10 Postoperative Complications

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The ability to minimize, recognize, and treat postoperative complications is one of the most important aspects of surgery. This chapter will focus on those surgical complications most often encountered by colorectal surgeons: injuries to the bowel and genitourinary structures, pelvic hemorrhage, small bowel obstruction, wound infections, abscesses, and anastomotic leaks, strictures, and bleeding.

Unrecognized Enterotomies and Enterocutaneous Fistulae

Patients undergoing extensive adhesiolysis are at highest risk for enterotomies. An enterotomy in and of itself is not a complication, rather it is the failure to recognize and adequately repair an enterotomy that leads to trouble. In cases in which any significant degree of adhesiolysis is performed, the entire bowel should be carefully inspected at the end of the procedure. Although the natural history of serosal tears is unknown, they should be repaired when recognized with imbricating seromuscular sutures. Full-thickness enterotomies can be repaired using a number of different and equally effective techniques; one common method is a two-layer closure using an inner layer of absorbable seromuscular stitches (i.e., 3-0 Vicryl) and an outer layer of permanent Lembert stitches (i.e., 4-0 Ethibond). In cases in which multiple enterotomies have occurred within a short segment of bowel, resection of the involved segment with primary anastomosis is performed. If the mesentery has also been injured during the course of adhesiolysis, the viability of the bowel ends should be confirmed before anastomosis.

Failure to recognize an enterotomy at the time of surgery will lead to one of several postoperative complications. The patient may develop peritonitis within the first 24 to 48 hours after surgery. This may be difficult to detect in the background of narcotic analgesia and the surgeon and patient's expectation of postoperative incisional pain. The diagnosis is purely based on patient appearance and examination. The usual markers of bowel perforation (leukocytosis, fever, and pneumoperitoneum) are not reliable, because they are normal findings in the early postoperative patient. A high index of suspicion should be maintained with a low threshold for reexploration. Reoperation within the first several days is usually not difficult because significant adhesions have not yet formed. Most enterotomies found in this situation can be repaired primarily, provided that the bowel edges are viable. Should the repair fail, if the repair can be placed directly under the midline fascial closure, this may result in the development of a direct enterocutaneous fistula rather than recurrent peritonitis. If conditions are not favorable for primary repair, a stoma should be created. An especially difficult situation is that in which bilious fluid is encountered at reexploration but no enterotomy can be found. After running both the small and large bowel at least twice and excluding a duodenal, gastric, or gallbladder injury, the only remaining option may be to place drains in both paracolic gutters and the pelvis in hopes of creating a controlled enterocutaneous fistula. Insufflation of the small bowel with carbon dioxide gas through a nasogastric tube has also been described as a method for localizing small enterotomies. Gas bubbles may be seen emanating from the site of injury after the abdomen has been filled with saline.

An unrecognized enterotomy may also present as an enterocutaneous fistula, with enteric drainage emanating from the incision or wound later in the postoperative course. If there are no signs of sepsis, a nonoperative approach may be considered, especially if the patient is more than 1 week removed from surgery. The patient is placed on complete bowel rest, a nasogastric tube is placed, broad-spectrum antibiotic coverage is initiated, and a computed tomography (CT) scan is obtained to assess for an associated abscess or fluid collection. If a fluid collection greater than 4 cm in diameter is present, percutaneous, radiologically guided drainage should be used. If available, an enterostomal therapist should be involved to assist with pouching the fistula in order to protect the skin from irritating enteric contents. In most cases, parenteral nutrition will be started to meet the patient's caloric and protein requirements in anticipation of a prolonged period of fasting. H2 antagonists should be added to decrease gastric secretions. Somatostatin analogs may also be used to decrease the volume of fistula output, although they do not seem to increase the rate of spontaneous fistula closure.[1] The rate of spontaneous small bowel fistula closure varies but is typically less than 50%. Chances of spontaneous closure are thought to be reduced by high output because of proximal location, distal obstruction, local sepsis, radiation exposure, a short or epithelialized tract, malignancy, a foreign body in the tract (e.g., mesh, sutures), Crohn's disease, and malnutrition.[2]

Most enterocutaneous fistulae that close spontaneously will do so within the first month. If the fistula persists, fibrin glue injection can be attempted. Several reports have been published describing this technique and successful closure has been achieved in some cases.[3–5] Although no large series exists to define the success rate, little is lost in making the attempt. Surgical intervention should be delayed until all sepsis has resolved, adequate nutrition has been restored, and intraabdominal adhesions have softened to the point of allowing safe reoperation. Most authors recommend a delay of at least 6 weeks since the last laparotomy, but 3–6 months may be more appropriate.[6,7] The ultimate healing rate after definitive surgical repair is approximately 80%.[7]

Anastomotic Complications

Anastomotic complications are among the most feared in colorectal surgery. They can lead to emergent reoperation and/or a prolonged, complicated, and costly postoperative hospitalization. If the patient recovers from the acute event, chronic sequelae may develop because of stricture or pelvic fibrosis leading to poor bowel function and the possibility of further revisionary surgery or permanent fecal diversion.

Anastomotic complications are usually related to technical factors (ischemia, tension, poor technique, stapler malfunction) or preexisting conditions in the patient such as local sepsis, poor nutrition, immunosuppression, morbid obesity, and radiation exposure. The contribution of the former may be minimized by a careful, methodical approach to construction of the anastomosis (Table 10-1). For colorectal anastomoses, a tension-free anastomosis may be achieved by full division of the lateral attachments of the descending colon, complete mobilization of the splenic flexure, high ligation of the inferior mesenteric artery (IMA), separation of the omentum from the distal transverse colon and mesocolon, and division of the inferior mesenteric vein at the lower edge of the pancreas. Adequate blood supply should be confirmed by cutting across the marginal artery or bowel wall with anything less than pulsatile bleeding considered unacceptable. Further colon resection should be performed until adequate bleeding is encountered. If necessary, anastomoses between the hepatic flexure or distal ascending colon and rectum are easily achieved by passing the colon through a window in the mesentery of the terminal ileum.

TABLE 10-1. Steps to minimize risk of leak from colorectal or coloanal anastomoses

1. Ensure good blood supply (pulsatile bleeding from marginal artery at level of anastomosis)
2. Ensure tension-free anastomosis by complete mobilization of splenic flexure (includes high ligation of IMA and ligation of inferior mesenteric vein at lower border of pancreas)
3. Avoid use of sigmoid colon in creation of anastomoses
4. Inspection of anastomotic donuts for completeness after circular stapled anastomoses
5. Air or fluid insufflation test to rule out anastomotic leak immediately after construction in the operating room

Nutritional status, degree of immunosuppression, and general medical condition should be considered when deciding whether or not to perform a primary anastomosis. If severe malnutrition (albumin <2.0 or weight loss >15%) or significant immunosuppression (chemotherapy, high-dose steroids) are present, an end colostomy and Hartmann stump will minimize the risk of complications. Colostomy takedown can then be performed if and when these factors have been corrected. Preoperative weight loss, if able to be accomplished by the morbidly obese patient, will make the construction of deep pelvic anastomoses easier. When operating in the radiated pelvis, one end of the bowel used to construct the anastomosis should come from outside the field of radiation.

Bleeding

Anastomotic bleeding is common and varies greatly in severity. In most cases, bleeding is minor and is manifested by the passage of dark blood with the patient's first bowel movements after surgery. In rare instances, bleeding can be massive and require transfusion and active intervention.

Bleeding can occur after either stapled or hand-sewn anastomoses, but is probably more common with the former. This complication can be reduced by careful inspection of the staple line, particularly in the case of side-to-side/functional end-to-end anastomoses. Before closing the enterotomy through which the stapler was introduced, the linear staple line can be everted and inspected. Bleeding points should be controlled with sutures rather than cautery to prevent a deep burn injury which may lead to delayed leak. The incidence of bleeding from the linear staple line can be minimized by using the antimesenteric borders of each limb to construct the anastomosis, thus avoiding inclusion of the mesentery in the staple line.

Bleeding from circular stapled anastomoses or from the staple lines of ileal or colonic J pouches is usually not diagnosed until after the patient has left the operating room. After performing proctoscopy to evacuate clot from the rectum or neorectum, a rectal tube is inserted and a 1:100,000 solution of saline and epinephrine is instilled. The tube is then clamped for 15 minutes. If bleeding persists after the solution is allowed to drain, the procedure may be repeated. If bleeding continues or hypotension develops, the patient should be returned to the operating room for transanal examination of the anastomosis or pouch under anesthesia. Bleeding from anastomoses that are not accessible using these techniques (i.e., ileocolic or small bowel to small bowel) may be managed with supportive care and correction of any underlying coagulopathy. If bleeding is severe, angiography may be required to localize the site and allow selective infusion of vasopressin. Alternatively, colonoscopy may be used. If the anastomosis can be visualized, the bleeding site can be treated with either cautery or injection of epinephrine. In rare cases, reoperation with resection of the bleeding anastomosis is required.

Leaks

The incidence of anastomotic leak varies widely and is related to the factors listed above as well as the type of anastomosis. The lowest leak rates are seen after small bowel or ileocolic anastomosis (1%–3%) whereas the highest occur after coloanal anastomosis (10%–20%). Vignali et al. reported on 1014 colorectal anastomoses. The overall clinical leak rate was 2.9%. The incidence of leak was strongly associated with the distance of the anastomosis from the anal verge. Eight percent of low anastomoses (<7 cm from anal verge) leaked compared with only 1% of high anastomoses (>7 cm from anal verge). Although diabetes mellitus, use of a pelvic drain, and duration of surgery were each related to anastomotic leak in the univariate analysis, only low anastomosis was predictive in the multivariate model.

Another high-risk anastomosis is the ileal pouch-anal anastomosis. Leak rates of 5%–10% have been reported.[8–10] Data from series of ileal pouch-anal anastomosis in patients with ulcerative colitis identify prednisone dosage >40 mg/day as a significant risk factor.

Role of Fecal Diversion

The creation of a proximal diverting stoma minimizes the severe consequences of an anastomotic leak but it does not reduce the incidence of leak itself.[11–13] A diverting stoma should be considered for any high-risk anastomosis [coloanal, low colorectal (<6 cm from anal verge)]. In addition, patient factors such as severe malnutrition, significant immunosuppression, and purulent peritonitis or pelvic sepsis should be considered as indications for diversion. Consideration should also be given to the patient's comorbidities and general condition; in cases in which the "physiologic reserve" necessary to tolerate an anastomotic leak does not exist, the use of a proximal stoma should be strongly entertained. Neoadjuvant radiation therapy does not seem to increase the incidence of anastomotic leak in patients undergoing restorative proctectomy for rectal cancer[14,15] but this may be because of the tendency for surgeons to cover these anastomoses with a proximal stoma, thus reducing the clinical manifestations of a leak. In fact, recent data from a large randomized trial assessing the efficacy of short-course neoadjuvant radiation therapy in rectal cancer found that a protecting stoma reduces the need for surgical intervention should an anastomotic leak occur.[16]

Role of Pelvic Drains

The use of pelvic drains is controversial. Whereas surgeons have long believed that preventing the collection of fluid or hematoma in the pelvis minimizes risk of anastomotic leak, the use of drains has not been shown to be of benefit or harm in a recent, large randomized study[17] and in a metaanalysis.[18] However, examination of the data from the Dutch TME trial showed that the use of pelvic drains reduced the incidence of clinical anastomotic leak after short-course neoadjuvant radiation therapy from 23% to 9%. In the absence of data suggesting harm, the authors routinely drain low colorectal or coloanal anastomoses, especially after neoadjuvant therapy.

Management of Anastomotic Leak

Anastomotic leaks can be divided into "free" and "contained" varieties. Free leaks are those in which fecal contents leak from the anastomosis and spread throughout the abdominal cavity. Patients usually present with fever, tachycardia, leukocytosis, and diffuse peritonitis. Feculent fluid may present itself through the surgical incision or via the pelvic drains. Hypotension and other signs of systemic sepsis may ensue. If the patient is stable, radiologic investigation is helpful to localize the leak and to determine its size and severity.

Patients with "free" leaks should be taken to the operating room after fluid resuscitation and administration of broad-spectrum intravenous antibiotics. Surgical treatment will be dictated by the findings at operation. Most leaking colorectal anastomoses will require abdominal washout and takedown of the anastomosis with creation of an end-colostomy and Hartmann stump. If the stump cannot be stapled or sutured closed because of the friability of the tissues, transabdominal pelvic and peranal drains should be placed. However, leaking ileocolic or small bowel to small bowel anastomoses can occasionally be repaired primarily in carefully selected circumstances, i.e., small defect with viable edges. However, resection of the anastomosis with either reconstruction or creation of a stoma is the wisest and most conservative option. Placing the repaired anastomosis directly under the midline incision will usually result in an enterocutaneous fistula rather than a second bout of peritonitis should the repair fail. If the viability of the bowel ends is questionable, takedown of the anastomosis and creation of a stoma is mandatory. Small defects in colorectal anastomoses may also, under ideal circumstances, be repaired primarily and covered with a proximal ileostomy. This is contraindicated, however, if there is a significant fecal load present between the ileostomy and the site of repair.

"Contained" leaks are those in which the extravasation of contrast material is limited to the pelvis and usually result in the development of a pelvic abscess (Figure 10-1). If the abscess cavity is small and contrast flows freely back into the bowel, the patient may be treated with intravenous antibiotics, bowel rest, and observation. If the abscess is larger or somewhat removed from the site of the anastomosis, then

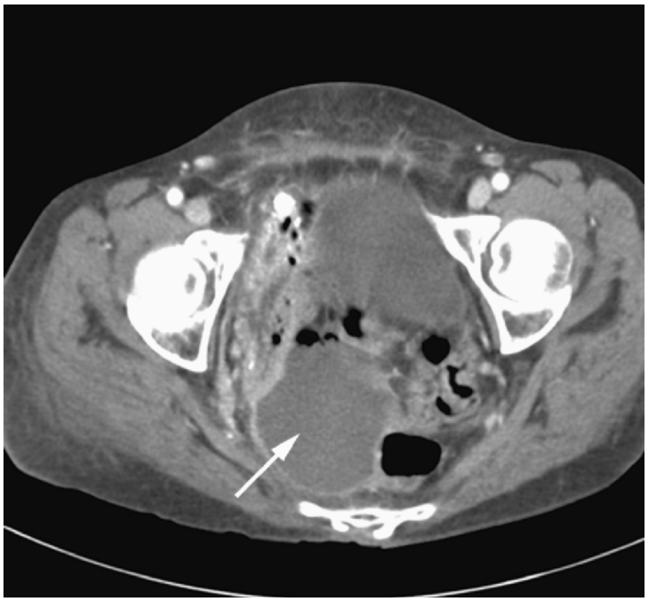

FIGURE 10-1. Pelvic abscess resulting from ileocolic anastomotic leak (white arrow). Extravasated enteric contrast can be seen in the right pelvis tracking down toward the abscess.

percutaneous abscess drainage using CT or ultrasound guidance may avoid laparotomy. Such leaks rarely require subsequent fecal diversion.

Fistulae

Anastomotic leaks may also result in fistulae to the skin, vagina, male genitourinary system, or chronic presacral abscess (presacral sinus). Colocutaneous fistulae will frequently close with conservative management consisting of either bowel rest with total parenteral nutrition or a low residue diet and pouching of the fistula to protect the surrounding skin. If drainage persists, reoperation for fistula takedown and reconstruction of the anastomosis can be performed after a delay of 3–6 months. Patients can usually eat a normal diet during this time period to maintain nutritional status. Fibrin glue injection has been reported as a successful alternative to surgery (see above).

Colovaginal fistulae are usually the consequence of either an anastomotic leak necessitating through the vaginal cuff in a patient who has undergone a prior hysterectomy or the inclusion of the vagina during creation of a stapled anastomosis. In either case, spontaneous closure is rare. If the vaginal drainage is copious and intolerable to the patient, proximal fecal diversion may be necessary. An alternative measure to avoid a stoma during the period of fistula maturation is to use a large-volume daily enema to evacuate the colonic contents at a predictable time each day. After a waiting period of 6–12 weeks, reoperation may be performed. Options include attempts at local repair using mucosal flaps (colonic or vaginal)/sleeve advancements or laparotomy with redo coloanal anastomosis, either primary or delayed (“Turnbull-Cutait pullthrough”).

Chronic presacral abscess or sinus may result from a posterior leak in a coloanal or ileal pouch-anal anastomosis. Patients may have an occult presentation consisting of vague pelvic pain, fevers, frequency of stool, urgency, and bleeding. A pelvic CT scan will usually show presacral inflammatory changes and a contrast enema will confirm the presence of a sinus tract originating from the posterior midline of the anastomosis and extending cephalad into the presacral space. Examination under anesthesia can then be performed with careful inspection of the anastomosis. A probe or clamp is placed through the anastomotic defect and the chronic presacral cavity is simply lain open using cautery and gently curetted of granulation tissue. This will allow free drainage of the presacral abscess and healing by secondary intention. This may result in a chronic posterior sinus or “pseudo-diverticulum.”

Stricture

Anastomotic stricture may be the end result of anastomotic leak or ischemia. It typically presents 2–12 months after surgery with increasing constipation and difficulty evacuating. If the initial resection was done for malignancy, recurrence as a cause of the stricture must be excluded with a combination of CT scan and fluorodeoxyglucose–positron emission tomography (PET) scan. Biopsy is mandated if a mass or abnormality is identified. Low colorectal, coloanal, or ileal pouch-anal anastomotic strictures may be successfully treated with repeated dilatations using an examining finger or rubber dilators. Dilation is more successful if initiated within the first few weeks after surgery. In fact, almost all coloanal or ileoanal anastomoses will stricture to some degree during the early postoperative period, especially if a diverting stoma is present. All such anastomoses should undergo digital examination at 4–6 weeks after surgery and just before stoma closure (usually at 2–3 months). Strictures are usually soft and easily dilated during these examinations. Higher colorectal, colocolic, or ileocolic strictures may be approached using endoscopic balloon dilatation (Figure 10-2). If these measures fail, or if the stricture is extremely tight or long, revisionary surgery may be required. These are difficult operations, however, because of the pelvic fibrosis that develops after anastomotic leak and complications are common. In some cases, permanent fecal diversion is the only option.[19,20]

Genitourinary Complications

Ureteral Injuries

Injury to the ureters typically occurs at one of four specific points in the procedure. The first is during high ligation of the IMA where the junction between the upper and middle thirds of the left ureter lies in close proximity to the vessels. Failure

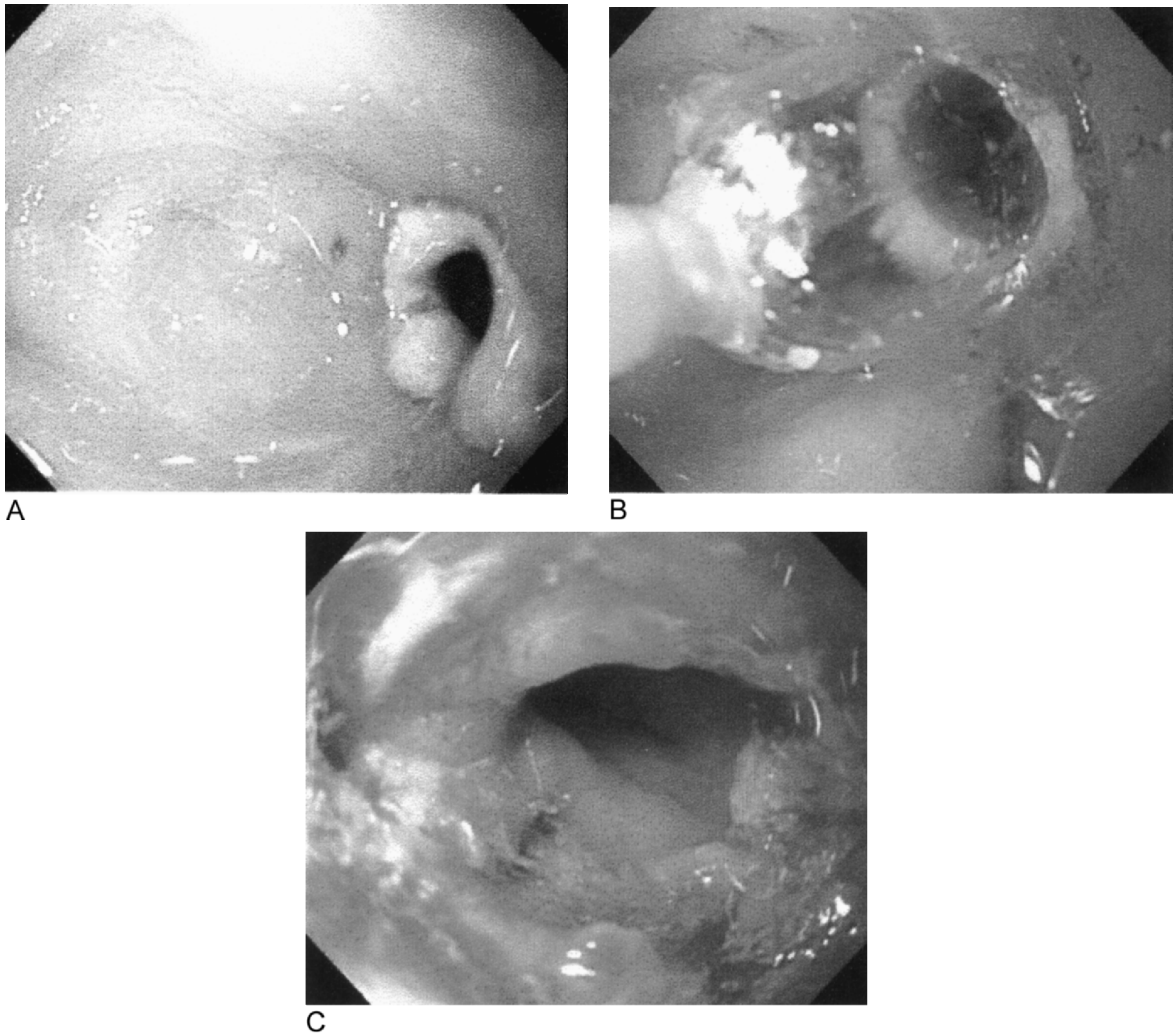

FIGURE 10-2. Endoscopic balloon dilatation of a colorectal anastomotic stricture. **A** Five-millimeter colorectal anastomotic stricture. **B** Balloon dilator inflated. **C** Result.

to mobilize the ureter laterally before ligation of the IMA may result in its inclusion with the vascular pedicle when clamped and subsequent division. It is good practice to always confirm the position of the left ureter before and after applying clamps to the IMA and before division of the vessel. Injury at this level is usually limited to transection and can be repaired primarily using an end-to-end, spatulated anastomosis performed over a stent. The second point of danger is during mobilization of the upper mesorectum near the level of the sacral promontory. It is at this point that the ureters cross over the bifurcation of the iliac artery and course medially as they enter the pelvis. The left ureter may be closely associated with the sigmoid colon and can even be adherent secondary to prior inflammatory processes. The injury may be tangential and not readily recognized in the setting of a phlegmon or abscess. Ureteral stents in this setting are most beneficial in identifying the injury rather than preventing it. Injury at this level is usually managed by either primary repair or ligation of the distal stump and creation of a ureteroneocystostomy with a Boari flap or psoas hitch repair.

The third point of risk is during the deepest portion of the abdominal phase of the operation. Anterolateral dissection in the plane between the lower rectum, pelvic sidewall, and bladder base can result in ureter injury at the ureterovesical junction. The ureter may also be injured at this level during division of the lateral stalks. The final area of risk is during the most cephalad portion of the perineal phase of the operation. If exposure is limited (obese patient, android pelvis), the ureter may be unknowingly divided near the ureterovesical junction. In either of these circumstances, the injury can be managed by creating a ureteroneocystostomy. The ureter is reimplanted into the bladder by tunneling the ureter through the bladder wall and creating a mucosa to mucosa anastomosis.

Should ureteral injury occur, the key to minimizing its consequence is immediate (intraoperative) recognition and repair of the injury. In cases in which a difficult pelvic dissection is anticipated, because of prior pelvic surgery, inflammation, or a locally advanced tumor, the preoperative placement of ureteral stents can be invaluable. Although the literature does not demonstrate that stents prevent ureteral injuries, palpation of the stents can aid in localization of the ureters and can also facilitate identification and repair should injury occur. In cases in which the surgeon is suspicious of occult injury, indigo carmine can be administered intravenously. After several minutes, the urine will turn blue-green and the operative field can then be inspected for staining. Unfortunately, the literature suggests that less than 50% of ureteral injuries are identified intraoperatively, usually because the injury is not suspected. Ureteral stents should be used selectively, however, because their use can lead to complications such as obstruction secondary to hematoma, perforation, or acute renal failure.

Urethral Injuries

Iatrogenic injury to the urethra may be the result of abdominoperineal resection (APR). The injury typically occurs during the perineal portion of the procedure and usually involves the membranous or prostatic portion. Intraoperatively, urethral injury may be recognized by visualization of the Foley catheter through the defect. These injuries may be difficult to avoid in the presence of a large, deeply penetrating anterior tumor in which involvement of the prostate gland can occur. Desmoplastic reaction to the tumor or edema from neoadjuvant radiation therapy may also obscure anatomic planes. Small injuries can be repaired at the time of surgery using 5-0 chromic sutures with the Foley catheter left in place to stent the repair for 2–4 weeks. Larger injuries or those not presenting until the postoperative period (urine draining from the perineal wound) require proximal urinary diversion via suprapubic catheter and delayed repair. This should be performed by a skilled urologist with experience in urethral reconstruction and typically utilizes a gracilis muscle flap.

Bladder Injury

Bladder injuries are relatively frequent and are, in most cases, related to resection of an adherent rectosigmoid tumor or diverticular phlegmon. When created purposefully or recognized immediately, defects in the bladder dome are easily repaired in two layers with a Foley catheter then left in place for 7–10 days postoperatively. Before removal, a cystogram may be obtained to confirm healing. Injuries to the base of the bladder are more problematic. The major risk of repair in this situation is occlusion of the ureteral orifice at the trigone. Most urologists advocate opening of the bladder dome to gain access to the bladder lumen with subsequent repair of the trigone injury under direct vision from the interior. Ureteral patency is confirmed at the conclusion of the repair before closing the cystotomy. Injuries not recognized at the time of surgery will present in the postoperative period with urine in the abdominal cavity, pneumaturia, or fecaluria. Initially, fecal and urinary diversion may be necessary to temporize the situation until reoperation can be safely performed. At that time, takedown of the colovesical fistula is performed with primary repair of the bladder. If available, omentum should be interposed between the bladder repair and any bowel anastomosis. Catheter drainage of the bladder is maintained for 1–2 weeks.

Urinary Dysfunction

Urinary dysfunction is one of the most common urinary complications of APR.[21] Some degree of voiding difficulty occurs in up to 70% of patients after APR, but it is usually confined to the early postoperative period. In most instances, urinary retention is the result of denervation of the detrusor muscle causing partial paralysis. Bladder contractility is under parasympathetic control via pelvic nerve branches originating from the inferior hypogastric plexus. These nerves can be injured if the endopelvic fascia is breached, especially during blunt dissection of the rectum. Temporary dysfunction of these nerves is nearly universal after APR, even when a meticulous sharp dissection is used. Most patients, however, will only require maintenance of a Foley catheter for 5–7 days postoperatively. In a small percentage of patients, the problem persists beyond several months and urologic consultation is required. A small percentage of these patients may require prostatectomy or even intermittent self-catheterization on a long-term basis.

Sexual Dysfunction

Recent series report an incidence of sexual dysfunction of 15%–50% in male patients undergoing APR for rectal cancer.[22–24] This wide range is likely attributable to several factors such as patient age, preoperative libido, use of adjuvant radiation therapy, varying definitions of dysfunction, time point of follow-up, and social barriers preventing a frank discussion of the problem. The type of dysfunction is dependent on the pattern of nerve injury. Damage to the superior hypogastric (sympathetic) plexus during high ligation of the IMA or to the hypogastric nerves at the sacral promontory during mobilization of the upper mesorectum, results in ejaculatory problems such as retrograde ejaculation. This is the most common type of sexual dysfunction seen in male patients after APR and is also the type most likely to resolve with time (6–12 months). Damage to the pelvic plexus during the lateral dissection or to the nervi erigentes or cavernous nerves while dissecting the anterior plane (abdominal or perineal phase) may result in erectile dysfunction. The cavernous nerves arise from branches of the pelvic plexus and course anterior to Denonvillier's fascia at the lateral border of the seminal vesicles. Parasympathetic innervation from these routes controls the inflow to and retention of blood within the corpora cavernosa. The important anatomic relations of the pelvic nerves are illustrated in Figure 10-3.

Risk of injury to these nerves may be reduced by tailoring the anterior dissection based on the location of the tumor. The highest risk of parasympathetic nerve injury occurs when dissection is performed in the plane anterior to Denonvillier's fascia and flush with the posterior aspect of the seminal vesicles and prostate. Whereas some believe that this plane is a vital part of total mesorectal excision for any low rectal cancer, others will only include Denonvillier's fascia in the resection specimen for an anterior tumor where it may help obtain a clear radial margin.[25] For posterior tumors, Denonvillier's fascia is preserved by dissecting between it and the fascia propria of the rectum in order to protect the small cavernous nerves. Using a "nerve sparing" approach to total mesorectal excision, several authors have reported an incidence of erectile dysfunction of 5%–15% after proctectomy for rectal cancer. Factors shown to increase risk are older age, poor

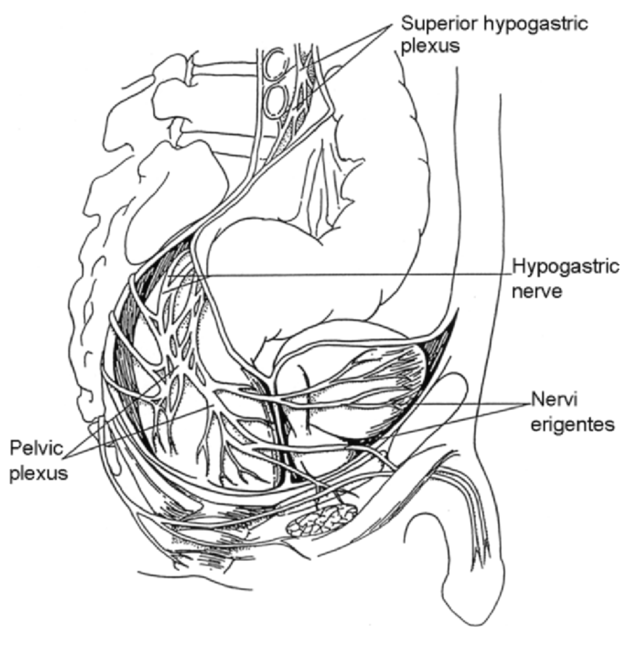

FIGURE 10-3. Anatomic relations of the pelvic nerves. Damage to the superior hypogastric plexus during high ligation of the IMA or to the hypogastric nerves at the sacral promontory during mobilization of the upper mesorectum results in retrograde ejaculation. Damage to the pelvic plexus during the lateral dissection or to the nervi erigentes or cavernous nerves while dissecting the anterior plane may result in erectile dysfunction.

preoperative libido, and low rectal tumor requiring APR (two- to threefold increase compared with low anterior resection).

Although harder to quantify, sexual dysfunction also occurs in women after proctectomy. It is characterized by dyspareunia and inability to produce vaginal lubricant and achieve orgasm. The incidence is lower than that seen in males and varies between 10% and 20%.[26]

Female Infertility

Several recent studies have documented decreased fertility in women who have undergone restorative proctocolectomy for ulcerative colitis or familial adenomatous polyposis.[27,28] The postoperative infertility rate exceeds 50% in this group when defined as "one year of unprotected intercourse without conception." This has important implications in both preoperative patient counseling and in the modification of operative technique to minimize the effect of pelvic adhesions on fertility. Women of childbearing age should be informed of this potential complication before elective restorative proctocolectomy because it may influence the timing of surgery. In addition, because pelvic adhesions are thought to interfere with egg transit from the ovary to the fallopian tube, measures to minimize their occurrence may be of benefit. Tacking the ovaries to the anterior abdominal wall outside of the pelvis and wrapping the adnexa with an anti-adhesion barrier sheet are frequently used techniques but there are no data to support their efficacy.

Trapped Ovary Syndrome

Trapped ovary syndrome is a fairly common complication after restorative proctocolectomy in young women. The adhesions that form after ileal pouch-anal anastomosis trap the ovaries in the pelvis and cover the fallopian tubes. With each ovulatory cycle, there is release of fluid into the pelvic cavity defined by these adhesions. As fluid accumulates and the cavity expands, patients will complain of pelvic or lower abdominal pain relevant to the side of the trapped ovary. A CT scan or ultrasound will reveal a cystic lesion in the pelvis containing no air and with no surrounding inflammatory reaction. Operative findings are a cyst containing clear or tan fluid, surrounded by adhesions and with the ovary attached. Treatment consists of unroofing and evacuation of the cyst, pelvic adhesiolysis, and suspension of the ovary to the pelvic brim or iliac fossa with sutures. Trapped ovary syndrome may be prevented by suspending the ovaries at the time of restorative proctocolectomy and by placement of an adhesion barrier film in the pelvis.

Small Bowel Obstruction

Perhaps the most critical components in the management of patients with bowel obstruction are the recognition and prevention of the disastrous effects of bowel ischemia. Timely surgical intervention, before the development of transmural necrosis, will limit complications and improve outcome. In one recently published series of more than 1000 patients undergoing surgery for small bowel obstruction, nonviable strangulated bowel was present at laparotomy in only 16% of cases but the risk of death in this group was increased fourfold.[29] It is also important to distinguish between early (< 30 days) and late postoperative small bowel obstruction.

Presentation and Diagnosis

Nausea and vomiting, colicky pain, abdominal bloating, and obstipation are the hallmark signs of small bowel obstruction. The degree to which each of these contributes to the clinical picture will depend on the location, degree, and duration of the obstruction.

The commonly regarded hallmarks of strangulated bowel are fever, tachycardia, leukocytosis, sepsis, peritoneal signs, and the presence of continuous as opposed to intermittent pain. If any of these are found, the suspicion of ischemia should be high. These signs may also be found in patients without strangulation and are, therefore, nonpathognomonic. In many cases, however, this determination is not made until laparotomy, and timely surgical intervention in symptomatic patients may be the best means of avoiding the progression to bowel ischemia. This fact is underscored by a report from Sarr and colleagues[30] who found that the traditional clinical parameters frequently used to predict strangulation were neither sensitive nor specific. Nearly one-third of patients with strangulation were not diagnosed until the time of surgery.

Radiographic Studies

Plain Radiographs

An acute abdominal series is the initial imaging study performed in most patients suspected of having small bowel obstruction and consists of both upright and supine abdominal films and an upright chest X-ray. Typical findings include dilated, air-filled loops of small bowel, air-fluid levels, and an absence or paucity of colonic air. These findings may be absent, however, when the obstruction is proximal or the dilated bowel loops are mostly fluid filled. The sensitivity of plain radiographs in detecting small bowel obstruction is approximately 60%. The findings of pneumatosis intestinalis or portal vein gas is worrisome for advanced bowel ischemia.

CT Scan

Abdominopelvic CT scanning is increasingly used as a primary imaging modality in patients suspected of having small bowel obstruction. In addition to establishing the diagnosis, CT may also be able to precisely define a transition point and reveal secondary causes of obstruction such as tumor, hernia, intussusception, volvulus, or inflammatory conditions such as Crohn's disease and radiation enteritis. CT may also reveal closed loop obstructions or signs of progressing ischemia such as bowel wall thickening, pneumatosis, or portal vein gas. Several studies have shown that the sensitivity of CT in diagnosing small bowel obstruction approaches 90%–100%.

Contrast Studies

Contrast studies using water-soluble agents are frequently used in patients with acute small bowel obstruction. In patients with distal small bowel obstruction, a contrast enema is an efficient means by which colonic obstruction can be excluded. Antegrade studies of the small bowel can help to differentiate partial from complete obstruction, and may therefore predict the need for surgical intervention. In fact, some authors have used small bowel contrast studies as a "screening test" for patients presenting with adhesive obstructions. Failure of contrast material to reach the colon by 24 hours is used as an indication for prompt surgical exploration. Several studies have also shown that the antegrade administration of contrast agents may speed the resolution of partial small bowel obstruction, presumably through an osmotic effect. However, conflicting data also exist and the therapeutic effects of the small bowel contrast study remain to be defined.

Initial Therapy and Nonoperative Management

Once the diagnosis of small bowel obstruction is made, the patient is admitted to the hospital. Those with peritonitis, perforation, or signs of ischemic bowel are immediately prepared for laparotomy with expeditious correction of fluid and electrolyte deficits. A urinary catheter is inserted to guide resuscitation with the end points being resolution of tachycardia and hypotension and/or achieving a urine output of at least 0.5 cc/kg/h. Broad-spectrum antibiotic coverage is initiated. A nasogastric tube is inserted preoperatively to decompress the stomach, because these patients are at risk for aspiration on induction of general anesthesia.

If signs of perforation or ischemia are not present, a trial of expectant management may be undertaken. Patients with partial small bowel obstructions secondary to adhesions will resolve with a nonoperative approach in 80% of cases.[31–33] The success rate for patients initially presenting with complete obstruction is significantly lower. The nonoperative management of small bowel obstruction consists of fluid and electrolyte replacement, bowel rest, and tube decompression. The debate between standard nasogastric tube versus long nasoenteric tube decompression has mostly settled in favor of the nasogastric tube. This is in part attributable to the fact that long tubes with mercury-weighted tips (Miller-Abbott) are no longer available for use (because of concern about the elemental Mercury) and have been replaced with a balloon-tipped tube (Gowen tube) that requires endoscopic placement. Long tubes are more difficult to place, requiring special expertise, serial radiographic studies, or endoscopy to guide insertion. There has been some recent resurgence in interest in the use of nasoenteric tubes, mostly among radiologists. Indications for long tube management of small bowel obstruction include early postoperative obstruction and recurrent partial obstruction where the transition point is difficult to identify on contrast studies.

Narcotic analgesics may be administered to comfort the patient, but not to the point of diminishing mental status. The practice of withholding pain medication to avoid masking the signs of perforation or ischemia is probably unnecessary. Serial abdominal examinations (ideally just before the next dose of analgesics) should be performed to assess for increasing tenderness or the presence of peritoneal signs. Any change in the patient's condition that suggests developing bowel ischemia mandates exploratory laparotomy. In general, a nonoperative course may be followed for 24–48 hours. If the obstruction has not resolved within that time period, it is unlikely to do so and laparotomy is advised.

Decision to Operate

Several studies have attempted to define certain criteria that would reliably predict the presence or absence of strangulated bowel. Unfortunately, none have been shown to be particularly accurate and the best tool remains sound clinical judgment. Certainly, patients with fever, peritonitis, pneumoperitoneum, or overt sepsis should undergo emergent laparotomy because these are hard signs of transmural bowel necrosis. The presence of early ischemia, however, is much more difficult to discern. It is not uncommon for patients with small bowel obstruction to present with tachycardia, relative hypotension, mild acidosis, and leukocytosis, all of which may be secondary to dehydration. These patients should be aggressively rehydrated with isotonic intravenous fluids and the above parameters should be reassessed. Persistence of any of these signs after fluid resuscitation should prompt immediate laparotomy. Adherence to this simple algorithm should minimize the progression to strangulation while limiting the number of unnecessary laparotomies.

Distinguishing between partial and complete obstruction is also a key element in deciding which patients should be taken for early operation. As stated above, the likelihood of resolution of a complete obstruction with expectant management is low (20%). Delaying operative therapy until after a nonviable strangulation or perforation has occurred will substantially increase the mortality rate. Although this distinction may be difficult to make clinically, there are some useful caveats. The passage of stool or flatus cannot be relied on as an accurate predictor because patients with complete obstruction may continue to pass stool and flatus until the bowel distal to the site of obstruction is evacuated. However, if this continues for more than 12 hours after the onset of obstructive symptoms, the likelihood of complete obstruction is diminished. The passage of large volumes of nonbloody, watery stool along with vomiting and distension is pathognomonic for partial small bowel obstruction. The onset of flatus, however, usually signals the beginning of resolution of the obstruction because flatus is produced from swallowed air.

Surgical Technique

After the adequacy of resuscitation is confirmed and broad-spectrum antibiotics active against enteric pathogens are administered, the peritoneal cavity is entered through a midline incision. This is a point in the operation where the risk of inadvertent enterotomy is very high because bowel loops are distended and often adherent to the undersurface of the abdominal wall. Once the fascia is encountered, the application of gentle pressure with the bevel of the scalpel blade, rather than a cutting stroke, is used to breach the peritoneal cavity. Using this technique, it is usually possible to recognize an adherent bowel loop before enterotomy occurs.

In the most favorable scenario, a single constricting band will be encountered that can be sharply divided to relieve the obstruction. In the worst cases, the peritoneal cavity will be totally obliterated by scar tissue. An orderly and systematic approach to adhesiolysis is advised in these instances. First, the underside of the midline scar is cleared so that the entire length of the incision can be opened if necessary. Next, adhesions to the abdominal wall are dissected laterally until both paracolic gutters are reached. This will allow the placement of a self-retaining retractor to facilitate exposure. In cases in which bowel distension is severe, needle decompression may be used to gain additional working space. Particularly severe adhesions that defy identification of the bowel and peritoneal surfaces ("frozen abdomen") may be injected with saline through a fine-gauge needle to separate the surfaces and thus facilitate adhesiolysis. Attention is then turned to the pelvis where the most difficult adhesions are often encountered. Rather than separating individual bowel loops at this stage, the small bowel residing in the pelvis should be mobilized "en-masse" by lysing adhesions to the pelvic structures in an anterior to posterior manner in order to roll the mass of intestine up and out of the pelvis. The final portion of this stage of the operation involves mobilizing the plane between the small bowel mesentery and the retroperitoneum until the duodenum is encountered. Only at this point are all adhesions between individual bowel loops lysed in order to free the entire length of the small intestine. The bowel is then inspected for any coexisting pathology and for enterotomies or serosal tears created in the course of mobilization.

Assessment of bowel viability is usually possible by using the triad of color, peristalsis, and mesenteric pulsations. In cases in which these signs are questionable, the ischemic segment should be wrapped in warm, wet packs and viability reassessed after 15 minutes. If viability is still in doubt, use of the Doppler probe or systemic injection of fluorescein dye followed by inspection of the bowel under a Wood's lamp may aid in decision making. If the area in question is a short segment, it may be best to proceed with resection. If an extensive segment of questionable viability is present, then a second-look operation 24 hours later should be planned before committing the patient to a massive small bowel resection.

There is some debate as to the need for complete adhesiolysis when the point of obstruction is encountered early in the operation. It is our policy to divide the majority of adhesions if this can be done safely. This will facilitate inspection of the entire length of the small bowel and allows for the placement of anti-adhesion barriers if desired (see below).

Special Situations

Early Postoperative Bowel Obstruction

Early postoperative bowel obstruction is generally defined as mechanical obstruction occurring within 1 month of abdominal or pelvic surgery. This condition is special in that attempts at relaparotomy in the early postoperative period frequently result in disastrous complications. The mantra of "never let the sun rise or set on a patient with bowel obstruction" should not be broadly applied in this group. An intense inflammatory response usually begins within the abdomen at 7–10 days postoperatively and persists for at least 6 weeks. If forced to operate during this period of time, the surgeon is likely to encounter dense hypervascular adhesions that may obliterate the peritoneal cavity. The risk of enterotomy and subsequent fistulization is extremely high. In addition, vascular or extensive serosal injury of the bowel may lead to massive resections. Therefore, immediate reoperation for early postoperative bowel obstruction is not advised, especially considering the fact that the development of strangulation in this setting is extremely rare. These patients should be managed conservatively with nasogastric or long tube suction and intravenous fluids. If resolution does not occur within the first 5–7 days, a percutaneous gastrostomy tube may be placed for longer-term decompression, and the patient is started on hyperalimentation. Patients may be discharged from the hospital on this regimen and laparotomy performed in 6 weeks if the obstruction has not resolved. However, if peritonitis or signs of sepsis are present initially or develop during the course of nonoperative therapy, a CT scan should be performed immediately. Any abscess or fluid collection caused by an enteric leak can be percutaneously drained and a controlled enterocutaneous fistula established. Exploration is usually only required in cases of ischemic or necrotic bowel. There is a place for very early exploration within the first 10 days postoperatively if obstruction is recognized promptly. The adhesions encountered during this time period have not usually become severe and can be dealt with safely.

Anastomotic "Overhealing"

Anastomotic overhealing is a rare cause of postoperative small bowel obstruction. It is most often attributable to early adhesion and healing of the staple lines of the linear cutter between the limbs of a functional end-to-end/side-to-side anastomosis. This is best prevented by maximally distracting the two staple lines as the transverse staple line is placed to close the enterotomy made to introduce the side-to-side stapler. When this occurs in the early postoperative period, it will be easily diagnosed with a water-soluble contrast study, especially if administered via a long tube near the point of obstruction. The treatment should be conservative initially and may include long tube decompression. In some cases, the balloon-tipped catheter itself has broken through the healing web and relieved the obstruction. In the case of an obstructed ileocolic anastomosis, colonoscopic balloon dilatation may be carefully used. Operative intervention should be a last resort and usually requires resection and reanastomosis.

Prevention of Adhesions

More than 90% of patients undergoing abdominal surgery will develop some degree of intraabdominal adhesions. Adhesion formation can occur wherever the visceral or parietal peritoneum has been disturbed. Once an area of injury is established, fibrin is deposited and then organizes to form a matrix for collagen deposition. Bowel motility and endogenous lubricants attempt to counteract this process, but in most cases, adhesions will eventually result as the deposited collagen matures. As discussed earlier, the progression from early to mature adhesions usually takes approximately 6 weeks.

Several strategies have been developed to minimize, prevent, or influence adhesion formation. Gentle handling of tissues, avoiding the deposition of talc by wearing powder-free gloves, and copious lavage of the peritoneal cavity at the conclusion of the operative procedure are simple means that should be used in all cases. In instances in which particularly severe adhesion formation can be anticipated, for instance patients with multiple recurrences of small bowel obstruction, the use of long intestinal tubes placed at the conclusion of surgery to "splint" the bowel open during adhesion formation has been advocated. This is usually accomplished by inserting a Baker tube via a proximal jejunostomy.

Recently, several chemoprophylactic agents have been developed in an attempt to reduce or eliminate adhesions through a barrier mechanism. The best studied of these is a bioresorbable membrane of modified sodium hyaluronate and carboxymethylcellulose. A large multicenter study by Becker et al.[34] has shown that this material substantially reduces the extent, incidence, and severity of adhesion formation. Its efficacy in reducing the incidence of adhesive bowel obstruction has recently been reported.[35] However, the decrease in incidence of bowel obstruction from 3.4% in the control group to 1.8% in the treatment group is of uncertain clinical significance. The use of adhesion barriers in patients at high risk for subsequent reoperation because of disease or previous adhesions may be justified by the likely improvement in the ease and safety of the subsequent abdominal reentry and explorations. One of the problems with the barrier material is that it only prevents adhesions between the surfaces where it is applied.

Pelvic Bleeding

Serious pelvic bleeding may be encountered during proctectomy and is usually caused by injury to the presacral venous plexus or the internal iliac vessels or their branches. Although rare, pelvic bleeding can be a devastating event and is a significant cause of operative mortality. Presacral venous hemorrhage is especially challenging because the anatomy and fragility of the presacral venous plexus make control of bleeding difficult. Attempts at electrocoagulation or suture ligation of these vessels usually results in an increase in bleeding and is not advised. Direct finger pressure should be used to gain temporary control of bleeding while allowing the anesthesia team to "catch up" with the resuscitation. Once the patient is stabilized, several methods exist for permanent hemostasis. The most common of these is the use of sterile thumbtacks or specially designed "occluder pins" that are driven into the sacrum at right angles and directly over the site of bleeding.[36,37] If this is unsuccessful, a rectus abdominus muscle flap may be rotated down into the pelvis based on the inferior epigastric pedicle. Heavy sutures are then placed on either side of the sacrum and tied down to compress the rectus flap against the sacrum to tamponade the bleeding.[38] Other methods to control presacral bleeding have also been described[39–42] such as removing a 2×2 cm square of rectus muscle and tacking this to the sacrum with absorbable sutures placed on either side of the bleeding site and tied tightly to secure the muscle patch. Application of electrocautery to the muscle then produces a secure coagulum on the surface of the bleeding venous plexus. If these measures fail, pelvic bleeding may be controlled by packing several laparotomy sponges tightly into the pelvis with the ends being brought out through the lower portion of the abdominal wound. The abdomen is then closed and the patient is taken to the intensive care unit for blood transfusion, fluid resuscitation, correction of coagulopathy, and general support. After 24–48 hours, the patient is returned to the operating room for removal of the packs.[43]

Wound Infection and Intraabdominal Abscess

Wound Infection

Because of the large bacterial content of the colon (10^{10} anaerobes and 10^8 aerobes/gram of stool), wound infection rates are high after colorectal surgical procedures.[44,45] The introduction of an oral antibiotic preparation before surgery by Nichols and Condon reduced wound infection rates from 40% historically to the present day level of 5%–10%. In many centers, a single parenteral dose of antibiotics at induction has replaced the more complicated "Nichol's prep." Several single-agent or combination choices exist, each with adequate gram-negative and anaerobic coverage. Risk factors for wound infection have been identified and include malnutrition, diabetes mellitus, immunosuppression, age >60 years, American Society of Anesthesia score >2, fecal contamination, length of hospitalization before surgery, and extensive surgery.[46] Recently, there is a growing body of literature that shows that mechanical bowel preparation does not decrease the incidence of wound infection. Several metaanalyses have examined this question and are in agreement.[47–49] The largest and most recent also found that the risk of anastomotic leak was actually increased in patients receiving a bowel preparation (odds ratio 1.75).[50]

Wound infections typically present on or around the fifth postoperative day and are characterized by erythema, warmth, tenderness, fever, and purulent drainage. Initial treatment consists of opening a portion of the skin incision over the area of maximal change to allow drainage. Antibiotics are not prescribed unless there is cellulitis present. If a significant amount of necrotic tissue is present, it should be débrided. Once the wound is adequately drained, a packing regimen is begun and the wound is allowed to heal by secondary intention. Large wounds may be treated with application of a vacuum-assisted wound closure device. After the wound has been débrided by several days of wet to dry dressing changes, the vacuum-assisted closure device is applied (V.A.C.; KCI Therapeutic Services, San Antonio, TX). The advantages of this system are simplification of wound care and quicker closure. The dressing only needs to be changed every 4–5 days and wounds typically close within several weeks.

Several situations require more aggressive treatment. Deep infection involving the rectus muscle and fascia may occur and result in dehiscence. These patients should be taken back to the operating room for debridement of the necrotic fascial edges and repair of the dehiscence. Invasive wound infections with either clostridium perfringens or beta-hemolytic streptococcus is a potentially life-threatening complication. These infections may have an atypical presentation in that they can occur within the first 1–2 days after surgery and may be associated with minimal skin changes. The combination of fever and unusually severe wound pain early in the postoperative course should prompt opening of the skin incision. A necrotizing infection is suggested by the drainage of thin gray fluid. The key to timely diagnosis and treatment of these severe infections is a high level of suspicion. The patient should be taken to the operating room for a thorough wound exploration. All devitalized tissue should be removed and the fascia excised back to healthy, bleeding edges. Broad-spectrum antibiotic coverage should include high-dose penicillin.

Intraabdominal Abscess

Intraabdominal abscesses can result from anastomotic leaks, enterotomies, or spillage of bowel contents at the time of surgery. Patients will usually present with fever, leukocytosis, and abdominal or pelvic pain 5–7 days after surgery. The diagnostic modality of choice is a CT scan of the abdomen and pelvis performed with intravenous and oral contrast (and rectal contrast in the patient with a colorectal anastomosis). The finding of a fluid collection with a thickened, enhancing rim and surrounding inflammatory stranding is diagnostic. Air bubbles may also be present in the collection. Proximity to a staple line and the presence of contrast material in the abscess suggest an anastomotic leak as its cause.

Most intraabdominal or pelvic abscesses can be successfully treated with percutaneous catheter drainage performed under ultrasound or CT guidance. Intravenous antibiotics should also be administered. The CT scan is repeated 48 hours after drainage to assess its efficacy. Further follow-up is usually performed by contrast studies obtained by injecting the drainage catheter. Once the abscess cavity has collapsed and no fistula to the bowel is identified, the catheter can be safely removed. Some abscesses cannot be drained percutaneously because of their location and lack of a safe "radiographic window" for drainage. Reported success rates for percutaneous drainage of intraabdominal abscesses range from 65% to 90% and depend on size, complexity, etiology, and microbial flora.[51–54]

Perineal Wound Infection

Perineal wound infection and delayed healing are major causes of morbidity after APR with the incidence ranging from 11% to 50%.[55–58] The rigidity of the lower pelvis combined with wide resection of the perineal soft tissues and levator muscles is mostly to blame, because this results in dead space cephalad to the skin closure which is easily infected.[59] Technical modifications that may help reduce the incidence of perineal wound problems include reapproximation of the

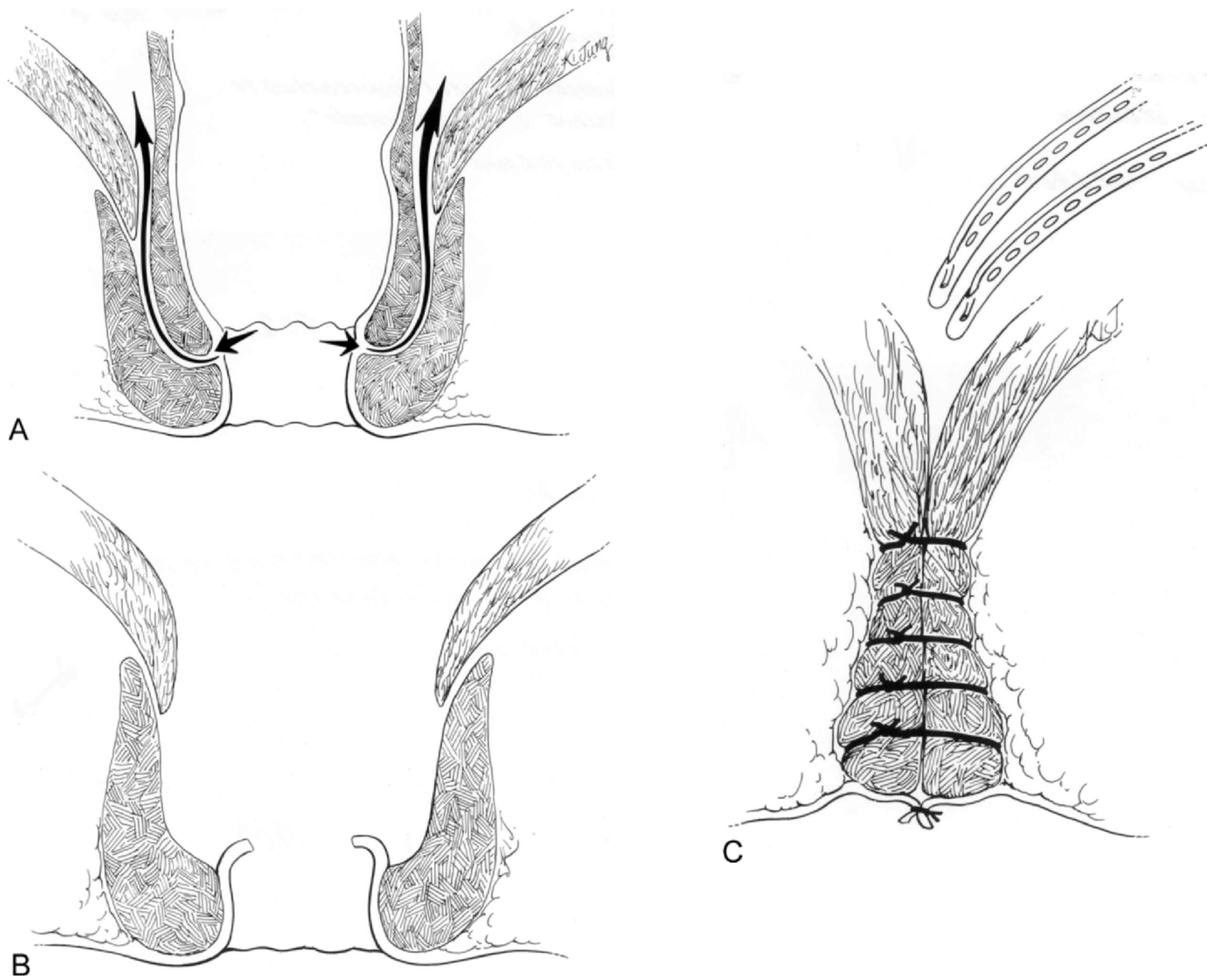

FIGURE 10-4. Technique of intersphincteric proctectomy. **A** The mucosa overlying the intersphincteric groove is incised near the dentate line and the dissection is carried cephalad between the internal and external sphincters. **B** This results in retention of the external sphincters and levators which are then able to be closed in the midline **C**.

subcutaneous tissues, suction drainage of the pelvis (with or without irrigation) to prevent hematoma formation and resultant fibrosis,[60] and filling of the dead space with an omental pedicle graft.[61–65] The area of raw surface deep in the pelvis also frequently fills with small bowel and may lead to small bowel obstruction. The bowel can be excluded from the pelvis by closing the pelvic peritoneum when possible, pulling the uterus posteriorly to close the defect, or by rotating the cecum into the pelvis. The use of absorbable mesh has also been described, but this has been associated with multiple reports of obstruction and fistulization. If possible, based on oncologic factors, a cuff of levator muscle can be left by incising the pelvic floor just outside of the external sphincter muscle. This should always be possible for small rectal cancers. This allows closure of the levator muscles in the midline and prevents dead space formation and perineal hernia. Several risk factors for perineal wound complications have been identified. Foremost among these is the use of neoadjuvant radiation therapy. In one study, the incidence of perineal wound infection increased from 13% to 34% with the addition of preoperative radiation whereas the rate of nonhealing at 30 days increased from 19% to 51%. Rates of perineal wound complications were even higher if intraoperative radiation was used.[66] Other factors are long operative time (>300 minutes), intraoperative hypothermia, and fecal contamination during the perineal dissection.[67,68] Patients with anorectal Crohn's disease are also at increased risk when undergoing APR for rectal cancer. However, an intersphincteric dissection in patients with inflammatory bowel disease allows closure of the external sphincter and may improve wound healing (Figure 10-4).

If infection does occur, the skin should be opened to allow drainage and a program of wet to dry packing begun. A vacuum-assisted closure device can then be placed, as described above. In cases in which a chronic perineal sinus develops, closure of the defect will require wound debridement and myocutaneous flap reconstruction with gracilis, inferior gluteus, or rectus abdominus muscle.

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