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Surgical management of anastomotic leak following colorectal surgery

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A B S T R A C T

Management of anastomotic leak following colorectal reconstructive procedures is perhaps the most challenging issue facing both the patient and surgeon. These complications are frequently encountered in deconditioned and septic patients where clinical judgment and experience play a paramount role in the care of these patients. Several algorithms have been presented for evaluation and management of anastomotic leak based on location, chronicity, symptoms, locations, and diversion status. Timely management of anastomotic leak is paramount to minimizing short- and long-term morbidity and mortality in patients. With a varied armamentarium, and frequent need for multiple interventions, restoration of intestinal continuity and acceptable functional outcomes are achievable in a majority of instances.

Introduction

Management of anastomotic leak following colorectal reconstructive procedures is perhaps the most challenging issue facing both the patient and surgeon. These complications are often the most complicated and enduring faced by a colorectal surgeon. They are frequently encountered in deconditioned and septic patients where clinical judgment and experience play a paramount role in the care of these patients.

Leak rates range from 1% to 21% in the literature with associated mortality of 3–22%.[1] Rates will vary by location with distal colorectal, coloanal, and ileoanal leak rates ranging between 1% and 19%, colocolonic leak rates from 0% to 2%, and enteroenteric and ileocolonic leak rates from 0.02% to 4%.[2] Although some attribute leak rates to volumes, in one study, Hyman et al. demonstrated that even in a group of high-volume surgeons, leak rates ranged from 1.6% to 9.9%, with complications ranging from 30.5% to 44%. Given these findings, they concluded that even with highly skilled surgeons with high volumes of colorectal surgery, there may be a wide variance in leak and morbidity, and in some cases, these may be possibly preventable.[3] Given the gravity of this dreaded surgical complication, numerous authors have attempted to come to a consensus on the management of anastomotic leaks.[4–11] The most deliberate attempts at clarifying the management of anastomotic leaks were proposed by the International Anastomotic Leak Study Group—based in intraperitoneal vs. extraperitoneal location,[2] later by the International Study Group of Rectal Cancer—based on chronicity, symptoms, and location,[10] and most recently by Blumetti et al.[1] also by diversion status and intra- vs. extraperitoneal location. This article will present a modified compendium of the above algorithms to aid the surgeon in approaching management of the patient with an anastomotic leak (Fig). As with any attempt at standardization of medical approaches, clinical symptoms, surgeon experience, and clinical judgment may help in identifying the ideal modality and deviation from the above algorithms to assure the best care for the patient.

Management of anastomotic dehiscence is facilitated by a thorough understanding of not only the risk factors associated with anastomotic leak but also the theoretical pathophysiology of its development. It is clinically evident that timely management of anastomotic leak is paramount to minimizing short- and long-term morbidity and mortality in patients. To that end, a high index of suspicion followed by an appropriate workup is critical in choosing a management plan that optimizes patient outcome.

When an anastomotic leak is identified, the patient and family must be prepared for a prolonged hospitalization.[12] With this comes prolonged ICU and overall increased hospital length of stay followed by increased cost[13,14] and additional staged operative and non-operative interventions. Increased patient morbidity and mortality[15–19] must be realized and prepared for appropriately by the caring surgeon. In some instances, maintenance of intestinal continuity may not be initially feasible, often times requiring an interval of 3–12 months prior to attempted restoration. Furthermore, several studies have now demonstrated a correlation between anastomotic leak and poor oncologic outcomes with increased locoregional recurrences and decreased survival.[19–22] This is most likely attributed to shedding of micrometastatic disease and inflammatory-mediated cytokine release.[23,24] Similarly, health-related outcomes as measured with physical,

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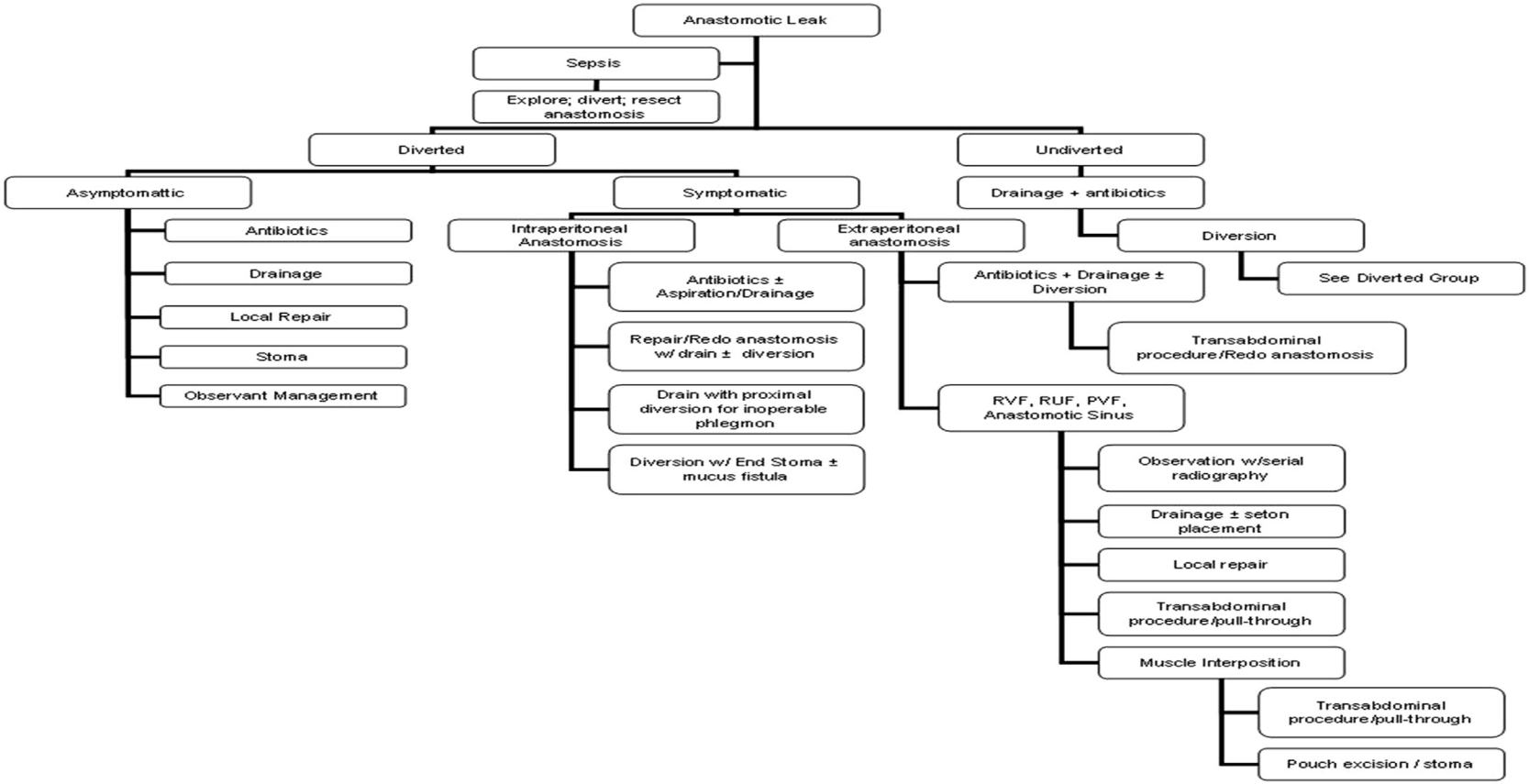

Fig. Algorithm for surgical management of anastomotic leak. Presented is an algorithmic approach to management of complex anastomotic leaks that may present in the setting of colorectal anastomoses. Surgical judgement and discretion will allow for repetition, bypassing, and jumping to various branching pathways. All steps are not exclusive, and often times numerous interventions may be performed simultaneously. RUF—rectourethral fistula; RVF—rectovaginal fistula; PVF—pouch–vaginal fistula.

emotional, social, and overall quality-of-life scores were significantly lower in patients who had leaks compared to patients who had uncomplicated courses.[12]

Prophylactic management

Generally, the best treatment for an anastomotic leak is prevention of one. Based on patient, surgeon, and operative risk factors, certain modifications in timing, operative technique, and potentially even choice of operation may be adjusted for. Although some of these factors cannot be modified (age, sex, location of lesion, and radiation), others may be correctable or altered preoperatively (malnutrition, corticosteroid use, obesity, tobacco and alcohol use, and antineoplastic or anti-tumor necrosis factor agents—predominantly those based on monoclonal antibodies such as bevacizumab or infliximab).[25,26] Additionally, by adhering to principles of surgical technique, anastomotic leak rate can be minimized. These principals include assurance of a tension-free anastomosis (i.e., mobilization of the splenic flexure for distal colorectal/coloanal anastomoses), adequate blood supply, viability of proximal and distal tissue, and verification of patency and avoidance of distal obstruction. Furthermore, minimizing operative time and blood loss has also been shown to reduce development of anastomotic leak,[11,25,27–29] though these may be surrogates for more complex procedures or sicker patients. Recently, appropriate choice and administration of preoperative antibiotics, maintenance of normo-thermia, and appropriate oxygenation intra- and peri-operatively have been measured, cited, and indeed mandated as quality indicators for colorectal surgery through the Centers for Medicare and Medicaid Services Surgical Care Improvement Project (CMS SCIP) and also the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP).[30–43] Although there remains some controversy, it is the authors preference to create a temporary diverting ileostomy at the time of any anastomosis within 7 cm of the anal verge or dentate or in the setting of prior pelvic radiation therapy or perioperative corticosteroid use. Indeed, den Dulk et al.[44] have reported their data from the Dutch Total Mesorectal Excision trial demonstrating that reactionary stoma creation due to postoperative sepsis was associated with a significantly increased risk of failure to achieve long-term stoma closure, $p < 0.01$.

Surgical approach for operative management

Traditionally, most colorectal procedures have been performed in an open fashion. With more widespread acceptance and facility with laparoscopic procedures, an increasing number of cases are being performed in a minimally invasive fashion. Reoperations for sepsis, however, present as challenging cases for even the most experienced surgeons. Vennix et al.[9] examined the effect of laparosopic vs. open management for anastomotic leak, perforation, or abscess following laparoscopic colorectal procedures. In their series of 56 patients, 18 underwent traditional laparotomy and 38 underwent laparoscopic re-interventions. The laparoscopic group had significantly shorter length of stay (20 d vs. 31 d, $p < 0.05$), decreased fascial dehiscence ($p = 0.033$), and a trend toward significantly lower in-hospital mortality. This information should be taken into context as patients who required laparotomy were generally sicker at time of presentation as demonstrated by increased fecal contamination in this group. As surgical experience improves, laparoscopy for intervention following anastomotic leaks is an acceptable, safe, and feasible method of reintervention provided that clinical findings permit this modality.

Categorization of leak

It may be best to define anastomotic leak based on multiple criteria including timing postoperatively (early vs. late), extent of anastomotic dehiscence, location (intraperitoneal vs. extraperitoneal), and patient presentation and degree of sepsis (uncontrolled leak vs. contained abscess). With these elements in mind, an appropriate algorithmic approach can be instituted to manage these patients.

Sepsis

When evaluating a patient for anastomotic leak, certain parameters must be defined. Although typically considered the worst case scenario, patients who show signs of sepsis (pronounced leukocytosis, fever, tachycardia, hypotension, abdominal guarding, or rigidity) and/or have free uncontained leaks are the most straightforward to manage in the acute setting. The primary focus should be immediate control of the acute septic process with diversion of the fecal stream. These patients must be aggressively resuscitated, possibly in the intensive care setting, followed by urgent exploration with creation of a diverting stoma and washout and debridement of the intraabdominal and pelvic cavities. Depending on the patient's overall status, takedown of the anastomosis may be necessary. Generally, the septic patient will not tolerate, nor have acceptable, long-term and durable outcomes with repair/revision of the flawed anastomosis in the acute setting.

Presentation/timing of anastomotic leak

Early-onset (within 1 week) anastomotic leaks

Patients that develop anastomotic leak within the first week will present with an atypical clinical exam and abnormal laboratory findings (pain, fever, urinary symptoms, pronounced leukocytosis, and tachycardia). Along with an appropriate but focused history and physical examination, radiological tests such as computed tomography and/or water-soluble contrast enemas may help define the leak. However, one must be careful to avoid unnecessary test if clinical suspicion is high in order to avoid postponing early operative re-exploration and management. For the most part, exploration is technically easier in the immediate postoperative period, within 7 days of the initial operation. In this situation, there is generally less fibrinopurulent exudate experienced, and if present, easier to dissect.

Late-onset (> 1 week) anastomotic leaks

Patients that develop anastomotic leak more than 7 days postoperatively often present as an outpatient with vague insidious abdominal complaints, low-grade fever, inability to tolerate oral diet, prolonged ileus, or urinary symptoms.[45,46] A delayed-transit CT scan with oral contrast is helpful to distinguish abscess from unopacified bowel loops. Rectal contrast during CT or water-soluble contrast enema may also be used as an adjunct in select cases. Several series have demonstrated that 7–50% of asymptomatic leaks are identified by water-soluble enema in anticipation for stoma reversal.[1,7]

Most anastomotic leaks that present after 1 week manifest as a contained abscess and can often be managed conservatively with interventional drainage and/or antibiotics. Antibiotics alone can be used for abscesses less than 3–4 cm in size. These less-invasive methods have proven effective in controlling sepsis with subsequent sealing off of minor anastomotic defects.[47] Hyman et al.[46] describe a series of 33 anastomotic leaks. Of these, the

overwhelming number of late-onset anastomotic leaks were managed non-operatively. In one large series of 1639 patients with a 2.4% leak rate, most anastomotic leaks were managed with percutaneous drainage procedures and/or antibiotics alone.[48] Similarly, Blumetti et al.[1] reported a 73% non-operative management rate for anastomotic leak, with a median time to diagnosis of 27 days, whereas 27% requiring operative intervention had a median time to diagnosis of 6 days. It is also noteworthy to mention that the majority of the leaks in this cohort were extraperitoneal (66%), and these had a non-operative management success rate of 54–57% compared to the intraperitoneal leak management rate of 58–73%.

Exploration of the abdominal or pelvic cavity between 2 and 6 weeks after major surgery is usually not advised as the formation of dense adhesions and their separation may lead to an associated high rate of enterotomy, development of fistula, major bleeding, or injury to nearby structures or organs.[11] However, there may be circumstances when the less-invasive approaches cannot adequately control the sepsis and operative management is necessary. In this unfortunate scenario, proximal diversion and drainage without undue dissection is the safest approach.

Size/grading of anastomotic leak

Although no particular scientific basis exists for the dichotomy between major and minor anastomotic disruptions, two groups can be described: major and minor. This has been extrapolated from the trauma literature, with minor disruptions measuring less than 1 cm or 1/3 the circumference and major disruptions consisting of greater defects. With the latter, there is often associated peri-anastomotic ischemia because of the acute inflammatory process.[2,49,50]

Intraperitoneal vs. extraperitoneal leak

Phitayakorn published the results of the International Anastomotic Leak Study Group. Based on their analysis using modified Delphi research, a standardized management algorithm was proposed for anastomotic leaks. This was predicated on three subgroups: intraperitoneal anastomotic leaks, extraperitoneal anastomotic leaks (low pelvic), and anastomotic leaks with proximal diverting stomas. Workup is similar to other studies with CT scanning and water-soluble contrast enemas. As above, in the setting of generalized peritonitis with high-grade sepsis, the recommendation was for resuscitation followed by (1) drainage with proximal diversion for inoperable phlegmon, (2) primary anastomotic repair with diversion and drainage for minor defects, or (3) Hartmann's procedure with exteriorization of both anastomotic ends, or redo anastomosis with proximal diversion for major defects. Subclinical leaks were observed and managed conservatively. In the case of contained intraperitoneal anastomotic leaks, drainage and/or intravenous antibiotics with aspiration were recommended based on abscess size, with the latter for abscesses $\leq$ 3–4 cm in size.

For extraperitoneal anastomotic leaks without *in situ* diversion, the algorithm became more challenging. Again, patients with generalized peritonitis or sepsis and those with clinical leaks were managed similar to those with intraperitoneal sepsis. Patients with more proximal extraperitoneal anastomotic leaks and abscess were also similarly treated as above, with the caveat that proximal diversion was also recommended. Low pelvic-contained abscesses without fistula/leak demonstrated on water-soluble contrast enema were treated with intravenous antibiotics and combinations of image-guided drainage and/or trans-rectal, transanastomotic, transvaginal, transanal, or transabdominal drainage. The latter can be done via the anastomosis followed by placement of exchangeable catheters which can be downsized or with creation of a large defect to allow for appropriate drainage.

Lastly, patients that already had diversions in place were unique based on the location of the leak. Subclinical leaks that were intraperitoneal were managed conservatively with serial imaging and antibiotics every 6–8 weeks. If no resolution was seen by 6–12 months, surgical revision of the anastomosis was recommended. Contained extraperitoneal abscesses were also managed non-operatively. Persistence of small <1 cm sinuses after 3 months can generally have their diverting stomas reversed without ill effect. Otherwise, these patients may require frequent examinations under anesthesia with placement and exchange of mushroom-tipped catheters that are serially downsized. This process may help control festering sepsis and allow the cavity to heal by secondary intention. Larger posterior cavities may require division and marsupialization of the posterior wall using scissors, electrocautery, or endoscopic linear stapler devices.[2]

Management based on type of anastomosis

Enteroenteric and enterocolic anastomoses

In the absence of pronounced sepsis and high-dose corticosteroids, early-onset leaking enteroenteric and enterocolic anastomoses can generally be managed with resection and creation of a new primary anastomosis. As before, following appropriate surgical principles will help minimize risk of recurrence.

In the setting of hypotension and/or sepsis, however, it is preferable to avoid creation of a new anastomosis and simply fashion an ileostomy. To minimize morbidity and requirement for subsequent laparotomy, the distal small or large intestine may be brought up through the stoma defect alongside the ileostomy, similar to a mucus fistula, for subsequent local reanastomosis.[11]

Colocolonic or colorectal anastomoses

When faced with dehiscence of one-third or more of a colocolonic or colorectal anastomosis in the early postoperative period, preservation of intestinal continuity is generally not possible. The surgeon should proceed with a modification of a Hartmann's procedure with division of the anastomosis, creation of an end colostomy, and oversewing of the distal end of the bowel.[11] In very selected stable patients with minimal surrounding sepsis, resection with new primary anastomosis and diverting ileostomy can be attempted.[10,51–53]

When faced with a minor dehiscence, less than one-third circumference, treatment can be directed with proximal diversion, omentoplasty, and drainage. Attempts at suture repair of the anastomotic disruption typically lead to increasing size of the defect.[54,55] Drainage and proximal intestinal diversion is particularly important in the setting of distal pelvic (i.e., colorectal and coloanal) anastomoses as future restoration of intestinal continuity to a short distal anal stump is particularly challenging.[11] Hedrick et al. published a series of 27 patients with anastomotic leaks. Of the 19 patients that underwent proximal diverting stomas, 63% went on to have restored intestinal continuity, compared to only 33% in patients who underwent primary anastomotic resection and end colostomy.[5]

Coloanal anastomosis

Sabbagh et al. reported on the resolutions put forth by the International Study Group of Rectal Cancer and the proposed management of anastomotic leaks. They concluded that the

successful treatment for coloanal anastomotic leaks is best performed under fecal diversion. Although limited number of studies and evidence exist for successful repair of a coloanal defect, local treatments such as glue, plugs, or flaps may be used as first-line treatments due to their overall low morbidity.[10] Blumetti et al. reported on their limited series for transanal repair in diverted patients following low anterior resection for rectal cancer. In this cohort of 36 leaks, five underwent transanal repair, with one patient undergoing two procedures. They reported an 80% success rate (4/5) with one persistent leak.[56] Abdominal interventions should be reserved for high/proximal anastomotic leaks and/or failure of perineal approaches. Lastly, in the case of asymptomatic leaks found during water-soluble contrast studies, closure of the leak, and subsequently the stoma, may be successfully performed after a long interval ($\geq$ 6months) assuming any associated abscess cavity or local sepsis has been appropriately drained.[10]

Asymptomatic isolated coloanal anastomotic leak

In their respective series, Lim and Fong both reported on successful closure of diverting ileostomies in patients undergoing observant management for asymptomatic, simple leaks without associated abscesses.[57,58] If stable persistence of an asymptomatic leak is demonstrated after 6 months by radiological criteria, ileostomy reversal may be considered.[10]

Anastomotic sinus after coloanal or ileoanal anastomosis

Approximately 8–15% of patients undergoing low anterior resection or ileal-pouch–anal anastomosis may develop anastomotic sinuses due to leak. To minimize morbidity from pelvic sepsis, typically these patients already have diverting loop ileostomies created at the time of the initial operation and are therefore asymptomatic.[59,60] These leaks are often identified by contrast enema performed prior to ileostomy takedown.[57,58,61,62] Numerous techniques have been advocated for management of these chronic sinuses, including expectant observant management, transanal sinus unroofing/laying-open technique, creation of new anastomosis, sinus tract debridement, and transanastomotic or percutaneous drainage.[7,62,63–65]

Zhuo reported on a series of 20 patients with anastomotic leaks, of which, 13 (65%) had symptomatic leaks. A total of 8 (8/12, 40%) had complex sinuses with associated cavities or severe strictures while the remaining 12 patients had simple sinus tracts. Nearly half of those patients with simple sinus tracks (5/12) were managed with conservative observation alone. The remaining 15 required some form of surgical intervention, all while diverted. Interventions included curettage, drainage, debridement, and marsupialization. Patients typically required a median of two to five of these procedures. All 12 patients with simple sinus tracts and half the patients with complex sinuses underwent successful stoma reversal after 8 months (range: 3.5–24) following initial surgery. The group concluded by stating that persistent complex sinus associated with pelvic cavity or severe stricture despite surgical intervention was likely to lead to permanent stoma.[7] It is important to note that nearly half of the asymptomatic leaks were identified by water-soluble contrast enema and the other half based on endoscopy demonstrating anastomotic sinus despite a negative contrast study.

Sirois-Giguère reported on their series of 37 patients with leaks, of which 16 underwent transanal drainage, 12 underwent abdominal re-exploration, and 9 underwent conservative medical management. Transanal drainages were generally performed in those patients already diverted and with demonstration of limited, confined anastomotic dehiscence. Patients underwent curettage and irrigation with subsequent transanastomotic placement of suction drains. In some cases, Malecot, Foley, or chest tube catheters were required. Of the three cohorts, stoma reversal rates were greatest in the transanal drainage group (93%), after a median waiting time of 7 months. Anastomotic stricture (33%) and permanent stoma for poor function (13%) were the notable late complications.[66]

Chronic sepsis and/or stricture in the setting of colorectal anastomotic leak

Patients that present with chronic pelvic sepsis and/or stricture typically require some form of abdominal operative reintervention. In preparation for subsequent operation, it is critical to create proximal diversion with a stoma. This generally helps to minimize the sepsis and soften the tissues for subsequent exploration. Options then include resection of the anastomosis with terminal colostomy or new primary anastomosis. In several studies, the rate of permanent stoma ranged from 0.6% to 21%.[44,67–69] Of those with restored intestinal continuity, only 30% had no issues with incontinence and 63% had frequent, poorly formed stools.[69] Non-traditional accessory maneuvers utilized in anastomotic creation were required in up to 42–58% of cases and included Deloyers' maneuver for mobilizing the hepatic flexure with subsequent right colon to rectal anastomosis,[70,71] Toupet's maneuver for freeing the transverse colon,[72] Baulieux or Turnbull–Cutait procedure of colonic exteriorization with delayed coloanal anastomosis,[73,74] or Soave coloanal anastomosis through a rectal muscular sleeve.[75] Morbidity ranged from 26% to 55%.[69,70,73,75] Similarly, in the setting of near-complete disruption of a distal colorectal or coloanal anastomosis, the Turnbull–Cutait procedure may be the best option for restoration of intestinal continuity. After a median follow-up of 21 months, the median number of bowel movements per day was 2 (range: 1–10).[70]

Rectovaginal (RVF) or rectourethral (RUF) fistula

Patients presenting with rectovaginal (RVF) or rectourethral (RUF) fistula can be particularly difficult to manage. These can be seen in up to 5% of coloanal anastomoses as well as ileal-pouch–anal anastomoses. In the former, these are classically seen in patients undergoing proctectomy preceded by neoadjuvant (chemo)radiation therapy.[76,77] Treatment should generally be predicated on symptom control. Control of the septic process should first be performed by placement of a draining seton through the fistula. This seton permits appropriate drainage, decrease in symptoms due to minimizing risk for abscess formation, and maintenance of control with sphincter preservation. Local interventions with moderate success include rectal or vaginal advancement flaps,[56,78–82] sphincteroplasty for transsphincteric rectovaginal fistulae, biological glues or plugs,[83–86] and in select cases, modifications of the ligation of intersphincteric fistula tract procedure.[87–90] Success rates range from 14% to 85%.[86,91,92]

In the event the above local modalities fail, other options include interposition of harvested bulbocavernosus muscle into the rectovaginal space or gracilis muscle for both RUF and RVF. The technique is similar for both. The initial stage consists of transperineal dissection to the fistula, transection of the fistula, and procession of this dissection cephalad for approximately 3 cm above the fistula. The rectal wall is closed if possible with interrupted absorbable suture. At that point the harvested muscle is then interposed into the space created through a subcutaneous tunnel while assuring that the vascular pedicle is maintained.[93] Success rates of up to 65% are reported.[94,95] In cases where bulbocavernosus muscle in incompatible or in the setting of

rectourethral fistula, gracilis muscle interposition has had reported success rates of 33–97% with a median of approximately 75%. Morbidity ranges from 38% to 47%.[93,96–98] Unfortunately, radiation therapy was an independent negative predictor of success.

Anastomotic leaks after restorative proctocolectomy and ileal-pouch–anal anastomosis

Anastomotic leaks following restorative proctocolectomy with ileal-pouch–anal anastomoses (RPC/IPAA) are particularly challenging as the surgeon must be able to differentiate from a technical/surgical issue vs. other causes including an inflammatory bowel disease-related issue. The latter may be due to Crohn's disease or even a retained segment of active IBD that may be acutely inflamed (cuffitis). Generally, if a leak presents within 6 months of the operation, the general consensus would be that this can be attributed to a mechanical rather than inflammatory (Crohn's) process. Although this text will not go into detail with the latter, the surgeon and patient may need to be prepared for the requirement for additional temporary, or permanent stoma, and also possible pouch excision. One study by Lian et al. evaluated functional results and pouch failure rates and the effect of the type of anastomosis (stapled vs. handsewn) in the setting of anastomotic leak. Patients who developed leaks with stapled anastomoses had lower incontinence rates and less nocturnal seepage rates at 1, 3, and 5 years than those with handsewn anastomoses. Although they concluded that patients who developed leaks after a stapled anastomosis fared significantly better compared to those who had a handsewn anastomosis, they attributed some of this disparity to the fact that patients requiring handsewn anastomosis required more complex surgeries.[99] Surgical revision has generally been seen to be more successful when patients either present while diverted or after undergoing diversion prior to repair. Gorfine published a series of 89 salvage procedures in 51 patients. A total of 48 transanal procedures were performed in non-diverted patients, and 37 transanal revisions and four abdominal revisions were performed in diverted patients. When successful, bowel frequency and continence were similar to patients without leaks. Although not clinically significant ($p = 0.448$), patients with diversion had an increased success rate (29.7% vs. 20.8%). Overall pouch function was retained in 56.9%. With an aggressive surgical approach, acceptable functional results were observed in highly motivated patients. The average range of interventions was 1–4, and this itself did not adversely affect outcome.[100]

Pouch–anal leak/sinus

Several options exist for management of ileal-pouch–anal anastomotic disruptions with resultant presacral sinuses. In the setting of asymptomatic leak, similar to that described above with coloanal sinuses, these can be managed non-operatively with observant management while proximally diverted. Many of these will heal spontaneously while diverted, and the ileostomy reversed in several months after verification of closure with a water-soluble contrast enema. The time frame of healing and subsequent stoma reversal in this situation ranges from 1.9 to 8.7 months with a successful closure and ileostomy reversal rate of 60–90%.[62,101] The median number of pouchograms performed, at an average interval of 2–3 months, was 2.7.[62] If larger sinuses are noted, curettage, revision, flap, transanal drainage, or debridement should be attempted.[7] In some cases, more than one procedure may be required, with a median of approximately 2 procedures performed.[62,101] If a larger sinus orifice is visualized, division and sinus unroofing or marsupialization can be performed. This opens up the distal end for better drainage with maintenance of continence. Whitlow et al.[65] first reported on this technique, with subsequent modifications including unroofing using endoscopic linear staplers also being advocated. Patients with asymptomatic sinuses demonstrated improved healing than those with symptoms (84% vs. 30%, $p = 0.001$).[101]

Pouch–vaginal fistula

Similar to complex coloanal–vaginal or rectovaginal fistula, bulbocavernosus[102] and gracilis interposition flaps[93] can be utilized when local procedures are unsuccessful in the setting of proximal diversion. In select cases, pouch advancement may be an option to preserve intestinal continuity. Unfortunately, with failure of the latter technique, patients may be left with permanent chronic fistula or may require permanent diversion with or without pouch excision for symptom control. In a series of 152 patients with pouch–vaginal fistula, healing rates were noted to range from 42% to 66% with transanal–ileal-pouch advancement flaps and 40% to 55% with transvaginal repair. Successful healing was noted in 58% of patients overall. A postoperative delayed diagnosis of Crohn's disease was the single factor associated with failure of healing on multivariate analysis (22% vs. 73%, $p < 0.001$).[103]

Tip of "J" pouch/efferent limb

These patients generally are diagnosed prior to ileostomy reversal during a water-soluble contrast enema study or may present after reversal with pain or an abscess. If the latter occurs, this can occasionally be treated with bowel rest and interventional radiological drainage. Most of the time, however, these will require reoperation and primary repair of the leak or revision of the pouch. Identification of a tip of the "J" pouch leak is generally observed after prior interventional drainage procedures for pelvic abscesses or radiographic imaging for abdominal pain or discomfort. Repair can be performed via handsewn closure or stapling. In a small group, this may require a redo pouch procedure. In a series of 27 patients, Kirat demonstrated salvage with pouch repair (23) or new pouch creation (2) in 25 patients. Of these patients, 24 had a functioning pouch after a mean follow-up of 3.2 years.[104]

Other modalities

Newer modalities have recently become available as part of the surgeons' armamentarium in management of colorectal leaks.[105] These methods include novel uses of endoscopically placed stents across larger anastomotic disruptions,[105–111] closure of the fistula with newer generation macroclips (Over-the-scope clips, Ovesco, Tubingen, Germany) for smaller fistulae, or transanal endoscopic vacuum devices for distal sinuses with near 1/3—½ circumferential disruptions.[112,113] With the endoscopic macroclips, more work has been published in the repair of esophagogastric and esophagojejunal anastomotic leaks.[114–116] A key step to increase the success rate was to initially proceed with mucosal ablation of the re-epithelialized margins surrounding the fistula.[117–119] Arezzo reported a study on treatment with the over-the-scope clip closure for management of acute and chronic leaks after low anterior resections, including rectogaginal and colocutaneous fistulae. Overall success rate was 86% (12/14) without any device-related complications.[120] The endoscopic vacuum-assist device is best placed into the posterior abscess cavity transanally under endoscopic guidance and exchanged every 2–3 days for a median period of 34 days. Details regarding novel modalities in the management of anastomotic leak are further discussed in "Fecal microbiota transplantation for *Clostridium difficile* infection: A surgeon's perspective.

Conclusion

Management of anastomotic leaks is a dreaded and challenging problem facing surgeons and patient alike. Once the leak is diagnosed, the surgeon must cross the Rubicon and synthesize and appropriate attack for addressing this complication and be prepared for a lengthy and deliberate management schema. Anastomotic leaks and their management come at a significant cost to the patient, healthcare industry, and society. Issues such as timing, chronicity, location of the leak, patient anatomy, and patient condition all play a role in deciding on how best to proceed. Numerous algorithms have been suggested, as well as a simpler modification being proposed currently (Fig).[1,2,10] The surgeon's clinical judgment and experience will play a role in electing the best course of action to pursue. First and foremost, control of the septic process must be attained. As management for the anastomotic leak proceeds, intermediary steps may be repeated as necessary, or bypassed, based on the disease process and patient condition. Both the patient and surgeon need to be prepared for the possibility of multiple subsequent operative interventions to restore intestinal continuity. In few cases, this may not be possible. Newer, minimally invasive, endoscopic techniques are now becoming available that may be used as adjuncts in management of these complex problems.

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