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ASMBS Guidelines/Statements

Bariatric emergencies for the general surgeon

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Metabolic and bariatric surgeries (MBS) are types of operations that are performed commonly worldwide in the treatment of obesity and metabolic disease (Fig. 1). It is important for the general surgeon to be familiar with diagnoses that can present as surgical emergencies, their etiology, and recommended management. MBS has been shown to be an effective and durable treatment of obesity and obesity-related co-morbid conditions [1–4]. The benefits of MBS are seen across diverse populations of age, sex, ethnic and racial groups, and socioeconomic backgrounds [5–8]. As the global obesity epidemic has persisted over the past several decades, the demand for MBS has increased, such that MBS is now one of the most commonly performed elective operations in general surgery with more than 250,000 annual operations performed in the United States [9,10]. The growing potential for acute postsurgical presentations of patients who have undergone MBS in emergency rooms has been recognized [11].

The most common operations performed currently are the sleeve gastrectomy (SG) and the Roux-en-Y gastric bypass (RYGB) [9,12]. While the adjustable gastric band (AGB) is now less frequently performed, there is a significant number of individuals who underwent placement in the past, and thus patients with AGB can still be encountered in the emergency setting. Presenting complications may be common across MBS procedures or specific to the type of operation performed. The minimally invasive surgical approach to these operations has proven to be safe, as it is associated with a short hospital stay, early return to normal activities, and low morbidity. Perioperative mortality has decreased in the past several decades and is now estimated to range from .03% to .2% [10,13], which compares favorably with other elective general surgical operations, such as laparoscopic cholecystectomy and laparoscopic fundoplication [14,15].

Due to the increasing number of individuals who have undergone MBS, the incident number of potential short- and long-term complications leading to presentation to hospitals and clinics has increased. While reported rates vary, short-term readmission rates are approximately 5% [16]. Because MBS carries the potential for long-term complications as well, the incident rates of total long-term complications requiring visits to the emergency room over the course of a lifetime are likely to be higher [17,18]. MBS complications often manifest acutely, and patients may frequently present to facilities that are remote from the center in which they had their surgery, are not MBS centers themselves, accredited or otherwise, and may not have bariatric surgeons on staff or taking call. Therefore, it is likely that a general surgeon without expertise in MBS may be called upon to care for patients presenting with MBS emergencies. To

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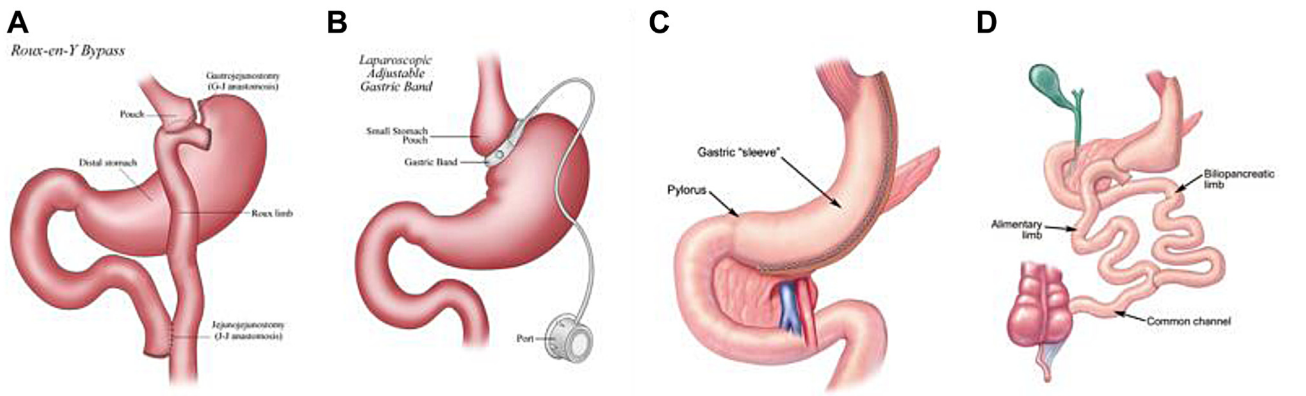

Fig. 1. Commonly performed bariatric procedures. (A) Roux-en-Y gastric bypass. (B) Laparoscopic adjustable gastric band. (C) Sleeve gastrectomy. (D) Duodenal switch.

account for this reality, the American Society for Metabolic and Bariatric Surgery has produced a clinical tool to provide resources for the care of patients undergoing bariatric surgery in the emergency room (acep.org/patient-care/beam/).

Here we describe clinical presentations and typical management of common bariatric emergencies that could serve as a guide, although every patient must be assessed individually, and care decisions determined by the managing physician. Thus, consultation with or referral to an MBS surgeon, when available, should be considered early in the presentation of the patient. Final recommendations are summarized in Table 1.

Gastrointestinal leak

Background

Gastrointestinal (GI) leakage (leak), as a surgical complication is familiar to the general surgeon. Signs and symptoms at presentation that raise suspicion for this diagnosis are generally common to all GI leaks, irrespective of the specific etiology. Leaks after MBS, however, warrant a thorough understanding of the type of operation performed, the postprocedure anatomy, and the timing of the leak presentation from the index procedure, to optimize early identification and appropriate management. This understanding will also help alleviate some of the anxiety that leaks may provoke when encountered by treating teams who do not regularly treat bariatric patients but, nevertheless, include general surgeons with the requisite skill, training, and experience to effectively rescue and care for patients with leaks and GI complications following bariatric surgery needing urgent intervention.

In general, leaks after MBS originate from a surgical staple line (gastric or small bowel) or anastomosis. Staple line leaks occur anywhere along the gastric staple line after an SG; from the stapled bypassed stomach after an RYGB; or duodenal stump staple line of a biliopancreatic diversion with duodenal switch (BPD-DS). Anastomotic leaks can occur anywhere a GI anastomosis is constructed as part of MBS, such as at the gastrojejunal (GJ) anastomosis or jejunojejunal (JJ) anastomosis in the case of a RYGB, or at the duodenoileostomy (DI) or at the ileoileostomy (II) anastomosis when a classic BPD-DS is performed. In addition, it is important to note that leaks can also occur from any site of inadvertent enteric injury. Furthermore, leaks can occur from injuries to the gastric remnant or esophagus during dissection, but these are rare. Even though the GI tract is not divided in AGB placement, leaks can still occur early from direct injury to the stomach or esophagus, or late from a band erosion.

Despite the improved safety profile of MBS over the past several decades, GI leak remains a serious potential complication [19]. Leaks can result in significant morbidity and contribute to postoperative mortality. Delays in diagnosis worsen outcomes, and an appreciation for the timing of a leak after surgery can be helpful [19,20]. In pooled data of large case series, postoperative leaks were found to occur mostly after hospital discharge. Based on a systematic review of over 300 patients with a diagnosis of GI leak from 15,772 patients, leaks most commonly present within 35 days after SG, and within 12 days after RYGB [21]. Other reviews have shown no difference in timing of leaks between SG and RYGB, with the majority (62.4%) of leak diagnoses made before 30 days, but after hospital discharge (range, 5–15 d) [19]. It is therefore imperative to consider GI leaks on the differential diagnosis of any postoperative patient who presents to the emergency department after an uncomplicated hospital course. This can ensure timely detection and intervention to minimize serious morbidity.

The incidence of leaks after MBS varies from 0% to 8%, across different procedures: 0% to 7% after SG, 0% to 5.6% after RYGB, and .7% to 8% after BPD/DS [22,23]. Leaks are associated with a mortality rate of 29%. Mortality after GI leak is related to a delay in diagnosis, emphasizing the importance of a high index of suspicion and early recognition.

Early leaks are attributed to technical causes. Delayed leaks are often due to patient factors such as age, high

Table 1
Final recommendations based on diagnosis

Diagnosis	Recommendations
GI leak	• GI leaks result in significant morbidity and contribute to postoperative mortality. The timing of a leak after surgery can be helpful to determine the acuity of presentation and the trajectory of symptoms. • Delays in diagnosis worsen outcomes and should be avoided. A high level of suspicion, timely detection, and early intervention help minimize morbidity and mortality. • In hemodynamically stable patients, CT imaging with IV ± oral contrast can be useful to secure the diagnosis and localize the leak. Negative imaging does not rule out a leak in patients with a high index of suspicion. Thus, unexplained persistent tachycardia may warrant surgical exploration. • In clinically stable patients, there is a role for nonoperative management including antibiotics, image-guided percutaneous drainage, endoscopic therapy, and nutritional support. • Definitive surgical planning should be done in collaboration or consultation with a metabolic bariatric surgeon if available after the patient is stabilized and the leak site is identified and controlled in the initial phase of treatment.
MU	• The need for urgent intervention for MU is uncommon in the absence of perforation or bleeding. • A patient with perforated MU presents to the emergency room with signs and symptoms consistent with a perforated viscus, including localized or generalized sepsis. Most such patients will have a prior diagnosis of MU and a history of abdominal pain, but for some patients, perforation will be the initial presentation. • Diagnosis can be made with an upright chest x-ray demonstrating free air, upper GI series, or CT scan. • After resuscitation and administration of broad-spectrum antibiotics, operative repair with an omental patch, appropriate wide drainage, and consideration for a feeding/drainage tube in the excluded stomach is the preferred treatment. • Significant upper GI bleeding due to MU can present acutely with hematemesis, melena, and/or hemorrhagic shock. Upper endoscopy can be diagnostic and therapeutic. Surgical exploration is rarely needed but may be necessary if other modalities fail.
Gastric band	• The number of patients with gastric bands in situ is still significant, and general surgeons should be familiar with the AGB placement procedure and its complications. • Urgent complications of AGB are uncommon but include band slippage and erosion with perforation. • Initial management of band slippage includes aspiration of band fluid. If the slippage does not resolve after decompression, surgery is indicated for band removal. • Patients with band erosion may be asymptomatic or can present with loss of restriction or weight regain, vague epigastric pain, bleeding, port-site infection, or intra-abdominal abscess. Emergent surgery is seldom needed for a band erosion. However, if a patient is unstable or has peritoneal signs, urgent band removal and drainage is required to control sepsis.
Bowel obstruction	• While all bariatric procedures are susceptible to adhesive bowel obstruction similar to other laparoscopic abdominal operations, procedures with intestinal have the additional potential risk of internal hernia, closed-loop obstruction, and intussusception, which are associated with high morbidity and mortality. • An internal hernia may present with nonspecific acute or intermittent symptoms, and diagnosis requires a high index of suspicion. A CT scan is an adjunct in the diagnostic workup; however, a negative study cannot exclude it. Due to the devastating consequences of bowel strangulation, early suspicion and timely surgical exploration are critical. • Intussusception often involves the JJ and has the risk of bowel ischemia and strangulation. A CT scan can help aid the diagnosis; however, a normal CT scan does not rule out intussusception, and early surgical exploration should be considered in RYGB patients with acute abdominal pain and bowel obstruction. • The most common surgical procedure for intussusception involving the JJ, with the lowest incidence of recurrence, is revision of the anastomosis.
Biliary disease after RYGB	• Emergent transoral ERCP may not be feasible in patients who underwent MBS involving GI bypass. • Laparoscopic-assisted ERCP through the remnant stomach is often the best approach to the papilla in the emergent setting.
PVT	• Patients with PVT can present acutely 1–3 wk after surgery with abdominal pain, nausea, and possibly intermittent emesis. • Abdominal CT scan demonstrates the portomesenteric venous thrombus. • Treatment includes rehydration and anticoagulation. • Surgical exploration is reserved for patients with suspected bowel ischemia.

GI = gastrointestinal; CT = computed tomography; IV = intravenous; MU = marginal ulcer; AGB = adjustable gastric band; JJ = jejunojejunal; RYGB = Roux-en-Y gastric bypass; ERCP = endoscopic retrograde cholangiopancreatography; MBS = metabolic and bariatric surgery; PVT = portomesenteric vein thrombosis.

body mass index, male sex, and sleep apnea [24,25]. Moreover, certain anatomic leak locations are more common than others, depending on the bariatric procedure done, and they deserve special review.

Leak rate after SG is approximately 2.2%, and most often at the proximal gastric staple line [26–28]. After RYGB, anastomotic leaks occur most commonly at the GJ anastomosis and have been decreasing in incidence over the past several decades to under 1% of cases [26,28]. Anastomotic leaks at the JJ are rare (.2%) but similarly morbid if missed or left unresolved. Likewise, the most common and serious site of leakage after a BPD/DS is at the duodeno-ileostomy; leaks at the ileo-ileostomy are infrequent, but result in a high output leak that can lead to rapid clinical deterioration [23].

Diagnosis

A leak should be suspected in any patient who had MBS and is presenting with persistent tachycardia (heart rate

>120), shortness of breath, fever, and/or acute abdominal pain [29]. These findings are also present in patients with venous thromboembolism, and pulmonary embolism should be on the differential diagnosis. Less subtle is the patient presenting with an acute abdomen, although the clinical diagnosis of peritonitis may be difficult in patients with obesity, especially in the postoperative period where pain and other cardiopulmonary conditions can confound the presentation. A proximal gastric leak can result in shoulder pain on deep inspiration, a sign of diaphragmatic irritation and referred pain mediated by the phrenic nerve (C3-C5).

In hemodynamically stable patients, computed tomography (CT) imaging of the abdomen with intravenous (IV) ± oral contrast can be useful to work up unexplained tachycardia and assess for leak, hemorrhage, or pneumonia. Furthermore, when combined with a thoracic CT angiogram, it can simultaneously evaluate the patient for pulmonary embolism. Upper GI contrast study can also demonstrate a proximal GI leak, but does not provide additional detail of chest and abdomen, and should be avoided in patients at high risk for emesis or aspiration. A negative imaging study does not rule out a leak. Upper GI study has a high sensitivity for a GJ leak (RYGB) or gastric staple line (SG), but can miss leaks at other anatomic locations [21]. Therefore, unexplained, persistent tachycardia in the postoperative patient, with or without positive imaging results, may be sufficient indication for surgical exploration [22,30].

Management

Many strategies have been proposed for the management of leaks, but definitive guidelines are lacking. However, standard surgical principles apply: effective leak management requires source control of the leak, adequate resuscitation, antibiotics, and when needed, nutritional supplementation, preferably through enteral feeding distal to the leak. Treatment commences with IV fluid resuscitation, broad-spectrum antibiotics, nil per os, and intensive care unit admission if hemodynamically unstable.

Operative management is focused on confirming the source of GI leak, control of the leak. and drainage of infected fluid collections [31,32]. This is achieved with peritoneal irrigation and washout of the infected area and wide drainage with careful drain positioning. Suturing of the defect may be attempted when managing early leaks, but the tissues are usually inflamed and there is a high risk of breakdown [33]. Furthermore, since the gastric pouch of a RYGB is a low-pressure system, strategies that control the leak and allow healing without repairing the perforation are effective and sufficient in the majority of patients [34]. SG leaks, on the other hand, occur in a higher-pressure system and thus can be more challenging to heal, especially if there is a relative gastric outflow obstruction distal to the leak. The presence of a hypertrophic pylorus, or stenosis, kinking, or twisting of the gastric tube would need to be addressed to relieve the intraluminal pressure and promote healing. This can often be accomplished endoscopically (e.g., with endoscopic stenting) [35–37]. This can be done in collaboration or consultation with a bariatric surgeon or gastroenterologist after the patient is stabilized and the leak site identified and controlled in the initial phase of treatment. Operative omental patching of a leak site may be helpful, but the key is effective drainage. In addition, consideration should be made at the time of surgery for enteric tubes to be inserted distal to a leak site in order to achieve adequate nutritional support. In the case of gastric or GJ leak, the enteral feeding tube is preferably placed in the biliopancreatic limb or common channel of malabsorptive procedures with a Roux-en-Y reconstructive configuration (RYGB or BPD-DS). If an excluded stomach is present as in a RYGB procedure, then a gastrostomy tube can be inserted here for feeding and/or drainage as needed. A standard feeding jejunostomy tube is adequate in patients with a leak after SG.

Because leaks at the JJ or excluded stomach typically present later or have a delayed time to recognition [31], their surgical treatment is aimed at source control, and ensuring that there is no distal bowel obstruction. If accessible, endoscopic stenting may facilitate closure of the leak after appropriate control of sepsis has been obtained [35,38,39]. Revision of the GJ or JJ may be required in refractory leaks.

In clinically stable patients, there is a role for nonoperative supportive care with antibiotics, image-guided percutaneous drainage, endoscopic therapy, and nutritional support. On rare occasions, leaks result in intrathoracic contamination and fistula formation. These require prompt recognition and timely surgical intervention that may include a thoracic approach [40]. In the case of RYGB, leaks can lead to stable gastro-gastric fistulas. These typically do not present in the emergency setting [41,42].

Marginal ulcer

Background

Classically, a marginal ulcer (MU) is a peptic ulceration that forms on the small-bowel side of a gastrojejunostomy and thus in MBS is most commonly seen after RYGB [43]. Its incidence varies between <1% and 16% in reports with variable sample sizes, methods of diagnosis, and duration of follow-up [44–46], although the true incidence is difficult to determine due to the large proportion of patients who are asymptomatic. Some patients may present as early as 1 month after surgery, but most patients develop symptoms months to years after surgery, and patients remain at a life-long risk for development of MU [45,47].

While the etiology is not fully understood, it likely relates to prolonged acid exposure and/or increased vulnerability of the jejunal mucosa through inflammatory mechanisms or impairment of its microcirculation. Importantly, the jejunum, unlike the duodenum, does not have the capacity to buffer the gastric acid to which it is newly exposed [48]. Thus, predisposing factors can be surgery-specific or patient-related. Surgery-specific factors that have been implicated include the presence of a large acid-producing gastric pouch, gastro-gastric fistula, technique of gastrojejunostomy (circular versus linear versus hand-sewn), and use of nonabsorbable suture at the gastrojejunostomy. Patient-related factors include tobacco use, chronic use of nonsteroidal anti-inflammatory drugs, steroid use, poorly controlled diabetes, and untreated Helicobacter pylori infection [43,46,49–52]. Individuals with a history of RYGB can present to the emergency room or outpatient clinic with symptoms of MU, but in the absence of perforation or bleeding, they uncommonly require urgent intervention.

Presentation

MU can present as an uncomplicated new or chronic ulcer. Patients with uncomplicated MU may be asymptomatic or complain of subacute or chronic, vague or burning epigastric/substernal pain, have dysphagia, nausea, vomiting, or unexplained anemia [53,54]. Individuals with complicated MU leading to perforation or bleeding can present to the emergency room and require urgent intervention.

Perforation of an MU occurs in approximately 1% of postoperative patients following MBS, but can be a source of significant morbidity [47,55]. The presence of tobacco or illicit drug use, peripheral vascular disease, and renal failure, were found to be associated with MU progression to perforation [47]. Perforation of MU can occur at any time in the postoperative period, although several studies report presentation at a mean of approximately 12 months after bariatric surgery, and most within 2 years [47,55]. Patients with perforated MU present with signs and symptoms consistent with a perforated viscus, including localized or generalized sepsis. Patients have acute onset of severe upper abdominal pain and a combination of tachycardia, fever, peritonitis, and leukocytosis. Less commonly patients can present in septic shock. Most such patients will have a prior diagnosis of MU and a history of abdominal pain, but for some patients, perforation will be the initial diagnosis [54,56].

Presenting symptoms of bleeding MU are usually mild due to chronic, low-volume hemorrhage, presenting as iron deficiency anemia. Large-volume bleeding from an MU can also occur, but it is much less common than hemorrhage from a duodenal peptic ulcer. Significant upper GI bleeding presents emergently, with hematemesis, melena, and/or hemorrhagic shock. Acute hemorrhage from MU is uncommon, occurring in fewer than 5% of cases, but can be life-threatening, and requires appropriate, timely intervention [48,54].

Diagnosis

Most MUs are diagnosed within 2 years of surgery [57] and upper endoscopy is the diagnostic modality of choice. MUs may occur in the small bowel, at the anastomosis, or less commonly on the gastric side of the gastrojejunostomy. In the setting of bleeding, endoscopy may be therapeutic as well as diagnostic.

Upright chest x-ray in the emergency room may demonstrate free air under the diaphragm, although this is not specific to perforated MU. Upper GI contrast series can provide anatomic and functional information. It has a high sensitivity and specificity for detecting MU in patients with a gastrojejunostomy [58], and an especially high sensitivity in detecting perforation. This study may not always be available in the acute setting, and some patients may not tolerate an oral bolus of contrast well.

Individuals with a history of MBS who present to the emergency room with abdominal pain often undergo CT as an initial diagnostic study. A CT scan can detect uncomplicated MU, although findings on cross-sectional imaging can be subtle and only suggestive, such as stranding in the area of the gastrojejunostomy. If the patient can tolerate it, administration of oral contrast can aid in detection [59]. CT has a high sensitivity and specificity for the detection of pneumoperitoneum. A focus of gas adjacent to the gastrojejunostomy following RYGB is highly suggestive of perforated MU; however, the clinical context is important to distinguish from a gastrojejunostomy leak. Ultimately, in the absence of diffuse peritonitis, upper endoscopy is often necessary to secure the diagnosis.

Management

Uncomplicated MU is treated nonoperatively. Lifetime risk for surgical revision varies widely (<1%–30%) [60–62]. Revisional surgery is best accomplished by an experienced bariatric surgeon. Importantly, patients who undergo revisional surgery for MU remain at risk for future MU formation.

Perforation is a surgical emergency and requires a high index of suspicion in patients with known RYGB who present with peritonitis and/or imaging demonstrating peritoneal free air. Since individuals who had MBS are still susceptible to other causes of GI perforation (e.g., peptic ulcer disease, diverticulitis), imaging studies as described previously can localize the perforation prior to operation, if the patient condition allows. Most perforated MUs in RYGB localize to the antimesenteric jejunal wall of the gastrojejunostomy. In addition to intravenous fluids, it is prudent to add intravenous multivitamin, thiamine, and folate for patients who have undergone MBS presenting with acute symptoms to guard against concomitant micronutrient deficiency and specifically thiamine deficiency.

After resuscitation and administration of broad-spectrum antibiotics, operative repair with an omental patch, appropriate wide drainage, and consideration of enteral feeding access is preferred to surgical revision of the GJ, resulting in lower postoperative morbidity and shorter duration of hospital stay. A study using a New York State longitudinal database of 35,000 patients undergoing RYGB demonstrated that the rate of postoperative complications may be as high as 37% to 50% in the revision group, but only as high as 11.3% of patients in the repair group [47]. Other studies suggest that revision of the gastrojejunostomy should be avoided altogether in the emergent setting due to the associated potential high morbidity [63]. A laparoscopic approach, in experienced hands, is similarly preferred to an open surgical approach [47,63,64].

In the setting of bleeding MU, immediate upper endoscopy offers the possibility of confirming the diagnosis, and in most cases providing definitive control of hemorrhage. Endoscopic experience with bleeding MU following gastric resection for any reason (e.g., cancer) has shown this modality, including clip placement, epinephrine injection or thermocoagulation, to be expedient and effective in controlling upper GI bleeding. Rebleeding rates range from 5% to 30% and repeat endoscopy may be necessary [65]. Uncommonly, erosion into surrounding vessels could require angioembolization to avoid massive GI bleeding [48] . With these modalities available, the need for surgical exploration is rare [66].

Bowel obstruction

Background

While purely gastric MBS procedures (e.g., AGB, SG) may be susceptible to adhesive bowel obstruction similar to other laparoscopic abdominal operations, small bowel obstruction after procedures with intestinal rearrangement (e.g., gastric bypass, duodenal switch) may be due to internal hernia, intussusception, or closed-loop obstruction [67]. In addition, nonoperative management with NGT decompression may be less effective in patients with adhesive small bowel obstruction after RYGB due to the very small gastric pouch and concomitant inability to decompress the excluded stomach transorally.

The incidence of bowel obstruction after MBS due to different surgical techniques varies in the literature. A national analysis of 184,660 laparoscopic RYGBs based on the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) 2015–2018 showed that .64% of patients required readmission for small bowel obstruction in 30 days. Reoperation and mortality rates in readmitted patients were 69% and 1.3%, respectively. Of these patients, 8.4% were found to have internal hernias [68]. In studies with longer follow up, the incidence of bowel obstruction after RYGB has been reported to be 1% to 5% [69,70]. Depending on the location of the obstruction and the surgical anatomy, patients will variably present with nausea and vomiting, abdominal pain, distention, and hypovolemia. Leukocytosis and acidosis raise the possibility of bowel ischemia.

Diagnosis and management

The initial approach to bowel obstruction includes resuscitation followed by an abdominopelvic CT scan, unless the abdominal exam mandates emergent surgical exploration. If oral contrast is considered for a CT scan, then a limited volume of water-soluble contrast and aspiration precautions should be communicated with the radiology team. These patients may not have significant emesis, and placement of a nasogastric tube for decompression and relief is indicated if gastric or proximal small bowel distention is suspected. In the early postoperative period, however, caution should be exercised not to disrupt new staple lines or anastomoses. In addition, in the case of internal hernia as the cause of the obstruction, decompression is not sufficient and urgent surgical exploration is necessary.

Obtaining more details about the surgical history, and details of bariatric surgery (e.g., type of procedure, antecolic versus retrocolic gastric bypass, closure of mesenteric defects, and concurrent procedures) can suggest the etiology and anatomical location of the obstruction [71]. In addition to IV hydration, it may be necessary to add an intravenous multivitamin, thiamine, and folate for patients with a history of a bariatric surgery, who present with acute symptoms, in order to reverse any micronutrient deficiencies. Very early presentation of small bowel obstruction after RYGB is often caused by technical narrowing of the JJ, Roux limb angulation adjacent to the JJ, or intraluminal blood clot resulting in obstruction [68].

Internal hernia. There are 3 potential spaces for herniation of the bowel through defects in the mesenteric spaces after RYGB: (1) mesenteric defect at enteroenterostomy (most common site for internal hernia after RYGB); (2) retroalimentary limb space between the Roux limb, transverse mesocolon, and the retroperitoneum can be a space for herniation of the small bowel both in antecolic and retrocolic RYGB; and (3) mesocolon window (created in the mesentery of the transverse colon in retrocolic technique through which the Roux limb [afferent limb of jejunum] will pass toward the gastric pouch) [72] (Fig. 2).

In a meta-analysis of 45 studies with 31,320 patients after RYGB the incidence of internal hernia was 1% to 3% and was dependent on surgical technique [72]. Another meta-analysis showed a significantly higher rate of internal hernia after retrocolic/retrogastric RYGB compared with the antecolic/antegastric technique (2.3% versus 1.3%) [69]. However, an internal hernia may occur years after the index bariatric procedure, and thus its incidence after RYGB has been reported to be as high as 12.8% in 328 antecolic/

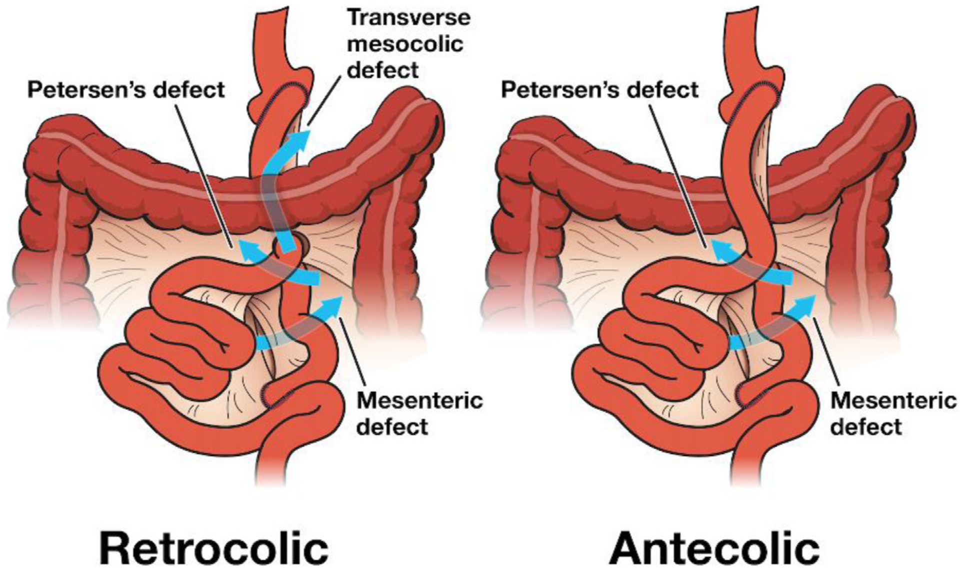

Fig. 2. Internal hernia defects during a retrocolic and antecolic Roux-en-Y gastric bypass. Courtesy of Dr. Jonathan Carter.

antegastric RYGB with 10+ years' follow-up [73]. Internal hernia is not limited to RYGB and has been reported after other MBS procedures involving GI bypass, such as the standard duodenal switch, single anastomosis duodenoileostomy, and one-anastomosis gastric bypass [74–76].

An internal hernia may present with nonspecific acute or intermittent symptoms, and diagnosis requires a high index of suspicion. Patients may not have vomiting if there is a closed-loop obstruction. Signs of internal hernia on CT may include a swirl sign, small-bowel obstruction, clustered loops, mushroom sign, hurricane eye sign, small bowel behind superior mesenteric artery, right-sided jejunal anastomosis, enlarged nodes secondary to lymphatic obstruction, venous congestion, and mesenteric edema. Nonetheless, CT scan may have limited accuracy in the diagnosis of internal hernia and may be reported as normal in up to 30% of patients with an obstruction [71,77]. It is important to note that a negative CT scan does not exclude the presence of internal hernia and patients with recurrent pain may require laparoscopic exploration for diagnosis and treatment [78].

Due to the devastating consequences of bowel strangulation within an internal hernia, early suspicion and timely surgical exploration (laparoscopic or open) are critical. In laparoscopic exploration, the surgeon can be on the left side of the patient and run the small bowel retrograde from the ileocecal valve toward the ligament of Treitz [79]. While following the distal bowel proximally, the herniated small bowel should be reduced and evaluated for viability. After complete reduction and confirming the bowel viability, the space in the mesentery causing the hernia should be closed, as should other potential spaces for internal herniation.

Diagnosing an internal hernia during pregnancy can be more challenging due to other potential obstetric diagnoses and limitations on the use of imaging studies. A systematic review of 52 pregnant patients with an internal hernia after bariatric surgery showed that clinical signs were subtle and only 65% had new nausea and vomiting. A CT scan or magnetic resonance imaging was helpful in only 75% of patients. Nine (17%) of these patients required bowel resections due to ischemia. Two maternal and 3 perinatal deaths occurred in patients who underwent surgery later than 48 hours after onset of symptoms [80], highlighting the need for a high level of suspicion and the need for an early and aggressive approach.

Intussusception. Intussusception is a less common cause of small bowel obstruction after RYGB. Intussusception, or telescoping of the small bowel, can commonly occur at the level of JJ, either in an anterograde or retrograde fashion into the proximal or distal segment. Intussusception represents a risk for jejunal strangulation. In a meta-analysis of 6 studies including 107 patients, the incidence of intussusception was .6%, the mean interval between RYGB and intussusception was 4.8 years (range, .5–38), and 38% of patients had bowel ischemia, necrosis, or perforation at the time of surgical exploration [81]. The "lead point" for intussusception is typically the site of anastomosis. Typical CT scan findings include a target sign, or nonspecific findings such as distended segments of bowel, air-fluid levels, or distention of the biliopancreatic limb and excluded stomach. A false-positive CT scan with a target sign is seen in up to 39%, although inflammation and edema can be seen at the JJ in the absence of frank intussusception. Conversely, a normal CT scan does not rule out intussusception, and early surgical exploration should be considered in patients with a history of RYGB, who present with acute abdominal pain and bowel obstruction [82,83].

The most common surgical procedure for intussusception involving the JJ anastomosis is revision of the jejunojejunostomy. Nonrevisional procedures have been described and include reduction only, imbrication/plication of the JJ, and jejunopexy of the biliopancreatic limb to the common channel. The decision about the type of procedure is based on the intraoperative finding and surgical familiarity with the anatomy. Excision and revision of the anastomosis is preferred in patients with a significantly dilated JJ or irreducible bowel. Recurrent intussusception after surgery has been reported in 4% to 26% of patients, the highest after reduction only, and the lowest after resection and revision of anastomosis [84,85]. Reduction only and other less invasive procedures can be an option in higher-risk patients, with later referral to an MBS surgeon for possible laparoscopic revision of anastomosis.

Complications specific to gastric band

Background

AGB, once the second most common bariatric procedure, has fallen out of favor due to high rates of complications and the need for revision and conversion to other procedures [9]. In a study following 19,221 patients with AGB placement between 2004 and 2010, 1 in 5 bands were either removed or revised by 2013 [86]. Another study by Ibrahim et al. showed similar findings as 18.5% of the patients subsequently underwent 17,539 reoperations [87]. Despite the fact that many AGBs have been removed or revised, the number of patients with these devices in situ is still significant and general surgeons should be familiar with the procedure and its potential complications. Common complications following gastric banding include band slippage/migration, overtightening (proximal gastric obstruction), and erosion into the stomach [88].

Band slippage

Presentation

Band slippage or prolapse occurs when the wall of the stomach migrates upward through the band, which can cause gastric outlet obstruction and gastric wall ischemia, and occurs at a lifetime rate of up to 22% [74] (Fig. 3). Eid et al. classified band slippage into 5 types: (1) anterior slip; (2) posterior slip; (3) pouch enlargement; (4) immediate postoperative prolapse; and (5) anterior or posterior slip with gastric necrosis [89]. With most band slippage patients, symptoms tend to be nonspecific, such as abdominal or chest pain, nausea, vomiting, and/or reflux, but can also present with the inability to tolerate larger meals.

Diagnosis and management

A plain chest or abdominal radiograph can diagnose a slipped band, but a more reliable diagnosis can be made with a fluoroscopic water-soluble contrast swallow study. The pathognomonic finding on an anteroposterior x-ray to aid in the diagnosis of a slipped band is the phi angle, the measurement between the longitudinal axis of the gastric band and the spinal column. The phi angle should be

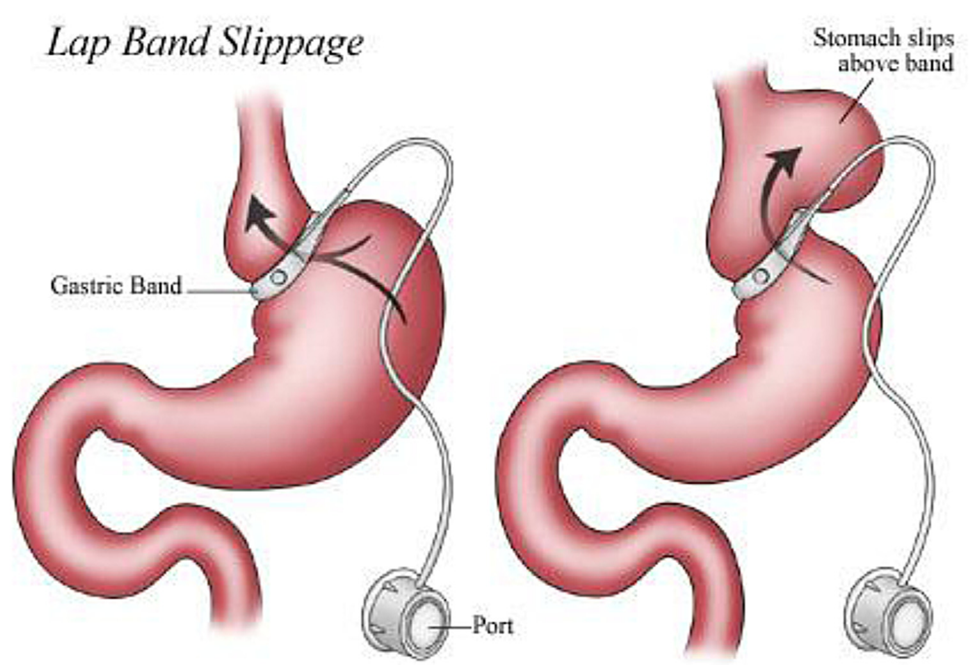

Fig. 3. Band slippage.

between 4 and 58 [90]. A CT scan can also aid in diagnosis if there are concerns about gastric wall ischemia.

When a slipped band is encountered, one should attempt immediate decompression of the band by accessing the subcutaneous fill-port and aspiration of the fluid from the band with a Huber needle. If the slippage does not resolve after decompression, surgery is indicated. Surgical options include band removal, gastric reduction and repositioning of the band, and band replacement. Gastric reduction and reapplication of the band have fallen out of favor due to high frequency of repeated gastric slippage [91]. If there is concern for gastric wall ischemia, immediate exploration and band removal are indicated. Once the abdomen is entered, the tubing from the subcutaneous port can be followed to the band, which is usually encased in a fibrous capsule. The operative approach is to start from the medial side at the lesser curvature to expose the band. By placing some traction on the tubing, the buckle can be identified and the fibrous tissue around it is split or excised. Once the band is exposed, it can be opened or cut, then removed. Upper endoscopy can be performed to evaluate the gastric mucosa for necrosis or injury.

Band erosion

Presentation

Band erosion, also known as intragastric migration, describes an AGB that gradually erodes through the stomach wall and into the gastric lumen. It is a relatively uncommon complication with a reported incidence up to 3.8% [92,93]. Band erosion occurs most commonly within the first 2 years following placement [94]. The etiology is not fully understood, as early erosion can be secondary to infections or undiagnosed gastric perforations during the initial procedure, and late erosion may be a result of gastric wall injury during placement or tight fixation, thus causing chronic ischemia [92].

Diagnosis and management

Diagnosis can be made with CT scan with PO contrast, upper GI series, or an upper endoscopy, which can provide a definitive diagnosis and treatment. In the case of a chronic process of contained perforation, emergent surgery is seldom needed for a band erosion. During surgery, if the band cannot be removed from outside the stomach, it is best to make a gastrotomy near the greater curvature far from the site of AGB erosion to remove the band. This allows for a lower incidence of leak as the gastrotomy is placed in healthy stomach and not near the erosion. An intraoperative endoscopy with air-leak test can be performed at the conclusion of the operation. A hybrid procedure can be performed, which consists of a laparoscopic approach to extract the connecting tube, followed by endoscopic retrieval of the band transorally [95]. However, if the patient is unstable or has peritoneal signs, urgent surgical intervention is warranted, in which a hybrid procedure with upper endoscopy can be performed that can allow for the band to be retrieved transorally [82].

Other causes of abdominal pain

Biliary disease after RYGB

Individuals who underwent MBS are susceptible to complicated biliary disease as nonbariatric individuals. Postsurgical patients can present with classic findings of acute cholangitis, including right upper quadrant abdominal pain, nausea, vomiting, fever, and altered mental status. The management of biliary disease in this population may be complicated by anatomic changes after GI bypass operations such as RYGB and DS [96], in which the Roux limb is often constructed to be 100 cm or longer, making traditional transoral endoscopic retrograde cholangiopancreatography (ERCP) not feasible. The most common approaches to obstructive, biliary disease after RYGB include laparoscopic-assisted ERCP or balloon endoscopic-assisted ERCP [97,81]. In the emergent setting, the general surgeon can facilitate ERCP most readily by accessing the remnant stomach, into which a flexible endoscope can be inserted to perform an ERCP through familiar anatomy.

Portomesenteric vein thrombosis

Portomesenteric vein thrombosis (PVT) has an incidence as high as 1% after bariatric surgery, more commonly after SG. The exact etiology is not known, although thermal injuries to the splanchnic venous system, reduced flow through the splanchnic system, vasoconstriction from the hypercarbia of minimally invasive surgery, local or other intraabdominal inflammation, and dehydration are implicated [98,99]. Patients typically present 1 to 3 weeks after surgery with vague abdominal pain, nausea, and intermittent emesis. Food intolerance and dehydration are common. The diagnosis is made by CT scan demonstrating a portomesenteric venous thrombus.

Treatment of PVT includes rehydration and anticoagulation. Uncommonly, patients present with bowel ischemia requiring surgical intervention or thrombectomy [99,100].

Other considerations

Individuals who had MBS may present clinical challenges in the emergent setting, due to medication interactions or nutritional deficiencies. Thiamine (vitamin B1) deficiency in the MBS patient is a complication that can present quickly and result in permanent and devastating side effects. Furthermore, it should be considered in any bariatric patient presenting with protracted nausea and vomiting. Thiamine deficiency can present with acute cardiac and neurologic signs, but it can be mistaken for dehydration or hypoglycemia

[101]. Thus, it is important to supplement these patients with IV thiamine, in addition to IV rehydration.

Patients undergoing bariatric surgery are also at a risk for medication interactions, as in the case of sodium-glucose cotransporter-2 (SGLT2) inhibitors, which can result in euglycemic diabetic ketoacidosis (DKA). SGLT2 inhibitors are antihyperglycemic drugs that are used as a second-line therapy for patients with diabetes. However, there is a growing number of reports showing that SGLT-2 inhibitors can lead to euglycemic DKA following MBS [102,103]. Currently, the American Association of Clinical Endocrinologists and the American College of Endocrinology recommend withholding SGLT-2 inhibitors 24 hours prior to elective surgery [104]. However, while there are no recommendations regarding postbariatric surgery, it might be beneficial to discontinue the medication in order to avoid euglycemic diabetic ketoacidosis.

Conclusion

Individuals with complications following MBS can present to the emergency room with acute pathology that risks morbidity and mortality, while presenting a diagnostic and therapeutic challenge. MBS is performed in a large number of patients who are geographically dispersed, and the timing of complications can range from early to late; thus, patients can present to a hospital at a time or place in which a bariatric surgeon is not immediately available. Therefore, a familiarity of common complications and their management is critical for the general surgeon on call. A high index of suspicion, early diagnosis, and prompt management can prevent significant morbidity and mortality. Early consultation with a bariatric surgeon is highly recommended when available, and the expertise of a gastroenterologist and/or interventional radiologist may be necessary for diagnosis and treatment.

Disclosures

The authors have no commercial associations that might be a conflict of interest in relation to this article.

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