# 24 Large Bowel Obstruction: Current Techniques and Trends in Management

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## Introduction

The management of an acute large bowel obstruction (LBO) remains one of the most complex surgical diseases presenting in the emergency setting. Historically, operative treatment was the standard of care, extirpating the pathology and oftentimes creating a permanent stoma [1]. The acute blockage of fecal flow often results in an overt need for laparotomy; nevertheless, having a systematic and algorithmic approach to the management of a LBO will significantly influence the patient's quality of life (Fig. 24.1). It is imperative that the surgeon not only treat the obstructing process but also consider the underlying etiology. Many LBOs are mechanical in origin; however, nonmechanical causes such as pseudo-obstructions have also been described. Both benign and malignant diseases, with either intrinsic or extrinsic compression, may result in obstruction, and the underlying disease and patient's physiology will often dictate the treatment required. As experience and technology has advanced in the management of acute colonic emergencies, several treatment options are available, and all should be in the armamentarium of the acute care surgeon.

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## Etiology

The pathophysiology of a LBO most commonly occurs due to the progressive narrowing of the colon lumen due to an intrinsic process. Colorectal cancer is the third most common malignancy and is the third leading cause of cancer-related death in the United States [2]. An obstruction will be the initial presentation in 10–33% of these cases, accounting for over 50% of all LBOs [3–5]. A diverticular stricture is reported to be the second most common cause of intrinsic obstruction with a prevalence ranging between 10% and 20%. Additionally, acute diverticulitis may also result in a LBO due to an inflammatory process or abscess formation. Volvulus, which accounts for 10–17% of LBOs, typically develops in the sigmoid colon and cecum [5]. Diseases such as ischemic colitis, radiation enteritis, Crohn's disease (CD), and endometriosis may also present as an obstructive process; however, these are much less common.

Malignant obstructions are most likely to form in the descending colon and rectosigmoid junction. Often it may be difficult to differentiate between benign and malignant pathology, and this will further add to the complex decision-making process. Extrinsic compression either



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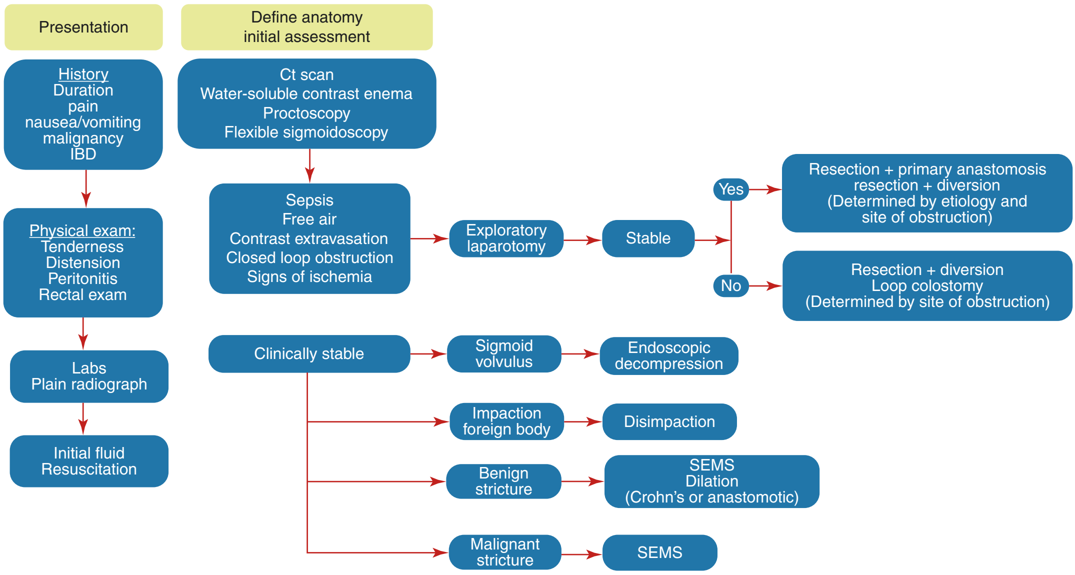


**Fig. 24.1** Evaluation and treatment algorithm for the management of an acute large bowel obstruction

from carcinomatosis or extra colonic malignancies may result in an acute obstruction, and rarely postoperative adhesions may significantly occlude the colon. It is critical that a thorough history and physical is performed as this will guide the subsequent steps in determining the diagnosis and treatment.

## Pathophysiology

The nature of the obstruction will often dictate the patient's clinical status, as well as the urgency in which an intervention must be rendered. The colon is a resilient organ, with great compliance, and patients can often tolerate an obstructive process for several days before an emergent situation arises. When the ileocecal valve is not competent, large bowel contents may decompress proximally, and this prevents the development of a closed-loop obstruction and subsequent perforation. The effects of colonic distention on perfusion have been evaluated in a dog model by Boley and colleagues. Findings demonstrated that once an intraluminal pressure has reached above 30 mmHg, there is an immediate fall in intestinal blood flow, a decrease in the oxygen extraction by the intestine, and ultimately intestinal ischemia, hypoxia, and perforation [6]. The timing in which this develops is dependent on the severity and duration of the obstruction.

The mechanical effects inflicted on each portion of the colon are dependent on wall tension. The degree of tensile force on the wall is proportional to the pressure generated in the colon and the diameter of the at-risk segment as dictated by the law of Laplace [7]. Therefore, the cecum, which has the largest diameter, will have the greatest degree of tension distributed in this segment. This incremental rise of intraluminal pressure will result in a hypoxic environment generated at the level of the mucosa and submucosa, and subsequent perforation will ensue [6, 8].

## Presentation

The initial presentation of an acute LBO may be variable based on the degree, timing, and etiology of the disease (Table 24.1). Typically, an obstruction secondary to a colonic volvulus will present in a rapid fashion, versus a diverticular stricture or malignant process which may be more chronic. Some signs and symptoms may be subtle, com-

**Table 24.1** Etiology of large bowel obstruction

| Malignant disease | Benign disease |
|---|---|
| Colon cancer | Diverticular disease |
| Rectal cancer | Volvulus: cecal or sigmoid |
| Carcinoid | Fecal impaction |
| Lymphoma | Foreign body |
| Gastrointestinal stromal tumor | Ischemic colitis |
| Extrinsic compression from metastatic carcinoma | Inflammatory bowel disease |
| | Colonic pseudo-obstruction |
| | Anastomotic stricture |
| | Adhesions |
| | Hernia |

pared to others who present with a profound physiologic derangement. Patients may develop a prodrome of symptoms to include bloating, obstipation or constipation, thinning of the stool caliber, and colicky or cramping abdominal pain. Emesis is often a late sign of disease progression if decompression through the ileocecal valve has occurred. As previously discussed, when the ileocecal valve is competent, a closed-loop obstruction will result, and patients experience progressive dilation, pain, and eventual perforation [8].

Physical exam may demonstrate a distended tympanic abdomen, with an associated dominant mass. Signs of focal abdominal tenderness and peritonitis warrant urgent operative intervention, as one must be concerned for associated ischemia or perforation. A digital rectal exam should be performed in all patients to identify a distal rectal or anal cancer, stricture from a prior low colorectal anastomosis, foreign body, or fecal impaction. When feasible, proctoscopy may be performed at the bedside to evaluate the rectum and distal sigmoid colon; however, care must be made not to over distend the colon as this may worsen the patient's condition.

Colonic dilation may result in severe volume depletion and electrolyte disturbances due to fluid shifts in the intestinal luminal, bacterial overgrowth, and concomitant emesis. Overt septic shock may be present with more advanced disease. Following an initial assessment, complete blood work should be performed to include a complete blood count, chemistry, and lactic acid levels. Acid-base abnormalities should be noted to guide the initial resuscitation, and a serum creatinine should be evaluated prior to administering intravenous contrast. When the suspicion for a malignancy is high, a carcinoembryonic antigen (CEA) level should be obtained, and complete imaging of the chest abdomen and pelvis to identify metastatic disease must be performed.

The initial management as well as a thorough workup of the acute obstruction should occur simultaneously. The patient's volume status must be addressed and fluid resuscitation should commence in the emergency room. In addition to closely monitoring the patient's vital signs and laboratory results, a Foley catheter should be placed for an accurate measurement of urine output. Nasogastric tube decompression should be performed in patients with active nausea, ongoing emesis, or if small bowel dilatation is recognized on imaging. If the patient does not mandate immediate operative exploration, then observation in a monitored setting is critical.

Although often overlooked due to the ease of obtaining advanced imaging, a flat and upright abdominal and chest plain film should be performed to evaluate for free perforation which would warrant operative exploration. These films can provide insight to the location of the obstruction, size of the cecum, as well as subtle findings associated ischemia. Although there is no exact correlation between cecal diameter and ischemia or perforation, 12 cm is generally a cutoff that warrants concern; however, perforations have occurred with a smaller luminal dilation [9–12]. Furthermore, these images are diagnostic for either a sigmoid or cecal volvulus, with the colon mesentery of the volvulized segment oriented toward the quadrant of concern. Swenson and colleagues demonstrated that plain radiographs were unable to determine the diagnosis of a cecal and sigmoid volvulus in 85% and 49% of patients, respectively. Therefore, additional imaging is required when clinical suspicion is high [13]. The inability to interpret a plain film should not delay identifying the correct diagnosis.

## Advanced Imaging

Once the stability of the patient has been determined, and there is no urgent surgical intervention required, a more thorough radiographic evaluation of the patient is performed. Computed tomography (CT) of the abdomen and pelvis has become the diagnostic modality of choice in the setting of a LBO due to its near-ubiquitous availability, technical easy to obtain, and it provides rapid access to high-quality images (Fig. 24.2). This imaging modality has largely replaced contrast enemas (CE) and endoscopy as an initial test. CT is a critical tool in the event of any diagnostic dilemma. When performed correctly, this study provides quality information regarding intra-abdominal pathology and can help differentiate between intrinsic and extrinsic compression of the colon. CT has a reported sensitivity and specificity of over 90%, with an accuracy of 94% in correctly identifying the level of obstruction and 81% in determining the correct diagnosis [14]. In a study by Frager and colleagues, a CT scan was found to have a significantly greater sensitivity, accuracy, and negative predictive value in the evaluation of a LBO when compared to a contrast enema [14]. Intravenous, oral, and rectal contrast may be administered to further increase the accuracy and quality of the study. In addition, these adjuncts have resulted in the overall improvement of both false-negative and false-positive rates [14]. Based on these advantages, a CT scan should be strongly considered as the initial diagnostic test of choice in the evaluation of an acute LBO.

Contrast enemas have historically been the gold standard in the diagnosis of a LBO. It is recommended to instill water-soluble contrast for this study rather than barium, as there is a risk of peritonitis secondary to barium if a perforation occurs (Fig. 24.3). Contrast enemas are beneficial as they may further elucidate details about the obstructing lesion anatomy. This includes size, tortuosity, or whether the lumen has a benign smooth appearance versus a malignant one. These characteristics provide important insight if endoluminal stenting is to be considered. This

**Fig. 24.2** Computed tomography demonstrating sigmoid stricture with proximal dilation


**Fig. 24.3** Water-soluble contrast enema of sigmoid stricture

modality has a sensitivity of 96% and specificity of 98% in identifying the level of obstruction. These findings are similar to CT scan but significantly greater compared to plain radiographs [15]. In a patient with volvulus a "bird's beak" or tapering of the lumen can be observed [13, 16]. Due to the decreased accessibility, increased variability of administration, risk of perforation, and associated patient discomfort, water-soluble CE should be considered as a radiographic adjunct to CT, or for preprocedural planning for colonic stent placement, as will be discussed below [5].

### Endoscopy

Flexible sigmoidoscopy should also be considered while evaluating the stable patient with a LBO. This procedure imparts minimal risk to the patient and is often readily available and requires no sedation. The risk of perforation is rare; however, carbon dioxide insufflation should be used as this has been found to have a lower risk of perforation when compared to air. Carbon dioxide is absorbed 250 times faster than air and this will minimize the degree of distention proximal to the disease [17]. This diagnostic and therapeutic tool will identify a rectal or sigmoid mass, allow for biopsies to be obtained, and provide information for consideration of stent placement simultaneously. In addition, if a sigmoid volvulus is encountered detorsion can be performed, and an emergent condition can now be mitigated to a semi-elective one.

## Management

Traditionally all patients with a large bowel obstruction required operative exploration. In the setting of a patient with a closed-loop obstruction, evidence of ischemia, or findings of a perforation with a subsequent physiologic insult, the decision for surgical intervention is relatively straightforward. Volume resuscitation should be ongoing as the operating room is prepared, adequate vascular access should be confirmed, and the patient should receive appropriate parenteral antibiotic coverage against anaerobic and gram-negative bacteria. A stoma marking both for a colostomy and an ileostomy should be placed on the patient while awake. When possible, this should be performed in the supine, sitting, and standing positions. However, this may be challenging in patients who are in acute distress. Maturing a stoma in an emergency setting has been associated with poor outcomes, and every effort to obtain a preoperative enteric stomal therapist site marking should be made [18]. A thorough discussion with the anesthesia service should be performed to ensure appropriate ongoing volume repletion. The patient and family should be fully informed on the gravity of the situation which includes a significantly elevated rate of stoma creation. In the stable patient, without signs of impending abdominal sepsis, a non-operative and potentially endoscopic approach can be considered. This process may be as straightforward as fecal disimpaction or as complex as the placement of a self-expanding metallic stent (SEMS) to temporarily alleviate the obstructive process. Presently, this strategy has become more accepted, and in the appropriately selected patient, this is a viable option to avoid a technically challenging and potentially morbid operation.

## Operative Management

### Right-Sided Obstruction

Proximal or right-sided obstructions have traditionally been treated with right colectomy and ileocolic anastomosis and can be safely performed in most patients [19]. The decision to perform a primary anastomosis requires the surgeon to assess the patient's overall clinical status, their physiology during surgery, and bowel viability at the proximal and distal resection margins. The incidence of an anastomotic leak was not significantly different when primary anastomosis was performed in the setting of obstruction (10%) compared to no obstruction (6%) [20]. When clinical factors are questionable, a proximal protective loop ileostomy may be performed to mitigate the effects of an anastomotic leak if one subsequently occurs. Furthermore, in the unstable patient presenting with generalized peritonitis, as in the setting of cecal perforation, this may require resection of the obstructed segment with an end ileostomy and consideration of a distal mucous fistula [4]. If the distal colon is unable to be brought to the skin surface, it may be secured in the subcutaneous tissue at the stoma site or midline incision.

Greater than one half of LBOs are caused by a malignant process; therefore, an oncologic resection should be pursued when approaching these lesions. Current recommendations are that a segmental resection be performed which includes the lymphatic and vascular drainage of the tumor [21]. For lesions in the cecum or ascending colon, resection should include the distal terminal ileum through the transverse colon, with proximal ligation of the ileocolic vascular pedicle and division of the right branch of the middle colic artery. Tumor spread occurs through a submucosal plane; consequently, a minimum margin of 5–7 cm proximal and distal to the mass should be obtained [21]. Obstructing masses at the hepatic flexure and transverse colon should be managed with an extended right colectomy including a high ligation of the middle colic artery.

A laparoscopic resection may be considered by a surgeon with appropriate training and experience. There are multiple factors which will add to the complexity of this operation. The presence of an obstruction will diminish the working space available in the intra-abdominal cavity; additionally, the distended colon will have a significant stool burden and may be friable and compromised due to ischemia. This may result in a higher degree of iatrogenic injury when the colon and small intestine are handled by laparoscopic instruments. Complete laparoscopic or hand-assisted laparoscopic colectomy has been shown to be safe and effective when performed by those proficient in this technique; however, one should have a low threshold to convert to an open approach [22, 23]. Furthermore, if proceeding with a laparoscopic approach, a sound oncologic operation must be performed.

In the elective setting, a colectomy performed through a minimally invasive approach has been shown to decrease hospital length of stay and risk of postoperative adverse events [24–28]. Due to the significant differences in outcomes reported for emergent open colectomy when compared to elective minimally invasive colectomy, it is naturally appealing to explore stenting as a bridge to elective surgery in right-sided LBO. There have been several retrospective studies showing that in centers with appropriate support and experienced providers, stenting can be safe and effective [29–31]. Evidence for this practice is limited, and due to technical challenges, it should only be attempted by an experienced endoscopist. Procedural details and clinical outcomes following endoscopic stenting will be discussed below.

## Left-Sided Obstruction

While right-sided obstructions are predominantly treated by primary resection and anastomosis, the management of a left-sided obstruction is far more complicated and controversial. Due to a high risk of anastomotic leak, these patients have been generally treated with either diversion alone for decompression or resection and end colostomy [20]. In a less ideal surgical candidate, those with compromised bowel, intraoperative instability, or evidence of perforation at the site of obstruction, a Hartmann's procedure (resection and end colostomy) may still be necessary.

More recently, it is recommended that the surgical treatment of left-sided obstructions be individualized to the patient. Postoperative outcomes appear to be similar and potentially better following primary resection for left-sided lesions [32, 33]. The operative approach should be based on location of the lesion, completeness and chronicity of the obstruction, benign or malignant pathology, nutritional status, and history of radiation or an immunocompromised state. In patients who remain stable, with low operative risk factors and a proximal colon that is not severely distended or ischemic, segmental resection with primary anastomosis can be considered [34, 35]. A side-to-end or side-to-side anastomosis can be utilized to correct for a size mismatch in the setting of chronically dilated but healthy proximal colon. Decompression of a severely dilated colon can often be advantageous to allow for better manipulation of the colon to perform a resection; the addition of colonic irrigation may also be done simultaneously in selected cases [36, 37].

The utilization of intraoperative on-table colonic lavage is preferred by some surgeons in the management of left-sided obstruction. This procedure is performed in an attempt to relieve the stool burden, allow for an intraoperative colonoscopy when indicated, and aid in creating a primary anastomosis with efforts to minimize the risk of an anastomotic leak [38]. Recent data, including a randomized trial, has demonstrated equivalent outcomes between colonic lavage versus those who only received manual evacuation of the colon [39–41]. Multiple techniques for this procedure have been described. Regardless of the methods used for irrigation, the colon is first fully mobilized and vascular ligation is performed. Following mobilization Otsuka et al. recommend inserting an irrigation catheter through the appendix or cecum, a non-crushing bowel clamp is placed on the terminal ileum to prevent proximal flow of stool, and the colon is then fully irrigated. Once the fecal residue is softened by the warm irrigation, it is drained out the catheter into a collection bag, the resection and anastomosis is then performed [39]. Lim and colleagues advise dividing the colon proximal to the site of obstruction and placing that end into a basin. After manual decompression of any hard-bulky stool from the colon, an appendicostomy is created in the mid-appendix and a 16 French Foley catheter is placed into the cecum and secured in place. The terminal ileum is occluded with a bowel clamp, and the colon is irrigated with 4–8 liters of saline. Once completed an appendectomy is performed. Interestingly, in this cohort of patient, there was no significant difference in the time to recovery of bowel function, hospital length of stay, risk of wound infection, and rate of anastomotic leak [40]. Due to the variability in outcomes when on-table lavage is implemented, this operative step should only be considered when technically necessary to create an anastomosis.

## Subtotal Colectomy

An alternative effort to avoid stoma creation is performing a subtotal or total abdominal colectomy with ileorectal or ileosigmoid anastomosis. Although this may be an appealing operation to perform in the acute setting, with a similar risk of morbidity and mortality, this procedure will result in a significant alteration in bowel function as well as a decrease in quality of life compared to those undergoing a segmental resection [42, 43]. It is important to ascertain the patient's defecatory function preoperatively, as someone with incontinence at baseline will have significant difficulties postoperatively. Indications to perform this operation include a synchronous neoplasm proximally or a known hereditary colorectal cancer syndrome, ischemia of the cecum, or a perforation proximal to the obstructing lesion [44]. Determining when to perform a subtotal colectomy should be based on the patient's clinical status, comorbid conditions, degree of fecal continence, and intraoperative findings.

## Rectal Obstruction

Obstruction secondary to a rectal cancer is a clear sign of locally advanced disease and careful evaluation, and staging is critical to determining the best initial treatment of the patient. While proximal rectal cancers causing obstruction may be bridged with an endoluminal stent, mid and distal rectal masses have a higher rate of failure [45]. In patients with complete obstruction, loop colostomy provides both proximal and distal decompression and allows for the timely resumption of a diet. Patients who present in the emergency care setting will most likely demonstrate abdominal symptoms. However, if an endoscopically obstructed rectal cancer is identified, the patient should be referred for immediate neoadjuvant chemoradiotherapy. This cohort can safely be managed without proximal diversion or stenting, with only a 4.3% risk of progressing to a complete and clinically significant obstruction [46].

## Nonoperative Therapies

### Disimpaction

A colonic obstruction may occur as a result of significant fecal impaction or a retained foreign body. Although not often considered a surgical emergency, fecal impaction is associated with 1.3% of LBOs. This develops at a greater rate in patients with spinal cord injuries, leading to a reported risk of mortality as high as 16% [47]. Oftentimes disimpaction can occur manually or with the aid of enemas and sedation. When stool is inspissated proximally, or in the setting of a large calcified fecalith, an endoscopic approach may be required to alleviate the impaction. Under colonoscopic guidance, stool can be broken up with a water irrigator, or large calcified stool can be extracted with a Roth Net® retriever.

When approaching a retained foreign body endoscopically, there are multiple tools that may be utilized. Depending on the object inserted, this may be removed in the emergency bay; however, this oftentimes requires moderate sedation. Simple insufflation may disrupt the vacuum effect of the rectum and allow for decent of the object. An endoscopic balloon or Foley catheter can be placed proximally to aid in bringing the foreign body down into the anal canal. Additionally, a large snare or long wire folded into snare tubing can be utilized to lasso the object and extract it. In cases where endoscopic retrieval is unsuccessful, general anesthesia should be induced. When transanal extraction fails, despite complete relaxation and paralysis, milking of the object distally either laparoscopically or through an open laparotomy incision is necessary. Furthermore, creation of a proximal longitudinal colotomy with transabdominal extraction may be required. This defect should then be closed in a transverse fashion. If a perforation of the colon or rectum is discovered, this may be repaired primarily based on the size of the defect and viability of surrounding tissue. It is critical that following successful removal of any object, the mucosa should be evaluated endoscopically for any significant damage.

**Fig. 24.4** Pinwheel sign of colonic mucosa from sigmoid volvulus

### Decompression

Endoscopic decompression is the first-line treatment of choice in the management of acute sigmoid volvulus in the stable patient without evidence of perforation. This procedure functions as both a diagnostic and therapeutic intervention. The colonoscope should be inserted and passed carefully to the level of obstruction. A classic pinwheel sign of the colonic mucosa can be identified at the volvulus site (Fig. 24.4). Gentle insufflation and pressure result in detorsion of the colon and its mesentery, relieving ischemia and decreasing intraluminal pressure. This maneuver is successful in 85–95% of patients with a sigmoid volvulus [48]. The scope may then be advanced proximal to the volvulized point to assess mucosal integrity and to suction any additional fluid or air from the lumen (Fig. 24.5). A long colonic decompression tube should be placed to minimize the risk of recurrent volvulus (Fig. 24.6). These patients should be observed for recurrence, and sigmoid colectomy is recommended during the index hospital admission as there is a 60% risk of recurrence [49]. Decompression is not advised in the setting of cecal volvulus unless the patient is of prohibitive surgical risk. Endoscopic management has a high failure rate, and patients have a greater risk of ischemia, necessitating a more urgent operation

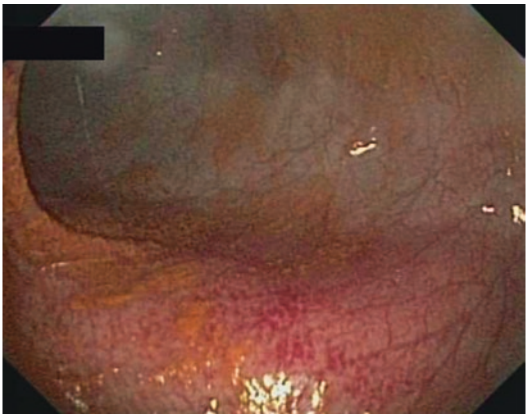

**Fig. 24.5** Assessment of colonic mucosa and decompression of a sigmoid volvulus

**Fig. 24.6** Placement of long colonic decompression tube

[50]. These patients should be appropriately resuscitated and ileocolectomy is recommended. A primary anastomosis may be performed in the majority of patients unless clinically unstable [5].

## Dilation

Endoscopic balloon dilation is a suitable treatment option for select cases of LBO in the stable patient. The circumferential radial expansion balloon system utilized in this procedure distributes pressure evenly around the bowel wall. The mechanical effects of this balloon result in a decreased the risk of perforation and prevent slippage above or below the stricture during dilation. This technique should be considered in the management of benign disease to include inflammatory bowel disease (IBD) and anastomotic strictures. Dilation alone has a greater success rate, and lower risk of complications, when alleviating an obstruction secondary to a short fibrotic stricture.

Crohn's disease is a transmural inflammatory process that has an associated risk of either inflammatory or fibrotic stricture formation in up to 30% of patients [51]. Dilation in the setting of CD has a risk of perforation as high as 10%. Risk factors for this complication include hospitalized patients with active mucosal inflammation, malnutrition, and chronic steroid use [52]. The etiology of an anastomotic stricture may be multifactorial. This complication may be secondary to the suture or stapling technique, mucosal ischemia, suture or staple line ischemia, or the effects of prior radiation therapy [53]. These risks factors must be considered when determining the appropriate intervention for these patients. In general, an anastomotic stricture is defined as a luminal diameter that an endoscopist cannot pass a standard 13-mm-diameter adult colonoscope through. Dilation may be performed with either an over-the-wire (OTW) balloon or through-the-scope (TTS) balloon dilation system (Fig. 24.7). The risk of perforation is low, and Di Giorgio and colleagues found no significant difference in either technique. However, the majority of patients required more than one dilation [53]. Creating a radial cut in the stricture with a precut sphincterotome may aid in successful dilation. This technique has also been reported as an independent procedure by creating radial cuts in four quadrants of the stricture with no additional balloon dilation [54]. If there is any concern for perforation following the procedure, a water-soluble contrast enema may be obtained. If a perforation is discovered, this may require antibiotics or an urgent exploration depending on the severity of injury. Caution must be taken to ensure there is

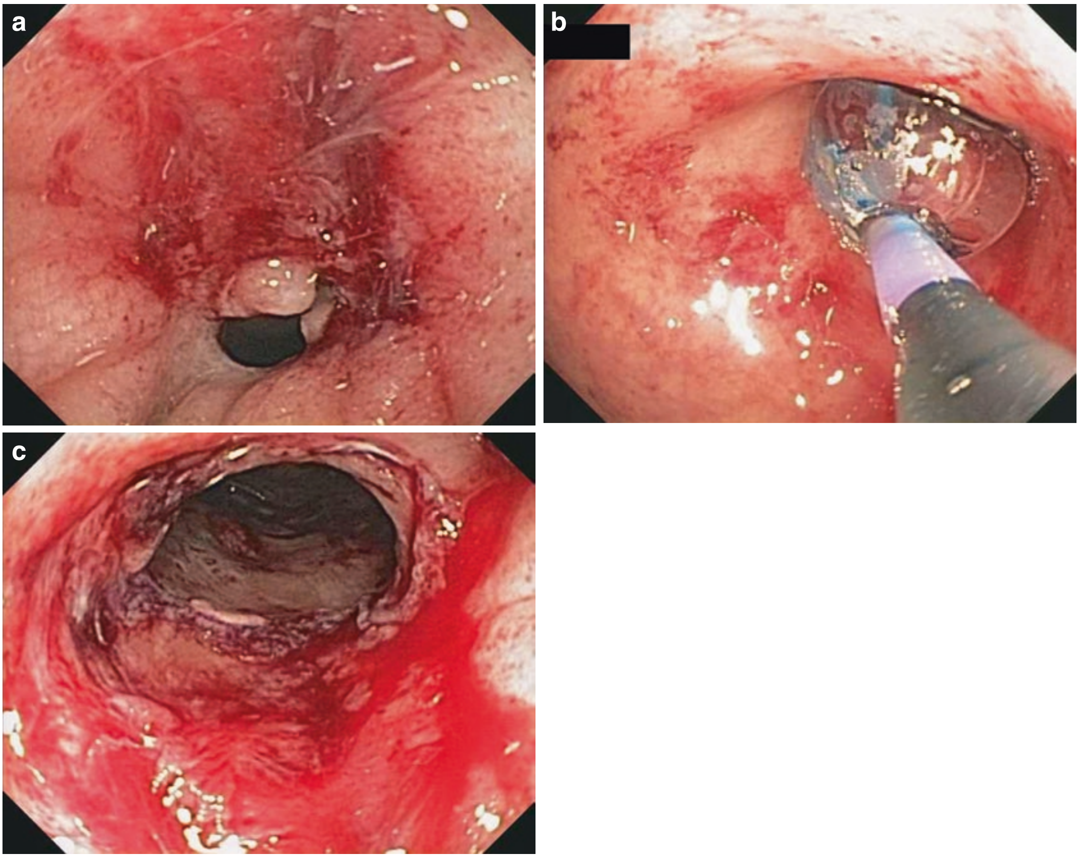

**Fig. 24.7** Anastomotic stricture and dilation. (**a**) Anastomotic stricture prior to dilation, (**b**) dilation of stricture with a through-the-scope balloon system, (**c**) successful dilation of anastomotic stricture

no evidence of recurrent cancer prior to pursuing anastomotic dilation. Biopsies should be obtained, and an alternative treatment option should be considered in this situation [55]. Although there is a paucity of data in the utilization of endoscopic balloon dilation in the setting of an acute LBO, this is an effective option in the appropriately selected patient and may avoid a laparotomy and stoma creation.

## Self-Expanding Metallic Stent Placement

The utilization of SEMS in the setting of LBO has become popularized over the past few decades since its inception in 1991 by Dohmoto who reported on the efficacy of this procedure in the palliative treatment of a metastatic LBO [56]. Shortly thereafter Tejero and colleagues applied this technique as a temporary measure in the setting of a malignant LBO, in order to decompress the colon, to allow for a bowel preparation, and to bridge these patients to an elective operation [57]. Since the introduction of this procedure, the deployment of a SEMS has been used as a strategy in the treatment of malignant obstructions or as palliative measure in those with incurable disease. There have been more recent reports in the placement of colonic stents for benign disease. This procedure temporizes an emergent situation and may act as a “bridge to surgery,” in patients with curable malignant or benign disease. The ability to provided prolonged endoscopic decompression for a period of days to weeks can provide time for a full bowel preparation, await a histologic diagnosis, perform a proximal endoscopic evaluation for synchronous lesions, and allow for a laparoscopic resection and primary anastomosis in a semi-elective fashion. Ultimately the goal is to transition an emergent operation into an elective one, reducing the risk of postoperative mortality, morbidity, and stoma creation. Furthermore, the placement of SEMS has been associated with an overall improvement in quality of life for these patients [58].

## Technical Aspects

Prior to SEMS placement, it is critical that all appropriate material and equipment for the procedure are available. The current Food and Drug Administration-approved stents are composed of either nitinol, cobalt-chromium-nickel, or stainless steel. Similar to dilators, these are designed as either TTS or OTW devices (Table 24.2) [59]. An uncovered stent is utilized to prevent SEMS migration; therefore, removal may only be performed at the time of surgical resection (Fig. 24.8). Due to the diameter of the TTS system and the friction generated in the working channel when looping occurs, an adult or therapeutic colonoscope with a 3.7–4.2 mm diameter instrument channel is required to accommodate the device. By placing the SEMS through the scope, the device can be deployed as far proximally as the scope can reach, including the right colon and ileum if required [59, 60]. However, when managing a LBO secondary to an obstructing rectal process, it is imperative that the distal aspect of the stent be positioned at least 6 centimeters from the anal verge to prevent severe tenesmus and anal pain from the device [61].

Preoperative imaging to include a CT scan or water-soluble contrast enema is helpful in determining if there is a complete obstruction. If present, this may prevent passage of a guidewire, which is the first critical step of SEMS insertion. However, Small and colleagues have demonstrated that the lack of luminal flow of contrast on

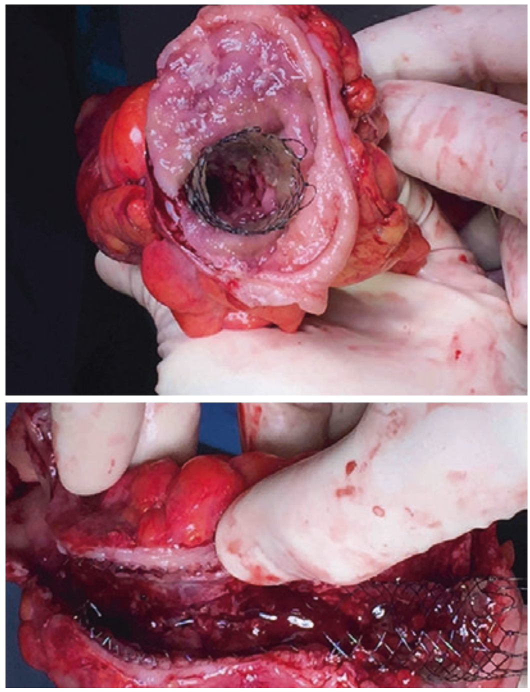

**Fig. 24.8** Self-expanding metallic stent removed at time of surgical resection

**Table 24.2** Food and Drug Administration-approved colonic stents [59]

| Industry name | Composition | Diameter | Type of device |
|---|---|---|---|
| Boston Scientific | | | |
| Ultraflex Precision Colonic | Nitinol | 25 mm + 30 mm proximal flare | OTW Nonreconstrainable |
| Wallstent Enteral | Elgiloy (cobalt-chromium-nickel) | 20 mm and 22 mm | TTS Reconstrainable |
| Wallflex Enteral Colonic | Nitinol | (a) 25 mm body + 30 mm proximal flare<br>(b) 22 mm body + 27 mm proximal flare | TTS Reconstrainable |
| Cook Endoscopy | | | |
| Colonic Z-stent | Stainless steel | 25 mm | OTW |

*OTW* Over the wire, *TTS* Through the scope a water-soluble enema is not a contraindication to stent placement [62]. These imaging techniques provide anatomic information regarding the stricture. Factors that may influence the complexity of stent placement and aid in preprocedural planning include the length of the stricture and the degree of angulation. Previous studies have reported that shorter strictures with a median length of 40 mm and those with a wider colonic angulation at the distal extent of the stricture (median 121°) had a greater rate of successful stent deployment and decompression [63]. Identifying any signs of perforation is important prior to proceeding with stent placement, as this could rapidly change an urgent situation into an emergent one. It is recommended to perform the procedure under fluoroscopic guidance when possible [61]. Once the endoscope is passed to the level of the stricture, a 0.035-inch hydrophilic guidewire can be inserted through the working channel of the scope, and this should be positioned as far proximal to the stricture as possible (Fig. 24.9). Care should be made to ensure adequate control of the guidewire once inserted. A biopsy of the lesion should not be performed at the time of the SEMS placement as this may lead to a greater risk of perforation during deployment. An endoscopic retrograde cholangiopancreatography (ERCP) catheter may then be passed over the guidewire and contrast injected to opacify the lumen and confirm appropriate positioning. The catheter is then removed, and the TTS system is passed over the guidewire and deployed inside the stricture under fluoroscopic guidance. The proximal landing zone of the stent is observed radiographically and the distal aspect is visualized endoscopically. It is critical to maintain the device within the stricture during the entire deployment to avoid incorrect placement. Some devices may be reconstrained to allow for small adjustments during placement; however, this must be known prior to stent selection (Figs. 24.10 and 24.11). Once the SEMS is fully deployed, an abdominal radiograph is obtained to confirm appropriate positioning (Fig. 24.12). The stricture should be fully traversed, and the stent displays an hourglass-like configuration with both ends open on either side of the lesion. Balloon dilation is not required to augment decompression [61]. Due to the technical complexity of this procedure, Lee and colleagues recommend at least 30 SEMS insertions to achieve proficiency [64].

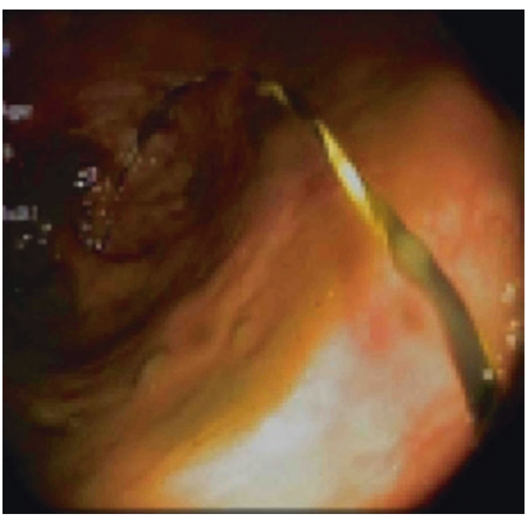

**Fig. 24.9** Guidewire placed through obstructing colonic stricture

## Outcomes of Colonic Stenting

The advent of SEMS in the management of an acute LBO has played an integral role in both benign and malignant diseases. Emergent colonic resection in the setting of a LBO is associated with a significantly worse outcome and a greater rate of stoma creation when compared to elective colorectal surgery. Mortality rates range as high as 15% at 30 days and 12% at 90 days for emergent colectomy, versus an elective colorectal resection having a 2.1% risk of mortality at 90 days [65, 66]. Furthermore, operative morbidity has been reported as high as 50% following emergent colectomy [67]. In addition, endoscopic decompression may allow for a completion colonoscopy to evaluate for synchronous tumors. This not only provides the best oncologic procedure but allows for a well-informed decision of the operative plan [5, 68]. Unfortunately, upward of 60% of patients who require a colostomy under urgent or emergent circumstances

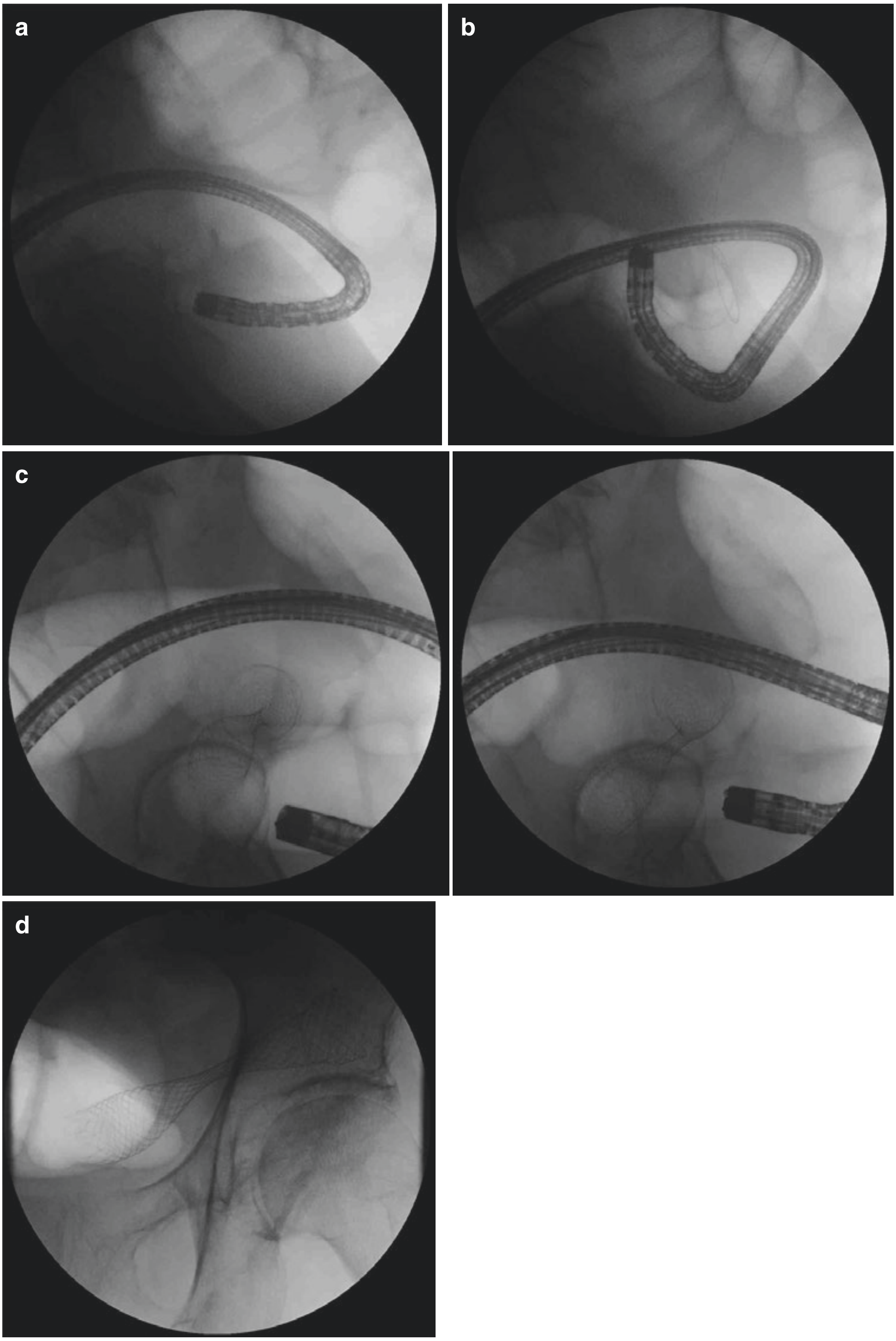


**Fig. 24.10** Fluoroscopic guidance for self-expanding metallic stent deployment. (**a**) Colonoscope passed to level of obstruction, (**b**) guidewire passed through the lesion, (**c**) stent partially deployed, (**d**) stent deployed with hourglass shape across the lesion

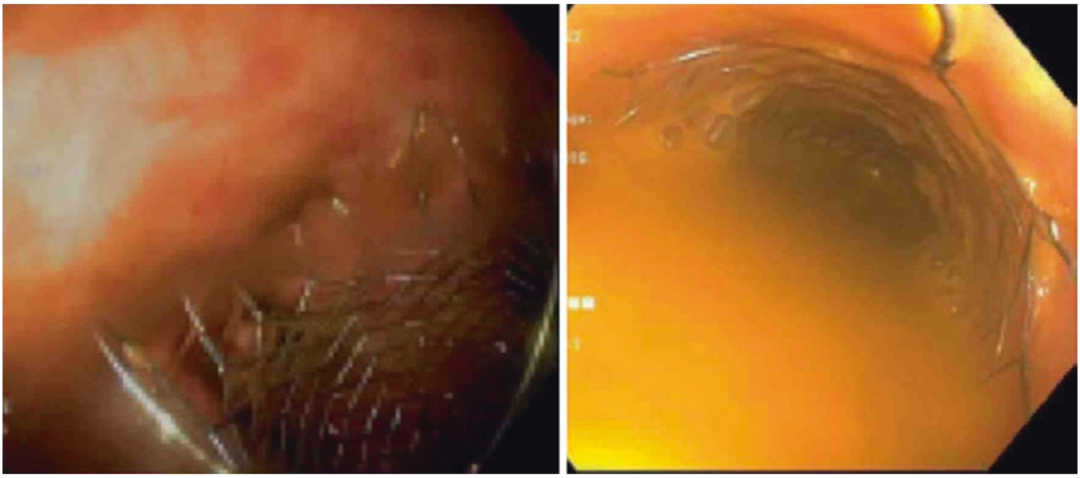

**Fig. 24.11** Endoscopic visualization of the distal landing zone following stent deployment with successful decompression


**Fig. 24.12** Abdominal radiograph following colonic stent placement

will never be reversed [69, 70]. Additionally, colostomy reversal is fraught with multiple complications to include anastomotic leak, with an overall morbidity rate of 16%. These findings support an effort to avoid an emergent colonic resection when possible [71]. Cumulative rates of stoma creation following an acute LBO secondary to metastatic colorectal cancer were found to be significantly less following SEMS (15%) compared to primary colectomy (29%) at 1 year [67]. Although Kavanagh and colleagues have questioned the benefit of SEMS as a bridge to surgery, they recognized this intervention is associated with a significantly lower risk of requiring a total abdominal colectomy in the emergency setting (4% vs. 23%; $p = 0.03$) [72].

Clinical and technical success rates of SEMS deployment range from 73% to 95% [58, 63, 73–75]. The utilization of endoscopic colonic stenting as a bridge to surgery has now become a strong recommendation in the most recent update of the American College of Colon and Rectal Surgery (ASCRS) Clinical Practice Guidelines for the management of obstructing left-sided colon cancer with potentially curable disease [21]. Furthermore, these guidelines, in addition to two retrospective studies, have demonstrated the efficacy of SEMS and interval colectomy in the setting of right-sided and transverse colon cancer. Therefore, this approach should be considered to provide decompression and an opportunity to perform a minimally invasive operation [21, 31, 76]. A decision analysis review by Targownik et al. reported not only a reduction in stoma formation and mortality but a significant decrease in cost for those requiring SEMS vs. emergent resection [77].

## Malignant Disease

Despite advances in colorectal cancer screening, greater than one third of patients may present with a malignant LBO. The majority of current literature focuses on the utilization of this technique in cancer patients as either a palliative measure or a bridge to surgery [78, 79]. A Cochrane library review on the use of colorectal stents in the management of malignant bowel obstructions from 2011 concluded that stenting had no advantage over emergency surgery. This systematic review of five randomized trials identified a greater clinical success rate with primary resection; however, a longer hospital length of stay and a significantly greater risk of blood loss were reported in the surgical arm compared to endoluminal stenting [80]. Subsequently, Jimenez-Perez and colleagues, in a multicenter international randomized trial, demonstrated the efficacy of SEMS as a bridge to elective resection, with a 90% clinical success rate and only a 6% risk of stoma formation [81]. A randomized trial of 48 patients identified SEMS to be safe and provided a means to perform a laparoscopic resection and create a primary anastomosis. This approach resulted in improved perioperative complications to include a decrease in blood loss, postoperative pain control, anastomotic leak, wound infection, and rate of permanent stoma formation. From an oncologic standpoint, stenting as a bridge to surgery resulted in a greater median lymph node harvest (23 nodes) compared to an open emergent intervention, with only 11 nodes obtained. These findings may significantly affect the patient's prognosis [82].

The median survival of stage IV colorectal cancer has significantly improved from 9 to 12 months to greater than 24 months with advancements in chemotherapy; however, a cure from chemotherapy alone is rare [83] [84]. The long-term effects of endoscopic stenting when placed as a palliative measure may be questioned as the life expectancy increases with advanced disease. Stent patency rates at 12 months are approximately 50%. SEMS placement is associated with an increased frequency of subsequent operations or repeat stent placement at 1 year, and this may result in significant morbidity [85, 86]. In a retrospective risk-adjusted analysis of 345 patients from the New York State Department of Health Statewide Planning and Research Cooperative System, patients undergoing stent placement were associated with a significantly decreased hospital length of stay, blood transfusion requirement, use of total parenteral nutrition, hospital charges, and death when compared to stoma creation as a palliative procedure. Furthermore, in this analysis, there was no significant difference in hospital readmission at 90 days and 1 year or the need for operative intervention at 90 days between these cohorts [86]. The long-term clinical success of SEMS is debatable; therefore, future surgical resection may be warranted based on the patient's clinical status and response to systemic chemotherapy [85].

## Benign Disease

As experience and technology has grown with the use of SEMS for malignant disease, its success has now been applied in the setting of benign pathology. Technical placement is often more challenging as these strictures tend to be longer with a more torturous colonic wall. The majority of supporting evidence to date includes small case series, with a paucity of large retrospective data. Endoscopic stenting has been reported in the treatment of LBO secondary to anastomotic stricture, CD, diverticular stricture, radiation induced, and ischemic colitis. Technical success in stent placement is high (85–100%), and colonic decompression is achieved between 71% and 86% of the time [87, 88]. Diverticular strictures have been evaluated to the greatest extent. Cautious and careful SEMS placement is required as the risk of complications is reported as high as 38–71%. This includes the risk of stent migration, perforation, reobstruction, fistula formation, and stent fracture [73, 88, 89]. Small and colleagues evaluated 23 cases of an acute LBO secondary to benign disease and demonstrated that the majority (87%) of complications were identified 7 days following stent insertion. These patients were successfully bridged from an urgent to an elective operation, and over half were able to avoid a colostomy [73]. Levine et al. reported on the long-term follow-up of endoscopic stenting for five anastomotic strictures in the setting of CD. Mean patency length was over 30 months, with one complication. There is even a greater paucity of data in the management of de novo strictures in fibrostenotic CD, and the risk of malignancy must be strongly considered in these circumstances [90]. There is certainly a role for SEMS in a benign acute LBO; however, stent placement should be performed by an experienced endoscopist. Long-term stent placement appears to influence the risk of perforation; therefore, it is recommended this intervention be a means to convert an emergent operation to a semi-elective one with goals to minimize surgical complications and stoma creation.

## Complications

Regardless of the indication for endoluminal stenting, this procedure has associated risks and potential complications. Small and colleagues demonstrated an overall complication rate of 24%, with the majority of adverse outcomes identified greater than 7 days following stent insertion. Minor complications to include hematochezia, fevers/bacteremia, and tenesmus all occurred <5% of the time. The overall rate of perforation was 8%, with a risk of stent occlusion and migration being 8% and 7%, respectively. Complications were significantly greater following palliative stenting, with a mean time to perforation of 27 days [62]. At a median time of 116 days post-stent placement, Gianotti and colleagues identified a 43% risk of complications. The rate of hospital readmission secondary to SEMS complications has been reported at 34% [91]. In a prospective multicenter trial of 182 patients by Jimenez-Perez et al., the risk of procedurally related major complications was 3.3%. The risk of perforation requiring surgical intervention was 1.7%. In addition, persistent obstruction occurred in 1.1% of cases, and transient bleeding occurred in one patient. Delayed post-procedural complications occurred in 4.2% of patients, with one colonic perforation presenting 6 days after stent insertion. This is one of the largest reviews to date evaluating SEMS as a bridge to surgery, and this data supports the safety of this intervention [81]. Although stent-related perforation rates are low, there is a trend toward an increase in cancer recurrence and a potential decrease in disease-free survival following SEMS if complicated by a perforation. Furthermore, subclinical perforation is of concern as this may also impact overall survival [92]. There is limited data regarding the oncologic safety of SEMS. Despite these findings, previous studies have identified similar rates of both overall and cancer-specific survival [72, 93]. Reports on the outcomes following endoscopic colonic stenting are variable; nevertheless, multiple studies support the safety and efficacy of this approach. Patients should be well-informed, and the surgeon should be vigilant in detecting any complications when proceeding with this intervention.

**Conclusion**

Despite advances in the management of acute colorectal conditions, the treatment of a large bowel obstruction remains a complex surgical decision-making process. The presentation of this condition is quite variable, ranging from subtle findings to overt physiologic decompensation. The patient's presentation and clinical status will often dictate which intervention is required. However, in the era of advanced flexible endoscopy and minimally invasive surgery, patients now have an opportunity to potentially bridge an urgent or emergent operation to one that is semi-elective. This may avoid the significant morbidity associated with a laparotomy, as well as the risks of a permanent colostomy. Presently, there are multiple strategies to treat these patients, and the acute care surgeon should be well-versed in these techniques. Regardless of all the technology available, some patients may still require the creation of a stoma, and this should never be viewed as an unsuccessful operation. Each case should be individualized based on clinical status, comorbidities, location, as well as etiology of the obstruction. The patient should be well-informed on the risks, both operatively and oncologically, prior to any intervention. Nevertheless, maintaining a thoughtful algorithmic approach in the treatment of this condition will ultimately result in better outcomes and quality of life for these patients.

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