Reoperative Surgery in Complex Crohn's Disease

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Abstract

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- intestinal failure
- small bowel transplantation

This article provides a structured approach to the technical aspects of reoperative surgery for Crohn's disease. Specific indications for surgery including repeat ileocolic resection, Crohn's complications of ileal pouch anal anastomosis and continent ileostomy, completion proctectomy, and the role of small bowel transplant will be discussed.

Patients requiring operative intervention for Crohn's disease are a diverse and heterogeneous population, with indications for surgery ranging from complications of disease to failure of medical management. The urgency of operative planning varies widely based on disease severity and presentation. Mild obstructive symptoms from chronic stricture or inflammatory phlegmon with abscess or fistula in the stable patient are relatively nonurgent as compared with pelvic sepsis in an unstable patient. Some of the most complex and challenging patients are those who require repeated operative intervention. However, the basic principles of Crohn's surgery remain the same: surgery is not curative and the majority of patients have recurrent disease. Therefore, preservation of small bowel length is crucial, and the surgeon must consider the implications of the current operation in case of future surgical intervention.

Successful reoperative surgery for Crohn's disease requires thoughtful preparation, a thorough understanding of the particular patient's anatomy and disease distribution, contingency plans based on intraoperative findings, considerable experience, and setting realistic expectations for functional outcomes. This article will cover preoperative evaluation and preparation of the patient, common pitfalls

encountered during reoperative Crohn's surgery, useful technical tips, and finally a discussion of clinical scenarios that lead to reoperative Crohn's surgery: repeat ileocolic resection (ICR), completion proctectomy, role of small bowel transplant, and Crohn's complications of ileal pouch anal anastomosis (IPAA) and continent ileostomy (CI). The specifics of strictureplasty, segmental colectomy, and complex enteric fistulae will be discussed in other chapters.

Preoperative Evaluation and Preparation

Operative planning requires detailed evaluation of the patient's current symptomatology and physical exam findings, past medical and surgical history, and delineation of anatomy and areas of active disease via endoscopy and cross-sectional imaging. Nutritional assessment, including body mass index, recent weight loss, serum albumin, prealbumin, and transferrin levels, is important as malnutrition increases the risk of poor wound healing and anastomotic complications. Similarly, the patient's medication regimen needs to be considered, as steroids and anti-tumor necrosis factor (anti-TNF) agents may also increase the risk of perioperative complications.

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Obtaining an accurate history of current symptoms will help determine when and if a patient requires surgery. Specific questioning regarding the timing of disease flares, pain, weight loss, self-imposed dietary restrictions, quality of life, perianal disease, and smoking status provides important clinical context for decision making. Goals and expectations for any operative intervention will be based on relief of specific symptoms, as surgery is not indicated for asymptomatic patients.

A complete physical exam should be performed. Abnormal vital signs indicate a higher acuity patient who may require resuscitation prior to any intervention. Important abdominal findings include locations of tenderness, presence of palpable mass, prior incisions, stomas, or evidence of draining fistulas. Examination of the perineum should be performed looking for tags, fissures, fistulae, or abscess. A digital rectal exam may reveal scarring or anal stenosis and proctitis may be visible on rigid or flexible proctoscopy. Anorectal involvement has important implications for operative planning.

The surgeon must understand disease distribution and severity, current anatomy, and roughly how much remaining small bowel is present to determine which operation is indicated and what timing is appropriate. Review of operative reports, prior endoscopies and imaging, and pathologic records provides a useful baseline with which to compare the results of current diagnostic testing. Endoscopic evaluation of the colon, rectum, and terminal ileum is essential. Biopsies should be obtained from both grossly involved and noninvolved bowel to confirm active inflammation versus normal tissue, and to rule out dysplasia. Size and health of the ileal pouch must be evaluated prior to consideration of redo IPAA. CT enterography and MRI enterography are useful tools not only for assessment of disease distribution and severity but also for evaluation of anatomy and relationship of phlegmon/abscess/fistulae to critical structures, such as the ureters.

Timing of Surgery

The proper timing of surgery for Crohn's disease may be one of the most critical components for its success. The longer the interval between operations, the greater the likelihood of success. Delaying surgery for a minimum of 6 months from the last laparotomy is recommended before attempting complex procedures such as enterocutaneous fistula takedown or redo IPAA. In cases where the previous laparotomy was extremely difficult due to dense adhesions, delaying reoperation for 12 months may be wise. If necessary, intra-abdominal abscess or pelvic sepsis can usually be controlled with percutaneous drains. In the event a proximal fecal diversion is required, a limited upper abdominal laparotomy will usually allow the creation of a loop jejunostomy or ileostomy while avoiding the hostile lower abdomen or pelvis. Bowel rest and total parenteral nutrition may be required.

Preparation for Surgery

Preparing for reoperative surgery for Crohn's disease involves both the patient and the surgeon. Patients should undergo a thorough preoperative medical clearance evalua-

tion to identify and correct any underlying cardiopulmonary risk factors. In steroid-dependent patients, steroids should be tapered to the lowest dose possible without a flare in symptoms. For patients on biologic therapy, the surgeon should strongly consider stopping the medication altogether or adjusting the timing of surgery with regard to dosing interval. Severely malnourished patients, defined as greater than 10% loss of body weight and albumin less than 3.5, may benefit from preoperative parenteral nutrition.

In some extremely high-risk patients, the patient and surgeon may choose to manage the existing complication nonoperatively rather than embark on a high-risk reoperative procedure. In these circumstances, the patient's current quality of life must be weighed against the chances for success, the degree of potential improvement, and the inherent risks of surgery. Patients must have a thorough understanding of the magnitude of the surgery, length of hospital stay, risk of complications, and the possible need for rehabilitation after hospital discharge. The preoperative consent process should also include a realistic and clear discussion of the goals of surgery. Bowel function, risk of sexual dysfunction, and anticipated quality of life should all be clearly articulated so that expectations are realistic. Patients should also understand that in some cases, the goals of surgery cannot be achieved without undue risk and that the operation may need to be aborted.

Reoperative procedures can be long and challenging. It may be best to avoid additional surgical cases on these days. Preoperative consultation with any subspecialty surgeons that may be needed is recommended, and the operation scheduled with respect to all potential teams' availability. This avoids the need to scramble for an unplanned operative consult late in the day. The patient should have a consultation with an enterostomal therapist and be marked for a stoma in all four quadrants of the abdomen. As for all complex abdominopelvic procedures, blood products should be reserved, and appropriate antibiotics and deep venous thrombosis prophylaxis administered. Patients undergoing reoperative surgery are particularly high risk for thromboembolic complications and wound infections.

Pitfalls of Reoperative Pelvic Surgery

Pelvic surgery is generally difficult due to the narrow and deep confines of this anatomical compartment. Rigidly bound by bone, connective tissue, and muscle, the pelvis contains many vital structures in close proximity to one another which are at risk of inadvertent damage. The challenges of adequate visualization and precise dissection are compounded in the reoperative patient as scarring from previous surgery often further limits exposure and obliterates the normal anatomical planes. In addition, structures such as the ureters, pelvic nerves, and blood vessels may be displaced into unusual positions where they are more prone to injury.

Understanding the fascial planes within the pelvis is a critical component for successful operation. The pelvis is lined by a parietal fascia which then extends to cover the pelvic organs as the visceral fascia. The presacral fascia overlies the

sacrum and constitutes a condensation of the parietal endopelvic fascia which protects the underlying presacral venous plexus. The vast majority of pelvic surgeries should be conducted in a plane anterior to this presacral fascia, between it and the parietal fascia investing the mesorectum. Rarely is violation of the presacral fascia indicated, such as for the resection of a locally advanced or recurrent rectal cancer that involves this layer. Dissection deep to the presacral fascia, often blunt and due to lack of exposure, will invariably result in injury to the presacral veins. These vascular structures will bleed precipitously because they are avascular and communicate directly with the basivertebral veins. Controlling bleeding from the presacral veins can be difficult, as injury often results in an end-on venotomy rather than a hole in the lateral wall of the vessel. The special techniques used to deal with this complication are discussed later in the article, but precise anatomical dissection and avoidance of presacral venous injury is the best approach. Even in the reoperative situation, the plane between the presacral fascia and the mesentery of the ileal J-pouch or colonic neorectum is usually present and can be identified.

The anterior counterpart to the presacral fascia is Denonvilliers fascia. Denonvilliers fascia separates the rectum from the base of the bladder and protects the underlying seminal vesicles, prostate gland, and parasympathetic nerves involved in sexual function. Damage to these Nervi erigentes will lead to erectile dysfunction in the male patient. Only in the case of an anterior rectal tumor that is closely opposed to Denonvilliers fascia should this plane being knowingly violated to assure a clear radial margin.

Surgical Technique

Patient Positioning and Equipment

Proper patient positioning is critical in reoperative surgery cases. Modified lithotomy position allows for good access to both the abdomen and perineum. We routinely use yellowfin stirrups for this purpose. Sufficient padding to the posterior and lateral aspect of the calf near the fibular head is important. Prolonged pressure in this area can result in superficial peroneal neuropathy with resultant loss of dorsiflexion and eversion of the foot. Injuries to the sciatic nerves have also been described after lithotomy positioning. Femoral nerve injury may occur after improper placement of a pelvic Balfour or Bookwalter retractor. The buttocks should slightly hang off the bottom of the operating table to provide adequate access to the perineum. The patients should be secured to the table with a chest strap or beanbag to prevent them from sliding cephalad while in steep Trendelenburg position. After adequate intravenous access has been established, the arms should be tucked at the patient's side. Leaving the arms extended outward on arm boards can sometimes limit the surgeon's mobility when working in the pelvis. The skin should be prepared from the nipple line to the perineum and draping should maintain access to the perineum.

Several pieces of equipment are especially useful during reoperative pelvic surgery. A foot pedal Bovie control coupled with the extender tip will provide adequate reach

into the deepest pelvis. Likewise, long instruments such as forceps, needle drivers, and clamps along with suction catheter tips are essential. A set of lighted deep pelvic retractors is crucial for gaining adequate exposure and a headlamp can also be complementary. The senior author's preferred retractors include a lighted BriteTrac (VitalCor Inc, Westmont, IL) along with Deaver and curved deep pelvic retractors with narrow, medium, and wide blades (Electrosurgical Instruments, Rochester, NY). The Deaver retractor is typically used to elevate the bladder and provide anterior exposure early in the pelvic dissection. The Britetrac provides anterior retraction of the rectum and mesorectum for dissection of the mesorectal plane and is also useful for exposing the anterolateral junction of the perirectal tissues and the pelvic sidewall and seminal vesicles. The curved deep pelvic retractors are used for both posterior and anterior exposure in the deepest phase of pelvic dissection.

Abdominal Entry and Adhesiolysis

A generous midline incision is advised for reoperative pelvic surgery, extending from the pubis to the epigastrium. Small bowel adherent to the undersurface of the prior midline scar should be anticipated in all cases and initial entry to the peritoneal cavity is usually safest in the upper abdomen. 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 peritoneum. Using this technique, it is usually possible to recognize an adherent bowel loop before enterotomy occurs.

In the most favorable scenario, intra-abdominal adhesions will be few in number and soft in character. 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. 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. Particularly severe adhesions that defy identification of the bowel and peritoneal surfaces, the so-called 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 to roll the whole of the intestine up and out of the pelvis. In some instances, individual loops adherent to the deepest recesses of the pelvis must be mobilized individually. Isolating both the afferent and efferent limbs and using gentle traction with a gauze sponge can expose the apex of the loop. Sharp dissection flush with the serosal surface will allow the loop of bowel to be dissected off of the endopelvic fascia without injury to underlying structures.

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, and if justified by the indication for surgery, are all adhesions between individual bowel loops lysed 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. These are repaired with inverting seromuscular sutures.

In some instances, adhesions are so severe or the anatomy is distorted to such a degree that the operation must be abandoned. It is important for the surgeon to recognize this point and to back away before becoming fully committed by devascularizing a portion of the bowel or creating enterotomies in a loop that is not able to be mobilized for repair. Planning for a reoperative abdominopelvic surgery should always include a well thought out strategy for abandoning the operation if needed. An example would be the creation of a high loop jejunostomy in the case of a patient with a frozen abdomen and chronic pelvic sepsis due to a coloanal anastomotic leak. Surgery can then be deferred further until adhesions have softened or referral to a more experienced reoperative surgeon can be made.

Identifying Pelvic Structures

One of the most difficult aspects of reoperative pelvic surgery can be the identification of pelvic structures. Prior surgery, pelvic sepsis, and pelvic radiation therapy can conspire to severely distort the anatomy and in some cases hide the rectal stump, bladder, vagina, and ureters under a thick layer of pelvic peritoneum. The inexperienced surgeon may, in fact, encounter what appears to be an empty pelvis and only through bimanual examination can the presence of a rectal stump or vaginal cuff be confirmed. The following maneuvers can be helpful to identify structures in the reoperative pelvis.

Ureters

There is a high risk of ureteral injury during reoperative surgery, as the ureters may be displaced medially due to prior mobilization or concealed by scar tissue. Injury can occur at any location but is most common where the ureter crosses the pelvic brim or close to its insertion into the bladder. Injury in the former location is usually due to overaggressive and early lateral dissection, whereas damage in the latter instance typically results from inadequate exposure and visualization. Ureter injuries are inevitable in a high-volume reoperative surgery practice. To minimize the risk of injuries occurring, the surgeon should liberally utilize ureteric stents and must maintain a high index of suspicion so that injuries can be immediately recognized and repaired. Ureter injuries that are dealt with at the time of surgery rarely have adverse consequences, whereas those that go unrecognized and present later in the postoperative period often lead to significant morbidity.

One of the first steps in a reoperative surgery should be identification of the course of the ureters. This can be achieved by palpation of previously placed plastic stents. In some cases, however, stents cannot be placed due to strictures or angulations of the ureter due to previous

surgeries. In these circumstances, we prefer to identify the ureter within the retroperitoneum before entering the pelvis. The ureter can then be tagged with a Silastic vessel loop for identification and referred back to intermittently as the pelvic dissection proceeds. Dissection within the pelvis should be done sharply and without cautery whenever possible, and should hug the surface of the organ being mobilized to minimize the risk of ureter injury.

In the case of overt injury, enlisting the aid of an experienced urologist for repair or reimplantation is vital. If occult injury is suspected, the administration of methylene blue or indocyanine green intravenously may aid in identification.

Bladder

As the bladder is an anterior and relatively superficial structure, it is usually readily identified during reoperative pelvic surgery. There are several points in time, however, where bladder injury can occur. The first is while opening the caudal most aspect of the midline incision. In some instances, the bladder will have been previously mobilized and found to be densely adherent to the undersurface of the lower abdominal wall. If care is not taken when dividing the fascia, the bladder can be entered. It is our practice to immediately look for the prevesical fat after dividing the lowermost aspect of the fascia and then to push the bladder downward as the remainder of the fascia is opened. If injury occurs during this phase of the operation, it usually involves the bladder dome and can easily be repaired with absorbable seromuscular sutures. A Foley catheter is then left in place for 5 days postoperatively and a cystogram obtained to confirm healing before removal.

The base of the bladder can also be injured during reoperative pelvic surgery, especially during the later phases of pelvic dissection. It is common to encounter a dense fibrous band at the bladder base in patients who have been treated with previous radiation therapy and who have suffered low colorectal or coloanal anastomotic leaks. This band can often severely limit exposure within the deep pelvis and can restrict the blood supply to a colon pull-through. Radial incisions made with cautery into this band of scar can loosen the pelvic outlet and facilitate exposure. While this is often a useful maneuver, it must be done carefully as the bladder base or even the ureteral insertions can be injured. Injury to the trigone region of the bladder should be addressed by a urologist as repair is complicated and must often be performed through a cystotomy in the bladder dome.

Rectal Stump

Identification of the rectal stump in the reoperative pelvis can be straightforward at times and nearly impossible at others. During Hartman's procedure, the upper rectum or distal sigmoid colon is typically divided with the linear stapler. This results in a relatively long rectal stump that in some cases can even be secured to the underside of the lower abdominal wall. In the setting of severe inflammation or

perforation of the sigmoid colon, a significant length of the distal sigmoid colon can be left adherent within the pelvis. The upper rectum must always be fully mobilized to confirm the location of the anterior peritoneal reflection. Full mobilization of the rectum will also aid in the passage of a circular stapler in the event creation of a colorectal or ileorectal anastomosis (IRA) is desired. If the majority of the rectum was resected leaving a very short remaining Hartman's stump, it can be extremely difficult to identify the rectal remnant from a transabdominal approach. Use of a bougie, EEA sizer, or bimanual examination by the surgeon can help locate the rectal stump and facilitate dissection. As a general rule, the midline posterior plane between the mesorectal fascia and the presacral fascia should first be identified. A narrow, posterior midline dissection is then carried down to the level of the pelvic floor and only then is the dissection extended laterally. By limiting the dissection to the midline initially, the ureters, autonomic nerves, and iliac vessels can be identified and swept away as the dissection proceeds toward the pelvic sidewall. Lateral attachments are then mobilized once these vital structures have been protected. Finally, the anterior plane between the rectal wall and the vagina or prostate gland can be developed. This dissection should be performed flush with the serosal surface of the rectum to minimize the risk of violating Denonvillier's fascia and injuring the parasympathetic Nervi erigentes. For extremely short rectal stumps, grasping the apex with a Babcock clamp or a heavy suture can provide upward retraction that can facilitate dissection. In a female patient with a prior hysterectomy, the vaginal cuff can be densely adherent to a short rectal stump and similar maneuvers directed there can help separate these structures.

Vagina

The vagina is at risk for injury during reoperative pelvic surgery, especially in women who have previously undergone hysterectomy. Inadvertent injury to the apex of the vaginal cuff is easily repaired with absorbable sutures. In the case of injuries involving the anterior wall and extending toward the pelvic floor, repair can be more difficult. Posterior "injuries" are often purposeful en block resections during proctectomy for primary or recurrent rectal cancers or if a colovaginal fistula has resulted from a stapled colo- or ileal pouch-anal anastomosis that incorporated the vaginal wall. Relatively narrow defects can be closed primarily through the perineal wound. If possible, an omental pedicle graft should be placed over the vaginal repair or interposed between it and the new bowel anastomosis. Larger defects, and those occurring after pelvic radiation therapy, typically require flap closure. A vaginal closure that fails after proctectomy can be the source of prolonged and disabling perineal wound drainage.

Bleeding

Significant pelvic bleeding during reoperative pelvic surgery is often the result of blind and blunt dissection in the wrong

surgical plain. This most commonly occurs posteriorly in the pelvis when the presacral fascia is inadvertently breached and withdrawal of the surgeon's hand is followed by brisk venous bleeding. This can be a difficult situation, as the rate of bleeding and the fact that posterior dissection has just begun may make it impossible to identify and expose the source. The first step should be to apply direct pressure to the area of bleeding, either with carefully placed packs or the surgeon's finger. The anesthesia team is then notified and blood transfusion can be initiated. A second suction device should be employed and long instruments obtained. If the presacral space can be packed and the bleeding tamponaded, then attention should be directed to further mobilization of the rectum, neorectum, or ileal pouch so that the presacral area can be adequately exposed. At a minimum, the lateral stalks or attachments should be dissected, but if the anastomosis can be reached and taken down to allow the surgeon to completely remove the bowel segment from the pelvis then this is best. Efforts to blindly address presacral venous bleeding before good exposure is obtained will usually result in worsening hemorrhage due to tearing of the veins during attempts at suture ligation or development of coagulopathy as bleeding persists. Once the area of bleeding has been adequately exposed, more precise control of bleeding can be achieved by applying point pressure with a gauze "peanut" on a long Kelly clamp. A careful attempt to ligate the bleeding vein can then be made with a 2-0 Prolene suture fixed to a deeply curved "UR-type" needle. If this fails to control bleeding on the first or second attempt, the surgeon should not persist with attempts at ligation but should instead move to an alternate approach. These secondary measures usually rely on tamponade of the bleeding vein with either synthetic materials (sterile thumb tacks, sacral pins, or surgical pledgets) or autologous patches of rectus muscle.

Other sites of bleeding during reoperative pelvic surgery are often unavoidable. Anterior bleeding from the periprostatic vessels and bleeding from the pelvic sidewall can occur as the rectum, neorectum, or ileal pouch may be fused to these vessels as a consequence of chronic pelvic sepsis. Anterior bleeding usually ceases with packing and application of direct pressure. Lateral bleeding, on the other hand, typically requires suture ligation and is the result of injury to branches of the internal iliac artery or vein. As with presacral bleeding, blind attempts at suture ligation of lateral bleeding is dangerous and can result in inadvertent ligation of the adjacent ureter. Obtaining the help of a vascular surgeon in this situation can be invaluable. If pelvic sidewall dissection is anticipated, the surgeon should first dissect and encircle the internal iliac vessels at their origins with Silastic vessel loops. This will allow for quick occlusion should bleeding be encountered.

Drains

Dead space can be a major problem in the reoperative pelvis due to the absence of organs that typically fill this space such as the rectum, bladder, and uterus. In addition, the raw surface created by extensive pelvic dissection along with

the likelihood of ongoing postoperative bleeding can result in accumulation of a pelvic fluid collection. Placement of pelvic drains allows for removal of this fluid which can become superinfected or might drain from a perineal wound. We utilize either a 10-mm Jackson-Pratt or Atrium drain placed through a stab incision in the left or right lower quadrant and lateral to the rectus muscle. Drains are removed when output has decreased to below 30 mL/day. Intra-abdominal drains are not routinely used except in the situation of intra-abdominal or retroperitoneal abscess, where a drain may be placed in a prior abscess cavity.

We routinely utilize omental pedicle grafts to help obliterate pelvic dead space and buttress anastomoses. Interposition of omentum between bowel anastomosis and other nearby suture lines such as vaginal cuff repairs and uretero-ocystostomies helps prevent fistulas. The graft is usually based on the left gastroepiploic vessels. Once mobilized, the omentum is brought to the pelvis along the left paracolic gutter and held in place with a suture.

Specific Indications and Procedures

Repeat Ileocolic Resection

As the terminal ileum is the most common location for Crohn's disease to occur, it is not surprising that ICR is the most common operation performed in Crohn's patients. Manser et al published a large observational cohort derived from the Swiss IBD cohort study in 2014.¹ Of the 1,138 patients with Crohn's disease, 305 (27%) required ICR during their disease course. Eighty (26%) patients required more than one ICR, most within 5 years of their initial surgery. Ileal disease location, age less than 16 years at diagnosis, and penetrating disease phenotype increased the risk of a second ICR by 84, 150, and 117%, respectively. A significant risk reduction of 68% was associated with a nonstricturing and nonpenetrating disease phenotype. Regarding the impact of therapy on postoperative disease course, use of any immunomodulatory therapy at the time of the first ICR or within 1 year after first ICR reduced the risk of surgical recurrence by 66%. The absolute risk reduction with use of anti-TNF drugs was 3.6% with a corresponding NNT of 27. These results are similar to data from Regueiro et al,² a randomized controlled trial comparing infliximab chemoprophylaxis to placebo after ICR, which reported a clinical recurrence rate of 0% in the infliximab group and a recurrence rate of 38.5% in the placebo group.

Repeat ICR is indicated for patients with symptomatic disease of the neoterminal ileum or following technical complications of ileocolic anastomosis. After complete abdominal exploration to assess location and severity of disease, the surgeon is faced with the decision between repeat resection and strictureplasty. In the spirit of bowel preservation, short strictures greater than 10 cm in length without fistulizing disease can be considered for Heineke-Mikulicz strictureplasty. Isoperistaltic stricturoplasty (Michelassi or Poggioli) may be considered for long segment strictures, typically greater than 20 cm. These procedures, while technically more demanding, have the benefit of

preserving bowel length without bypass or creation of a blind loop. Patients with fibrosis of the small bowel and mesentery that preclude strictureplasty, fistula to adjacent bowel, or longer segment of diseased ileum not amenable to strictureplasty will require repeat resection. Resection should be limited to grossly diseased bowel, as the presence of microscopic disease at the margins does not increase rate of recurrence.³ Decisions regarding resection and anastomosis, with or without diversion, or resection and end ileostomy must take risk of anastomotic leak into consideration based on the patient's overall health, nutritional status, and use of steroids and/or biologic therapy.

The mesentery of bowel affected by Crohn's disease is often thickened and friable, and the surgeon must take special care during ligation and division to prevent tearing and mesenteric hematoma formation. In general, advanced energy devices are not suitable for division of the mesentery in Crohn's disease because the tissue is too thick for adequate sealing. We prefer a serial ligation using a Kelly/Kocher clamp technique. A large Kelly clamp is placed on the bowel side of the mesentery. Kocher clamps are then serially applied in 1.5 to 2 cm segments on the proximal side as the mesentery is sharply divided, overlapping the crotch of each subsequent Kocher with the tip of the prior clamp. Once the entire mesentery has been divided and the specimen passed off, the mesentery under the Kocher clamps is serially suture ligated with no. 1 chromic horizontal mattress stitches from the crotch to tip of each clamp, ensuring that the subsequent suture ligatures overlap.

A rare complication (<1% of ileocolic Crohn's disease with prior ICR) is development of an ileoduodenal fistula. Recurrent disease of the neoterminal ileum may involve the duodenum as an ileocolic anastomosis generally lies adjacent to the third portion of the duodenum. Even more uncommon is the situation of primary gastroduodenal Crohn's disease fistulizing to the transverse colon or prior ileocolic anastomosis.⁴ In the majority of cases, the defect in the duodenum is small and can be managed with debridement and primary repair. Separation of the duodenal repair and the new ileocolic anastomosis with the use of an omental pedicle flap may help prevent recurrence. Larger defects in the duodenum may require duodenojejunostomy to a disease-free segment of jejunum.

Another uncommon complication of ileocolic Crohn's disease is development of an iliopsoas abscess. Identification of these abscesses in the operating room can be difficult if not identified on preoperative imaging. Intraoperative findings may be subtle, such as a small area of purulence draining from the retroperitoneum. The treatment is cautious unroofing and debridement with placement of a surgical drain. Aggressive debridement may result in hemorrhage which can be difficult to control.

Repeat Surgery for Ileal Pouch Anal Anastomosis in Crohn's Disease

While primary IPAA is a well-accepted method of restoration of intestinal continuity for ulcerative colitis, with high primary success rates of approximately 95%, IPAA remains

controversial in the setting of known Crohn's disease. This topic is discussed extensively elsewhere in this edition. However, it is worth exploring several clinical scenarios which may be encountered in the patient with a diagnosis of Crohn's disease and a complication associated with their pouch.

While Crohn's disease can develop in the pouch or anal canal after restorative proctocolectomy for presumed ulcerative colitis, it is a rare, but often over-blamed, cause of IPAA failure. Most causes of primary IPAA failure are technical errors made at the time of primary surgery. Common complications of IPAA include chronic presacral abscess due to posterior IPAA leaks, afferent limb syndrome and refractory proctitis due to excessive rectal length distal to the IPAA, and ischemic pouchitis resulting from inadequate mobilization of the small bowel mesentery or twisting of the pouch during anastomosis. Some patients may have a combination of these technical errors.

It is imperative to rule out disease of the pouch itself as a cause of failure prior to embarking on a reoperative intervention in patients with Crohn's disease. This is ensured by physical exam and pouchoscopy with biopsy. If recurrent Crohn's disease involves the body of the ileal pouch, then pouch excision is the best option if medical therapy has failed. In Crohn's patients with IPAA failure and no evidence of disease affecting the pouch, the strategies for pouch salvage are identical to those for non-Crohn's patients. Salvage of the IPAA is possible in this select subset of patients. In the Cleveland Clinic series of 502 transabdominal redo IPAA's, the overall success rate was 80%. Thirty-two (6%) of these patients had a primary diagnosis of Crohn's disease at the time of redo IPAA.⁵ As with all reoperative surgery, the success of redo IPAA requires both a highly experienced, expert surgeon and an extremely motivated patient.

In the setting of pelvic sepsis, creation of an initial diverting loop ileostomy upstream of the failed pouch serves two important functions. First, it allows for source control and treatment of pelvic sepsis to optimize the patient for future operative intervention. Second, and of equal importance, it allows the patient to mentally prepare for life with a permanent stoma in the event that pouch salvage is not possible. The location of the loop ileostomy must be strategically placed such that it may be used in the formation of a new pouch if the existing pouch is not useable.

The operative approach for redo IPAA begins with mobilization of the existing pouch by establishing the posterior midline plane between the pouch mesentery and the presacral fascia at the level of the sacral promontory. The ureters and the iliac vessels should be identified prior to any dissection in the lateral pelvic sidewall and should remain lateral to the dissection plane. Ureteric stents are helpful to facilitate identification of the ectopic ureters and aid in the recognition of injuries. Mobilization of the plane flush with the serosal surface of the pouch anteriorly and laterally prevents injury of anterior and lateral pelvic sidewall structures and the anterior parasympathetic nerves that control aspects of sexual function. This dissection is done sharply with scissors to prevent cautery damage of the pouch, rendering it un-

sable for redo IPAA. Once the dissection reaches the level of the failed IPAA, the anastomosis is divided sharply, ideally on the distal side to include the previous staple line with the pouch. It is more common, however, for the IPAA to simply separate at this stage of the operation in the setting of chronic anastomotic leak. The pouch can then be brought out of the pelvis for inspection.

The existing pouch is amenable for construction of the redo IPAA in more than half of cases. Primary pouch excision and creation of a neoleal J pouch may be necessary due to pouch pathology, surgical trauma, or anatomical problems such as abnormally small volume. As mentioned previously, creation of the neopouch is facilitated if the previously created diverting loop ileostomy was made thoughtfully and placed approximately 20 cm proximal to the pouch. This allows the linear stapler to be introduced through this enterotomy for creation of the 15- to 20-cm linear pouch staple line. The failed pouch is then resected by dividing the afferent limb where it enters the pouch. This staple line will become the tip of the new J pouch. Reach of the new J pouch to the anus is usually not a problem as long as the small bowel mesentery is completely mobilized to its origin and all interloop small bowel adhesions are divided. If reach is difficult, creation of an S-pouch will add several centimeters of length. The efferent limb of the S-pouch must be less than 2 cm in length to avoid potential of outlet obstruction.

In the case of chronic presacral abscess due to IPAA leak, the presacral scar and granulation tissue must be completely excised to prevent postoperative pelvic sepsis. Anal canal mucosectomy is then performed from the perineal approach beginning just above the dentate line. All remaining proximal anal canal and low rectal mucosa must be resected, including the previous IPAA staple line if it was not included in the resection of the pouch. Finally, the apex of the existing or new pouch is brought through the anal canal with a long Babcock clamp and a hand-sewn neo-IPAA is fashioned using interrupted 3-0 absorbable sutures. A new diverting loop ileostomy is created, typically utilizing the existing stoma aperture, and a presacral drain is placed.

In the setting of recurrent Crohn's disease in the afferent limb but with an uninvolved pouch, the surgical approach varies based on the extent and location of disease. There are little data to drive decision making. If not on medical therapy, the patient should strongly consider treatment with a biologic agent to try to induce disease quiescence. If medical therapy fails, the diseased afferent limb can be resected and intestinal continuity restored by anastomosing healthy small bowel to the apex of the pouch. Limited, short strictures of the afferent limb may be amenable to strictureplasty, but the patient must understand that the likelihood that they will ultimately require pouch excision is high.

Management of Crohn's disease of the anal canal and/or perineum after IPAA with an unaffected pouch is largely dependent on severity of symptoms. Patients should strongly consider treatment with a biologic agent. Fistulas are best managed long term with setons to control sepsis. Pouch advancement for the treatment of fistula is unlikely to be effective in the setting of active disease, although it may be

considered for patients whose disease is in remission on medical therapy. The decision to proceed with pouch advancement should be made carefully, however, as failure of the neo-IPAA can lead to stricture and thus accelerate pouch failure. Ultimately, many patients will require permanent fecal diversion or pouch excision.

There are limited data regarding outcomes of redo IPAA for Crohn's disease; in the Cleveland Clinic series, these highly selected patients did well with 100% pouch retention at 5 years.⁵ However, the number is small and none of these patients had perianal or small bowel disease at the time of reoperation. Bowel function after redo pouch surgery is generally characterized by 6 daytime and 2 nighttime bowel movements/24 hours with approximately 50% of patients admitting to some degree of incontinence, seepage, or pad usage.

Continent Ileostomy in the Setting of Crohn's Disease

Originally described by Kock, the CI is a surgical procedure performed for patients who wish to avoid permanent conventional end ileostomy after proctocolectomy. Nowadays, it is most commonly used for ulcerative colitis patients with failed IPAA or in situations where primary IPAA is not possible. The intussuscepted valve in the pouch creates a functional obstruction allowing for continence, and therefore creation of a stoma that does not require application of an appliance to collect stool. There is little reported literature on outcomes in patients with Crohn's disease and CI, but what data we do have suggest that outcomes are poor. A recent case series reported by Dr D.D. included 48 patients who underwent CI surgery between 1978 and 2013.⁶ Fifteen patients had known Crohn's disease at the time of surgery, and the remaining 33 were diagnosed in a delayed fashion. The cohort had a high rate of complications requiring reoperation, with 83% of patients requiring a major pouch revision, and 23% requiring a minor revision. CI failure occurred in 22 patients (46%), with a Kaplan–Meier estimated survival of 48% at 20 years. CI does not appear to be a durable option for patients with Crohn's disease, regardless of the timing of diagnosis. For this reason, careful patient selection and extensive counselling should occur before CI is offered to these patients.

Completion Proctectomy

Colonic resection with IRA or without reestablishment of intestinal continuity (Hartmann's procedure) is reasonable surgical option for the management of Crohn's colitis. The benefit of these procedures is maintenance of intestinal continuity with an IRA or avoidance of complications from a nonhealing perineal wound for a Hartmann's procedure. In either case, some proportion of these patients will subsequently require resection of the rectal remnant due to recurrence of disease, rectal stricture, rectal stump leak, or development of dysplasia or cancer. Multiple case series report a 61 to 73%^{7–9} rate of functional anastomosis 10 years after IRA. Approximately one-third of patients with Crohn's disease and IRA will develop symptoms severe enough to require proctectomy or diversion. After Hartmann's procedure, 70% of patients develop disease in the rectal remnant

and 50% require completion proctectomy within 10 years.^{10–12}

The degree of difficulty for completion proctectomy largely depends on the length of time of active disease in the rectal remnant, particularly in the case of a Hartmann's procedure. Initial perianal disease distribution is predictive of future rectal remnant involvement requiring proctectomy. Early completion proctectomy should be considered in this subgroup of patients when primary total proctocolectomy was not performed.

Patients with a long rectal remnant may require a combined abdominoperineal approach, while a perineal approach is sometimes appropriate for very short rectal remnants. The technique for identifying the rectal stump from a transabdominal approach is described in the prior section. The perineal portion of the dissection should be performed with a skin-sparing, intrasphincteric approach so as to minimize the size of the perineal wound. The operative approach for patients with a prior IRA is similar to the approach for redo IPAA.

Rectal stump leak with chronic pelvic abscess can be challenging to manage. The abscess itself can be managed via transabdominal or transrectal drain placement and may require both approaches for complete control of sepsis. After sepsis is controlled, the patient can be medically optimized for proctectomy. In a frail patient or a patient for whom proctectomy would be too difficult or risky, transrectal drainage with a mushroom catheter may provide definitive treatment when the drain is left in place indefinitely.

Role of Transplantation for Intestinal Failure in Crohn's Disease

Crohn's disease is one of the most common etiologies of intestinal failure in adults, although the overall incidence is low.¹³ A 2011 cohort from the United Kingdom comprising all patients with intestinal failure requiring long-term home parenteral nutrition reported that 29% had Crohn's disease.¹⁴ Crohn's disease was the second most common etiology of intestinal failure in adults receiving intestinal or multivisceral transplantation in a large case series from the University of Pittsburgh published in 2012.¹⁵ Of the 376 patients transplanted between 1990 and 2006, 38 of the 213 adult patients (17.8%) had Crohn's disease.

Although improved, outcomes for intestinal transplantation still lag behind those of kidney, liver, and heart transplantation. Five-year actuarial survival for intestinal transplant for Crohn's disease ranges in the literature from 43 to 60%.^{16–18} Long-term survival data are limited and not categorized by indication for transplantation. In the University of Pittsburgh series, of the patients who survive to 5 years, 71% survive more than 5 years, and 29% survive more than 10 years. Nutritional autonomy is achievable in 90% of survivors. Many patients are able to successfully reintegrate into society with 35 to 56%^{15,19} of long-term survivors in part or full-time employment. However, it cannot be overstated that primary prevention of intestinal failure due to Crohn's disease by concerted efforts to preserve bowel length is of paramount importance.

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