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Managing Complications of Bariatric Surgery

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• Emergency • Bariatric surgery • General surgeon • Gastric bypass
• Sleeve gastrectomy • Laparoscopic adjustable gastric band
• Nutrition emergencies

Key points

- The general surgeon will most likely be faced with bariatric surgical emergencies at some time in their career.
- Having a plan for the most common emergencies (surgical and nutritional) that one will encounter can save time for the surgeon and the patient.
- Applying good surgical principles with some of the specialized considerations covered in this article can have a dramatically positive effect for the patient.

INTRODUCTION

Since 2011, more than 1.4 million bariatric surgeries have been performed in the United States [1]. There has been a slow but steady increase of about 6.5%, on average, in the number of surgeries performed each year over the last 5 years. The last 2 years have seen the number increase to more than 200,000 cases annually. These numbers are based on estimates from the American Society for Metabolic and Bariatric Surgery (ASMBS) and the American College of Surgeons combined national database known as the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program. Additional information can be gleaned from the National Inpatient Sample Data. What is not included in these estimates are the number of patients who are seeking surgical care abroad, with the highest volume of procedures being

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done in Mexico. The primary factor leading patients to centers outside of the United States is a lower cost of surgery due to the lack of universal national insurance coverage for bariatric surgical procedures. With the increase in volume from accredited centers or international surgical tourism, the general surgeon will undoubtedly face a growing number of bariatric surgical emergencies, regardless of where patients have their index procedure performed. This article addresses the most common surgical emergencies following the 3 most common bariatric surgeries currently performed in the United States and its international neighbors.

GASTRIC SLEEVE COMPLICATIONS

Although laparoscopic sleeve gastrectomy (LSG) has been championed as a safer, less-invasive, alternative bariatric procedure compared with the Roux-en-Y gastric bypass [2], complications of this procedure can still have severe consequences for patients. Thankfully, the rate of such devastating complications is relatively low compared with other abdominal operations [3]. The 4 most common sleeve-specific perioperative complications of the procedure include staple line leaks, bleeding, stenosis, and portal vein thrombosis (PVT).

Leaks

One of the more feared complications after LSG is a leak along a disrupted staple line. The incidence of leaks after sleeve gastrectomy is 2.1%, with most leaks occurring after discharge from the hospital [4]. The causes of leaks can include poor surgical technique, staple line failure, and, most commonly, a distal gastric obstruction (such as a midbody stricture) that causes increased intragastric pressure with disruption of the staple line near the gastroesophgeal junction [5]. Patients can present with tachycardia, fevers and chills, and worsening abdominal pain; and surgeons need to maintain a high index of suspicion when postoperative patients present with these symptoms [6]. Computed tomography (CT) with oral contrast is the diagnostic test of choice, with a greater sensitivity (84%) than swallow studies with gastrograffin (50%) [7]. Even though the definitive management of leaks after sleeve gastrectomy has evolved as the prevalence of the technique has increased, the treatment algorithm remains dependent on the hemodynamic stability of the patient, regardless of the number of postoperative days since surgery. Patients that are unstable should be explored either open or laparoscopically, controlling the area of leakage with drains and assessing the gastric tissue for debridement or repair. Unfortunately, most simple repairs tend to fail, but prompt treatment and control of sepsis often buys time for a more definitive solution. Patients who are stable and can be drained using interventional radiologic techniques should be maintained with broad-spectrum antibiotics and withheld oral feeds for at least 2 weeks, when they can then be reassessed radiographically for fistula healing. Patients who have chronic nonhealing leaks should be transferred to

a tertiary bariatric center, where treatment options include endoscopic stent placement [8], intragastric drainage [9], or a Roux-en-Y fistulojejunostomy [10].

Bleeding

The prevalence of bleeding requiring blood transfusion after LSG is estimated to be 1.0% [11]. Bleeding can be intraluminal from the staple line itself or extraluminal from the greater curve and perisplenic vasculature, both of which require dissection during the procedure. Intraluminal bleeding often presents with hematemesis or melena, whereas extraluminal bleeding can present quickly with signs and symptoms of hemodynamic compromise. There has been vigorous debate among bariatric surgeons on a preventative strategy to minimize staple line bleeding, including the use of reinforcement materials and other adjuncts [12]. Regardless of the source of bleeding, the first step in management of bleeding is resuscitation of the patient with intravenous fluids and the possible transfusion of packed red blood cells. For unstable patients, a prompt evaluation with an endoscope in the operating room can quickly differentiate between intraluminal and extraluminal bleeding. Some cases of mild intraluminal bleeding can be controlled with the application of endoscopically placed clips, but should that intervention fail, a fallback measure would be the oversewing of the gastric staple line. For unstable extraluminal bleeding, control of the source should be done quickly, either laparoscopically or in an open surgical fashion. For stable patients, most bleeding episodes will resolve spontaneously; however, vigilance is required for close monitoring, stopping anticoagulation, and replacement of blood products, if necessary. A worsening clinical appearance (dropping hematocrit or multiple transfusions) necessitates surgical exploration.

Stenosis

Gastric sleeve stenosis occurs with a prevalence of 3.9% [13]. Most patients present with:

- Food intolerance (especially solids)
- Nausea and vomiting
- Severe reflux

The most common location for narrowing is the midgastric body near the incisura. This may be due to technical factors during sleeve creation or corkscrewing of the sleeve. The diagnosis is easily confirmed with an upper gastrointestinal contrast study. Pneumatic balloon dilation has been shown to be modestly effective in almost 80% of cases [14]. For refractory cases, endoscopic treatment with covered stents is justified; however, a more permanent solution to a chronic stenosis is conversion to a laparoscopic Roux-en-Y gastric bypass.

Portal vein thrombosis

The incidence of PVT after bariatric surgery is reported at 1% to 3% of cases and it is estimated that there is an unexplained higher incidence after LSG [15–17]. Presentation of this complication usually occurs from 1 to 6 weeks after

surgery. The symptoms of PVT are usually nonspecific, highlighted by malaise, abdominal pain, and nausea. A diagnosis can usually be made with contrasted CT scanning, demonstrating partial or complete venous occlusion, as well as bowel compromise if present. Duplex ultrasonography can demonstrate the presence of portal venous flow but has limited information on potential bowel ischemia. The mainstay of treatment of nonocclusive clots is heparinization to prevent propagation. An algorithm [12] has been proposed for more difficult cases. For example, high-grade nonocclusive clots may be best treated with systemic or catheter-directed tissue plasminogen activator followed by heparinization; and occlusive disease (associated with potential bowel compromise and a high mortality rate) may be amenable to operative thrombectomy. The goal of all therapies should be achieving portal vein patency.

GASTRIC BYPASS

The open gastric bypass has been described in various forms since the 1970s, but the development of the laparoscopic Roux-en-Y gastric bypass (LRYGB), first described by Wittgrove in the 1990s, led to an expansion in the performance of bariatric operations. This was mainly due to the overall decrease in complications associated with fewer open incisions, development of laparoscopic endostaplers, and refinement of the technique. Although safer than its open surgical predecessor, the LRYGB is not immune to potential complications.

To quickly assess and treat postoperative LRYGB patients in distress, one can begin by classifying a complication as being part of an obstructive process or one associated with peritonitis. First and foremost, the stability of the patient must be addressed. As with all patients, good surgical principles should be applied. Unstable patients will likely require earlier and more invasive measures as guided by the surgeon's experience.

Looking at the 2 categories of obstruction and peritonitis, they can be further characterized by:

- Peritonitis
  - Early
    - Gastrojejunostomy leak
    - Jejunostomy leak
  - Late
    - Perforated marginal ulcer
- Obstruction
  - Early
    - Gastrojejunostomy stricture (6–8 weeks)
  - Early or late
    - Internal hernia
      - Jejunojejunostomy (JJ) mesentery
      - Retro-roux limb (Petersen's hernia)
      - Mesocolic
      - Adhesive disease
    - Intussusception

Early peritonitis

Gastrojejunostomy leak

As peritonitis from a gastrojejunostomy (GJ) leak typically occurs on average at 10 days following surgery (range 5–15 days), it should be considered one of the early sources of peritonitis after LRYGB [18]. Leak rates in the most recent literature suggest that the rate ranges from 1% to 3% [19].

The typical patient who presents to an emergency room will have been discharged home on a standard postoperative diet, which in the early phase is typically a sugar-free liquid diet or purees. The presentation of a leak is often heralded by tachycardia, fever, and increasing abdominal pain. Other less-specific signs can include nausea, vomiting, tachypnea, shortness of breath, and altered mental status. Patients who present with these less-specific symptoms after bariatric surgery may be indicators of 1 of the 2 most concerning postsurgical complications: leak and pulmonary embolism. These presentations may be similar, with the most common sign being tachycardia. Imaging is critical in this setting, and CT scan remains a more sensitive test to detect a GJ leak.

Source control is of paramount importance [20,21]. Lavage and drainage should be the main focus of the initial approach. One may find a primary repair possible, but in the setting of significant contamination and/or a robust inflammatory response, primary closure may not be possible. In this setting, using the remnant stomach for placement of a gastrostomy tube provides both access for decompressing the gastrointestinal (GI) tract from an impending ileus as well as enteral feeding remote from the site of leak as the ileus improves. Use of broad-spectrum antibiotics is necessary here.

Endoscopic approaches have also been used in the setting of a GJ leak. This is typically initiated after primary source control is obtained. In a study by Puli and colleagues [22], the use of self-expanding covered stents allowed patients to begin a clear liquid or high-protein liquid diet within 24 to 48 hours after stent placement. The reported success rate in their series of stenting after GJ leaks was noted at 87% [22].

Although interventional radiology may have some role in the approach to these patients as possible early source control, they lack the ability to thoroughly lavage the abdomen.

Jejunojejunostomy leak

A less-often considered postoperative source of leak is that at the JJ. Although much less frequent than a GJ leak, because of the difficulty of recognizing the diagnosis, it carries a 40% higher mortality rate [23]. The delay in detection relates to it not being considered in cases, and that the modalities to detect suspected leaks are often focused on the GJ anastomosis. Many surgeons use an upper gastrointestinal study to evaluate the GJ, but continuing the evaluation to the JJ is not routinely carried out. With the more frequent use of CT scans, more subtle fluid collections in the area of the JJ should raise the suspicion of this being the potential source. If all imaging modalities have not produced an

adequate source, visualization in the operating room is merited. Good surgical principles of sepsis control with lavage and drainage are the foundation of care. Broad-spectrum antibiotics should also be initiated.

Late peritonitis

Perforated marginal ulcer

Perforated marginal ulcer (MU) can be considered in the setting of late peritonitis given that the typical time of presentation after gastric bypass is approximately 18 months. Although less frequent than the other complications seen after gastric bypass, MU still seems to have a rate of about 0.5% to 1% [24,25]. The risk factors in the development of MU are listed here:

- Smoking[a]
- NSAIDs[a]
- Steroids[a]
- Nonabsorbable suture material
- Gastric acid hypersecretion
- *H. pylori* infection
- Recent surgery
- Alcohol use
- Stress

[a]More frequently associated with perforation.

A study by Felix found that the perforation rate was highest in patients who were smoking, taking nonsteroidal anti-inflammatory drugs (NSAIDs), or on steroids [26]. Their retrospective analysis of 3430 patients found that 35 (1%) had MU perforation. The factors most associated with perforation in their series were notable with 51% of patients actively smoking, 29% were taking NSAIDs, and 6% were taking steroids. The classic signs of perforated MU are tachycardia, fever and severe abdominal pain with abdominal rigidity and peritoneal signs. Imaging with plain films or CT scan will typically exhibit free air.

The operative approach can be laparoscopically or open and should be dictated by the surgeon's comfort level. Primary repair of the ulcer with omental patch or Graham patch is successful in the vast majority of patients [27,28]. Most authors advocate that the outcomes are improved when performed within the first 24 to 48 hours after the perforation. In addition to repair of the perforation, the abdomen should be washed out, as there will be contamination within the peritoneal cavity. Placement of a gastrostomy tube in the remnant stomach as a means for enteral access and as a decompressive tube in the setting of an expected ileus is similar to the treatment of an early GJ leak. Once the repair is complete, it is imperative to counsel the patient and

identify the cause to prevent continued marginal ulceration. In addition to the use of antibiotics, one should also consider use of an antifungal given the flora in the contaminant.

Obstructive

Much like the categorization of peritoneal complications of gastric bypass, obstructive symptoms can be broken down into early and late complications.

Early obstruction

Gastrojejunostomy stricture

GJ strictures most commonly present in the sixth to eighth week after surgery and may occur in 3% to 27% of these cases [29,30]. The symptoms are progressive in nature, and based on timing most patients will have already advanced to a more regular postsurgical diet and then will relate classic symptoms of progressive inability to tolerate solids and then liquids. Dehydration is a primary concern in these patients, and they will require fluid resuscitation. Diagnosis can be made with an upper GI radiology examination. An upper endoscopy will be both diagnostic and therapeutic because dilation is the basis of treatment. Strictures can occur after any of the techniques for fashioning the GJ anastomosis. These include hand sewn, linear stapler, and circular staplers. In each of these instances the anastomosis size to achieve is approximately 15 mm. Pneumatic dilation is the recommended treatment of choice, with dilations achieving 15 mm [31]. The success of the dilation is higher if the stricture is treated earlier. Early dilations have a 98% success rate versus late interventions (61%) [32].

Late obstruction

Internal hernia

Obstruction following gastric bypass must be handled expeditiously. The reformed anatomy of the gastric bypass limits conventional conservative "bowel obstruction" techniques and requires urgent exploration in the operating room. General surgical postoperative obstructions can often be managed conservatively in more than 40% to 78% of patients [33,34]. However, in the setting of LRYGB, with a small gastric pouch and small gastrojejunal anastomosis, these patients cannot be treated with nasogastric tube decompression and bowel rest.

Symptoms for obstruction from an internal hernia mirror those of any postoperative bowel obstruction, with the classic symptoms of nausea, emesis, and abdominal pain. Because the overwhelming majority of gastric bypasses are done laparoscopically, one should always consider an internal hernia in the differential for abdominal pain. It is much more common to have an internal hernia after a laparoscopic gastric bypass compared with an open gastric bypass, in which adhesion formation is more common and tends to prevent internal hernias [35]. For example, the rate of internal hernia after open gastric bypass is 0% to 0.7% [36]. whereas the overall rate of internal hernia after LRYGB is about 2.5%, with study results ranging from as low as 0.2% to as high as 8%

[37,38]. Internal hernias most commonly present after the first year of surgery [39,40].

There are 2 defects of concern in the antecolic gastric bypass: the mesomesenteric or JJ mesenteric defect and Petersen's hernia (also known as the retro-roux limb hernia). Internal herniation most commonly occurs at the JJ mesenteric defect, occurring in 50% to 62% of all internal hernia cases. Petersen's hernia occurs in approximately 12% to 15% of internal hernia cases. In the retrocolic gastric bypass a third site of internal hernia is found at the transverse mesocolon [41,42].

Computed tomographic imaging of patients presenting with abdominal pain after gastric bypass can have some classic findings to suggest an internal hernia in the acute setting. The most sensitive and specific of these is a swirl sign of the mesentery [43]. Other signs suggestive of internal hernia are gastric remnant distention with or without air and the JJ on the patient's right side. Laboratory examination may reveal increased amylase and lipase in the setting of obstruction after gastric bypass. Spector found that when the biliopancreatic limb was obstructed there was an increase in the amylase and lipase levels, with 48% of all patients with a small bowel obstruction noted to have elevated levels [44]. When it was the biliopancreatic limb that was obstructed, 94% of patients had elevated amylase and lipase levels.

The surgeon should proceed directly to the operating room. Dependent on the surgeon's comfort level, either a laparoscopic or open approach can be performed, with the goal of reducing the internal hernia in a timely fashion before bowel ischemia is irreversible. Most surgeons advocate for directing their attention to the cecum and run the bowel proximally. By approaching the bowel from this direction, the hernia is reduced and the appropriate anatomy restored. There will be 3 limbs to identify. The common channel will have been identified as it is the distal bowel, now reduced. At this point the 2 proximal limbs will be the roux limb and the biliopancreatic limb. In the case of antecolic, this will be the roux limb that is encountered as it passes anterior to the colon. In the retrocolic bypass the most lateral small bowel at the mesentery should be the roux limb. The biliopancreatic limb will be medial and the ligament of Treitz can be identified.

All defects of the mesentery should be closed with permanent suture. The antecolic bypass can have 2 defects. The first defect, the retro-roux limb defect, should be closed from the colon to the root of the mesentery. The JJ mesenteric defect is the second area to be inspected and is the most common area for internal hernia. Any gap or opening here should also be closed. With the retrocolic gastric bypass there will be 3 defects that should be evaluated. Two of these defects are smaller and occur at the mesocolic window created by the retrocolic dissection and the retro-roux limb defect. The third potential defect is at the JJ mesentery as in the antecolic gastric bypass.

Intussusception

An uncommon presentation of obstruction after gastric bypass is intussusception, and it should be considered in the differential diagnosis of a patient presenting with obstructive symptoms. If a CT scan is performed during the patient's active episode, then imaging will likely reveal a "target sign." This is pathognomonic for intussusception. This most commonly occurs at the JJ. Although not completely understood, hypothetical mechanisms include a patulous JJ, disruption of intestinal pacemakers, and orientation of the JJ (isoperistaltic vs antiperistaltic) [45]. These patients will require a surgical intervention to reduce the bowel and will most likely need a revision or resection of the JJ.

GASTRIC BAND COMPLICATIONS

Before the rise of popularity of the LSG, the laparoscopic adjustable gastric band (LAGB) was seen by many bariatric surgeons as a reasonable, lower-risk yet lower-reward alternative to the LRYGB. Although once one of the most commonly performed bariatric operations in the United States, the LAGB has fallen out of favor as a primary bariatric operation and has been supplanted by the LSG. Nevertheless, a significant number of gastric bands remain implanted and, unfortunately, many patients have been lost to follow-up from their original bariatric surgeon. The gastric band has been associated with unique, device-related complications that can have devastating consequences if not managed appropriately or if care providers do not have an awareness of their impact.

Erosion

Erosion of the gastric band, either partially or completely, into the gastric lumen has an incidence between 0.2% and 4% [46]. Patients can present with weight regain, a loss of restriction, or infection of the access port or tubing. Imaging studies such as a swallow study or a CT scan can demonstrate orally ingested contrast material leaking around the gastric balloon portion. Occasionally, CT scanning will demonstrate fluid around the access port or tubing itself. Upper endoscopy can be used to confirm the diagnosis, although often band erosions are detected serendipitously during band removals for other diagnoses, such as prolapse or weight regain. Eroded bands can be removed laparoscopically or endoscopically, depending on the intragastric or extragastric location of the "buckle" of the balloon [47].

Slippage

Although the device is often anchored in place by a plication of gastric tissue, the LAGB balloon can be displaced cephalad or caudally, in a manner akin to a napkin sliding through a napkin ring. Patients can present with a nonemergent, chronic band slippage that often manifests as nausea, regurgitation, and loss of satiety. Emergent slippages can present with acute epigastric abdominal pain, obstruction, and sepsis from gastric ischemia. Acute band slippages can be diagnosed with a plain film radiograph that demonstrates a change in the

angle of the band to an upright or flat position [48]. For patients with obstructive symptoms, an upper GI series will demonstrate the pooling of oral contrast above the band without passage of contrast through the balloon. Emergency measures include the removal of all fluid from the device, and if oral contrast passes through the band and no signs of gastric ischemia are present, the band can be removed in a less urgent setting. In all situations in which gastric ischemia is suspected or obstructions are not relived by the removal of fluid, the device should be removed urgently through a laparoscopic or open approach.

Esophageal dilation

A long-term consequence of the LAGB is development of esophageal dilation, with an estimated incidence as high as 50% [49]. With the progression of the dilation, esophageal motility can be affected, leading to reflux, dysphagia, regurgitation, loss of satiety, and eating-behavior modification [50]. It is speculated that overinflation of the balloon can lead to a chronic subclinical gastric obstruction. Often patients will have been lost to follow-up for some time, possibly unaware that their symptoms of reflux, nausea, or regurgitation are related to their LAGB. Esophageal dilation is diagnosed during a gastrograffin swallow. The standard initial treatment for this condition is removal of all fluid from the band circuit, as there is evidence that this ''pseudoachalasia'' is potentially reversible and salvageable [51]. It is unknown what the long-term implications are for chronic dilation of the esophagus related to LAGB, therefore, many bariatric surgeons elect to remove the band and perform a revisional, secondary salvage procedure such as a gastric bypass or sleeve [52].

NUTRITIONAL EMERGENCIES

Although there are various nutritional deficiencies that patients can exhibit after bariatric surgery, there are 2 that are considered emergent and should be on the forefront of the surgeon's mind.

Thiamine

Unrecognized thiamine (B1) deficiency can have permanent and disastrous consequences. It only takes 2 weeks to deplete the body's B1 stores. Several studies have found preoperative deficiency of B1 in patients ranging from 12% to 29% [53,54]. The primary location for B1 absorption occurs in the first part of the small intestine, and as such the altered anatomy of the gastric bypass or duodenal switch can exacerbate this deficiency. Limited oral intake and emesis can exacerbate this deficiency.

Nutritional guidelines as published by the ASMBS classifies B1 deficiency in 2 categories [55] (Table 1).

When this deficiency is suspected, rapid treatment is imperative. The guidelines for treatment include avoiding glucose in initial intravenous (IV) fluids, as this can worsen the symptoms and increase risk of permanent neurologic impairment. Lactated ringers or normal saline with an ampule of multivitamin

Table 1
Thiamine (B1) deficiency symptoms

Early:	Advanced:
• *Dry beriberi (without edema)*: characterized by brisk tendon reflexes, peripheral neuropathy and/or polyneuritis, muscle weakness and/or pain of the upper and lower extremities • *Wet beriberi*: heart failure with high cardiac output, edema in lower extremities, tachycardia or bradycardia, lactic acidosis, dyspnea, heart hypertrophy and dilation, respiratory distress, systemic venous hypertension, bounding arterial pulsations • *Other/gastroenterologic*: slow gastric emptying, nausea, vomiting, jejunal dilation or megacolon, constipation	• *Wernicke's encephalopathy*: polyneuropathy and ataxia, ocular changes (ophthalmoplegia and nystagmus), confabulation, short-term memory loss

can be initiated in the emergency room. In the advanced or severe form, the deficiency is treated with B1 500 mg IV q8 hours for up to 5 days followed by 250 mg IV daily until symptoms resolve. When switching to oral therapy, the dose is 100 mg 2 to 3 times per day.

Cobalamin (B12)

Preoperative B12 deficiency occurs in up to 18% of patients with obesity [56,57]. As with B1, there are also early and advanced manifestations of B12 deficiency. B12 stores are much greater than B1 stores, but it is still critical to recognize the signs and symptoms of this deficiency, as the consequences can be dire when left untreated (Table 2).

Treatment should consist of 1000 μg intramuscular or IV dose. For severe deficiencies treatment includes B12 1000 μg daily for 1 week and then weekly injections of 1000 μg for 1 month [58].

Table 2
Cobalamin (B12) deficiency symptoms

Early:	Advanced:
• Pernicious anemia, fatigue, anorexia, diarrhea • Numbness and paresthesia in extremities, ataxia • Lightheadedness or vertigo • Tinnitus • Palpitations	• Angina or congestive heart failure • Altered mental status

SUMMARY

The general surgeon will most likely be faced with bariatric surgical emergencies at some time in their career. Having a plan for the most common emergencies (surgical and nutritional) that one will encounter can save time for the surgeon and the patient. Applying good surgical principles with some of the specialized considerations covered in this article can have a dramatically positive effect for the patient.

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