Large Bowel Obstruction

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"The sun never sets on a bowel obstruction" has been considered as historical dogma in surgical training. Due to the high risk of complications, namely, intestinal ischemia and perforation, it has been a tenant of general surgery that these patients need aggressive intervention. In contrast to treatment for small bowel obstruction, which has largely moved to longer acceptable periods of observation, large bowel obstruction is still thought to be a time-sensitive diagnosis regardless of the underlying etiology.

While not as common as small bowel obstruction, colonic obstruction still represents 25% of all intestinal obstructions [1]. Furthermore, complication of large bowel diseases account for 47% of gastrointestinal emergencies [2]. The obstruction can come in many forms including, but not limited to, mechanical problems as in volvulus and cancer or physiologic in nature such as in Ogilvie's syndrome. Many clinicians differentiate between partial and complete obstruction to determine the time period available for intervention.

In this chapter, we will review the evidence for the management of large bowel obstruction, identify areas of controversy, and highlight future directions for refinement of current practices.

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Etiology/Pathology

The pathology that accounts for colonic obstructions is diverse. They range from benign and malignant tumors and strictures and volvulus-type pictures. Adhesive obstructions are possible in colonic obstruction but not seen with near the frequency seen in small bowel obstruction. The fact that the etiology is different from small bowel obstruction plays a key role in the more operative-based treatment of large bowel pathology.

Malignancy is the most common cause of colonic obstruction leading to emergent surgery accounting for approximately 70% of cases. This incidence is the largest driver of operative intervention over observation. This is not limited to colon cancer as distal tumors represent a significant portion of the cases. Overall 10% of the patients presenting with colonic obstruction have rectal cancer, while an additional 5% have anal cancer as the etiology [3].

The most common cause of benign colonic obstruction is volvulus which represents 5–15% of large bowel obstructions [4]. The mechanism of volvulus is when a mobile portion of the colon twists on a single point of attachment. Some patients have a longer mesentery genetically, while others develop redundancy over time due to issues with colonic motility as seen in severe constipation. The acquired mobility is more common and that explains why these patients present

M. D. Zielinski, O. Guillamondegui (eds.), *The Acute Management of Surgical Disease*,
https://doi.org/10.1007/978-3-031-07881-1_13

after their fourth decade of life [5]. Typical portions of the colon involved are the sigmoid colon (~60%), cecum (~40%), and transverse colon (~2%) [6]. Fig. 13.1 shows the typical types of volvulus.

A variety of other etiologies account for the remaining 15–25% of cases, including benign strictures from recurrent inflammation (most commonly diverticular disease), intussusception, adhesive disease, and hernias with incarceration. There are also exceptionally rare causes such as bezoar and retroperitoneal fibrosis that are clinically important to the individual but beyond the scope of this chapter. Despite the seemingly endless list of possible etiologies, the evaluation of colonic obstruction is repetitive in nature, and the management is comparable utilizing both endoscopic and surgical interventions.

Diagnosis/Pathology

The varied definition of large bowel obstruction in the scientific literature makes comparisons between treatment options and timing difficult. The most basic definition is obstipation with imaging demonstrating distended colon. In order to minimize morbidity, many authors have included "impending obstructions" such as tight strictures which are typically only found after intervention. The impending obstruction population needs to be studied, but the inclusion of such patients makes drawing conclusions about the time-sensitive nature of this disease process difficult. If we recognize that colon cancer is the most common cause of large bowel obstruction and is typically slow growing, a patient can tolerate "impending obstruction" for several days or weeks before they would develop complications.

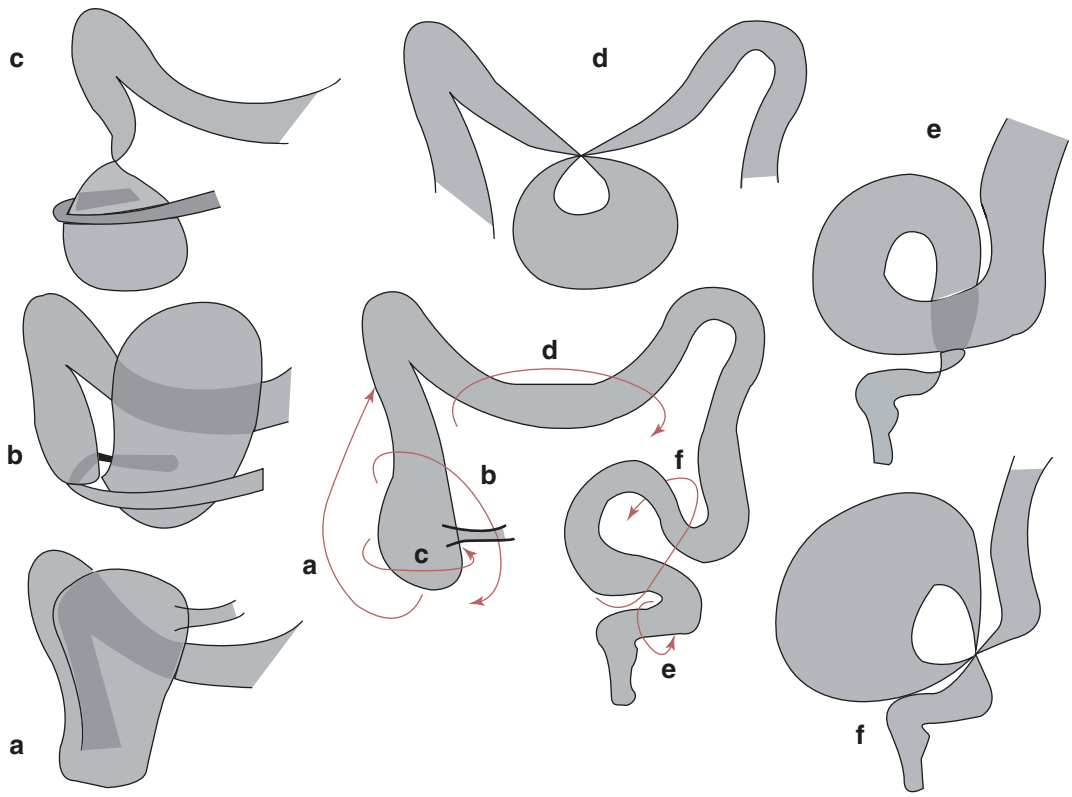

Fig. 13.1 Depiction of the three main types of colonic volvulus. Arrows represent the direction of volvulus accounting for the six presentations: (**a**) cecal bascule, (**b**) loop cecal volvulus, (**c**) axial cecal volvulus, (**d**) transverse colon volvulus, (**e**) organo-axial sigmoid volvulus, (**f**) classic sigmoid volvulus [7]

The clinical presentation of a large bowel obstruction is most commonly pain and bloating. Due to the distal nature of the obstruction, it does not have the classic nausea and vomiting seen in its small bowel counterpart. This can mean later presentation which is a key factor in its urgency and treatment as symptoms may not develop until just before abdominal catastrophe. Also due to the colonic flora and the potential for bacterial translocation, large bowel obstructions are more likely to present with systemic inflammatory response (SIRS) and electrolyte imbalances [8].

The presentation of colonic obstruction can be either acute or chronic. The presentation can point toward the etiology with a history of change in stool caliber or unintentional weight loss being more common in slow-evolving cancer. Acute pain is typically infraumbilical and crampy in nature. In the setting of large bowel volvulus, the nature of the pain can lead to the diagnosis. It has been shown that patients with sigmoid volvulus typically present with distention (79%), while cecal volvulus presents with pain (89%) [6].

While symptoms can help localize the source, imaging is required to further evaluate regardless of the etiology. Authors have suggested that plain x-ray should be utilized initially due to its lower cost and accessibility but has largely been replaced. Computed tomography (CT) is the standard diagnostic tool that would lead to most significant intervention. The global picture is essential for planning of treatment. Many consultants will not even proceed with adjuvants to non-operative therapy without a CT. While many surgeons learn the classic plain film appearance of colonic volvulus, they are not reliable and will miss up to 1/3 of the cases [9, 10]. Plain films may play a role in the patients at the extremes of physiology or in surveillance, but are otherwise relegated to irrelevant or a screening test for the evaluation of colonic obstruction. Another screening option is the ultrasound. Bedside ultrasound has higher sensitivity and the same specificity of plain x-ray but avoid moving the patient [11]. The later point could be of benefit in an ill unstable patient. The downside is that fact that some expertise is required with ultrasound limiting its widespread use.

Abdominal Computed Tomography

Virtually any hemodynamically stable patient suspected of colonic obstruction should get a CT scan secondary to its high sensitivity and specificity (both >90%) [12, 13]. CT can locate the obstructing lesions in 96% of cases and make correct diagnoses in 89% of cases. The use of triple contrast (intravenous, oral, and rectal) or the use of a computed tomographic enema allows an even more precise localization of the level of obstruction. It can also distinguish between an intraluminal cause of obstruction and an extraluminal compression. For patients diagnosed with a mass, a CT scan can also evaluate for the presence of distant metastasis which are present in 10% of cases of obstruction cancer [14].

Guidelines [15] would still recommend the use of CT even when free air is identified on screening imaging in the stable patient. As mentioned, this allows for identification of the scope of the disease and facilitates operative planning. Routine inclusion of the chest to look for distant spread in the case of colon cancer is not indicated.

Another essential trait of CT is the ability to differential true obstruction from the pseudo-obstructions such as toxic megacolon, paralytic ileus, and Ogilvie's syndrome [16]. In these diagnoses you will see the distended colon, but there will be a failure to identify a transition point.

Hydrosoluble Contrast Enema

Hydrosoluble contrast enema has historically been used to further evaluate colonic obstructions with regard to the nature of and degree of patency. The observed sensitivity of a contrast enema in the diagnosis of colonic obstruction is 80%, with specificity of 100% [12, 17, 18]. With the continued evolution of CT, this study has also been relegated as obsolete. CT scans, specifically with the addition of rectal contrast, gives equivalent information on the location of the tumor but also gives a wider picture of the local and regional spread.

Colonoscopy

Colonoscopy has two benefits which are as follows: it allows a direct visualization and potential biopsy of the cause of obstruction. It has limited roles in acute processes but is essential in evaluating chronic obstructions where malignancy becomes the dominant etiology. It also has the ability to evaluate for synchronous lesions which are seen in 10% of cases. The drawback is the availability. Many centers require consultation to gastroenterology for assistance which can add time to the evaluation process in an acute situation. Having a tissue diagnosis is attractive, but often delays in those results require practitioners to intervene before they return. Endoscopic evaluation still has some potential preoperative roles. One situation that would alter this would be in near obstructing colon cancer where endoluminal stents can be placed and markedly changes the therapeutic options available. A second role would be for the decompression of sigmoid volvulus to allow for transition to a semi-elective case.

Staging

Staging for bowel obstruction historically fell into two buckets—high grade and low grade. The distinction between the two categories was thought to be important given that high-grade obstructions (i.e., complete obstruction) classically required surgery and low-grade obstructions (i.e., partial obstruction) were thought to mostly resolve without surgical intervention. As practices have evolved and treatments have become less operative in nature, that distinction has become less important.

In 2014, the AAST set out to establish a uniform grading system (Table 13.1) for bowel obstruction with the intent to standardize both diagnosis and disease severity [19]. We previously lacked a method to characterize obstructions across differing institutions and geographic locations. The hope was to provide a framework to assist in measuring risk-adjusted outcomes and improve management protocols within the emergency general surgery realm as a whole.

Table 13.1 AAST grading for large and small bowel obstruction

Grade	AAST disease grade description	Intestinal obstruction–small and large bowel
I	Local disease	Partial obstruction
	Confined to the organ	
	Minimal abnormality	
II	Local disease	Complete obstruction, without bowel ischemia
	Confined to the organ	
	Severe abnormality	
III	Beyond the organ	Complete obstruction, bowel ischemic but viable
	Locally extension	
IV	Beyond the organ	Complete obstruction with gangrenous bowel OR perforation with local spillage
	Regional extension	
V	Beyond the organ	Perforation with diffuse peritoneal contamination
	Widespread extension	

This grading system has been applied to clinical cases involving both small and large bowel obstruction as the principles in management remain incredibly similar [20]. While formal recommendations for treatment based on severity of disease were not included in the AAST grading scale, the construction would favor more operative intervention as the grade increased.

Specific Pathologic Considerations

Obstructing Colon Cancer

Acute large bowel obstruction is the initial presentation in 7–29% of patients with colorectal cancer and represents one of the more common

causes of surgical emergency. The most common location for the obstructing colorectal cancer is the sigmoid colon, and >75% of tumors are located distal to the splenic flexure. Emergency presentation of colorectal cancer is more common in advanced stages of the disease and frequently occurs in elderly patients with significant comorbidities.

Although resection of the tumor is the "gold standard" for the treatment of malignant colonic obstruction, in the past two decades, self-expanding endoluminal colonic stents have been introduced in the therapeutic armamentarium as the initial maneuver in the management of distal colonic obstruction, aiming to relieve the obstruction and avoid emergency surgery. Surgery is proposed as a second-stage definitive treatment once the acute obstruction has been resolved. Several studies have shown the feasibility of managing acute malignant obstruction by colonic stenting. However, there is ongoing debate on the advantages of this strategy compared with emergency surgery in this scenario.

Treatment

Intervention falls into two large categories: operative and nonoperative. The operative intervention required is guided by the location and presentation of the obstruction. Nonoperative therapy which can include endoscopically based intervention is limited by the patient's physiology, the resources available to the surgeon, and the degree of obstruction.

Nonoperative Observation

A key component of nonoperative management is how long the obstruction can safely be observed without intervention. While the "hard deadline of sunset" has softened over time, there is little support for the 5–7-day period often seen in small bowel obstructions.

Initial management of the patient with mechanical colorectal obstruction consists of supportive care that includes gastric decompression for patients with nausea or vomiting and intravenous fluid therapy with correction of electrolyte abnormalities. Subsequent treatment depends upon the etiology and location of the obstruction, medical comorbidities of the patient, as well as local resources and expertise of the available clinicians. Unlike the majority of small bowel obstructions which can be successfully managed nonoperatively, approximately 75 percent of large bowel obstructions ultimately require surgical intervention, whether emergently, urgently, or electively during the same hospital admission.

Endoscopic Intervention: Benign Disease

For patients with imaging signs of sigmoid volvulus, gastroenterology/colorectal surgery consultation should be obtained. Flexible sigmoidoscopy is generally suggested to initially decompress the colon to allow for semi-elective surgery (rather than as an emergency) and may be the only treatment necessary in high-risk patients. However, for patients able to tolerate an operation, elective resection during the same hospital stay is recommended for sigmoid volvulus because of the high rate of recurrence (up to 50 percent) with endoscopic decompression alone.

Endoscopic Intervention: Malignant Disease

The primary therapeutic use of endoscopy in the acute setting, much like in benign disease, is to convert emergent surgery to semi-elective surgery. The hope is that this would decrease the morbidity and mortality as emergent surgery almost universally carries an increased risk regardless of pathology. Colonic stents can be placed for two indications: palliation and as a bridge to semi-elective surgery. In the acute setting, which indication is being followed is unclear as some patients are not determined to be palliative until after the intervention. The concept of using stents as a "bridge to surgery" has become popular and is well-studied. The numerous case series have been combined into two systemic

reviews, one with 598 patients [21] and one with 1198 patients [22]. These studies establish stenting as highly successful (>92%) and with low associated complications (perforation 3.7%). In a retrospective analysis of 5868 colostomies compared with 778 stents, the authors concluded that stent placement is less costly and associated with shorter length of hospital stay and fewer complications [23]. There are at least six existing randomized studies [24–29] on the topic. The variation in who received a stent coupled with the high rate of the studies being stopped early (three of six) makes a definitive statement difficult. When compared stent to emergent resection, most of the studies show equivalence. The attractive part of the stent is the association in the studies with an increased rate or primary anastomosis in the stent groups. Cheung et al. [25] showed that stenting leads to 67% of those patient being able to undergo successful laparoscopic single-stage surgery. The effect of stenting on anastomotic leak has had the opposite effect in two of the studies. Van Hooft et al. [29] showed leak rates 5 times greater in the stent group while Alcantara et al. [24] lower leak rates in the stent group (30.7% vs 0%).

In terms of oncologic outcomes, it would seem the outcomes are equivalent. There have been some noted differences in lymphatic invasion but that has not resulted in differences in long-term outcomes when used alone [30] or compared with emergency surgery [31–34].

Operative Intervention

Once the decision to proceed with surgical intervention has been made, the key point that must be determined is if an anastomosis will be done at the index operation or if a multistage plan is adopted. Regardless of the underling etiology, there is risk involved in creating a primary anastomosis. Two decades ago the default in unprepped colon resections was an ostomy. Historically, the leak rates of primary anastomoses were up to 50% and drove the decision to do multistage inventions. Modern leak rates are around 5% or slightly higher in the EGS population. The trauma literature was some of the first to describe how one-stage interventions in unprepped bowel could be performed. Also, the very utility of a preoperative bowel prep has been questioned with various colorectal studies reporting that they may not be helpful and could potentially be harmful. Finally, a greater understanding of the morbidity in ostomy takedowns which were usually thought as “risk free” now has been shown to have significant complications. All the above have moved toward a greater willingness to perform one-stage operations. Regardless of malignant or benign, there are some common surgical considerations.

Preoperative Bowel Preparation

Current recommendations do not advocate for the any type of bowel preparation (preoperative or intraoperative) prior to proceeding with emergency colon surgery for mechanical colorectal obstruction. The absence of mechanical bowel preparation is **not** a contraindication to primary anastomosis [35].

Bowel preparation can be considered but is not supported by evidence-based medicine. Numerous small studies show that successful bowel preparation with combined oral and mechanical bowel preparation prior to elective colorectal resections decreases rates of complications [36, 37]. This must be balanced against a large Cochrane analysis [38] of 18 trials with 5805 patients comparing preoperative bowel preparation in elective colon resection (2906 mechanical bowel preparation and 2899 without preperation) showing that mechanical bowel preparation has no effect on the rates of deep and superficial surgical site infections or, most importantly, anastomotic leaks. Currently bowel preparation would only be indicated when the surgeon plans of doing a simultaneous colonoscopy.

Benign Disease

In general, the surgical principles that apply to the malignant obstructions are true in benign

disease as well. Whenever possible, a one-stage curative procedure is the preferred treatment for right- or left-sided colon obstruction, whether benign or malignant [39, 40]. There are some specific considerations such as mega-rectum in sigmoid volvulus cases where continuity will not improve the patient's quality of life, but for the most part one- or two-stage procedures are the norm in benign disease. The DIVERTI trial addressed the resection in perforated diverticulitis where a two-stage (proximal diversion) intervention was performed. They showed that two-stage was the safest choice. While not the exact population as the large bowel obstruction described in this chapter, it does outline the baseline in modern times. It is difficult to imagine a patient in current times that resection, anastomosis, and loop ileostomy for diversion would not be considered the default operation performed. Future literature should consider which patients can have the loop ileostomy omitted as studies with an arm that includes three-stage procedures or Hartman's procedures would be antiquated. Those procedures would be reserved for special anatomic situations.

Malignant Obstruction

Two groups of patients can be defined according to the location of the tumor with respect to the splenic flexure: those with proximal and distal obstructions. The choice of surgery will depend on the location of the obstruction, the general condition of the patient, the surgical findings, and the experience or resources of the hospital team.

Proximal Colonic Obstruction

Right hemicolectomy has been accepted as the treatment of choice for tumors proximal to the splenic flexure. A primary anastomosis between the small bowel and the colon has been considered safe in the emergency setting, with published anastomotic leak rates of 2.8–4.6% [18].

While a primary anastomosis is still the operation of choice, literature does bring into question who and how these operations should be done. Frago and colleagues examined a cohort of patient undergoing emergent colectomy (defined as occurring in the first 24 h) and found a leak rate of 16.4% on the 173 patients who underwent resection and primary anastomosis for proximal colonic cancer obstruction [41]. These authors highlighted the difference in leak rates between colorectal surgeons (those that had done an additional year of training) and general surgeons (colorectal 5.8% and general surgery 21%, $p < 0.05$). Interestingly the distal resection, which would be considered the more technically challenging operations that would benefit from colorectal training, did not show a difference in leak rates (6.3% colorectal and 8.9% in general surgery). These and other similar data have been used to suggest that these operations should be done by colorectal surgeons. These manuscripts do often not include data about the physiology in the patient groups and even less about the availability of the colorectal surgeons on nights and weekends. It is clear from emerging data that emergency general surgery patients have unique physiology and comorbidities and that these differences lead to markedly different outcomes [42]. In order to mitigate these poor outcomes, the acute care surgeon will need to adapt their techniques. In a single institution experience, Farrah et al. [43] showed leak rates could be decreased by performing a handsewn anastomosis rather than a stapled one (15.1% in the stapled vs 6.1% in the handsewn, $p = 0.003$). In the small bowel to colon anastomoses, the overall leak rate was similar to that presented in the colorectal literature of 14.7%, but when comparing stapled vs handsewn anastomoses, the leak could be decreased (18% stapled vs 10% handsewn, $p = 0.4$). Similar data was seen in a subsequent multi-institutional trial where the leak rates were not different despite the handsewn cohort having significantly lower albumin and higher lactate and were more likely to be on vasopressors [44] (Fig. 13.2).

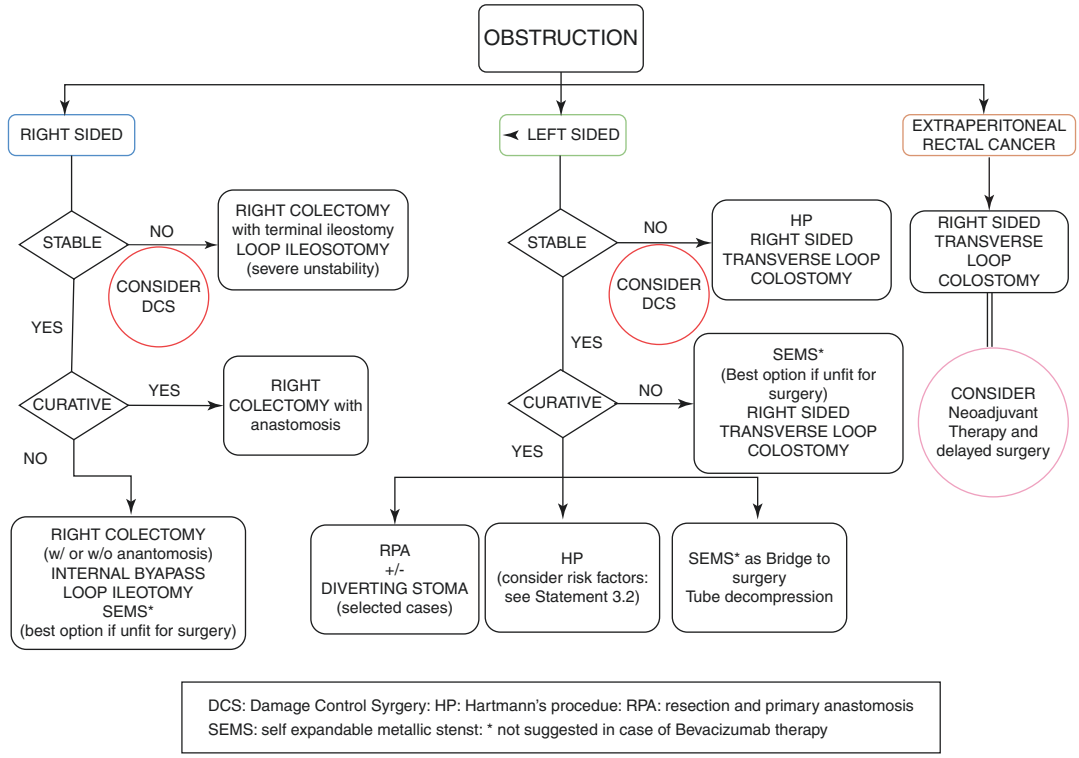

Fig. 13.2 Flowchart for the management of colonic obstruction due to colorectal cancer [15]

Distal Colonic Obstruction

The traditional surgical intervention was a three-stage procedure (proximal colostomy, second-stage tumor resection, and third-stage stoma closure) which has largely been relegated to being obsolete outside of extremely rare anatomic or physiologic situations. The issue is whether three low-risk interventions are better than one higher-risk operation. The literature has shown that staged resection does not improve survival and is instead associated with high morbidity and mortality rates [12, 17, 18, 39, 41, 45]. While many surgeons would still favor a two-stage procedure for high-risk patients, the literature has focused on what factors impart this increased risk and how they can be minimized. Most current research efforts examine which patients can safely undergo a one-stage procedure.

Prognostic factors for mortality in colonic obstruction have been identified: preoperative renal failure, American Society of Anesthesiologists class 3 or 4, and proximal colon lesions. The presence of all these factors could influence the choice of surgical technique.

There remain unique clinical situations where one-, two-, and three-stage procedures could be employed and where minimally invasive techniques could be utilized to improve outcomes. The surgical options available and the situations where they would be employed are the following.

The Three-Stage Management

While thought of as a "safe" surgery or a conservative intervention, this pathway has actually been proven to harm patients. Due to the morbidity of multiple interventions, increased complications have been shown in a comprehensive

Cochrane review [17] and in a prospective randomized trial. Kronberg and colleagues [46] showed similar oncologic outcomes and perioperative outcomes but shorter hospital days which is similar to the Cochrane results.

Currently, the role for three-stage intervention is limited to patient whose low rectal cancer advanced tumor characteristics would benefit from neoadjuvant treatment. It is also used for unresectable tumors or patients who are prohibitive operative risks. It could potentially be done under local anesthesia minimizing operative stress. The patient then can be evaluated to see if they can be made into an operative candidate to undergo definitive therapy.

Hartmann's Procedure (Two-Stage Procedure)

A Hartmann's procedure or two-stage procedure is still the preferred operation in emergent settings of distal obstructing tumors [47–49]. It allows cancer removal but avoids an anastomosis.

The comparison of two-stage procedures to others is complicated by the number of ostomies that are reversed and the wide range of reported complications with ostomy takedown. After a Hartmann's procedure is performed, only about 60% of ostomies are reversed due to age or comorbidities [17]. The morbidity (5–57%) and mortality (0–34%) varies greatly making determinations about the total complications difficult to determine [50].

Resection and Primary Anastomosis

The most attractive intervention is the one-stage procedure which minimizes hospital stays and all of the complications of subsequent operations. Surgical dogma has prevented progress in this area for many years, but recent studies have supported one-stage as a safe alternative [49, 51].

Efforts have focused on risk factors that would make one-stage intervention unsafe. There is data that supports primary anastomosis is feasible in both proximal and distal lesions [52, 53]. The factors that have been associated with anastomotic complications and may preclude one-stage intervention are malnutrition, chronic renal failure, and immunosuppression.

Mortality and anastomotic leak cannot be separated, and the risk of mortality has reproducibly been shown to be increased with age, ASA classification, operative urgency, and Duke's classification [47, 54, 55]. The decision to do a primary anastomosis or a stoma is often determined by real-time surgeon assessment. The main technical factors are a tension-free anastomosis and preservation of the blood supply to the anastomosis. If these two cannot be accomplished, then the surgeon should consider a stoma. The rate of leaks on the right side varies from 0.5 to 4.6% in perforated emergency cases and should be compared with 0.5–1.4% reported for elective surgery. Distal resection rates range from 3.5 to 30% in emergency versus 5–10% in elective cases [41, 56].

Subtotal Colectomy with Ileosigmoid or Ileorectal Anastomosis

One option to increase the safety of one-stage operation is to do a subtotal colectomy [14]. This avoids the colocolic anastomosis and eliminates the chance of missing a synchronous right side lesion in an unevaluated colon. Studies have shown that in patients with colonic obstruction, the leak rate is lower in ileocolic anastomosis than a colocolic anastomosis (<10% vs 18–20%) [14, 57].

The main drawback would be the incidence of diarrhea after surgery. There is evidence that 6 months out the functional difference between subtotal and segmental resection is minimal, 2 versus 3 bowel movements a day, but erratic follow-up and self-reported data may limit the validity of those outcomes [14]. In case of cecal perforation or ischemia and if synchronous neoplasms are present in the colon, this management

is recommended [57]. There is data that leaving 10 cm of colon above the peritoneal reflection and resecting less than 10 cm of terminal ileum can result in less diarrhea [58].

Resection and Primary Anastomosis with Intraoperative "on Table" Irrigation

Surgeons have feared that the stool in the colon being anastomosed would lead to increased leak rates. There has been animal studies that have shown that intraluminal content is a larger predictor of anastomotic complications than peritonitis [59]. In patients who could not undergo preoperative bowel preparation, the surgeons would irrigate burden in patients undergoing colonic resection. While it makes some practical sense, the literature would not support it having any effect on complications [49, 51]. One potential use is if the surgeon intends to do a colonoscopy to look for synchronous lesions. The use of a lavage would allow for better visualization of the colon [60]. Much like preoperative bowel prep which has faded in terms of importance over the years, the importance of intraluminal stool burden has not been an important predictor of anastomotic complications. Many of the complications can be explained based on patient comorbidities and physiology rather than the presence or lack of stool.

Resection and Primary Anastomosis with Intraluminal Device

There is a variety of intraluminal devices that have been proposed to decrease the complication rates in high-risk anastomoses. Devices fell into a few categories such as decompression devices, intracolonic devices, and biodegradable devices. They were intended either to decompress the colon by stenting the sphincter open or to protect the anastomosis from being bathed in stool. In principle they may have value, but unfortunately they have not been shown to work, and their use is reserved to a few non evidence-based uses [61].

Resection and Primary Anastomosis with Proximal Diverting Stoma

The use of a loop ileostomy or colostomy to protect a distal anastomosis has been considered an alternative to Hartmann's procedure. There has been data in the perforated diverticulitis literature that proximal diversion is associated with a greater number of ostomies being reversed [62]. Data supporting proximal diversion in the malignant obstruction group has not been as supportive. In an American College of Surgeons' National Surgical Quality Improvement Program Procedure Targeted Colectomy databases study, 2323 patients with no diversion were compared to 204 patients with diversion. They found the diversion group was more likely to have complications (sepsis, blood transfusions, readmission within 30 days). It could be assumed that there was a large selection bias that not be accounted for in such a large retrospective database study but should give pause to the routine use of diverting ileostomy [63].

Laparoscopic Versus Open Resection

The concept of laparoscopic surgery for acute large bowel obstruction is relatively new. The literature in non-acute situations suggests shorter hospital stays and faster return to daily activities with equivalent if not superior oncologic outcomes [64, 65]. The adoption of laparoscopic surgery in the emergent setting has been slower. There have been case reports that suggest it is safe but without comparisons to open resection [66, 67].

Perforation

One situation to consider is colon cancers presenting perforated. Typically, these patients were associated with poor outcomes due to the fact they were often both septic and had advanced tumor characteristics. It is true that perioperative mortality is tied to the presence of perforation with free perforation having the highest mortality (19%) which is significantly higher than contained perforations and no perforation (0% and 5%, p.038) [2]. Despite worse oncologic resection characteristics, the 5-year survival is not predicted by the presence of perforation but, like

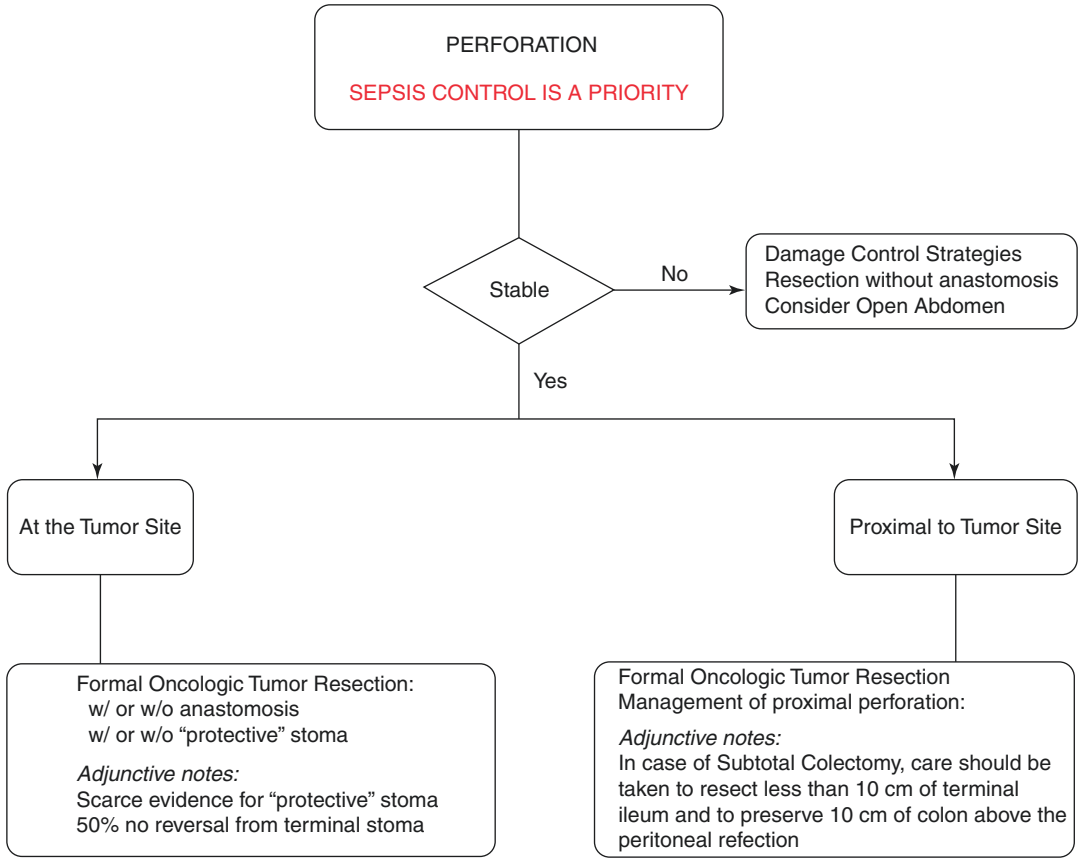

Fig. 13.3 Flowchart for the management of colonic perforation die to colorectal cancer [15]

most pathologies, is a by-product of the comorbidities and physiology [2]. The first priority must be control of the perforation with the completeness of the oncologic surgery taking a back seat. Sepsis is the most immediate threat to a perforated patients' life and is certainly time dependent (Fig. 13.3) [15].

Specific Surgical Considerations for Benign Disease

Sigmoid Volvulus

Any patient with volvulus presenting with signs of impaired intestinal blood flow or perforation should be taken to the operating room in an expeditious fashion following initiation of resuscitation and broad-spectrum IV antibiotics. Resection should ideally be performed without detorsion of the affected bowel segment to avoid unnecessary return of toxic waste products and bacterial load into the venous circulation [68]. When considering which operation to perform, whether it be a Hartmann's procedure or a segmental resection with colorectal anastomosis, one must take into consideration the physiologic status of the patient. In patients with hemodynamic instability or gross contamination secondary to perforation, a Hartmann's procedure is the preferred operation [69].

In stable patients with little to no enteric spillage, resection of the redundant colon with colorectal anastomosis is a reasonable option and has been shown to be a viable choice in large patient series [70].

The decision to create a protective ostomy should be based on comfort level of the surgeon

while taking into consideration patient factors such as nutrition status, overall health, and level of the anastomosis.

The initial treatment of sigmoid volvulus, in the absence of ischemia or perforation, has largely been endoscopic. Detorsion is the necessary first step, either by sigmoidoscopy or colonoscopy, and has been reported to be successful in up to 95% of cases [69]. Long-term recurrence rates of volvulus have been quoted as high as 75% in some patient populations, necessitating definitive surgical management in appropriate surgical candidates. Following successful endoscopic detorsion, a rectal tube is often placed to allow for ongoing colonic decompression and to prevent retorsion prior to sigmoidectomy. Without overt signs of intestinal ischemia, it is acceptable to allow for a period of several days in order to completely resuscitate the patient and optimize from a medical standpoint prior to surgery.

Once the patient has been adequately prepared for surgery, a segmental sigmoid resection with colorectal anastomosis is the most appropriate procedure for definitive therapy. A protective ostomy is rarely utilized; however it may be necessary based on patient-specific factors such as age, level of contamination, and nutritional and hemodynamic status. Complete resection of all redundant colon is paramount to minimize risk of recurrent volvulus. Both laparoscopic and open methods have been utilized; however, there is no definitive evidence to suggest outcomes are improved when minimally invasive techniques are used. The theoretical benefit of reduced postoperative pain and decreased hospital length of stay have not borne out in the literature; however, the ultimate choice of technique should be based on surgeon experience and level of comfort [71, 72].

For those patients with high or unacceptable surgical risk, nonresectional techniques and nonsurgical management have both been described. Several small series have described low recurrence rates following both intraperitoneal and extraperitoneal sigmoidopexy; however this has not been validated through larger studies. In patients felt to be at high risk for anastomotic leak or who would not otherwise tolerate a formal resection, sigmoidopexy does remain an option but is generally not considered first-line therapy. For patients with comorbidities that are prohibitive to surgery, a consistent bowel regimen and dietary modifications have become the mainstay of therapy [69].

Cecal Volvulus

As in the case of sigmoid volvulus, immediate surgical intervention is necessary for any patient diagnosed with cecal volvulus and presenting with signs of intestinal ischemia or perforation. In contrast to sigmoid volvulus, endoscopic decompression is typically not recommended given that endoscopic intervention tends to be ineffective for this anatomic location and conveys a higher risk of bowel perforation. In any case involving nonviable bowel, the entirety of the involved segment should be removed, and the operative surgeon may [73, 74] elect to perform an ileocolic anastomosis plus or minus a diverting ileostomy or bring up an ileostomy with a long mucous fistula. The large majority of the data supporting these statements comes from studies published 20 years ago and are somewhat outdated. However, morbidity rates following cecectomy for volvulus are not insignificant, and in cases involving perforation or contamination, expert consensus continues to rely on the judgment of the independent surgeon in such circumstances.

Patients who present with cecal volvulus without signs of intestinal ischemia may be better suited for segmental resection. Unfortunately, the published data on this subset of patients is even less substantial. Several small case series report zero recurrence of cecal volvulus when segmental resection is performed, however carrying with it higher rates of associated morbidity and mortality compared to patients undergoing cecopexy alone. In otherwise healthy patients, segmental resection is the preferred method of treatment for cecal volvulus, while cecopexy may be reserved for patients with extensive medical comorbidities or comparatively higher operative risk.

Pseudo-Obstruction

Acute pseudo-obstruction is an entity most commonly described in older patients, residents of nursing homes, or hospitalized individuals following surgery and traumatic injury. It is crucial to rule out sources of mechanical obstruction, ischemia, and perforation prior to initiating therapy. While a diagnosis is typically made before bowel becomes compromised, those patients presenting in extremis, with perforation or with a cecal diameter >12 cm, will likely require immediate surgical intervention.

For stable patients, the treatment algorithm lies largely in reversing the underlying etiology. Initial steps involve hydration, correction of underlying electrolyte abnormalities, and avoidance of narcotic pain medications. Nasogastric and rectal tube decompression often provide moderate relief, and in some instances, anticholinergic agents may prove beneficial. Avoidance of osmotic agents and stimulant laxatives is generally encouraged as these can lead to worsening of symptoms. Up to 90% of cases will see complete resolution utilizing medical therapies and without requiring surgical intervention.

When conservative measures prove ineffectual or are otherwise contraindicated, endoscopic decompression is recommended as part of a step-up management scheme in the treatment of colonic pseudo-obstruction. The goal of endoscopic therapy is to access the right colon with minimal to no insufflation, placement of a decompression tube, and evacuation of gas. Most patients will resolve their pseudo-obstruction without further need for intervention and, once they begin to show signs of bowel recovery, will likely need dietary modifications and an appropriate bowel regimen. Additional endoscopic management includes percutaneous cecostomy tube placement. While the use of this technique has been controversial in the surgical community, there are no currently available studies which look at outcomes related to percutaneously placed cecostomy tubes specifically for colonic pseudo-obstruction. What we do know is that they are associated with a relatively high morbidity rate, nearly 40%, and are fraught with complications including dislodged tube, peritonitis, bleeding, infection, and buried bumper syndrome.

In general, percutaneous cecostomy tubes are to be avoided if possible. Surgical intervention remains the last line of defense in cecal pseudo-obstruction [73, 74].

Approximately 10% of patients with pseudo-obstruction will fail conservative measures and progress to need for surgery. Both mortality and morbidity rates increase substantially for those patients requiring surgical intervention; thus all efforts to relieve the pseudo-obstruction by non-surgical means is advised. Cecal dilation >14 cm and symptom duration >4 days are all associated with worse outcomes; however in certain instances, surgery cannot be avoided [75, 76].

Both surgical cecostomy and resection have been demonstrated in small case series to be of benefit, although there is no data directly comparing one method to the other. The choice of which procedure to perform will undoubtedly remain preference of the surgeon based on independent patient factors and the quality of the involved bowel at the time of the procedure.

Benign Stricture

There is a significant lack of published literature related to efficacy of treatment for benign colonic stricture. Given the wide variability in etiology of benign stricture, the exact cause of obstruction secondary to narrowing of the colonic lumen must be investigated thoroughly to rule out an acute process. Strictures related to an acute episode of inflammatory bowel disease such as Crohn's or ulcerative colitis can usually be addressed with immunomodulators and steroids. Other causes of stricture may not be as clinically obvious and warrant a more extensive workup.

The preferred method for treatment of benign stricture, similar to pseudo-obstruction, is a step-up approach where surgical intervention is reserved for those with complete obstruction, evidence of perforation, and peritonitis or those who fail conservative therapies. Several advanced endoscopy techniques now exist, allowing for a

multidisciplinary approach to benign colonic stricture. Balloon dilation has been shown to be effective over the long term in >60% of patients and, although it carries a small risk of perforation, can generally be performed under light sedation [77].

It is considered a reasonable first step in patients presenting with both anastomotic and inflammatory strictures. Endoscopic administration of corticosteroid injections also serves as an adjunct to enhance the effectiveness of balloon dilation in Crohn's strictures. While the true efficacy has yet to be borne out in the literature, its theoretical benefit lies in avoiding repeat need for dilation.

Savary dilation is an alternative technique to endoscopy utilizing serial bougies over a fluoroscopically guided wire. Small series have suggested this is a cheaper technique when compared to balloon dilation, and while repeated intervention is occasionally necessary, most patients have excellent outcomes with very low-risk profiles [77].

Endoscopic stent placement has been a successful approach to strictures involving the proximal gastrointestinal tract. Its effectiveness in treating colonic strictures is less convincing. Often used to temporize obstructive symptoms related to malignancy, endoscopic stent placement for benign disease has not been as effective [77].

The risk of stent occlusion, migration, and perforation seem to outweigh any potential benefit, and larger prospective trials have not been pursued as a result.

Colonic Anastomosis in Open Abdomen

For many years, the principles of damage control surgery have been incorporated into treatment algorithms for the emergency general surgery population [78]. Despite their underlying fundamental differences, patients presenting with severe physiologic derangement secondary to late complications of intra-abdominal sepsis and hemorrhage often require laparotomy with immediate source control and temporary abdominal closure similar to their trauma counterparts [79]. The utility of damage control principles and the ultimate outcome is not nearly as well studied in the EGS population as it has been in the trauma cohort. This includes abdominal closure rates and when is the optimal timing to restore intestinal continuity. The decision between colostomy creation and a colonic anastomosis has yet to be definitely proven in the scientific literature and remains largely a practice based upon surgeon-specific experience and judgment.

Given the paucity of data relating to these scenarios specifically in the emergency general surgery population, evidence-based decisions must be extrapolated from more heterogeneous studies. In patients undergoing laparotomy for intra-abdominal sepsis or hemorrhage, all reasonable attempts should be made to avoid leaving the abdomen open as it is associated with significant morbidity and mortality. Mortality rates associated with open abdomen have been quoted as high as 35% in the non-trauma population with notable rates of severe complications such as enteroatmospheric fistula, intra-abdominal abscess, hernia, and delayed fascial closure [80]. While there has been concern regarding historical overuse of the open abdomen, there are certainly instances in which such a management scheme is necessary. Once a decision has been made to leave an abdomen open following intestinal resection, the dilemma becomes one of either performing an anastomosis or creating an ostomy to restore continuity.

Several patient-specific factors should help guide the decision to create a colostomy or to perform a colonic anastomosis. In patients with significant medical comorbidities, short life expectancy or intra-abdominal pathology such as significant intra-abdominal contamination, near-frozen abdomen, or destructive perforations with significant tissue loss, colostomy creation may be unavoidable. Patients with persistent physiologic derangements such as shock state, ongoing large volume crystalloid or blood product resuscitation, and ongoing intestinal ischemia may also necessitate colostomy creation given that ultimate closure of the abdominal wall should be a

priority and occur in as timely a fashion as possible to reduce rates of complication. Abdominal compartments that are left open for second look surgery and in patients where physiologic stability has been established, the decision to restore intestinal continuity is multifactorial.

In 2010, Ordonez et al. [81] retrospectively analyzed a series of 112 patients undergoing laparotomy for intra-abdominal sepsis. All patients had bowel resection performed and were managed with an open abdomen with temporary abdominal closure. A total of 34 patients underwent primary anastomosis, while the remaining 78 patients had a diverting ostomy created. There was no significant difference demonstrated in hospital mortality, anastomotic leak rate, or development of fistula. A subsequent prospective analysis of 51 patients treated with open abdomen for perforated diverticulitis, 38 patients underwent primary anastomosis with the remainder treated with a diverting stoma [82]. The overall mortality rate for the study was 10% which is consistent across patients treated with open abdomen, and >75% of the surviving patients were discharged from the hospital with intestinal continuity restored.

Both of these studies, along with several others, have demonstrated the relative safety of performing a primary colonic anastomosis in an open abdomen with the condition that adequate source control has been obtained and the patient has been appropriately resuscitated without ongoing physiologic derangement prior to restoring continuity.

For the patients who do ultimately require ostomy creation, surgeons must decide the optimal placement within the abdominal wall. Given that the majority of patients undergoing laparotomy in a damage control scenarios are by definition an emergent procedure, very little preoperative planning is likely to take place. Hernia rates in patients requiring emergent laparotomy often exceed 20% 1 year after their initial surgery [83]. Many of these patients go on to require additional surgery, especially in those with colostomy creation and subsequent takedown. These same patients are at higher risk for repeat laparotomy for adhesive bowel obstructions and incarcerated hernias. Complex abdominal wall reconstruction has become the mainstay in treatment of patients who have undergone multiple prior abdominal wall surgeries. The approach to these procedures is further complicated by the various tissue planes that have been disrupted during prior surgery.

To the extent possible, all patients who are to undergo laparotomy should ideally be marked for ideal stoma placement preoperatively. With increasing preponderance of obesity in the general population, and the difficulty in managing an ostomy in the outpatient setting, it is generally recommended that ostomies be sited above the belt line where abdominal wall thickness is minimized and should avoid natural skin creases [84]. Function takes precedence over appearance and aesthetics. Placement through the rectus muscle itself assists in prevention in stoma retraction and development of parastomal hernias. However, despite best intentions, many patients with ostomy creation and/or takedown will go on to develop large, complex ventral hernias and may require abdominal wall reconstruction.

Thankfully, in the last decade, techniques in abdominal wall reconstruction and hernia repair have made significant advancements including laparoscopic and robotic approaches. While the presence of a prior ostomy may add a certain level of complexity to an abdominal wall reconstruction, a retrospective study of 169 patients over 8 years showed that outcomes in abdominal wall reconstruction specifically utilizing a component separation technique were no different between those with rectus complex violation and those without [85]. Being mindful and intentional with ostomy siting is essential in the surgical process, but the site does not preclude patients from reconstruction at a later point in time.

Palliative Patients

Three randomized prospective trials [86–88] have compared the use of stents versus diverting ostomies in palliative patients with obstruction from unresectable colorectal cancer. In general

all three favor stents with positive effect being shorter hospital stays, earlier return to a diet, and improved quality of life. There were concerns in one of the studies [87] about the rate of perforations with stents, but this has not been viewed as prohibitive reason to avoid stents.

Overall survival in palliative patients who have stents placed compared to surgery has had mixed results. While stents have been associated with shorter hospital stays, lower rates of stoma creation, [45, 89] and an earlier start of chemotherapy, they have been unable to show increased survival. To the contrary, studies have shown resection of the primary tumor was associated with a better prognosis compared with the stent group [45, 90]. A mean survival rate of 15.9–23.7 months was observed in the resection group compared with 4.4–7.6 months in the stent group.

Conclusions

Colonic obstruction still remains a time-sensitive diagnosis that requires timely intervention to optimize patient outcomes. Endoscopic interventions such as stents have increased the options on hand, but the evidence is not convincing enough to exclude the need for surgical intervention. In general, surgery has move toward a one-stage procedure with two-stage procedure being the exception. Adjuvants such as bowel preparation and diverting proximal ostomies have limited use and have not been associated with improved outcomes. To the contrary primary anastomosis even in unprepped bowel has been shown to be safe. Benign disease continues to follow classic teaching. Most surgeons would treat adhesive disease and benign strictures the same as their malignant counterparts. If physiology permits, left-sided volvulus should be decompressed to allow for a semi-elective surgical intervention. Given that right hemicolectomy with primary anastomosis is the treatment of right-sided volvulus, surgery should proceed based on patient physiology.

References

1. Arezzo A, et al. Stent as bridge to surgery for left-sided malignant colonic obstruction reduces adverse events and stoma rate compared with emergency surgery: results of a systematic review and meta-analysis of randomized controlled trials. Gastrointest Endosc. 2017;86(3):416–26.
2. Zielinski MD, et al. Emergency management of perforated colon cancers: how aggressive should we be? J Gastrointest Surg. 2011;15(12):2232–8.
3. Deans GT, Krukowski ZH, Irwin ST. Malignant obstruction of the left colon. Br J Surg. 1994;81(9):1270–6.
4. Halabi WJ, et al. Colonic volvulus in the United States: trends, outcomes, and predictors of mortality. Ann Surg. 2014;259(2):293–301.
5. Jones DJ. ABC of colorectal diseases. Large bowel volvulus. BMJ. 1992;305(6849):358–60.
6. Lau KC, et al. A study of large-bowel volvulus in urban Australia. Can J Surg. 2006;49(3):203–7.
7. Vandendries C, et al. Diagnosis of colonic volvulus: findings on multidetector CT with three-dimensional reconstructions. Br J Radiol. 2010;83(995):983–90.
8. Kahi CJ, Rex DK. Bowel obstruction and pseudo-obstruction. Gastroenterol Clin N Am. 2003;32(4):1229–47.
9. Atamanalp SS. Sigmoid volvulus: Diagnosis in 938 patients over 45.5 years. Tech Coloproctol. 2013;17(4):419–24.
10. Taourel P, et al. Helical CT of large bowel obstruction. Abdom Imaging. 2003;28(2):267–75.
11. Chen SC, et al. Ultrasonography is superior to plain radiography in the diagnosis of pneumoperitoneum. Br J Surg. 2002;89(3):351–4.
12. Frager D, et al. Prospective evaluation of colonic obstruction with computed tomography. Abdom Imaging. 1998;23(2):141–6.
13. Gerhardt RT, et al. Derivation of a clinical guideline for the assessment of nonspecific abdominal pain: the guideline for abdominal pain in the ED setting (GAPEDS) phase 1 study. Am J Emerg Med. 2005;23(6):709–17.
14. Hennekinne-Mucci S, et al. Emergency subtotal/total colectomy in the management of obstructed left colon carcinoma. Int J Color Dis. 2006;21(6):538–41.
15. Pisano M, et al. 2017 WSES guidelines on colon and rectal cancer emergencies: obstruction and perforation. World J Emerg Surg. 2018;13:36.
16. Hayakawa K, et al. Radiological diagnosis of large-bowel obstruction: nonneoplastic etiology. Jpn J Radiol. 2012;30(7):541–52.
17. De Salvo GL, et al. Curative surgery for obstruction from primary left colorectal carcinoma: primary or staged resection? Cochrane Database Syst Rev. 2004;2:CD002101.

18. Gainant A. Emergency management of acute colonic cancer obstruction. J Visc Surg. 2012;149(1):e3–e10.
19. Shafi S, et al. Measuring anatomic severity of disease in emergency general surgery. J Trauma Acute Care Surg. 2014;76(3):884–7.
20. Hernandez MC, et al. The American Association for the Surgery of Trauma Severity Grade is valid and generalizable in adhesive small bowel obstruction. J Trauma Acute Care Surg. 2018;84(2):372–8.
21. Khot UP, et al. Systematic review of the efficacy and safety of colorectal stents. Br J Surg. 2002;89(9):1096–102.
22. Sebastian S, et al. Pooled analysis of the efficacy and safety of self-expanding metal stenting in malignant colorectal obstruction. Am J Gastroenterol. 2004;99(10):2051–7.
23. Varadarajulu S, et al. Endoscopic stenting versus surgical colostomy for the management of malignant colonic obstruction: comparison of hospital costs and clinical outcomes. Surg Endosc. 2011;25(7):2203–9.
24. Alcantara M, et al. Prospective, controlled, randomized study of intraoperative colonic lavage versus stent placement in obstructive left-sided colonic cancer. World J Surg. 2011;35(8):1904–10.
25. Cheung HY, et al. Endolaparoscopic approach vs conventional open surgery in the treatment of obstructing left-sided colon cancer: a randomized controlled trial. Arch Surg. 2009;144(12):1127–32.
26. Ghazal AH, et al. Colonic endolumenal stenting devices and elective surgery versus emergency subtotal/total colectomy in the management of malignant obstructed left colon carcinoma. J Gastrointest Surg. 2013;17(6):1123–9.
27. Ho KS, et al. Endoscopic stenting and elective surgery versus emergency surgery for left-sided malignant colonic obstruction: a prospective randomized trial. Int J Color Dis. 2012;27(3):355–62.
28. Pirlet IA, et al. Emergency preoperative stenting versus surgery for acute left-sided malignant colonic obstruction: a multicenter randomized controlled trial. Surg Endosc. 2011;25(6):1814–21.
29. van Hooft JE, et al. Colonic stenting versus emergency surgery for acute left-sided malignant colonic obstruction: a multicentre randomised trial. Lancet Oncol. 2011;12(4):344–52.
30. Iversen LH, et al. Self-expanding metallic stents as bridge to surgery in obstructing colorectal cancer. Br J Surg. 2011;98(2):275–81.
31. Dastur JK, et al. Comparison of short-and long-term outcomes following either insertion of self-expanding metallic stents or emergency surgery in malignant large bowel obstruction. Tech Coloproctol. 2008;12(1):51–5.
32. Kavanagh DO, et al. A comparative study of short- and medium-term outcomes comparing emergent surgery and stenting as a bridge to surgery in patients with acute malignant colonic obstruction. Dis Colon Rectum. 2013;56(4):433–40.
33. Saida Y, et al. Long-term prognosis of preoperative "bridge to surgery" expandable metallic stent insertion for obstructive colorectal cancer: comparison with emergency operation. Dis Colon Rectum. 2003;46(10 Suppl):S44–9.
34. Tilney HS, et al. Comparison of colonic stenting and open surgery for malignant large bowel obstruction. Surg Endosc. 2007;21(2):225–33.
35. Jimenez Fuertes M, Costa Navarro D. Resection and primary anastomosis without diverting ileostomy for left colon emergencies: is it a safe procedure? World J Surg. 2012;36(5):1148–53.
36. Kiran RP, et al. Combined preoperative mechanical bowel preparation with oral antibiotics significantly reduces surgical site infection, anastomotic leak, and ileus after colorectal surgery. Ann Surg. 2015;262(3):416–25; discussion 423–5.
37. Scarborough JE, et al. Combined mechanical and oral antibiotic bowel preparation reduces incisional surgical site infection and anastomotic leak rates after elective colorectal resection: an analysis of colectomy-targeted ACS NSQIP. Ann Surg. 2015;262(2):331–7.
38. Guenaga KF, Matos D, Wille-Jorgensen P. Mechanical bowel preparation for elective colorectal surgery. Cochrane Database Syst Rev. 2011;9:CD001544.
39. Breitenstein S, et al. Systematic evaluation of surgical strategies for acute malignant left-sided colonic obstruction. Br J Surg. 2007;94(12):1451–60.
40. Deen KI, et al. Surgical management of left colon obstruction: the University of Minnesota experience. J Am Coll Surg. 1998;187(6):573–6.
41. Frago R, et al. Differences between proximal and distal obstructing colonic cancer after curative surgery. Color Dis. 2011;13(6):e116–22.
42. Becher RD, et al. A critical assessment of outcomes in emergency versus nonemergency general surgery using the American College of Surgeons National Surgical Quality Improvement Program database. Am Surg. 2011;77(7):951–9.
43. Farrah JP, et al. Stapled versus hand-sewn anastomoses in emergency general surgery: a retrospective review of outcomes in a unique patient population. J Trauma Acute Care Surg. 2013;74(5):1187–92; discussion 1192-4.
44. Bruns BR, et al. Stapled versus hand-sewn: a prospective emergency surgery study. An American Association for the Surgery of Trauma multi-institutional study. J Trauma Acute Care Surg. 2017;82(3):435–43.
45. Lee WS, et al. The outcome after stent placement or surgery as the initial treatment for obstructive primary tumor in patients with stage IV colon cancer. Am J Surg. 2012;203(6):715–9.
46. Kronborg O. Acute obstruction from tumour in the left colon without spread. Int J Color Dis. 1995;10(1):1–5.
47. Biondo S, et al. Large bowel obstruction: predictive factors for postoperative mortality. Dis Colon Rectum. 2004;47(11):1889–97.
48. Meyer F, et al. Emergency operation in carcinomas of the left colon: value of Hartmann's procedure. Tech Coloproctol. 2004;8(Suppl 1):s226–9.

49. Trompetas V. Emergency management of malignant acute left-sided colonic obstruction. Ann R Coll Surg Engl. 2008;90(3):181–6.
50. Frago R, et al. Current management of acute malignant large bowel obstruction: a systematic review. Am J Surg. 2014;207(1):127–38.
51. Ortiz H, et al. Comparative study to determine the need for intraoperative colonic irrigation for primary anastomosis in left-sided colonic emergencies. Color Dis. 2009;11(6):648–52.
52. Hsu TC. Comparison of one-stage resection and anastomosis of acute complete obstruction of left and right colon. Am J Surg. 2005;189(4):384–7.
53. Chiappa A, et al. One-stage resection and primary anastomosis following acute obstruction of the left colon for cancer. Am Surg. 2000;66(7):619–22.
54. Tekkis PP, et al. The Association of Coloproctology of Great Britain and Ireland study of large bowel obstruction caused by colorectal cancer. Ann Surg. 2004;240(1):76–81.
55. Zorcolo L, et al. Toward lowering morbidity, mortality, and stoma formation in emergency colorectal surgery: the role of specialization. Dis Colon Rectum. 2003;46(11):1461–7; discussion 1467-8.
56. Veyrie N, et al. Anastomotic leakage after elective right versus left colectomy for cancer: prevalence and independent risk factors. J Am Coll Surg. 2007;205(6):785–93.
57. Single-stage treatment for malignant left-sided colonic obstruction: a prospective randomized clinical trial comparing subtotal colectomy with segmental resection following intraoperative irrigation. The SCOTIA Study Group. Subtotal colectomy versus on-table irrigation and anastomosis. Br J Surg. 1995;82(12):1622–7.
58. Papa MZ, et al. Avoiding diarrhea after subtotal colectomy with primary anastomosis in the treatment of colon cancer. J Am Coll Surg. 1997;184(3):269–72.
59. Ravo B, et al. The importance of intraluminal anastomotic fecal contact and peritonitis in colonic anastomotic leakages. An experimental study. Dis Colon Rectum. 1988;31(11):868–71.
60. Sasaki K, et al. One-stage segmental colectomy and primary anastomosis after intraoperative colonic irrigation and total colonoscopy for patients with obstruction due to left-sided colorectal cancer. Dis Colon Rectum. 2012;55(1):72–8.
61. Morks AN, Havenga K, Ploeg RJ. Can intraluminal devices prevent or reduce colorectal anastomotic leakage: a review. World J Gastroenterol. 2011;17(40):4461–9.
62. Bridoux V, et al. Hartmann's procedure or primary anastomosis for generalized peritonitis due to perforated diverticulitis: a prospective multicenter randomized trial (DIVERTI). J Am Coll Surg. 2017;225(6):798–805.
63. Shwaartz C, et al. Should patients with obstructing colorectal cancer have proximal diversion? Am J Surg. 2017;213(4):742–7.
64. Guillou PJ, et al. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. Lancet. 2005;365(9472):1718–26.
65. McLeod RS, Stern H, C.E.B.R.i.S. Group. Canadian Association of General Surgeons Evidence Based Reviews in surgery. 10. Laparoscopy-assisted colectomy versus open colectomy for treatment of nonmetastatic colon cancer: a randomized trial. Can J Surg. 2004;47(3):209–11.
66. Dudley HA, Racliffe AG, McGeehan D. Intraoperative irrigation of the colon to permit primary anastomosis. Br J Surg. 1980;67(2):80–1.
67. Gash K, et al. The role of laparoscopic surgery for the management of acute large bowel obstruction. Color Dis. 2011;13(3):263–6.
68. Madiba TE, Thomson SR. The management of cecal volvulus. Dis Colon Rectum. 2002;45(2):264–7.
69. Vogel JD, et al. Clinical practice guidelines for colon volvulus and acute colonic pseudo-obstruction. Dis Colon Rectum. 2016;59(7):589–600.
70. Atamanalp SS. Treatment of sigmoid volvulus: a single-center experience of 952 patients over 46.5 years. Tech Coloproctol. 2013;17(5):561–9.
71. Basato S, et al. Comparison of two surgical techniques for resection of uncomplicated sigmoid volvulus: laparoscopy or open surgical approach? J Visc Surg. 2014;151(6):431–4.
72. Cartwright-Terry T, et al. Laparoscopy in the management of closed loop sigmoid volvulus. Color Dis. 2008;10(4):370–2.
73. Benacci JC, Wolff BG, Cecostomy. Therapeutic indications and results. Dis Colon Rectum. 1995;38(5):530–4.
74. Bertolini D, et al. Severe delayed complication after percutaneous endoscopic colostomy for chronic intestinal pseudo-obstruction: a case report and review of the literature. World J Gastroenterol. 2007;13(15):2255–7.
75. Vanek VW, Al-Salti M. Acute pseudo-obstruction of the colon (Ogilvie's syndrome). An analysis of 400 cases. Dis Colon Rectum. 1986;29(3):203–10.
76. Jain A, Vargas HD. Advances and challenges in the management of acute colonic pseudo-obstruction (Ogilvie syndrome). Clin Colon Rectal Surg. 2012;25(1):37–45.
77. Kwon YH, Jeon SW, Lee YK. Endoscopic management of refractory benign colorectal strictures. Clin Endosc. 2013;46(5):472–5.
78. Stawicki SP, et al. The concept of damage control: extending the paradigm to emergency general surgery. Injury. 2008;39(1):93–101.
79. Coccolini F, et al. The open abdomen in trauma and non-trauma patients: WSES guidelines. World J Emerg Surg. 2018;13:7.
80. Sartelli M, et al. The role of the open abdomen procedure in managing severe abdominal sepsis: WSES position paper. World J Emerg Surg. 2015;10:35.

81. Ordonez CA, et al. Deferred primary anastomosis versus diversion in patients with severe secondary peritonitis managed with staged laparotomies. World J Surg. 2010;34(1):169–76.
82. Kafka-Ritsch R, et al. Damage control surgery with abdominal vacuum and delayed bowel reconstruction in patients with perforated diverticulitis Hinchey III/IV. J Gastrointest Surg. 2012;16(10):1915–22.
83. Fink C, et al. Incisional hernia rate 3 years after midline laparotomy. Br J Surg. 2014;101(2):51–4.
84. Whitehead A, Cataldo PA. Technical considerations in stoma creation. Clin Colon Rectal Surg. 2017;30(3):162–71.
85. Garvey PB, et al. Violation of the rectus complex is not a contraindication to component separation for abdominal wall reconstruction. J Am Coll Surg. 2012;214(2):131–9.
86. Fiori E, et al. Palliative management of malignant rectosigmoidal obstruction. Colostomy vs. endoscopic stenting. A randomized prospective trial. Anticancer Res. 2004;24(1):265–8.
87. van Hooft JE, et al. Early closure of a multicenter randomized clinical trial of endoscopic stenting versus surgery for stage IV left-sided colorectal cancer. Endoscopy. 2008;40(3):184–91.
88. Xinopoulos D, et al. Stenting or stoma creation for patients with inoperable malignant colonic obstructions? Results of a study and cost-effectiveness analysis. Surg Endosc. 2004;18(3):421–6.
89. Watt AM, et al. Self-expanding metallic stents for relieving malignant colorectal obstruction: a systematic review. Ann Surg. 2007;246(1):24–30.
90. Frago R, et al. Outcomes in the management of obstructive unresectable stage IV colorectal cancer. Eur J Surg Oncol. 2010;36(12):1187–94.