# Management of Bariatric Surgery Early and Delayed Complications

Uri Kaplan

## 1 Introduction

According to the World Health Organization (WHO), obesity rates have almost tripled in the last four decades [1]. It carries a significant public health concern and is associated with increased risk to develop chronic diseases such hypertension, diabetes mellitus, hyperlipidemia, and obstructive sleep apnea. Obesity negatively influences patient's morbidity and mortality.

Bariatric surgical procedures have been shown to be the best treatment option for achieving sustained weight loss and remission of obesity-related comorbidities [2, 3]. Nowadays, most bariatric cases are performed in centers of excellence by trained bariatric surgeons as part of multidisciplinary teams. These factors improve significantly the outcome of bariatric surgery.

The rapid development of laparoscopic instrumentation in the early 1990s had led to surge in bariatric procedures. Data comparing laparoscopic to open gastric bypass found that laparoscopic approach was associated with less complications, shorter hospital stay, and equivalent loss of excess weight [4]. In the last 20 years, with further advancement of laparoscopic bariatric surgery, this approach has become the standard of care. Nowadays, postoperative admissions are short, and some bariatric procedures are performed in outpatient clinics.

The aim of this chapter is to review both early and late bariatric procedure complications. We'll provide diagnostic tools and treatment option for patients who present to the emergency department.

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## 1.1 General

## 1.2 Epidemiology

Obesity has become a global epidemic and currently is one of the major public health challenges. According to the WHO, in 2016, 39% of adults (more than 1.9 billion) in the world were overweight (defined as body mass index (BMI) ≥25 kg/m$^2$) and 13% (over 650 million) were obese (defined as BMI ≥30 kg/m$^2$) [1]. In 2014, the global prevalence of morbid obesity (BMI ≥40 or BMI ≥35 with at least one obesity-related comorbidity) was 0.64% in men and 1.6% in women [5]. There are disparities in the prevalence of obesity across countries. This trend continues within the country among sex, age, ethnic group, and socioeconomic status [6].

Commonly performed bariatric procedures have a morbidity rate between 5 and 10%. In 5% of them, the complications will happen at home [7]. With that being said, the rate of emergency department (ED) visits of bariatric patients is much higher. The rate of ED visits, within 30 days of surgery, is around 11% of patients. The readmission rate is between 4.4 and 5.5%. Around 50% of those visits and readmissions occur in hospitals other than the one where the bariatric procedure was performed [8, 9].

## 1.3 Types of Bariatric Surgery

Knowledge regarding the gastrointestinal tract anatomical changes post-bariatric surgery is a key factor in the management of patients with post-surgical complications.

Historically, bariatric procedures were classified as either restrictive, reducing the volume of food patients can digest; malabsorptive, reducing the absorption of food at the mucosal level; or both. However, it is reasonable to associate the beneficial influence of surgery on the body adipose system as the key factor for bariatric surgery success [10]. The influence of bariatric surgery on the adipose system is beyond the scope of this chapter.

Clinical practice guidelines for bariatric surgery are well established [11, 12]. The fifth International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) global registry report contains data from over 60 countries on over 833,000 operations [13]. According to it, in 2019, the four most common operations worldwide were sleeve gastrectomy (SG) (58.6%), Roux-en-Y gastric bypass (RYGB) (31.2%), omega anastomosis gastric bypass/mini gastric bypass (OAGB/MGB) (4.1%), and adjustable gastric band (AGB) (3.7%). Over the last decade, there is a trend toward reduction in gastric banding and RYGB, while there is a rise in SG and OAGB/MGB procedures. Nowadays, almost all bariatric procedures are performed laparoscopically (99.1%) [13]. Currently, there is no evidence regarding which operation suits each patient, and that is the main reason for many operative options.

### 1.3.1 Sleeve Gastrectomy (SG)

The operation was developed as a first stage for duodenal switch operation however, due to comparable outcomes, became a stand-alone procedure. Most of the stomach

(approximately 70–80%) is excised. The procedure starts with denuding the greater curvature from its blood supply starting 4–6 cm proximal to the pylorus up to the angle of His. A bougie, between 34 and 42 French, is inserted along the lesser curvature, and using a linear stapler, the fundus body and antrum of the stomach are excised creating a tubular pouch. The excised part of the stomach is removed (Fig. 1.I). The procedure is safe (mortality rate of 0.1–0.2%) with low complication rate [14, 15].

### 1.3.2 Roux-En-Y Gastric Bypass (RYGB)

The operation is considered the gold standard of bariatric surgery. The procedure involves the creation of a small proximal gastric pouch of approximately 30 mL. The pouch is separated from the rest of the stomach which is left in situ. The small bowel is divided 50–150 cm distal to the duodenojejunal (DJ) flexure. The distal limb of small bowel is anastomosed to the gastric pouch in an antecolic or retrocolic fashion. This limb is called the Roux limb. The proximal part, termed biliopancreatic limb (BP limb), is anastomosed 50–150 cm distal to the gastrojejunostomy anastomosis (Fig. 1.II). The proximal anastomosis is termed gastrojejunostomy

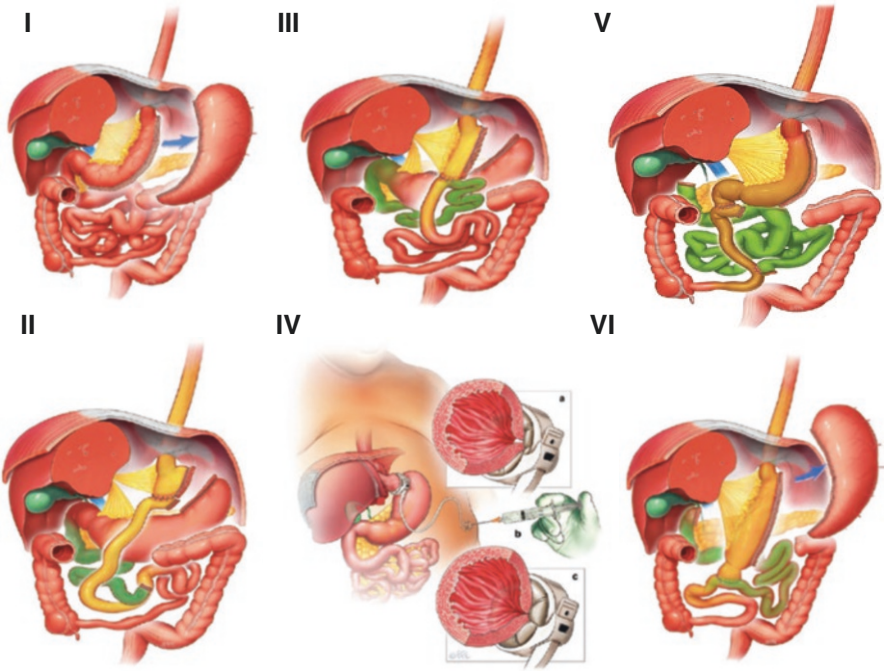



**Fig. 1** Common bariatric surgeries: I, sleeve gastrectomy; II, Roux-en-Y gastric bypass; III, omega anastomosis gastric bypass/mini gastric bypass; IV, adjustable gastric banding (a-deflated band, b-subcutaneous port, c-inflated band); V, duodenal switch; VI, single anastomosis duodeno-ileal anastomosis with sleeve gastrectomy (SADI-S). Reprinted from Ramos AC, Carraso HJ, Bastos EL. (2021). Bariatric Procedures: Anatomical and Physiological Changes. Bhaskar AG, Kantharia N, Baig S, Priya P, Lakdawala M, Sancheti MS (Eds). Management of Nutritional and Metabolic Complications of Bariatric Surgery. (pp. 41–50). Springer Nature

(GJ) and the distal anastomosis is called jejuno-jejunostomy (JJ). Any mesenteric defects are closed. The procedure is safe with slightly higher morbidity and mortality compared to SG with no statistical significance [14, 15].

### 1.3.3 Omega Anastomosis Gastric Bypass/Mini Gastric Bypass (OAGB/MGB)

OAGB/MGB is a recent modification of the RYGB. The procedure is easier to perform. It begins with the creation of a long and narrow proximal gastric pouch which ends at the area of the gastric incisura. The rest of the stomach is left in situ. The small bowel, approximately 200 cm from the DJ flexure, is anastomosed in an antecolic loop fashion to the gastric pouch (Fig. 1.III). The procedure is safe with comparable results to the RYGB [16].

### 1.3.4 Adjustable Gastric Banding (AGB)

The band is an inflatable silicone ring connected by the tube to a subcutaneous injection port. The band is located around the angle of His creating a small gastric pouch of around 30 mL. The band lies in the 2-to-8 o'clock position and usually secured with gastro-gastric sutures overlying the fundus to the proximal pouch. Insertion or aspiration of fluid from the band, via the subcutaneous port, adjusts the degree of constriction (Fig. 1.IV). The procedure is safe with low complication rate [17].

### 1.3.5 Other Bariatric Surgeries

Duodenal switch (DS) involves the creation of gastric sleeve followed by division of the duodenum in his first part. The ileum is divided 250 cm proximal to the ileocolic valve and is anastomosed to the duodenum in a Roux-en-Y fashion (Fig. 1.V). Single anastomosis duodeno-ileostomy (SADI) is similar to DS in terms of the gastric sleeve and duodenum division. However, the ileum is anastomosed to the duodenum in a loop fashion 250–300 cm from the ileocolic valve (Fig. 1.VI). Both procedures are mainly malabsorptive with acceptable safety [18].

## 2 Classification of Bariatric Surgery Complications

Complication post-bariatric surgery can be classified according to the type of surgery, initial presentation, or time from surgery. Almost all bariatric surgeries are performed in minimally invasive technique which enables short hospital stay post-surgery. For that reason, most patients will be evaluated by general surgeons and not bariatric surgeons. We will discuss early complication, which occurs up to 30 days from surgery, and late complication, which occurs more than 30 days from surgery, separately. In each part, we'll discuss the complication according to the initial presentation. In general, the three main complaints to the emergency department will be bleeding, obstruction, and sepsis. The classification is summarized in Table 1.

**Table 1** Complication of common bariatric surgeries

| Early (less than 30 days' postop) | | | |
|---|---|---|---|
| | SG | RYGB/OAGB/MGB | AGB |
| General | Cardiopulmonary complications (including PE, MI) | | |
| Bleeding | Staple line hemorrhage (intraluminal or extraluminal) | Staple line hemorrhage (intraluminal or extraluminal) | Hemorrhage (intraperitoneal) |
| Obstruction | Sleeve stricture | Anastomosis stenosis (GJ, JJ) | |
| | Port site hernia | | |
| Sepsis | Staple line leak | Staple line leak | Esophageal/gastric perforation |
| | | Anastomosis leak | |
| **Late (more than 30 days' postop)** | | | |
| General | Nutritional deficiencies/cholelithiasis | | |
| Bleeding | Esophagitis | Bleeding marginal ulcer | Esophagitis |
| Obstruction | Sleeve twist | Internal hernia<br>Small bowel adhesion | Band overtight<br>Band erosion<br>Band slippage |
| | Port site hernia/small bowel adhesion | | |
| Sepsis | Staple line leak | Perforated marginal ulcers | Port/band infection |

*Postop* postoperative; *SG* sleeve gastrectomy; *RYGB* Roux-en-Y gastric bypass; *OAGB* omega anastomosis gastric bypass; *MGB* mini gastric bypass; *AGB* adjustable gastric banding; *PE* pulmonary embolism; *MI* myocardial infarct; *GJ* gastrojejunostomy; *JJ* jejuno-jejunostomy

## 2.1 Early Complications

Early complications can be classified to nonsurgical, mainly related to general anesthesia and immobilization, and surgical, specific to the procedure itself.

### 2.1.1 Nonsurgical Complication

The nonsurgical complications are similar to other operative procedures and include cardiorespiratory complication and thromboembolic events.

Cardiorespiratory complications are usually present with chest pain or discomfort, shortness of breath, and tachycardia. Analysis of death within 30 days of surgery found that cardiac causes account for 28% of death and pulmonary embolism for 17% [19]. Bariatric population are predisposed to thromboembolic events due to numerous factors, including obesity itself, immobility, hypoventilation syndrome, and venous stasis disease. The rate of deep vein thrombosis (DVT) or pulmonary embolism (PE), up to 30 days post-bariatric surgery, is 2.2%, with a death rate of 0.03% [20]. Patient with chest pain and shortness of breath should have immediate 12-lead ECG, measurement of myocardial enzymes, and chest X-ray. While massive PE is usually fatal, a low threshold for CT angiogram can contribute to rapid diagnosis.

### 2.1.2 Surgical Complication

#### Bleeding

Although massive bleeding post-bariatric surgery is usually diagnosed during the perioperative admission, patient can present with hemorrhagic shock and even exsanguination. The main reasons for bleeding are staple lines, mesenteric or omental vessels, and iatrogenic injuries. In early postoperative period, port site bleeding should be in the differential diagnosis. The incidence of postoperative bleeding ranges from 0.5 to 4% [21]. The rate of reoperation due to bleeding ranges from 0.8 to 2.5% of all postoperative bleeding post-bariatric surgery [22]. Bleeding can be intraperitoneal or intraluminal. The clinical symptoms are tachycardia, oliguria, and decrease in hemoglobin (Hb) level. Gastrointestinal (GI) bleeding can also present with vomiting of blood, hematochezia, or melena. Intraperitoneal bleeding presents as abdominal discomfort or abdominal pain and even as peritonitis.

Staple line is the most common cause for bleeding in patients post-SG. Erosion at the staple line can cause intraperitoneal or intraluminal bleeding. Bleeding will occur in 0–20% of cases; however, only 1.4% will require reoperation due to major bleeding [23]. Early bleeding post-RYGB or OAGB/MGB results mainly due to staple line. The rate of bleeding post-RYGB is 1–4%. Common sites for bleeding post-RYGB are gastric remnant staple line (40%) followed by GJ (30%) and JJ (30%). Major bleeding in OAGB/MGB occurs in 0.2–28.6% of cases with 0.3–0.58% of these cases necessitate intervention including reoperation [23].

#### Obstruction

The prevalence of early post-bariatric surgery obstruction is low. The most common reason is stricture. The main reason for obstruction post-SG is stricture, usually at the incisura angularis (Fig. 2). The common causes for obstruction in the early phase are food intolerance and tissue edema. In RYGB or OAGB/MGB, the main reason is stricture at the anastomosis sites. Strictures in the GJ anastomosis or JJ anastomosis, in case of RYGB, are the main cause for early obstruction. The causes for GJ or JJ stricture are tension and/or ischemia at the anastomosis. Blood clot at the JJ can obstruct the anastomosis. Unlike the GJ anastomosis, which can present more slowly (up to weeks), JJ anastomosis stenosis has more acute presentation and more difficult to diagnose, due to altered anatomy. They present with epigastric pain or discomfort due to remnant distension and even as peritonitis due to gastric remnant perforation [23]. The rate of GJ stricture in OAGB/MGB is rare and was reported around 0.2% in revision cases [24]. The main causes are uneven traction during pouch creation and narrow anastomosis [23]. AGB is designed to partially cause obstruction in the cardia of the stomach. As such, patient can present with symptoms that resemble obstruction. With that being said, the rate of early obstruction is very low.

#### Systemic Inflammatory Response Syndrome (SIRS)/Sepsis

Gastrointestinal leak is the most common cause for sepsis post-bariatric surgery. Although early recognition is difficult in morbidly obese patient, prompt diagnosis

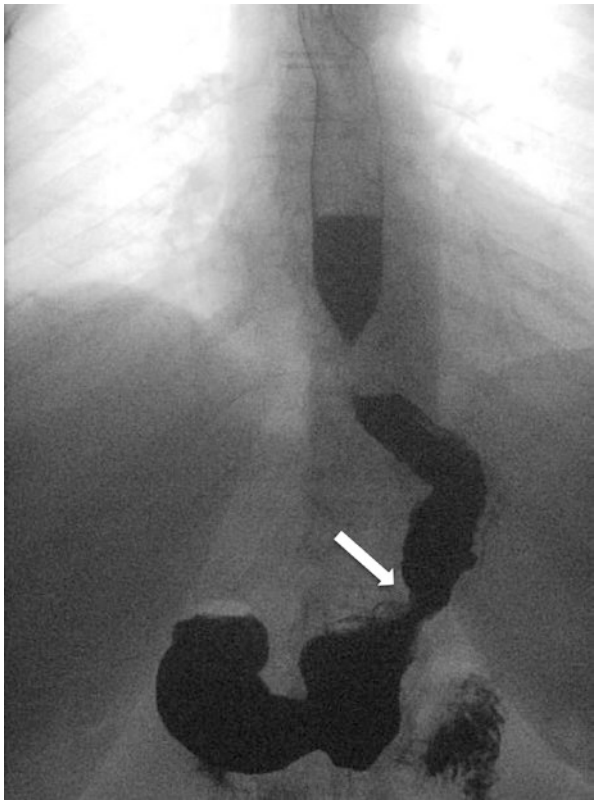


**Fig. 2** Upper gastrointestinal contrast swallow test showing narrowing of the sleeve (white arrow)

is crucial and can minimize the risk of developing chronic fistula or progression to septic shock. The etiology of leaks can be divided into technical issues and patient-related issues. The most common presentation is tachycardia, fever, and abdominal pain. The patient will usually be described as ill-appearing.

Staple line leak is the most dreadful complication of SG. The rate of staple line leak is 1–3% in primary cases and more than 10% in revision procedures [25]. The most common site is near the GEJ. The main two reasons are ischemia and distal obstruction due to stenosis, twist or kink at the incisura angularis. Leak should be categorized according to their occurrence time post-surgery: acute, less than 7 days; early, within 1–6 weeks; late, within 6–12 weeks; and chronic, more than 12 weeks [26].

Small bowel leaks post-RYGB and OAGB/MGB are usually diagnosed earlier, within 3 days of surgery. The rate of leak post-RYGB ranged from 0.1 to 5.8% [23]; however, this rate is gradually decreasing and today it is around 0.3% [27]. The most common sites for leaks are at the GJ anastomosis. Other sites include gastric remnant staple line, JJ anastomosis, and along the small bowel due to iatrogenic injuries. The rates of leaks post-OAGB/MGB are 0.8–1.6% in primary cases and 4.08% in revisional procedures [23].

Esophageal or gastric perforation can present to the emergency department 48 h post-AGB surgery. This complication is rare but should be considered.

## 2.2 Late Complications

### 2.2.1 Nonsurgical Complication

Nutritional deficiencies are common post-bariatric procedures. The most common are anemia due to iron, B12, or folic acid deficiency, abnormalities in bone metabolism, and other vitamin and mineral deficiency. Thiamine (B1) deficiency can occur within 8–15 weeks post-surgery and is related to inadequate repletion and persistent vomiting. Acute presentation, such as Wernicke's encephalopathy, can present with nutritional polyneuropathy, ophthalmoparesis, ataxia, and confusion. Early initiation of supplement can prevent permanent deficits, and recovery typically occurs within 3–6 month [28]. Vitamins and trace element levels should be assessed frequently in the first 2 years and afterward annually.

Cholelithiasis formation is common post-bariatric surgery due to rapid weight loss. The incidence of gallstone formation ranges from 10 to 38% [29]. During rapid weight loss, cholesterol travels from adipose tissue to bile forming high saturation index. This, in turn, encourages cholesterol crystals that eventually form to stones. The progression of asymptomatic cholelithiasis to symptomatic ones is less than 5%, and the rate of cholecystectomy after RYGB is 6.8% [29]. Choledocholithiasis is infrequent post-RYGB, with rate of 0.2–5.3% of cases with cholelithiasis [27]. As in any patient who present with right upper quadrant abdominal pain, biliary disease could be the cause for the emergency department (ED) visit.

### 2.2.2 Surgical Complication

#### Bleeding

The effect of SG on gastroesophageal reflux disease (GERD) is inconclusive [30]. However, patients who suffer from severe GERD can present with upper GI bleeding due to erosive esophagitis. The main cause for late bleeding in patients post-RYGB and OAGB/MGB is bleeding marginal ulcer (MU). MU is an ulcer that develops at the GJ anastomosis, usually at the jejunal side, with multifactorial etiology. The incidence of MU is 0.6–16%, of which 9.27% will require surgical intervention [31]. Symptoms include heartburn, epigastric pain, nausea, and vomiting. Risk factors include nonsteroidal anti-inflammatory medications (NSAIDs) or corticosteroid treatment, nicotine use, and *Helicobacter pylori* infection.

#### Obstruction

Bariatric surgery patients, like any other general surgery patients, can suffer from post-surgery intra-abdominal adhesions. The rate of intestinal obstruction due to adhesion in bariatric patients is 13.7% [32]. Bariatric patients are prone to develop incisional hernia due to their excess weight and comorbidities. The rate of port site hernia post-bariatric surgery has been reported to be as high as 37% [33]. The rate

of symptomatic or incarcerated port site hernia is not well documented, and for that, reason is unknown. Symptoms include nausea, vomiting, and usually focal abdominal pain around one or more of the surgical scars.

Twisting and kinking of the gastric sleeve are the main reasons for obstruction after SG. They account for 1.4% of SG surgeries and the average interval for diagnosis is 37 days [34]. Late obstruction in AGB can be caused by band slippage or overtighten of the band. The rate of slippage is 4.93% [35]. Band slippage can involve prolapse of the posterior pouch, anterior pouch, or concentric. It can deteriorate to ischemia of the gastric wall if left untreated and should be considered if symptoms do not respond to percutaneous decompression. Band erosion means reported rate is 1.46% (0.23–32.65%) [36]. Most cases do not mandate emergency treatment unless the presenting symptom is peritonitis or infection. Most cases will be asymptomatic, however, others can present as loss of restriction, bleeding, port infection, or dysphagia. Proximal migration can cause obstruction of the gastroesophageal junction (GEJ).

Internal hernia (IH) is the most common and dreadful cause for small bowel obstruction after RYGB or OAGB/MGB. It can occur at any time post-surgery but mainly has a late presentation. The incidence ranges from 1 to 5.8%. If not treated surgically, IH has a mortality rate of over 50% [37]. Post-RYGB reconstruction, the small bowel can pass through the new anatomic space. This passage can cause twisting, obstruction, and even incarceration of the small bowel. Nowadays, most RYGB is performed in an antecolic approach which means there are two anatomic spaces: between the two mesenteries of the small bowel at the area of the JJ anastomosis and between the mesentery of the Roux limb, the meso of the transverse colon, and the retroperitoneum. The latter is referred as Petersen's hernia. In a retrocolic approach, a third space is the defect in the meso-transverse colon (Fig. 3). The most common site for IH is the JJ mesenteric defect. Patients have intermittent obstruction and usually do not vomit. The episodic abdominal pain usually delays the diagnosis and imaging may also be negative. Patients with suspected diagnosis of internal hernia and negative imaging may need to undergo diagnostic laparoscopy. In OAGB/MGB, there is only one anatomic space that can cause IH which resembles Petersen's hernia in RYGB. OAGB/MGB has lower rate of internal hernia compared to the RYGB [16].

### SIRS/Sepsis

As mentioned before, the most common cause for sepsis post-bariatric surgery is gastrointestinal leak. Leaks post-SG can be diagnosed 3 months' post-surgery. Perforated marginal ulcer is another cause for bariatric patients to present with sepsis. The rate of perforated marginal ulcer post-RYGB is 0.83% [38].The etiology and outcome of this not well understood.

### Abdominal Pain/Discomfort

Abdominal pain is a common complaint for patient post-bariatric procedure. Abdominal pain was presented in 21.6% of the bariatric patients who present to the ED. In 33.4% of these patients, no explanation of the pain was found [39]. The

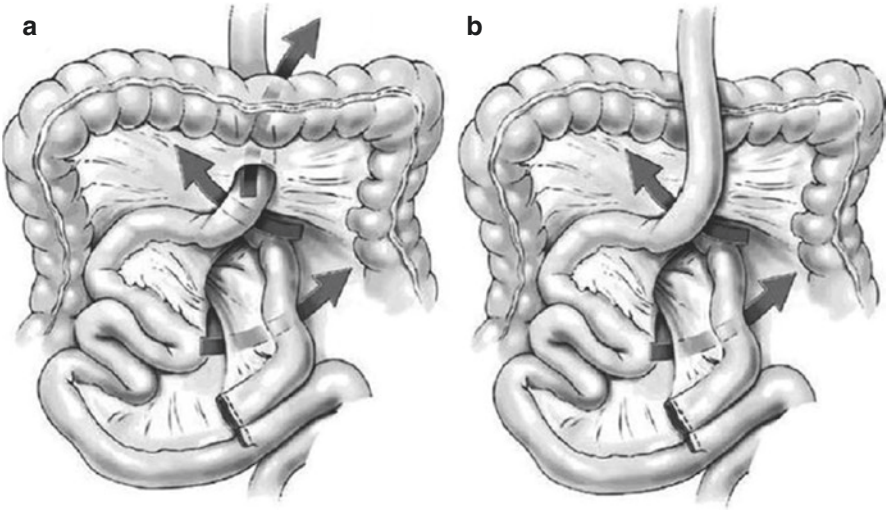



**Fig. 3** Mesenteric defects in Roux-en-Y gastric bypass: (**a**) Retrocolic approach creating three defects. (**b**) Antecolic approach creating two defects. Reprinted from Palermo M, Acquafresca PA, Serra E. (2020). Closing the mesentery defects. Ettinger J, Azaro E, Weiner R, Higa KD, Neto MG, Teixeira AF, Jawad M (Eds). Gastric bypass bariatric and metabolic surgery perspectives. (pp. 181–185). Springer Nature

pathologic features that contribute to the pain are divided into surgical, nonsurgical, and psychological or behavioral. These patients usually undergo numerous tests including imaging, endoscopy, and even surgery.

## 3 Diagnosis

Most bariatric patients will present with complaints of abdominal pain. Emergency department physician needs to complete the diagnosis based on the patients chief complaint and the procedure they have had. Other abdominal pathologies such as pancreatitis, appendicitis, diverticulitis, nephrolithiasis, and hepatitis should be included in the differential diagnosis.

### 3.1 Clinical Presentation

Any patient who arrives to the emergency department (ED) should initially be assessed and stabilized according to ABCs (airway, breathing, and circulation). Initial treatment warrants a special consideration in the obese patient.

#### 3.1.1 Airway

Patient may present with inadequate oxygenation due to problems with airway. It's essential to be prepared for difficult airway management due to their habitus and

difficulties in landmark identification. Preparing an adequate airway management strategy is of paramount importance. Placing the patient in ramped position and adequate preoxygenation are always imperative, and apneic oxygenation, using high flow nasal cannula, should be considered [40].

### 3.1.2 Breathing

Tachypnea can present as an indicator for pulmonary or cardiac disease; however, it may be an indicator for systemic acidotic process. Obese patients have reduced functional residual capacity and as a result suffer from limited oxygen reserve [40]. Calculation of tidal volume during mechanical ventilation should be based on ideal body weight and not actual weight.

### 3.1.3 Circulation

Tachycardia in obese patients should be taken seriously as it can serve as a clue for underline pathology [41]. It can indicate hypovolemia due to dehydration or bleeding, and it can also be the presenting symptom of pulmonary embolus or anastomotic leak. Hypotension is usually a sign of hypovolemia, due to bleeding, dehydration, or sepsis. Resuscitation should be initiated with IV crystalloid in case of hypovolemia or packed red blood cell transfusion in case of active GI bleeding.

### 3.1.4 History

Abdominal pain is the most common principal diagnosis associated with ED visits followed by metabolic disorders and infection [9], whereas abdominal pain nausea/vomiting and dehydration are the main symptoms associated with ED visits. A focused history can help narrow the differential diagnosis. Initial assessment should be in the search for evidence of obstruction, GI bleeding, or infection/sepsis. A meticulous question regarding the nature of the pain can assist the diagnosis. Epigastric pain can indicate GEJ or GJ anastomosis pathology, whereas dull or nonspecific pain could indicate small bowel pathology. Hematemesis, melena, or hematochezia is obvious sign of GI bleeding but can be seen in GI perforation as well. Particular importance should be given to the bariatric procedure itself. Type and time since surgery could give clues regarding the diagnosis. Surgical report is the preferable method; however, surgery that was performed in foreign country or long interval time since surgery could make it difficult to know which procedure the patient had. Medical history including underlying comorbidities, which can alter the initial treatment, as well as current medication and recent medication withhold should be sought.

### 3.1.5 Physical Examination

Abdominal examination could be misleading in the obese patient. The wide distance between the skin and abdominal wall muscle can make it harder to identify signs of peritonitis. Signs of wound infection or localized pain should be sought. Focal tenderness, guarding, and rebound will be difficult to elicit. A benign abdominal examination should not give a false assumption that abdominal pathology is not present.

## 3.2 Tests

### 3.2.1 Laboratory Tests

Initial tests should include complete blood cell count, renal and liver function, lipase, blood gases, and CRP. In case of suspected cardiac ischemia, troponin level should be obtained. Elevated liver enzymes could be seen in gallbladder disease or obstruction of biliopancreatic limb along with elevated lipase. Lactic acidosis can be found in bowel ischemia or sepsis. Blood cultures should be taken in any patients with suspected sepsis or fever. Type and crossed blood products should be prepared in bleeding patients.

### 3.2.2 Imaging Studies

During the early postoperative period, chest X-ray can help in patients with dyspnea for the diagnosis of atelectasis, effusion, or pneumonia. Free air under the diaphragm, in instable patient with abdominal pain, can be seen. Plain X-ray can determine the position of gastric band. The correct position should be in 1–2 to 7–8 position as seen in Fig. 4. Other positions of the band may indicate slippage of the band. Contrast swallow study assists in the diagnosis of leaks at the area of anastomosis or along the staple line; however, the low sensitivity (22–75%) and the high availability of computed tomography in the ED, resulted that contrast swallow study is rarely performed. The use of ultrasound (US) in bariatric patient is questionable due to their habitus. However, patients with suspected gallbladder disease may benefit from US exam.

CT is the main diagnostic tool in the assessment of bariatric patient at the ED and should be considered in the early assessment of patients with signs of obstruction or sepsis. In clinically stable patients with suspected bariatric surgery complication, CT of the abdomen and pelvis with intravenous and small amount of oral contrast has

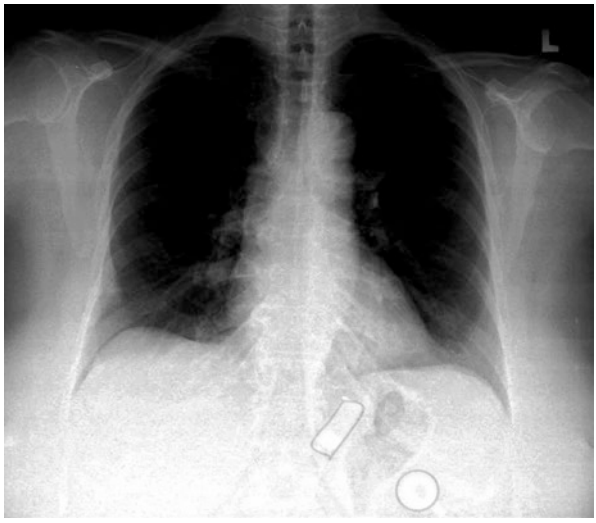


**Fig. 4** X-ray study showing a normally positioned gastric band at approximately 45° to the spine. The band and port are outlined in gray line

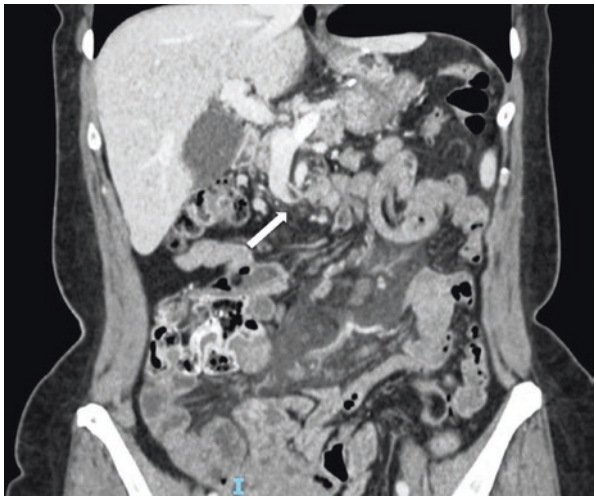


**Fig. 5** CT scan image shows superior mesenteric vein beaking sign. Internal hernia was diagnosed in this post-RYGB patient during diagnostic laparoscopy

higher sensitivity and specificity than contrast swallow study in identifying leak along with the ability to identify abscess, internal hernia, and other pathologies [42]. The addition of the chest to the study can help in ruling out PE or other pulmonary complications. CT detects leaks in the GJ anastomosis or in SG in 60–80% of the cases [43].

CT has a major role in the diagnosis of internal hernia (IH) which is one of the most difficult pathologies to identify. There are several signs for internal hernia in CT exam including swirled mesentery, small bowel obstruction (SBO), hurricane eye, and superior mesenteric vein (SMV) beaking (Fig. 5). The overall accuracy and sensitivity for diagnosis of IH were mesenteric swirl and SBO; however, SMV beaking with SBO had the highest specificity [44]. In case of clinical suspicion, negative CT study does not rule out the diagnosis and surgery should be considered.

### 3.2.3 Endoscopy

Endoscopy is the modality of choice in the diagnosis and treatment of bleeding complication. It can diagnose MU and treat active bleeding. Band erosion is easily diagnosed during endoscopy and, in certain conditions, can be treated by endoscopy. Stricture, leaks, and fistula can also be diagnosed and treated [45]. Most cases of GI bleeding necessitate early endoscopic intervention. Endoscopy is the modality of choice in the diagnosis of band erosion. The decision regarding the use of endoscopy during the diagnosis and treatment of other complication mandates a consultation between the surgeon and the gastroenterologist.

## 4 Differential Diagnosis

The differential diagnosis should be assessed according to the time since surgery, presenting symptoms, and type of procedure. The differential diagnosis is summarized in Table 1.

# 5 Treatment

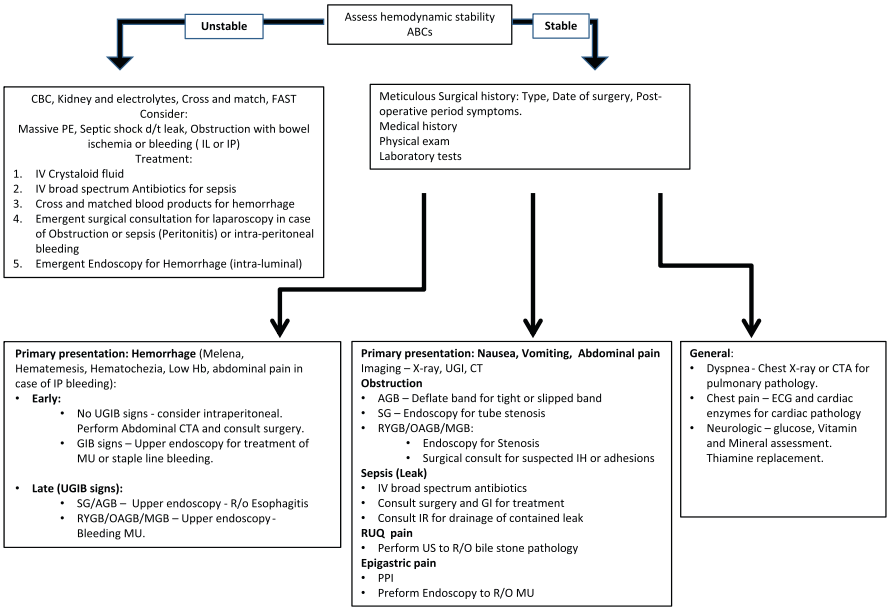
Initial assessment and treatment of bariatric surgery complications is summarized in Algorithm 1.

## 5.1 Medical Treatment

Initial treatment should start with rapid assessment of hemodynamic stability. Most patients will require IV crystalloid fluids. Antiemetic and PPI medication should be considered. Urgent surgical consult should be ordered in unstable patients post-bariatric surgery. The decision regarding explorative laparotomy vs. laparoscopy will be decided based on surgeon experience and preference.

### 5.1.1 Bleeding

The treatment of patients, who present with GI bleeding, should include the initiation of IV proton pump inhibitors (PPI) and blood sample for type and cross. Antidote for anticoagulation treatment should be considered based on




**Algorithm 1** Emergency department assessment and treatment for patient with bariatric surgery complications. *ABC* airway, breathing, circulation; *CBC* complete blood count; *FAST* focal assessment sonography for trauma; *IL* intraluminal; *IP* intraperitoneal; *Hb* hemoglobin; *GIB* gastrointestinal bleeding; *CTA* computed tomography angiography; *MU* marginal ulcer; *UGI* upper gastrointestinal contrast study; *US* ultrasound; *PPI* proton pump inhibitors; *ECG* electrocardiogram. *AGB* adjustable gastric banding; *SG* sleeve gastrectomy; *RYGB* Roux-en-Y gastric bypass

hemodynamic status and type of procedure planned. Upper endoscopy for diagnosis and treatment should be ordered in patients with intraluminal bleeding. Esophagitis or gastritis can be treated conservatively. Bleeding MU will usually respond well to nonsurgical treatment. It includes PPI, sucralfate, and treating causative factors. The indication for surgical intervention includes bleeding that does not respond to conservative treatment including endoscopy.

### 5.1.2 Obstruction

Patients with obstructive symptoms are usually dehydrated. The initial treatment should include IV fluids, electrolyte supplementations, and urinary output assessment. Endoscopy is used for the final diagnosis and treatment in case of stenosis post-SG or at the GJ anastomosis. Dilatation is performed with gradual pneumatic balloon dilatation. Multiple sessions are usually required. IH is treated surgically. Any patient with suspected IH should have immediate surgical consult.

Slipped or overinflated gastric band can be treated by deflation of the band. Band deflation should be performed under strict aseptic condition by any general surgeon. Port site can be difficult to palpate but usually the patient know the exact place. A noncoring needle, Huber needle, is preferably used; however, any needle can be used. The port should be held firmly between the thumb and index finger of the nondominant hand, and the needle should be inserted at the doom of the port until it touches the metallic base of the port. After complete aspiration of the fluid, immediate resolution of symptoms should be made. Patient with complete resolution should be sent to his bariatric surgeon. If symptoms do not resolve, surgical exploration is warrant.

### 5.1.3 Sepsis

The treatment of staple line leak post-SG is challenging. Initial management and the course of treatment are based on time of occurrence and septic condition of the patient [46]. After blood cultures, a broad-spectrum IV antibiotics, covering gram-negative, anaerobic, and gram-positive, in case of wound complication, should be initiated. Patients who are ill-appearing or hemodynamically unstable should have emergent surgical consult. While "contained cause" (e.g,. abscess, contained leak) can be treated conservatively, patients with signs of peritonitis warrant prompt surgical intervention. Initial treatment of leaks includes no oral intake (NPO), IV fluids, PPI, and parenteral nutrition. Percutaneous drainage of collection should be made by interventional radiology (IR). Surgical consult, as well as contacting the bariatric surgeon, is warrant. Other treatment options include stent, double pigtail drain inserted endoscopically, glue, and surgical washout and drainage. In proximal leaks after SG, conservative treatment should last at least 12 weeks before reoperation is considered [25].

Early leaks post-RYGB or OAGB/MGB can be treated conservatively with NPO and parenteral nutrition. Other treatment options include endoscopic stents and over the scope clips. The success rate of RYGB is higher than OAGB/MGB due to the fact that bile and pancreatic fluids do not pass at the anastomosis site.

Patient with the diagnosis of perforated MU is usually ill-appearing and the treatment is surgical.

## 5.2 Surgical Treatment

Patients with bariatric surgery complication and signs of peritonitis or unstable patients should have emergent surgical consultation for prompt surgical intervention. The decision on laparoscopic or open intervention is decided based on surgeon experience. If the patient is stable, transfer to bariatric excellence center is recommended due to surgical experience and supporting multidisciplinary team.

Surgical intervention for bleeding MU who failed endoscopic treatment can include suture of the ulcer with absorbable sutures under endoscopy surveillance, longitudinal enterotomy with suture of the ulcer bed followed by transverse closure of the enterotomy, or redo the GJ anastomosis. The recurrence rate of MU after surgical intervention is 24% after 12 months [31]. The treatment for perforated MU is similar to the treatment of anastomosis leak post-RYGB or OAGB/MGB. The surgical treatment includes primary suture or omental Graham patch with or without gastrostomy to the remnant stomach. Redo of the GJ anastomosis is another surgical option.

Acute SG leak can be treated with surgical irrigation and drainage of the staple line. Re-suture is an option; however, it is not recommended in patients of postoperative day 3–4 or friable tissue. Surgical treatment, after failed conservative treatment, can include total gastrectomy with Roux-en-Y esophagojejunostomy or Roux-en-Y fistulo-jejunostomy.

Obstruction at the JJ warrants surgical treatment. CT scan can help in identifying the precise location—at the BP limb, Roux limb, or both. It can also identify whether the cause is blood clot or not. In case of blood clot, enterotomy with clot removal is an option. Stenosis at the JJ anastomosis warrants redo of the stenotic part or resection of the JJ with reconstruction of a new JJ anastomosis.

The treatment for IH is emergent surgical exploration. In most cases, the bowel in Petersen's hernia traverses from left to right and in case of mesenteric hernia at the area of JJ anastomosis from right to left. Running the small bowel from the ileocecal valve to the DJ flexure can help with orientation during surgery. During surgery, after returning the bowel to their anatomic place, mesenteric defects are closed with nonabsorbable sutures.

Acute band slippage that does not respond to percutaneous band deflation is an indication for urgent surgical intervention. Laparoscopic band removal is usually the treatment of choice. After lysis of adhesion, the band is unclipped or cut and removed. Special attention should be made to divide the band capsule in order to relieve the obstruction symptoms. Skin incision above the port site, removal of the port and the connecting tube end the procedure. Band erosion is usually not treated operatively unless the presenting symptoms are peritonitis or infection. Band erosion above 50% of its circumference can be treated endoscopically. Subcutaneous removal of the port before the procedure is mandated. In case of peritonitis or infection, the treatment of choice is laparoscopic removal of the eroded band, repair of gastric wall, and drainage.

## 5.3 Prognosis

Bariatric procedures are safe. The mortality rate ranges from 0.03 to 0.2% and is constantly decreasing in the last 20 years. The 30 days' serious adverse event rate is less than 6%. The rates of early reoperation and readmission are 0.5–3% and 2.8–4.8% for SG, respectively, and 0.7–5% and 4.7–6.5% for RYGB [46]. Long-term studies found that the rates of reoperations or re-interventions range from 5 to 22.1% [47].

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