Acute Abdominal Pain in the Bariatric Surgery Patient

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KEYWORDS

• Anastomotic leak • Anastomotic stenosis • Stomal ulcer • Hernia • Dilatation • Band erosion • Band slippage • Gastric prolapse

KEY POINTS

- In general, bariatric procedures achieve weight loss by altering gastrointestinal absorption, restricting gastric size, or a combination of both.
- In bariatric patients, abdominal pain may be caused by complications specific to their particular surgical procedure or by nonspecific complications, such as surgical site infection, cholelithiasis, bleeding, and small bowel obstruction.
- The differential diagnosis of abdominal pain in the patient who has had a Roux-en-Y gastric bypass or a biliary pancreatic diversion includes anastomotic leak or stenosis, dumping syndrome, gastric remnant dilatation, stomal ulcer, and internal or incisional hernia.
- Following laparoscopic adjustable gastric banding, abdominal pain may be caused by esophagitis, hiatal hernia, gastroesophageal dilatation, band erosion, band slippage, gastric prolapse, stomal obstruction, or port infection.
- Patients who have had a sleeve gastrectomy may suffer from gastric leak, gastric stenosis, or gastroesophageal reflux.

INTRODUCTION

Obesity is present in epidemic proportions in the United States. Obese individuals are at increased risk of morbidity and mortality compared with those with normal body mass indices (BMIs).[1] Several studies have demonstrated the superiority of bariatric surgery over conventional therapy.[2–4] As a result, bariatric surgery has become more commonplace, and emergency physicians will undoubtedly encounter many

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patients who have undergone one of these procedures. This article reviews common bariatric surgery procedures, their complications, and the approach to acute abdominal pain in these patients.

OBESITY

Obesity is a widespread disease and essentially an evolving international epidemic even though it is not infectious in nature. In a study that examined data from the 2011 to 2012 National Health and Nutrition Examination Survey, more than one-third (34.9% or 78.6 million) of adults in the United States are obese. The age-adjusted prevalences of obesity by race are astounding: 47.8% of non-Hispanic blacks, 42.5% of Hispanics, 32.6% of non-Hispanic whites, and 10.8% of Asians.[5] The cost of obesity-related medical care is substantial, resulting in a 41.5% increase in per capita medical spending compared with adults of normal weight. In their article, Finkelstein and colleagues[6] estimate that these costs could amount to $147 billion per year.[6] Among the concomitant health care risks associated with obesity are heart disease, stroke, type II diabetes (DM), hypertension (HTN), hyperlipidemia (HLD), gallbladder disease, musculoskeletal disorders, and obstructive sleep apnea. Obese individuals also have an increased risk of mortality, dying 6 to 7 years earlier than those with a normal weight. Compounding the issue, obese smokers die 13 to 14 years earlier than non smokers with normal BMIs.[1]

CONVENTIONAL THERAPY

Diet and exercise are routinely promoted as integral parts of weight loss regimens by prominent laypeople and health care professionals. For example, healthier lifestyles have been advocated by First Lady Michelle Obama (the Let's Move campaign) and the National Football League (the Play 60 initiative). Unfortunately, lifestyle modifications may not be adequate for obese people trying to attain a healthier BMI. Several studies have shown that bariatric surgery results in greater improvements in BMI and higher rates of resolution of comorbidities, such as type II DM, HTN, and HLD, when compared with conventional therapy (including medication, lifestyle modifications, and education).[2–4]

BARIATRIC SURGERY ON THE RISE

Across the globe, the number of bariatric surgeries more than doubled between 2003 and 2011. In 2011, the United States and Canada combined, performed the greatest number of bariatric surgical procedures (101,645 cases or 29.8%) when compared with other countries worldwide. In the United States and Canada, the three most common procedures were Roux-en-Y gastric bypass (RYGB; 47,791 cases or 47.0%), adjustable gastric band (27,630 cases or 27.2%), and sleeve gastrectomy (SG; 19,486 cases or 19.2%). Of these, SG was the only one increasing in percentage of cases. Also of note, 18.6% of the 6705 bariatric surgeons worldwide reside in the United States and Canada alone.[7]

INCLUSION CRITERIA FOR BARIATRIC SURGERY

The formula to calculate BMI is weight (in kilograms) divided by height (in meters) squared. The National Institutes of Health and World Health Organization use BMI to classify degree of obesity and to aid in risk stratification. A normal BMI is 18.5 to 24.9 kg/m^2. A person with a BMI of 25 to 29.9 kg/m^2 is considered overweight. Obesity

is defined as a BMI greater than or equal to 30 kg/m^2 (class 1, 30–34.9 kg/m^2; class 2, 35–39.9 kg/m^2; class 3, $\geq$40 kg/m^2).

These classifications have been defined based largely on data from white populations; however, evidence exists that supports using ethnic-specific definitions. For example, a study by He and colleagues[8] supports using lower BMI cutoffs in Chinese because of higher prevalences of obesity-related comorbidities for a given BMI. This is thought to be at least in part caused by ethnic differences in abdominal and hepatic fat distribution.[9]

The National Institutes of Health has established evidence-based guidelines for surgical management of obesity. To qualify for bariatric surgery, a candidate must demonstrate a BMI greater than or equal to 40 kg/m^2 without comorbidity or a BMI of 35 to 39.9 kg/m^2 with at least one serious comorbidity, including but not limited to type II DM, HTN, HLD, obstructive sleep apnea, gastroesophageal reflux disease, asthma, or obesity-hypoventilation syndrome. In addition, the person must have failed other nonsurgical methods of weight loss.[10] Most major insurance carriers and bariatric programs in the United States also require that patients undergo psychological assessment before surgery.[11] Weight loss outcomes have been shown to be related to patients' preoperative psychological preparation and their ability to make lifelong changes in their dietary habits and physical activity.[12]

BARIATRIC SURGERY PROCEDURES

To evaluate acute abdominal pain in the bariatric surgery patient, the clinician needs to understand the most common bariatric procedures. In general terms, these procedures achieve weight loss by altering gastrointestinal (GI) absorption, restricting gastric size, or a combination of the two. Malabsorptive procedures bypass the distal stomach and some degree of small bowel, reducing the absorption of food. Gastric restriction is attained by gastroplasty or gastric banding, resulting in a functionally smaller stomach, delayed gastric emptying, and early satiety. Additionally these procedures may impact hormones that control appetite and satiety (eg, ghrelin, glucagon-like peptide 1 [GLP-1], peptide YY [PYY], and cholecystokinin).[13,14] Common types of malabsorptive and restrictive procedures are discussed in more detail next.

MIXED MALABSORPTIVE/RESTRICTIVE PROCEDURES

Roux-en-Y Gastric Bypass

In the 1960s, the first gastric bypass was performed by Mason and Ito.[15] Since then, the surgery has undergone several modifications (**Fig. 1**). Currently the most common weight reduction procedure worldwide is the RYGB (47% of all bariatric surgeries).[7] Although multiple variations of the RYGB exist, the general concept includes the creation of a small proximal gastric pouch (usually 15–50 mL) connected to a Roux or connecting limb of small bowel (typically 75–150 cm in length and found 30–50 cm distal to the ligament of Treitz). The distal stomach is stapled, and the proximal jejunum is anastomosed to the Roux limb as a jejunojejunostomy. The gastric pouch provides a restrictive element, causing early satiety and thus reducing a patient's total intake. The Roux limb promotes the malabsorptive process by bypassing the distal stomach and proximal jejunum.[13] RYGB may affect secretion of ghrelin (causing appetite suppression) and GLP-1 and PYY (resulting in satiety).[13,14] Various studies have demonstrated an approximately 70% excess weight loss at 2-year follow-up and 54% at 10 years and beyond.[14,16] In addition, RYGB has been shown to have a more appreciable benefit on DM and other metabolic derangements.[14]

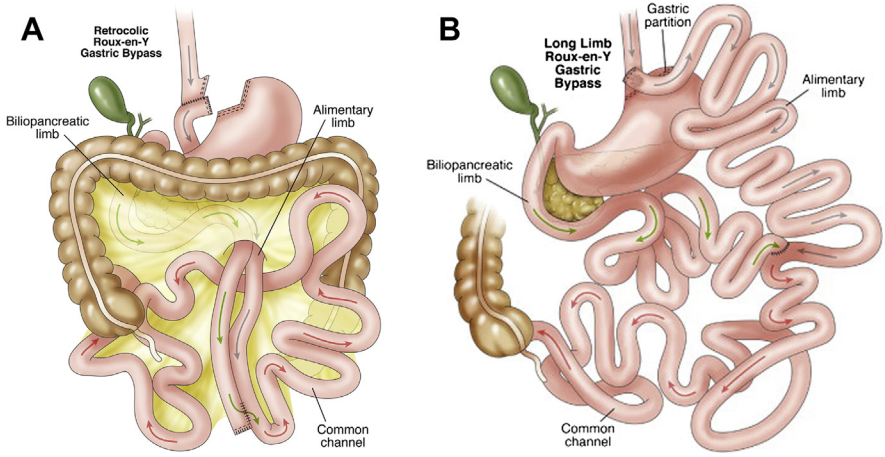

Fig. 1. (*A*, *B*) Examples of Roux-en-Y gastric bypass. (*From* Elder KA, Wolfe BM. Bariatric surgery: a review of procedures and outcomes. Gastroenterology 2007;132(6):2253; with permission.)

Biliary Pancreatic Diversion without and with Duodenal Switch

Biliary pancreatic diversion (BPD) is completed by performing a 50% to 80% gastrectomy removing the pylorus and dividing the ileum (Fig. 2). The distal ileum is attached to the proximal stomach, forming an alimentary limb. The proximal ileum is detached

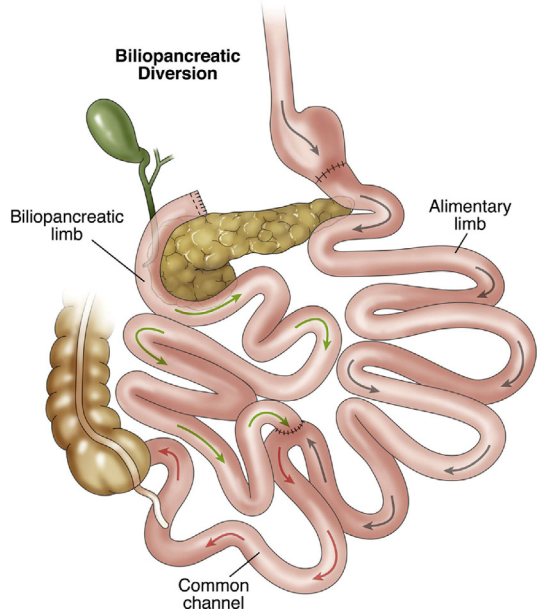

Fig. 2. Biliary pancreatic diversion. (*From* Elder KA, Wolfe BM. Bariatric surgery: a review of procedures and outcomes. Gastroenterology 2007;132(6):2253; with permission.)

becoming the biliopancreatic limb, which is then anastomosed to the alimentary limb about 50 cm PROXIMAL to the ileocecal valve.[13,17] In short, this results in restriction of the stomach and diversion of food, bile, and pancreatic secretions (malabsorptive component). BPD only comprises about 0.7% of bariatric procedures worldwide.[7] Excess weight loss was reported to be 68% and 71% at 2 and 4 years, respectively, after surgery.[16,18] BPD may be decreasing in favor because it is associated with higher rates of diarrhea, malnutrition, and stomal ulceration, and lower excess weight loss when compared with BPD with duodenal switch (BPD-DS).[19,20]

BPD-DS consists of an SG and an ileoduodenostomy distal to the pylorus. Thus, both the pylorus and proximal duodenum are preserved (**Fig. 3**).[13,17] This is performed as a single-stage procedure or with a staged approach (SG followed by BPD-DS). Controversy exists as to which is the preferred method.[21,22] BPD-DS accounts for 1.5% of bariatric procedures worldwide.[7] At 2 years after surgery, 85% excess BMI was lost.[16] The mean percentage weight loss for BPD ± DS (70.1%) was superior to that of RYGB (61.6%).[23] Furthermore this superior excess weight loss was maintained at 10 years and beyond.[14] In addition to RYGB, BPD-DS is the main surgical option for patients with BMI greater than 50 kg/m^2.[24]

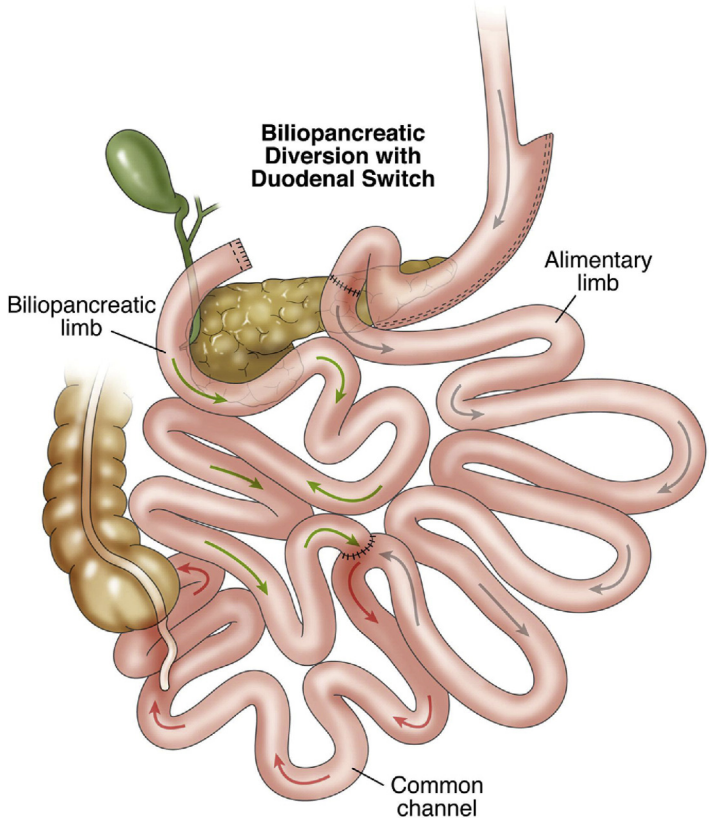

Fig. 3. Biliary pancreatic diversion with duodenal switch. (*From* Elder KA, Wolfe BM. Bariatric surgery: a review of procedures and outcomes. Gastroenterology 2007;132(6):2253; with permission.)

RESTRICTIVE PROCEDURES

Laparoscopic Adjustable Gastric Banding

About 18% of bariatric surgeries worldwide are laparoscopic adjustable gastric banding (LAGBs).[7] During LAGB (**Fig. 4**), an adjustable band is placed around the proximal stomach, creating a small gastric pouch. The band is filled with saline and is connected to a subcutaneous port located in the anterior abdominal wall, which can be accessed via a needle to adjust the amount of gastric restriction.[13,17] Besides its restrictive effects, LAGB also impacts appetite and satiety, possibly through vagal stimulation.[14] Of all bariatric surgeries, it has the lowest mortality rate (0.05%), one-tenth that of RYGB.[25] Even though excess weight loss is approximately only 47.5% at 2 years, longer term weight loss (≥10 years) is comparable with that of RYGB (47%–54.2%).[14,25,26]

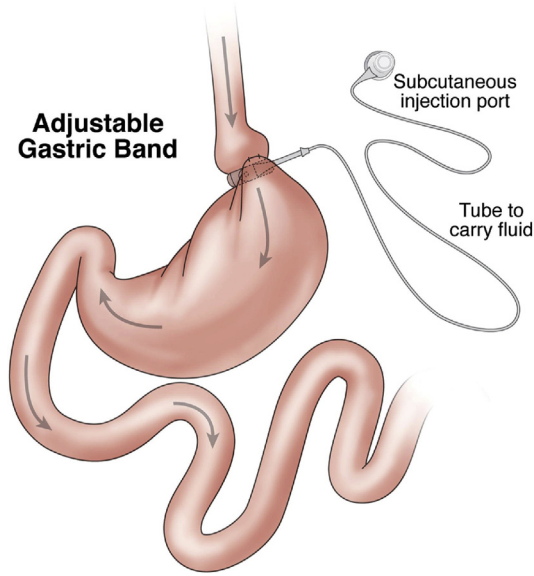

Fig. 4. Laparoscopic adjustable gastric banding. (*From* Elder KA, Wolfe BM. Bariatric surgery: a review of procedures and outcomes. Gastroenterology 2007;132(6):2253; with permission.)

Sleeve Gastrectomy

SG was initially reserved for high-risk patients with BMI greater than 60 kg/m^2 as an initial surgical intervention with subsequent RYGB (**Fig. 5**).[27] However, it is now considered a potential primary bariatric procedure. In 2011, it was the second most common type of bariatric surgery performed worldwide, constituting almost one-third of these cases.[7] During this procedure, the greater curvature of the stomach is resected, leaving a residual tubular structure behind.[13] As a result, the stomach cannot easily expand. SG also seems to affect ghrelin, GLP-1, and PYY levels and influences satiety.[14,28] At 2 years follow-up, excess weight loss is 67.4%.[29] A study is currently underway evaluating the long-term outcome of SG, including maintenance of weight loss.[30]

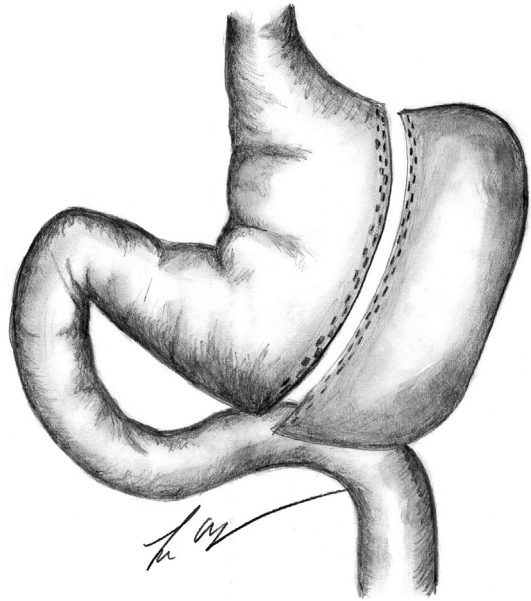

Fig. 5. Sleeve gastrectomy. (*Courtesy of* L. Aznaurova-Anderson, MD, Houston, TX.)

INTRAGASTRIC DUAL-BALLOON

In July 2015, the US Food and Drug Administration approved an intragastric dual-balloon device (ReShape Medical Inc, San Clemente, CA) for patients with BMI of 30 to 40 kg/m^2, who have failed to lose weight through diet and exercise, and who have one or more obesity-related comorbidities, such as DM or HTN.[31] The device is thought to induce satiety by occupying space in the stomach.[32] It is placed endoscopically and removed after 6 months. In a prospective, randomized controlled multicenter trial, patients with the dual-balloon device lost 25.1% excess weight, whereas those who relied on diet and exercise alone lost 11.3%.[33] The intragastric dual balloon offers a minimally invasive and reversible alternative to bariatric surgery (**Fig. 6**).

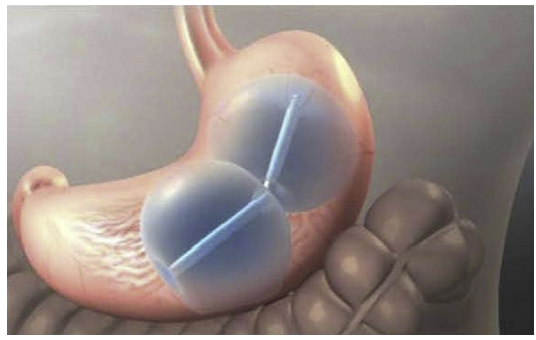

Fig. 6. Intragastric dual-balloon. (*From* Ponce J, Quebbemann BB, Patterson EJ. Prospective, randomized, multicenter study evaluating safety and efficacy of intragastric dual-balloon in obesity. Surg Obes Relat Dis 2013;9(2):291; with permission.)

APPROACH TO THE BARIATRIC PATIENT WITH ABDOMINAL PAIN IN THE EMERGENCY DEPARTMENT

As with any patient in the emergency department, initial evaluation and stabilization of the ABCs (airway, breathing, circulation, and so forth) is paramount. However, there may also be concerns specific to bariatric patients as described next.

Airway

In obese patients, airway management may be complicated by short necks and redundant soft tissues. Should the airway need to be secured, planning for a difficult intubation is crucial. If the initial approach for airway management fails, multiple backup plans may be needed (eg, direct and video-assisted laryngoscopy, supraglottic device, surgical cricothyroidotomy). Positioning the patient in a "ramped position" with elevation of the head and upper body to align the ear and sternum can help increase the chances of successful intubation and improve ventilation.[34]

Breathing

Once the patient's airway is secure, assessment of breathing ensues. Tachypnea may indicate a primary respiratory disorder (eg, pneumonia, pulmonary embolus, congestive heart failure) or a compensatory mechanism for metabolic acidosis (eg, caused by lactic acidosis or sepsis).[17] Obese patients have decreased functional residual capacity because of decreased chest wall compliance and increased intra-abdominal pressure. As a result, they have a limited oxygen reserve.[34] Obesity hypoventilation syndrome may cause hypoxia, hypercapnea, and subsequent altered mental status. Bilevel positive airway pressure may be useful in this case along with supplemental oxygen. Oxygen saturation should be maintained between 88% and 92% to avoid overoxygenation and a resultant decrease in respiratory drive and hypercapnic narcosis.[35]

Circulation

Assessing the patient's circulation (ie, heart rate, blood pressure, distal pulses) can provide clues about illness. In several papers, a persistently elevated heart rate greater than 120 beats per minute may indicate a gastric leak (GL) and possible sepsis.[36,37] Due to the fact bariatric patients may not always present with typical signs (eg, fever, peritoneal signs) even in the face of serious illness, clinical indicators, such as persistent tachycardia, may be especially useful. If available, bedside ultrasound may help assess cardiac function, volume status (ie, collapsibility of the inferior vena cava), and the presence or absence of free fluid in the abdomen.

Other General Considerations

Once the patient is stabilized, a focused history and physical examination can help narrow the differential diagnosis. The provider should inquire about the presence of fever, vomiting, diarrhea, symptoms of dehydration (eg, lightheadedness, syncope, urine output), and GI bleeding (ie, hematemesis, hematochezia, melena). Additional information should include food intake, timing of last bowel movement, and adherence to the postbariatric surgery diet. Knowing what type of procedure was performed and when can also affect the provider's diagnostic considerations. The physical examination should focus on assessment of vital signs and volume status and searching for evidence of infection, sepsis, GI bleeding, and obstruction.

While the provider is evaluating the patient, intravenous (IV) access should be obtained and diagnostics ordered. Depending on the specific patient, the following testing may be useful: basic versus complete metabolic profile, complete blood count,

lipase, blood gas (arterial or venous), lactic acid level, urinalysis, pregnancy test, stool hemoccult, and electrocardiogram. Imaging studies, such as plain radiographs, ultrasound, and computer tomography (CT) may be necessary for diagnosis as well. However, it is important to remember the potential limitations of imaging in the severely obese patient. General therapeutic options include IV fluids, pain control, and antiemetics. Blood products and antibiotics may be needed in patients with bleeding complications or sepsis respectively.

NONEXCLUSIVE COMPLICATIONS

In bariatric patients, abdominal pain may be caused by complications specific to a particular surgical procedure or by nonspecific complications.[36] General postsurgical complications include surgical site infection (SSI), cholelithiasis, bleeding, and small bowel obstruction. In addition, the clinician should consider other diagnoses, such as pneumonia and myocardial infarction.

Surgical Site Infection

SSIs may involve the skin, subcutaneous tissues, deeper soft tissues, and/or the abdominal cavity. These infections occur in up to about 15% of patients following bariatric surgery, although the incidence is lower after laparoscopic procedures (vs open surgeries).[36,38] Most SSIs occur within 2 to 3 weeks following surgery.[39] SSIs may be polymicrobial; however, the most commonly identified organisms are staphylococcal species.[38] Early recognition of an SSI is important as is source control (eg, opening the wound, abscess drainage, further operative intervention). Antibiotics are indicated in cases of cellulitis, deeper tissue infections, intra-abdominal abscess, or sepsis.

Cholelithiasis

Cholelithiasis is common after bariatric surgery because of rapid weight loss leading to increased mucin in the gallbladder, increased cholesterol in the bile, biliary stasis, and bile sludging.[40,41] The incidence of gallstones following bariatric procedures ranges from 30% to 53%.[40,42] However, only a minority of these patients (7%–15%) require cholecystectomy.[42] RYGB is associated with a higher rate of subsequent cholecystectomy than LABG or SG.[42] Due to this significant rate of cholelithiasis, some surgeons may opt to perform a cholecystectomy at the time of the bariatric procedure. Others may choose to prescribe prophylactic ursodeoxycholic acid and/or reevaluate if biliary symptoms arise.[13,40]

If gallbladder disease is suspected in a bariatric surgery patient, the diagnostic and therapeutic approach is usually similar to that for all patients. Ultrasound can be used to detect gallstones, biliary sludge, and evidence of cholecystitis and choledocholithiasis. In patients with an RYGB, endoscopy may be complicated by postsurgical anatomic alterations.[40]

Postoperative Bleeding

Postoperative bleeding may have extraluminal or intraluminal causes. Extraluminal causes may include iatrogenic injury to the mesentery, liver, or spleen or bleeding from a trocar site. Patients with this type of bleeding may present with tachycardia, hypotension, fatigue, lightheadedness, or peritoneal signs from hemoperitoneum. Intraluminal bleeding may present as upper GI bleeding (UGIB) (ie, hematemesis, melena, hematochezia, or hypotension).[17] Between 0.6% and 4% of bariatric surgeries are complicated by UGIB within 2 weeks of the procedure. Laparoscopic RYGB is associated with a higher incidence than open RYGB and other bariatric

procedures.[43] Although bleeding may arise from any anastomosis or staple line, the gastrojejunal anastomosis is the most common site of early UGIB following RYGB.[17,43] Late UGIB may occur years later because of gastric or duodenal ulcerations, stomal ulcers, or bleeding from the gastric pouch.[13,17]

In patients with postoperative bleeding, initial resuscitation potentially includes management of the ABCs, fluid resuscitation, blood product administration, correction of coagulopathy, and dosing of IV proton pump inhibitors. This supportive care suffices in many cases.[13,43] However, endoscopy and/or surgical intervention may be necessary if the patient is hemodynamically unstable, does not adequately respond to medical management, or has recurrent bleeding.[13,36,43] Depending on the patient's postprocedure anatomy, endoscopy may not be able to reach the site of bleeding (eg, if the bleeding arises from a bypassed part of the GI tract).[13]

Small Bowel Obstruction

Bowel obstructions are more commonly seen months after surgery (rather than in the early days to weeks following the procedure). They may be caused by hernias (incisional, internal, umbilical), adhesions, and kinking of the Roux limb. In addition, patients with anastomotic leaks may present in a similar fashion.[36] Because upper GI radiographs can be insensitive (especially in the case of internal hernias), CT may be more useful.[13] However, negative imaging may not obviate diagnostic laparoscopy if there is a strong clinical suspicion of obstruction.

Patients with an ileus or partial obstruction may be managed conservatively with bowel rest, IV fluids, and repletion of electrolytes.[36] Those with a complete obstruction are more likely to require diagnostic and/or therapeutic laparoscopy.[44]

SURGICAL COMPLICATIONS BY PROCEDURE

The 30-day morbidity following any bariatric procedure ranges from 3% to 20%.[45,46] Restrictive surgeries are associated with lower complication rates than the mixed malabsorptive/restrictive procedures.[47] During this same time period, the mortality rate is 0.1% to 1.2%.[23,45,47,48] Early mortality is most commonly caused by pulmonary emboli, sepsis, and anastomotic leaks.[47,49] Complications specific to certain procedures are discussed next (**Table 1**).

ROUX-EN-Y GASTRIC BYPASS

Anastomotic or Staple Line Leak

The incidence of anastomotic leaks ranges from 0.1% to 5.8%.[17,36,38,50] Several studies have shown the leak-associated mortality to be 14% to 17%.[51] These leaks most commonly occur at the gastrojejunal anastomosis but can also occur at the gastric pouch, gastric remnant, jejunojejunostomy site, or secondary to another GI injury.[13,17,36,51] This is typically an early complication of RYGB (most commonly within 1 week after surgery).[17] Patients may present with any combination of abdominal pain, persistent tachycardia, shortness of breath, fever, hypotension, and unexplained sepsis.[17,38,51] However, it is important to remember that the absence of abdominal pain does not exclude this diagnosis.[36]

Controversy exists as to the use of imaging studies, such as upper GI radiographs with water-soluble contrast and CT. Although these studies may help diagnose a leak, they may also delay definitive care of the patient.[36,38,50,51] Conservative management (bowel rest, IV fluid resuscitation, broad-spectrum antibiotics) may suffice in hemodynamically stable patients with mild symptoms.[51] Other management options in stable

Table 1
Complications associated with procedures

Procedure	Complication	Timing	Diagnostic Tests	Treatment
Roux-en-Y gastric bypass (30%)	Anastomotic leak	Weeks to months	Gastrografin UGI or CT abdomen	Antibiotics, surgical exploration
	GI obstruction	Weeks to months	Abdominal radiographs	NGT decompression
	Stomal stenosis	6 mo	Endoscopy or UGI contrast study	Endoscopy and dilatation
	Internal hernia	Months	CT abdomen	Surgical
	Ventral incisional hernia	Months to years	Clinical, CT abdomen	Surgical
	Stomal ulcer	Months	Endoscopy	PPI, *Helicobacter pylori* treatment, smoking/NSAID cessation
	Dumping syndrome	Months to years	Clinical	Nutritional education
	GERD	Months to years	Clinical	PPI, nutritional education
Laparoscopic adjustable gastric banding (27%)	Esophageal/gastric pouch dilatation	Days to weeks	UGI series	PPI, nutritional education
	Port infection	Days to weeks	Clinical	Antibiotics, port removal
	Hiatal hernia	Weeks to months	UGI series, endoscopy	PPI, nutritional education, surgery if severe
	Gastric slippage	Days to months	UGI contrast study, abdominal radiographs	Surgery
	Esophagitis	Months to years	Clinical	PPI, nutritional education
	GERD	Months to years	Clinical	PPI, nutritional education
Sleeve gastrectomy (19%)	Anastomotic leak	Weeks to months	Gastrografin UGI or CT abdomen	Antibiotics, surgical exploration
	Gastric stenosis	Days to weeks	UGI series, endoscopy	Endoscopy and dilatation, conversion to RYGB
	GERD	Months to years	Clinical	PPI, nutritional education
Biliopancreatic diversion with duodenal switch (1.5%)	Anastomotic leak	Weeks to months	Gastrografin UGI or CT abdomen	Antibiotics, surgical exploration
	GI obstruction	Weeks to months	Abdominal radiographs	NGT decompression
	Stomal stenosis	6 mo	Endoscopy or UGI contrast study	Endoscopy and dilatation
	Internal hernia	Months	CT abdomen	Surgical
	Ventral incisional hernia	Months to years	Clinical, CT abdomen	Surgical
	Stomal ulcer	Months	Endoscopy	PPI, *H pylori* treatment, smoking/NSAID cessation
	Dumping syndrome	Months to years	Clinical	Nutritional education
	GERD	Months to years	Clinical	PPI, nutritional education

Abbreviations: GERD, gastroesophageal reflux disease; NGT, nasogastric tube; NSAID, nonsteroidal anti-inflammatory drug; PPI, proton pump inhibitor; UGI, upper gastrointestinal.

patients include percutaneous drainage or endoluminal stenting.[50] Patients with more severe symptoms or sepsis require operative intervention.[36,38,50,51]

Anastomotic Stenosis

Anastomotic stenosis occurs in 3% to 20% of RYGBs.[17,51,52] Although it may occur at any anastomosis, the gastrojejunostomy site is the most common.[36,51] Additionally, it is more common following laparoscopic RYGB than the open technique.[13,36] Stenosis formation may be related to anastomotic leaks, tension at the anastomosis, tissue ischemia, or marginal ulceration.[13,36] This complication most commonly develops 3 to 6 months postoperatively, and patients typically present with nausea, vomiting, abdominal pain, and/or progressive dysphagia.[17,36,51]

Endoscopy seems to be more useful than upper GI radiographs, being more sensitive diagnostically and potentially therapeutic.[13,17] Most of these stenoses can be treated with endoscopic dilatation, although operative revision is needed in some cases.[17,51]

Dumping Syndrome

Dumping syndrome occurs in about 40% of patients up to 12 to 18 months after RYGB.[17,53] Incidentally it has also been reported following partial or complete gastrectomy (including SG).[53] Symptoms of dumping syndrome begin following meals, particularly after ingestion of simple carbohydrates.

Early symptoms are caused by rapid gastric emptying and passage of stomach contents into the small bowel. The hyperosmolar intestinal contents may result in fluid shifts into the intestinal lumen. These patients may present with GI (nausea, diarrhea, abdominal pain) or vasomotor symptomatology (palpitations, diaphoresis, flushing, hypotension, syncope). Late symptoms occur 1 to 3 hour after meals as a result of hypoglycemia. Rapid gastric emptying transiently elevates glucose concentrations in the gut, which in turn triggers insulin secretion. After the intestinal contents are absorbed, hypoglycemia occurs, causing typical manifestations (ie, palpitations, diaphoresis, weakness, tremor, altered mental status, and/or syncope).[53]

Treatment in the emergency department is supportive (eg, IV fluids, antiemetics, electrolyte repletion). Patients should be counseled to eat smaller, more frequent meals that are high in fiber, complex carbohydrates, and protein. They should avoid eating sugars and lactose, and drinking during or after meals for at least 2 hours. Patients who are refractory to these interventions may be placed on a somatostatin analog by their surgeon.[53]

Gastric Remnant Dilatation

Gastric remnant dilatation is a rare complication of RYGB, occurring in up to 0.8% of patients following laparoscopic RYGB.[54,55] If this diagnosis is not discovered in a timely manner, gastric perforation, peritonitis, and sepsis may ensue. Potential causes include gastroparesis, gastrojejunostomy leak, jejunojejunostomy obstruction, hemorrhage, and gastric remnant ulceration.[54,55] Patients with gastric remnant distention may present with left upper quadrant or epigastric pain, nausea, vomiting, hiccups, tachycardia, or left upper quadrant tympany. Treatment options include prokinetics, gastrostomy tube for decompression, and surgical intervention.[54]

Marginal or Stomal Ulcers

Marginal ulcers occur in up to 20% of patients following RYGB.[13,51] Although these ulcers are probably multifactorial, various etiologic factors include increased gastric acid secretion, tissue ischemia, staple line dehiscence, nonsteroidal anti-inflammatory drug

(NSAID) use, *Helicobacter pylori* infection, smoking, and increased tissue tension.[13,17,36,56] Patients usually present 2 to 4 months postoperatively with nausea, vomiting, retrosternal or epigastric pain, dyspepsia, or UGIB.[17,51] The diagnosis is established by endoscopy. Treatment includes proton pump inhibitors, sucralfate, smoking cessation, *H pylori* therapy, and discontinuation of NSAIDs. Surgical intervention (ie, resection, reanastomosis) may be indicated for recurrent bleeding or refractory pain.[13,17,36,57]

Internal Hernia

Internals hernias are more common after laparoscopic RYGBs than open procedures with an incidence of up to 16%.[13,58,59] They are thought to occur because of abdominal-wall defects created during surgery.[58] Patients with internal hernias may present with nausea, vomiting, abdominal pain, and/or obstructive symptoms. Although CT is more sensitive than upper GI radiographs, a negative CT does not definitively rule out this diagnosis because herniation may be intermittent. Because delayed diagnosis is associated with a significant mortality if strangulation occurs, diagnostic laparoscopy should be considered for patients with persistent symptoms even if imaging is negative (**Figs. 7** and **8**).[13,58,59]

Ventral Incisional Hernia

The incidence of incisional hernias is low with the laparoscopic approach but much higher when conducted in an open fashion (ranging from 8% to 25%).[60,61] Clinical presentation, diagnosis, and management are similar to those of incisional hernias following other operations.

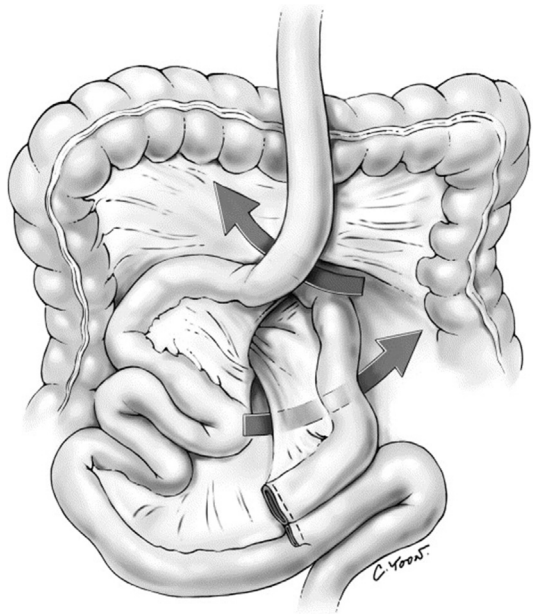

Fig. 7. Potential sites of internal hernia after antecolic RYGB. (*From* Carmody B, DeMaria EJ, Jamal M, et al. Internal hernia after laparoscopic Roux-en-Y gastric bypass. Surg Obes Relat Dis 2005;1(6):544; with permission.)

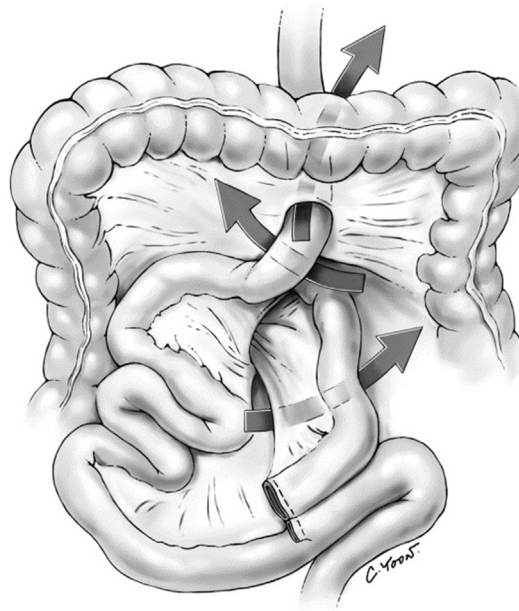

Fig. 8. Potential sites of internal hernia after retrocolic RYGB. (*From* Carmody B, DeMaria EJ, Jamal M, et al. Internal hernia after laparoscopic Roux-en-Y gastric bypass. Surg Obes Relat Dis 2005;1(6):545; with permission.)

BILIARY PANCREATIC DIVERSION WITHOUT AND WITH DUODENAL SWITCH

BPD and BPD-DS are associated with complications similar to RYGB: infection, bleeding, cholelithiasis, small bowel obstruction, anastomotic leaks and stenoses, marginal ulcers, and internal hernias.[62,63] The clinical presentation, diagnosis, and management of these conditions are as described previously. Other adverse symptoms include abdominal bloating and loose stools. Furthermore, postprandial vomiting and epigastric pain may occur because of rapid ileal distention.[17]

LAPAROSCOPIC ADJUSTABLE GASTRIC BANDING

Esophagitis

Esophagitis may occur in up to 30% of patients following LAGB.[64] These patients may present with reflux-like symptoms, such as dysphagia, chest pain, and dyspepsia. This may be related to such conditions as gastroesophageal reflux, hiatal hernia (HH) formation, gastric prolapse, and overly tight gastric bands.[65,66] Treatment is usually initiated based on a clinical presentation and includes acid-suppression therapy and nutritional counseling (ie, consumption of smaller, more frequent meals).

Hiatal Hernia

Because HHs occur in about 53% of severely obese people, they may be present preoperatively.[67] They have also been found postoperatively in association with band slippage, pouch and esophageal dilation, and gastric prolapse.[67,68] One hypothesis is that a "backpressure syndrome" of chronic overpressurization on the proximal pouch contributes to the worsening of a pre-existing or formation of a new HH.[67] Patients with HHs may present with reflux-like symptoms and may be diagnosed using

upper GI radiography or endoscopy. Although initial management is similar to that for esophagitis, surgical revision of the LABG or HH repair may be necessary.

Gastroesophageal Dilatation

Gastric pouch and esophageal dilatation may occur in about 15% and 13% to 14% of patients, respectively, following LAGB.[64,69] Possible etiologies include an overly restrictive or improperly placed band, excessive vomiting, and dietary noncompliance.[17,36,63] Symptoms may include dysphagia, epigastric pain, and inability to tolerate oral intake. Upper GI imaging can establish the diagnosis. Pouch dilatation is usually relieved by deflation of the band. However, esophageal dilatation can cause irreversible damage if not diagnosed and treated in a timely manner. Should complete deflation of the band not resolve the esophageal dilatation, revision or removal of the band or conversion to RYGB may be necessary.[36,63]

Band Erosion

In a review of 25 studies about band erosion (BE) following LAGB (that included more than 15,000 patients), the incidence was 1.46%.[70] Various causes have been postulated including intraoperative injury to the gastric wall, chronic infection, overly tightened band, tissue ischemia, excessive food intake, smoking, NSAID use, and alcohol consumption.[36,63,70,71] Although BE can present between 5 and 51 months after surgery, the mean time of presentation in one study was 22 months.[72] Clinical presentations vary depending on whether the BE results in free leakage of gastric contents or containment by inflammation and scar tissue. The three most common presentations were (1) lack of satiety and failed weight loss, (2) port site infection, and (3) abdominal pain.[70] However, patients may also present with frank peritonitis.[36]

Although upper GI radiography may demonstrate leakage of contrast from the BE site, endoscopy is the preferred diagnostic tool.[17,36,70] Treatment involves surgical removal of the band and repair of any identifiable gastric injury.[17,36]

Band Slippage and Gastric Prolapse

Gastric pouch enlargement can result from downward band slippage or upward herniation/prolapse of the stomach through the band.[63] Reported incidences range from 2.3% to 15%.[66] Clinical presentations mimic those of overly restrictive bands and gastric pouch dilatation: dysphagia, reflux, vomiting, epigastric pain, and food intolerance.[17,36,63] However, unlike gastric pouch dilatation, symptoms of band slippage/gastric prolapse are not improved by deflation of the band.[36,63]

The diagnosis should be evident on an upper GI series. Emergency department management includes repletion of electrolytes and IV fluids. However, timely surgical intervention is needed to avoid complications, such as gastric ischemia, tissue necrosis, and perforation.[17,36,63]

StomaL Obstruction

Stomal obstruction blocks the passage of food from the gastric pouch into the distal stomach. It may occur as either an early or late complication of LAGB. Early stomal obstruction may be caused by postoperative edema, hematoma, an overly restrictive band, incorporation of excess tissue in the band, insufficiently chewed food, or pills.[17,63,73] Late obstructions can result from iatrogenic band adjustment, gastric pouch dilatation, band slippage/gastric prolapse, or BE.[17,63] Patients often present with obstructive symptomatology, such as reflux, vomiting, dysphagia, and epigastric pain. The obstruction is typically evident on upper GI imaging. Conservative treatment is usually first line: IV hydration and band deflation. Endoscopy may be needed if pills

or a food bolus is causing the obstruction. Surgery may be required if there is complete obstruction, lack of improvement with conservative management, or evidence of tissue ischemia or perforation.[17,36,63]

Port Infection

Port infections have an incidence ranging from 0.3% to 9% and may occur during the immediate postoperative period, following port access/band adjustment, or at any point while the port is in place.[38,74] Patients commonly present with local tenderness, erythema, warmth, and swelling over the port site. It is imperative to consider BE if a port infection occurs outside of the immediate postoperative period.[36]

This is usually a clinical diagnosis, although endoscopy and/or CT may be needed to rule out other pathology, such as BE or intra-abdominal abscess.[38,74] Treatment of an isolated port infection involves systemic antibiotics (to cover skin flora) and possibly port removal.[36,74]

SLEEVE GASTRECTOMY

Gastric Leak

The incidence of GLs ranges in the literature from 0% to 7%.[75–77] They most commonly arise from the staple line in the proximal stomach near the gastroesophageal junction probably caused by a combination of mechanical stress and tissue ischemia.[63,76–78] Clinical presentations may be subtle but most commonly include fever, tachycardia, and abdominal pain.[76]

Early identification and treatment of GLs are vital to decrease the associated morbidity and mortality. Unfortunately upper GI radiography is notoriously insensitive for this diagnosis.[75,76] In the stable patient, CT may be more useful (83%–93% sensitivity, 75%–100% specificity).[76] However, re-exploration definitively diagnoses a GL. This procedure should be considered if there is a strong clinical suspicion for GL or if the patient is unstable. Nonoperative management is often the initial approach in stable patients. This includes IV fluids, parenteral antibiotics, and nutrition. Other possibilities include endoscopic or percutaneous drainage and endoluminal stenting.[63,76] Surgical intervention is usually necessary in unstable patients and those with early postoperative leaks. Chronic fistulae are generally managed nonoperatively and may require an average of 44 weeks to close.[76]

Gastric Stenosis

Gastric stenosis is an uncommon complication with a reported incidence ranging from 0.1% to 3.9%.[79] In this condition, delayed gastric emptying or true obstruction results from twisting of the gastric tube or an anatomic stricture. Patients commonly present with dysphagia, nausea, vomiting, or oral intolerance.[79,80]

Although gastric stenosis can be diagnosed with an upper GI series or endoscopy, the latter also has the potential to be of use therapeutically.[80] Patients who present during the immediate postoperative period may be managed conservatively with IV hydration and bowel rest. If there is no improvement, then endoscopic dilation is the next step. For patients with more chronic strictures, treatment options include endoscopy (ie, dilation or stent placement) or surgery (ie, conversion to RYGB).[63,79,80]

Gastroesophageal Reflux Disease

Although most studies have been inconclusive as to the effect of SG on gastroesophageal reflux disease, a recent meta-analysis demonstrated a trend toward an increased prevalence after SG.[81] Patients present with typical reflux-like symptoms

including regurgitation and dyspepsia. Most respond to treatment with proton pump inhibitors, prokinetic agents, and nutritional/lifestyle modifications.[80]

SUMMARY

Obesity is present in epidemic proportions in the United States, and bariatric surgery has become more common. Thus, emergency physicians will undoubtedly encounter many patients who have undergone one of these procedures. Knowledge of the anatomic changes caused by these procedures aids the clinician in understanding potential complications and devising an organized differential diagnosis when evaluating the bariatric surgery patient with abdominal pain.

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