler transanally until resistance from the stricture is met. Once positioned correctly, the stapler and anvil are mated and tightened, and the stricture is resected. Long-term results following this technique of stricture resection have been reported as 89–100 % return to normal bowel function with a mean follow-up of 12–49 months [62, 76].

Self-expanding metallic stents (SEMS) have been considered for medium-term symptom relief for recalcitrant benign colorectal strictures in patients who are otherwise unfit for surgery; but their use is associated with a high rate of delayed complications such as perforation, migration, and re-obstruction in up to 38 % of cases [77]. The SEM stents can be considered for short-term relief of acute obstruction and a as a bridge to elective surgery. Newer types of biodegradable stents [78] and fully covered self-expanding stents [79] have been evaluated, but their role in benign colonic and colorectal anastomotic strictures remains undefined.

Finally, diverting ileostomy or colostomy may be the only available treatment option for symptomatic relief of those patients who have failed all treatments or are not candidates for extensive surgical intervention to correct the anastomotic structure.

Anastomotic Bleeding

Anastomotic bleeding following stapled colorectal, colonic, or intestinal anastomosis is a common but usually self-limited complication, with the majority of cases resolving spontaneously with expectant management. Postoperative colorectal anastomotic bleeding can occur in up to 5 % of anastomoses [80–82]. Anastomotic bleeding may occur when the mesentery is incorporated into the staple line and can be further exacerbated by the use of anticoagulant and antiplatelet agents. Continued hemorrhage is rare but, when it occurs, often requires further treatment.

The clinical presentation of anastomotic bleeding is similar to lower gastrointestinal bleeding from other causes, but interventional therapy is more difficult owing to the risk of ischemia or breakdown of the anastomosis. The optimal treatment choices depend on the site of bleeding, patient factors, and skill of the surgeon or endoscopist and may include conservative treatment with packed red blood cells and coagulation factors transfusion, endoscopic therapy, angiographic embolization, locally applied vasoactive substances, or reoperation with anastomotic refashioning.

The risk of postoperative bleeding can be decreased by avoiding the inclusion of mesocolon into the staple line. We also recommend intraoperative assessment of colorectal anastomoses with intraoperative flexible sigmoidoscopy. Ishihara found active and continuous bleeding from the stapled anastomosis intraoperatively in up to 9.6 % of colorectal anastomoses [83]. In the intraoperative setting, an actively bleeding vessel can be visualized and immediate hemostasis achieved by placement sutures under direct inspection, endoscopic injection of 1:200,000 epinephrine, or careful coagulation.

Postoperative anastomotic bleeding can occur from 4 h to 9 days following the operation [84]. Initial management includes correction of any associated coagulopathy and transfusion of blood and blood products if necessary. Attention should be paid to the amount blood and clots that patient is passing as a more accurate measure of the rate of bleeding; the hemoglobin and hematocrit changes may not occur until hours later. Between 2 and 10 units of packed red blood cells may be required in the nonoperative treatment of anastomotic bleeding [16]. It may be important to keep the patient warm by infusing warmed solutions and preventing hypothermia.

If anastomotic bleeding persists, the preferred next step is usually colonoscopic evaluation and management. Colonoscopy allows for direct inspection of the anastomosis with subsequent application of various means of hemostasis. Submucosal peri-anastomotic injection of up to 10 ml of 1:200,000 epinephrine in saline has been shown to result in control of anastomotic bleeding [84]. Cirocco reported the successful use of electrocoagulation, although it was noted that an anastomotic fistula that developed in one of six cases may have been related to this technique [85]. This may be due to the presence of staples at the bleeding site; the dissipation of energy may not be uniform and localized leading to increased tissue damage.

Endoscopic application of clips is an excellent alternative to coagulation and has been shown to be safe and effective in control of anastomotic bleeding [81]. Endoscopic therapy has obvious advantages in terms of less physiological stress on the patient, no requirement for general anesthesia compared with the surgical revision of anastomosis, and is clearly less invasive and more cost-effective. Colonoscopic hemostasis should be performed by a skilled and experienced provider proficient in advanced endoscopic techniques. An alternative course of action should always be entertained in the event endoscopic therapy is unsuccessful, particularly if the bleeding is severe, making a clear endoluminal view of the point of hemorrhage impossible.

Briskly bleeding anastomoses may be amenable to angiographic localization and treatment of the bleeding site. This strategy provides access for vasopressin infusion or embolization to control the hemorrhage. Vasopressin may be associated with significant complications such as myocardial or intestinal ischemia and infarction and therefore has to be carefully considered [86].

Angiographic embolization is an alternative to vasopressin infusion. Although this option avoids myocardial complications, it may precipitate bowel ischemia and infarction by interrupting the distal arterial blood supply [87]. These angiographic methods are best reserved for other intestinal anastomoses, such as in the small bowel, where the endoscopic approach is significantly limited. Although extremely rare, significant anastomotic bleeding after large bowel resection can be severe enough to require reoperation with surgical revision or reconstruction of anastomosis.

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