Surgical management of small bowel obstruction: What you need to know

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DECIDING IF AND WHEN TO OPERATE

The surgical management of small bowel obstruction (SBO) remains a nuanced and complicated process, which requires decisive action in both the preoperative and intraoperative setting. No longer does the arrival of daylight or moonlight mandate operative exploration.[1] Rather, the lessons learned from trauma surgery have been applied to emergency general surgery; the use of practice management guidelines (PMGs) in the setting of SBO has been shown to reduce complications and the need for operative exploration.[2] For SBO specifically, the priority for these PMGs must be to ensure that those with strangulation obstructions are explored immediately, those who will not resolve without operative intervention will be explored in a timely fashion, and that those who will resolve nonoperatively will not undergo an unnecessary operation.

The decision to urgently/emergently operate requires a thorough history and physical plus laboratory analysis with appropriate radiographic assessment. Those patients who have the traditional signs of strangulation obstruction should undergo immediate operative exploration (Table 1, Fig. 1). Failure to recognize and timely treat strangulation obstructions was the cause of 86% of cases litigated for mortality from SBO management over a 33-year period.[3] If none of traditional signs are present, then surgeons should search for other criteria that convey a high risk of strangulation (Fig. 2). For patients with adhesive SBO, the combination of obstipation more than 24 hours plus mesenteric edema and the lack of small bowel feces on computed tomography (CT) predicts a 29% chance of strangulation, an even greater risk than the traditional signs.[4,5] Short of these features, surgeons can recommend nonoperative management with nasogastric decompression (NG), intravenous (IV) fluid resuscitation, and close observation.

At this point, we strongly recommend using the gastrografin challenge for patients with adhesive SBO because its use can decrease the rate of exploration and overall complications (Fig. 3). While protocols differ based on institution, our current practice is to mix 100 mL of GG in 50 mL of sterile water, which is then infused through the patient's existing NG tube after at least a 2-hour period of decompression to minimize the risk of GG aspiration and subsequent pneumonitis. If an abdominal x-ray taken approximately 8 hours after GG infusion demonstrates contrast in the colon or if the patient has a bowel movement (or stool in their ostomy), that is considered a pass and continued nonoperative management can be safely undertaken. If, however, the patient fails the GG challenge, then operative exploration should be strongly considered because these patients have a risk of strangulation of 7% with an 89% exploration rate during the index admission. Unless a patient deteriorates during the observation time, you do not need to emergently operate for failed GG challenges. Instead, we recommend waiting until daytime to operate because these cases can be quite challenging and labor intensive and distract you from other potential emergencies that may arise. For weekend cases that you anticipate hours-long adhesiolysis, you may even consider delaying until Monday.

Practice management guidelines incorporating the GG challenge have even been shown to reduce hospitalization rates when performed in the emergency department. While care must be taken to ensure the appropriateness of the candidates, there was a 49% reduction in costs with a median ED length of stay (LOS) of 23.6 hours.[6]

It must be noted that there are differing opinions regarding the use of the GG challenge. There have been 11 oral contrast randomized controlled trials (RCTs) in the setting of SBO over the past 30 years. Several meta-analyses of these trials have been performed over that timeframe with results showing favorable outcomes for the use of oral contrast agents.[7,8] These meta-analyses, however, are inherently flawed because of the wide variations in protocols including heterogeneity in inclusion/exclusion criteria, contrast agents, dosing, timing to abdominal x-ray, and SBO definition. Initially, the meta-analyses showed benefit for GG challenge use in terms of predicting operative exploration and decreasing hospital LOS when aggregated. However, when including the results from the latest RCT, those differences disappeared.[9] In this trial, Scotte et al.[9] performed both an RCT and meta-analysis. The RCT portion demonstrated similar rates of operative exploration (24% vs. 20%) in the GG challenge versus placebo (saline) arm with similar LOS (3.8 vs. 3.5 days). When they added the results of their trial to the meta-analysis portion of their paper, both the rates of operative exploration (26% vs. 21%) and LOS (3.5 vs. 3.5 days) lost significance. Uniquely among the RCTs, this trial included a placebo rather than NG tube decompression and IV fluid resuscitation alone. Despite the results of this trial, questions remain because of the heterogenous nature of the 11 RCTs, and further high-quality standardized trials are necessary. Meanwhile, the community of surgeons tends to favor the use of GG challenge in SBO PMGs.[10]

Submitted: October 13, 2023, Revised: October 27, 2023, Accepted: October 17, 2023, Published online: November 13, 2023.

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DOI: 10.1097/TA.0000000000004195

TABLE 1. Traditional Signs of Strangulation Obstruction

Peritoneal irritation
Lactic acidosis
Hypotension
Closed loop obstruction*
Pneumatosis intestinalis*
Portal-venous gas*

*Computed tomography finding.

The use of PMGs for SBO management has relegated the notion of a "complete" versus "partial" SBO to history. Originally defined based on x-ray imaging criteria of air fluid levels in dilated small bowel with the absence of colonic air, the advent of CT should have made these terms obsolete.[11] Nevertheless, these terms persist to the modern day. Instead, the need for operative exploration based on PMG and GG challenge results should be used.

OPERATIVE APPROACHES

Making the decision to operate is just as important as how you manage the conduct of the operation because there are considerations that must be accounted for to maximize its therapeutic potential. Paramount among these considerations may seem semantical but is critical to the approach for many emergency general surgery diseases. Sometimes, the most "conservative" approach to SBO management is to explore the patient to evaluate for strangulation. In other words, "conservative management" and "nonoperative management" are not synonyms, and exploration should be undertaken if there is a reasonable consideration that the patient might have a strangulation obstruction.

Laparoscopy Versus Laparotomy

The first consideration for operative approach is whether to start laparoscopically or proceed straight to an open procedure. In the setting of SBO, laparoscopy can be particularly challenging because of bowel distension creating visualization issues and thinned out small bowel walls that can easily perforate with aggressive manipulation. Therefore, surgeons must be careful to appropriately select patients. Preoperative CT images can provide some clues on which patients may be successfully managed using a minimally invasive approach. For instance, an isolated transition point can predict success.[12] Other risk factors associated with conversion to an open procedure include number or prior abdominal procedures, bowel resection, iatrogenic injury, malignancy, and dense adhesions.[13–15] Importantly, conversion to an open procedure is not a failure. Rather, it should be considered an appropriate progression to safely conduct the operation. If laparoscopy is successful, patients should have decreased morbidity and hospital LOS.[16] Of note, for those patients in which an open approach was performed, milking of small bowel contents back to the NG tube does not appear to confer any advantage to diet initiation, LOS, or complications.[17]

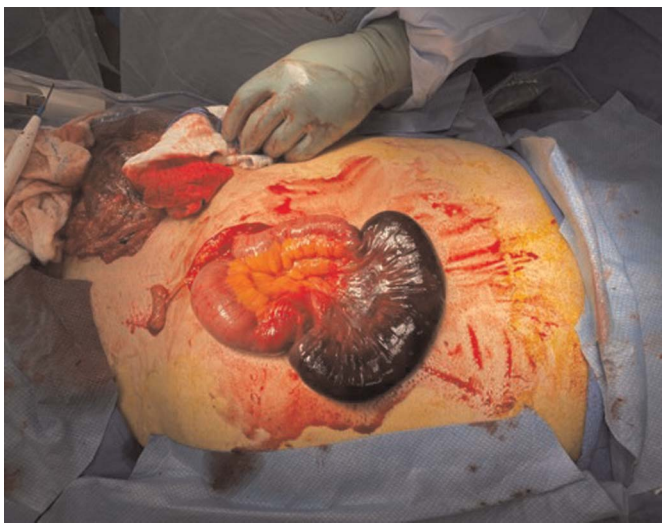

Figure 1. Strangulated SBO.

Figure 2. Pneumatosis intestinalis with SBO.

Robotic Approach

The Da Vinci Robotic approach can be a consideration if patient is a candidate for laparoscopy as mentioned previously. It can provide better ergonomics like wrist articulation, tremor filtration, visualization (three-dimensional view, close-up views) and enhancing precision by translating surgeon large motions to small movements of the instruments. Especially in complex cases, the robot facilitates easy suturing and knot tying compared with laparoscopy, which leads to easier intracorporeal anastomosis creation.[18] A robotic approach has been described as feasible in many cases of SBO caused by internal hernia, gallstone ileus, and Superior Mesenteric Artery syndrome.[19–21] Some studies have supported better outcomes with robotic surgery compared with laparoscopy in terms of conversion rate to open, LOS, and estimated blood loss.[22,23]

Adhesion Prevention

No matter the surgical approach chosen, the fundamental techniques of handling tissue must be followed. As the leading

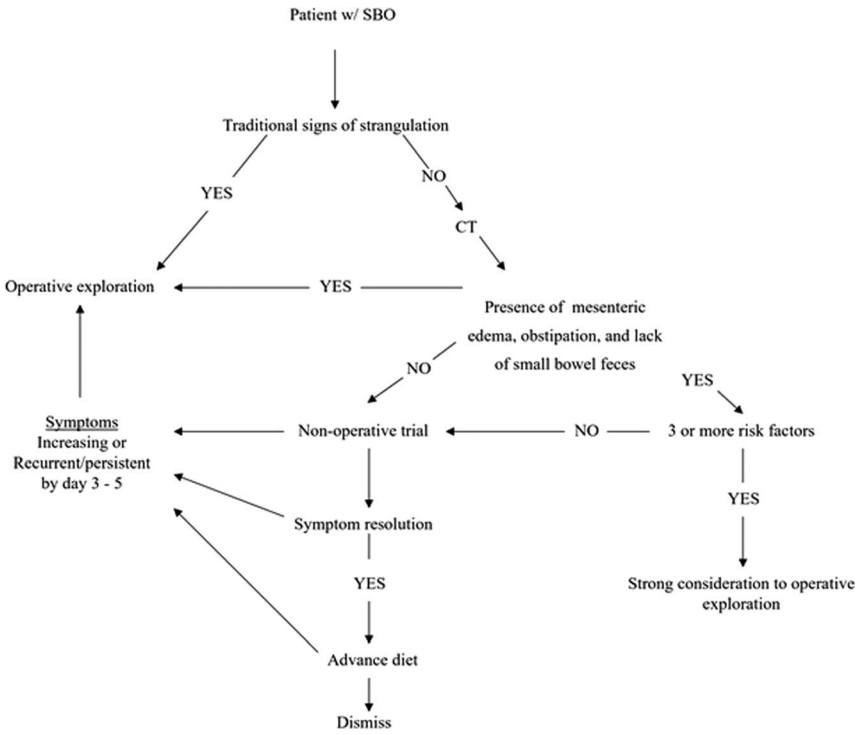

Figure 3. Small bowel obstruction management algorithm.

cause of SBO, adhesions are a normal, but undesirable, side effect from tissue manipulation during abdominal surgery. Consequently, care should be taken to curtail tissue trauma. Gentle handling of the bowel without undue force to the peritoneal mesothelium is paramount. This is just as important laparoscopically, as open laparoscopic bowel graspers are designed to maximize surface area when being used to minimize pressure. The entire grasper should be placed on the bowel wall, therefore, during manipulation. Additional pearls include minimizing disruption of tissue planes and meticulous hemostasis, as well as elimination of bacterial soiling and synthetic materials. Lastly, omentum is an effective barrier to protect bowel and other tissues and should be liberally placed at high-risk areas for dense adhesions including voids in the pelvis and under celiotomy incisions.

Unfortunately, despite the mindful use of these surgical techniques, adhesions will form.[24] While it is nearly impossible to define the rate of adhesion formation, up to 5% of patients who underwent open abdominal surgery will be admitted for adhesive SBO up to 5 years after their index operation.[25] Fibroblast proliferation with fibrin deposition, the beginning process of scar tissue formation, occurs as a direct result of tissue trauma including tissue dissection. Over time, collagen will remodel the scar tissue. Ultimately, adhesions form between structures within the abdominal cavity. Once formed, these adhesions can result in small bowel kinking, volvulus, and internal hernia formation causing an SBO. Pharmaceutical companies have made significant efforts to develop ant-adhesive agents to decrease the incidence of adhesive SBO. The goal of these pharmaceutical agents is to separate the internal organs from each other and control fibrinolysis and extracellular matrix remodeling while not impeding normal wound healing.[26] In the United States, there are three agents approved for use: two solid film/gel agents and one liquid, all of which are meant to be a barrier between structures at risk for adhesion formation. While myriad RCTs have shown a benefit for these products in terms of decreasing adhesion formation, no evidence exists that fewer adhesions lead to fewer SBOs.[24,27] Concerningly, evidence exists that wound healing in the form of anastomotic leak can be impeded.[28] Ultimately, a single adhesion can cause SBO.[29] As a result, the authors use these agents sparingly. For those cases where reoperation is highly likely (diverting loop ileostomy formation, Hartmann's procedure, multiply recurrent SBO), we will place these agents but not if an anastomosis was performed.

SURGICAL MANAGEMENT OF NONADHESIVE SBO

Malignant SBO

Surgical management of patients with malignant SBO must strongly consider the underlying cancer prognosis and the patient's symptoms and goals for quality of life. Key in this shared-decision-making process is to maximize the days out of the hospital while ensuring *prima non nocere*, as these patients survival is limited to 3 to 6 months on average.[30,31] In the most comprehensive trial to date, Krause et al.[32] performed a pragmatic effectiveness trial of patients with known intra-abdominal primary cancer and malignant SBO. Of the 199 evaluable patients enrolled in more than 30 centers, 82 were in the surgery arm (24 randomized; 58 patient choice) and 117 were in the nonoperative arm (25 randomized; 92 patient choice). There were no differences between the study arms regarding "good days" (42 ± 32.2 vs. 43.9 ± 29.5 days) for randomized patients or patient choice patients (54.8 ± 27.0 vs. 52.7 ± 30.7 days). There was, however, significant improvement in patient symptoms including nausea, vomiting, bloating, and constipation severity for

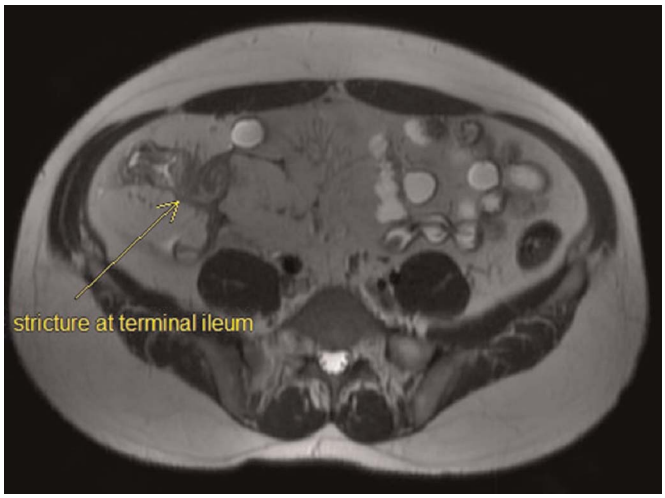

Figure 4. Crohn's disease with chronic stricture of terminal ileum seen on MRI.

surgically managed patients no matter if randomized or patient choice. There were 6 deaths during the index hospitalization and 10 throughout the 91 days of follow-up among both arms. The authors conclude that symptoms from malignant SBO may be improved with operative management in a highly selective population. A team-based approach with the patient and family along with medical oncology and palliative care is paramount in deciding for surgical or palliative management.

Surgeons should perform the safest procedure, which confers symptom relief. Therefore, we must be creative and use our entire armamentarium. Options include resection with anastomosis, intestinal bypass, and stoma creation in addition to gastrostomy/jejunostomy tube placement and even pharyngostomy creation and endoscopic stent placement.[33] Common intraoperative findings that lead to failure of surgical management include multiple transition points and fixed masses.[34] In addition, malignant ascites, frailty, and poor nutritional status lead to poor outcomes.[35]

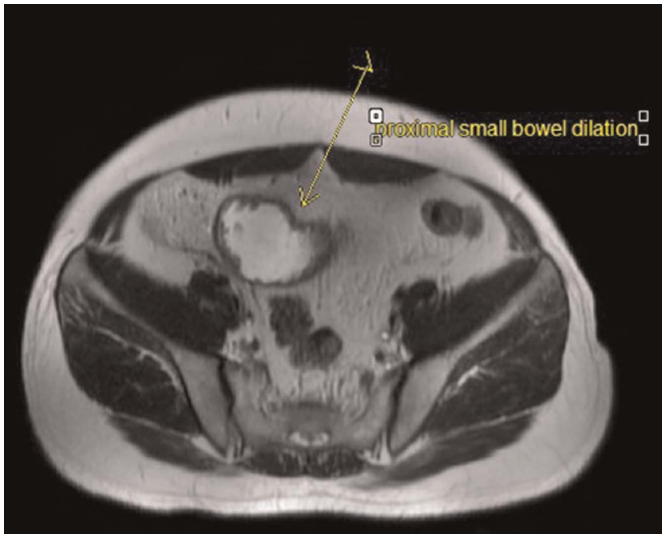

Figure 5. Crohn's disease with chronic stricture of terminal ileum cause distal ileum dilation on MRI.

TABLE 2. Differentiation of Inflammatory Versus Fibrotic Crohn's Disease on Magnetic Resonance Enterography

Characteristics	Inflammation	Fibrosis
Thickened wall	Present	Present
Delayed hyperenhancement	Present	Not present
Mucosal enhancement	Very suggestive	Not present
T2 mural signal intensity	High	Diminished
Mesenteric fat proliferation	Present	Highly suggestive
Mesenteric vascularity	Strongly diagnostic	Present
Fistula	Present	Present
Prestenotic dilation	Not present	Very suggestive

These patients will also generally have extensive adhesions and radiation enteritis from prior surgical resections to further complicate their management. When performing an anastomosis for intestinal bypass or resection, surgeons must ensure that the distal small bowel and colon are free of potential tumors that could create a distal obstruction leading to anastomotic leak. In this setting, stoma creation may be best. However, if creating a stoma, one must ensure that there is adequate proximal small bowel to absorb fluids and nutrition; frequent IV fluid and nutrition supplementation is counter to the goals of these end-of-life patients. Similarly, for intestinal bypass, the distal section of small bowel or colon must be able to adequately absorb the small bowel effluent to maintain hydration and nutrition status. Overall, it is critical that the patient's care team recommend individualized therapy based on patient preferences, cancer aggressiveness, and therapeutic options, plus the anatomy of the malignant SBO.

Patients with a history of abdominal or pelvic malignancy but without obvious recurrence on CT can be treated safely with the same GG challenge protocol as for adhesive SBO.[36] These

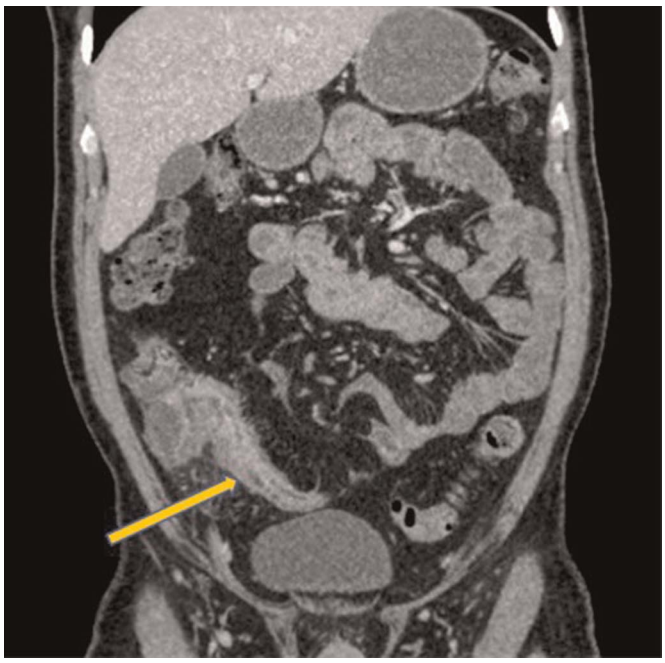

Figure 6. Long chronic stricture at terminal ileum in Crohn's disease.

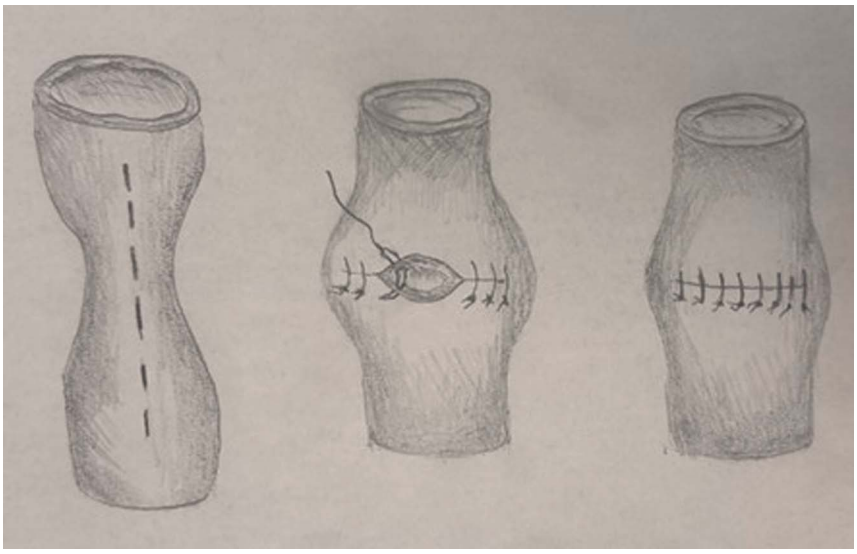

Figure 7. Heineke-Mikulicz stricturoplasty.

patients have several potential etiologies beyond cancer as the cause of their SBO (adhesions, radiation enteritis, hernia) and therefore may benefit. Unfortunately, those with known active malignant SBO do not benefit because of the fixed nature of their obstruction.

Virgin Abdomen

While the most common cause of SBO is adhesions, those patients who have not had prior surgical procedures in their abdominal cavity are at a lower risk of adhesion formation. As a result, they are at higher risk for malignant SBO for which exploration has historically been mandated.[37] With the advent of high-resolution cross-sectional imaging, however, this mandate has been called into question. In a post hoc analysis of a multi-institutional prospective study, there were 101 virgin abdomen patients with SBO; of these, only three patients had unrecognized malignancy.[38] The authors concluded that patients hospitalized with SBO and virgin abdomens do not necessitate exploration but that elective evaluation as an outpatient should be undertaken with close follow-up. Further support for this notion includes retrospective review of 60 SBO patients with SBO, 50 of whom underwent exploration and 10 who underwent nonoperative management. There were eight patients (13%) who had a malignancy upon presentation for SBO; five of these patients had their malignancy recognized at presentation, while the remaining three cancers were not identified. However, these tumors were indeed present on admission when rereviewing the scans with radiology. The combination of radiology rereview looking for evidence of intraluminal lesions and colonoscopy in follow-up would have identified all of these tumors.

Regarding operative approach to the virgin abdomen, we will generally start minimally invasively to explore the abdomen. Running the bowel is of paramount importance to identify any lesions. A low threshold to convert to open should be used because tactile sensation may be able to identify potential lead points that would not otherwise be visible.

Crohn's Disease

In patients with inflammatory bowel disease, specifically Crohn's disease, symptoms of SBO often present because of acute inflammatory or chronic strictures. Computed tomography enterography or magnetic resonance enterography can help evaluate these strictures (Fig. 4 and Fig. 5). The pattern of enhancement may help differentiate an inflammatory from a fibrotic

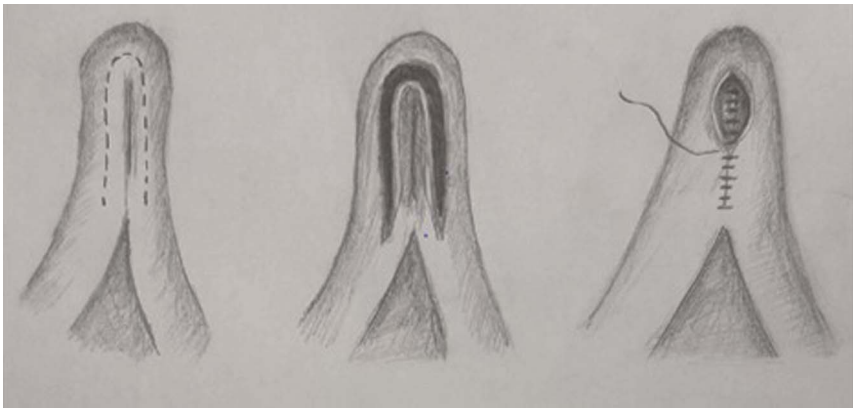

Figure 8. Finney stricturoplasty.

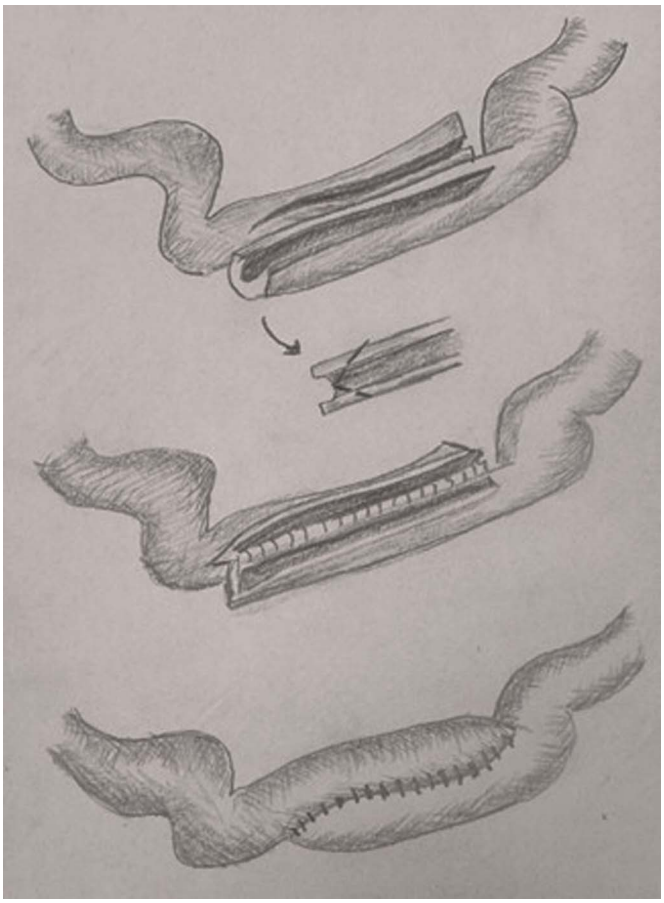

Figure 9. Michelassi stricturoplasty.

stricture (Table 2). If the SBO etiology is due to strictures, the nature of the stricture (inflammatory vs. fibrotic) and their anatomical characteristics (length, number, location, and severity of obstruction) will dictate surgical versus medical management.

Many patients will respond to medical therapy (anti-inflammatory such as steroids and/or anti-Tumor Necrosis Factor therapies) in acute setting.[39,40] Surgery management can be high risk because of common comorbidities such as immunosuppression, malnutrition, the risk for short gut syndrome, and recurrent disease at the anastomosis. Therefore, even with acute intestinal obstruction caused by either an inflamed or fibrotic segment, treatment should initially start with nonoperative management. Emergent surgery is only indicated in rare cases of strangulation or perforation. If the SBO is not responsive to medical therapy, surgery should be scheduled as an elective procedure after optimization. Careful monitoring for malnutrition must be done because it is a significant risk factor for perioperative complications. Therefore, parenteral nutrition should be of strong consideration.

Surgery is the preferred option in patients with localized ileocecal Crohn's disease with obstructive symptoms but no significant evidence of active inflammation.[41] Wide lumen stapled ileocolic side-to-side (functional end-to-end) anastomosis is the preferred technique. If emergency surgery is required, the patient should receive perioperative steroids if he or she has been on chronic steroids. There is little evidence, however, to support the use of "stress dose steroids" over simple continuation of the perioperative steroid doses. When SBO is caused by a primary stricture in a localized short segment, a bowel resection of the smallest length is appropriate. Patients with multiple strictures should undergo stricturoplasties (Fig. 6). In many cases, surgery is based on combination of small bowel resection and stricturoplasty(s) to minimize loss of small bowel length. The Heinecke-Mikulicz stricturoplasy is performed for lesions up to 10 cm by creating a longitudinal incision along the stricture and closing the defect transversely (Fig. 7). For lesions ranging 10 to 25 cm, the Finney technique can be used by folding the stricture over itself and creating a longitudinal enterotomy. The surgeon then suture the edges together to create a pouch (Fig. 8). The Michelassi stricturoplasty, a side-to-side isoperistaltic technique, is performed to avoid loss of large amounts of small bowel. The strictured loop is divided at the midpoint and sewn together in a side-to-side fashion forming a long opening between the affected segments (Fig. 9).

AUTHORSHIP

M.D.Z. wrote the majority of the paper save for the inflammatory bowel disease and robotic surgery portions, which G.Q. wrote. In addition, G.Q. created the hand-drawn figures and was responsible for editing along with M.D.Z.

DISCLOSURE

Conflicts of Interest: Author Disclosure forms have been supplied and are provided as Supplemental Digital Content (http://links.lww.com/TA/D381).

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