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Complications of Roux-en-Y gastric bypass and sleeve gastrectomy

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Abstract

Roux-en-Y gastric bypass and sleeve gastrectomy are two of the most common bariatric procedures performed in 2011. Although the complication rates associated with these procedures are low, the consequences of these complications are significant and can be associated with high morbidity and mortality. Timely diagnosis and proper management of these complications are extremely important. The most commonly used radiologic studies in bariatric surgery are the upper GI contrast study and the CT scan, which are used to rule out leak, obstruction, perforation, anastomotic stricture, or pouch dilatation. As with all imaging studies, a negative result should not override strong clinical suspicion of a complication.

Key words: Gastric bypass—Sleeve gastrectomy—Complication—Upper GI contrast study—CT scan—Bariatric surgery

Bariatric operations currently represent the second most common abdominal procedure in the United States [1]. In 2001, there were an estimated 40,000 bariatric procedures in the United States. By 2008, this number had increased to 220,000 [2]. During the past decade, Roux-en-Y gastric bypass (RYGB) has been the most common bariatric procedure in the United States [3, 4]. Over the past 5 years, however, laparoscopic sleeve gastrectomy (SG) and laparoscopic adjustable gastric banding (LAGB) have gained significantly in popularity [5].

Morbidity and mortality of bariatric procedures have substantially decreased over the last 20 years [6, 7]. The Longitudinal Assessment of Bariatric Surgery, a large multicenter prospective study, reported an overall adverse outcome rate for primary non-band surgical procedures as 5.3% [8]. The same study measured the mortality rate for RYGB and LAGB procedures of 0.3% [9]. Complication rates may be significantly increased for revisional bariatric procedures, with major complication rates as high as 11.5% [10, 11].

While the diagnosis of bariatric complications requires excellent clinical judgment and a high index of suspicion, radiologic imaging is a critically important component of the diagnostic process. Additionally, interventional radiologic procedures may be very useful in the management of such complications. Thus, it is important for both surgeons and radiologists and emergency room physicians to be familiar with the complications of bariatric surgery and their radiological appearance. In this article we discuss the more common complications of RYGB and SG and how imaging techniques may be useful in their diagnosis and management.

Anatomy of gastric bypass and sleeve gastrectomy

RYGB and SG are commonly performed through a laparoscopic approach. Laparoscopic access ports, or trocars, are placed through 5–7 abdominal incisions ranging from 5 to 15 mm in length. Some centers may still perform these bariatric operations through an open approach, typically through a vertical midline incision.

In RYGB, a surgical stapler is used to divide the stomach from the lesser curvature in a cephalad direction to create a small gastric pouch superiorly and a large bypassed gastric remnant inferiorly. The gastric pouch includes the portion of stomach immediately distal to the gastroesophageal junction and is generally 30 mL or less in volume. The jejunum is surgically divided 25–100 cm distal to the Ligament of Treitz and re-anastomosed in a Roux-en-Y configuration. The Roux limb is brought cephalad and anastomosed to the upper gastric pouch. Thus, all ingested food passes first through the esophagus, then into the small gastric pouch before passing across the gastrojejunostomy anastomosis into the jeju-

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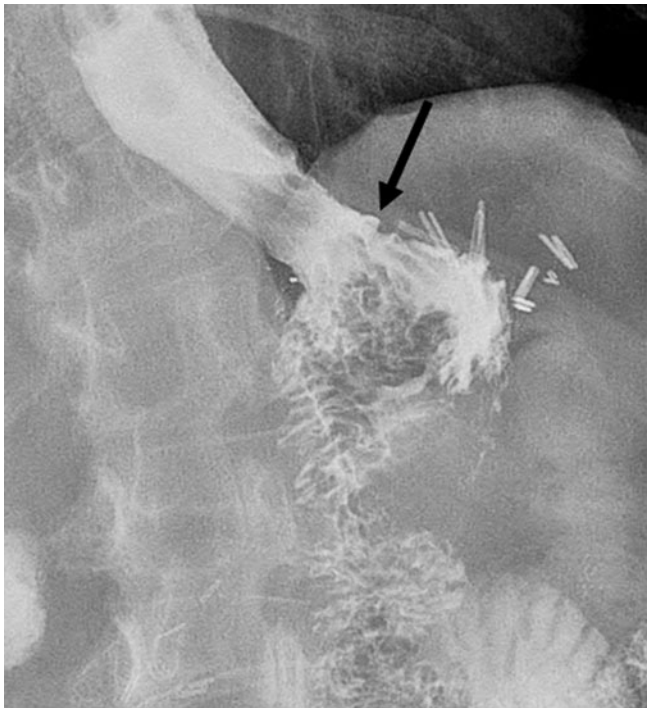

Fig. 1. Normal Roux-en-Y gastric bypass. Gastrojejunostomy is indicated (*arrow*).

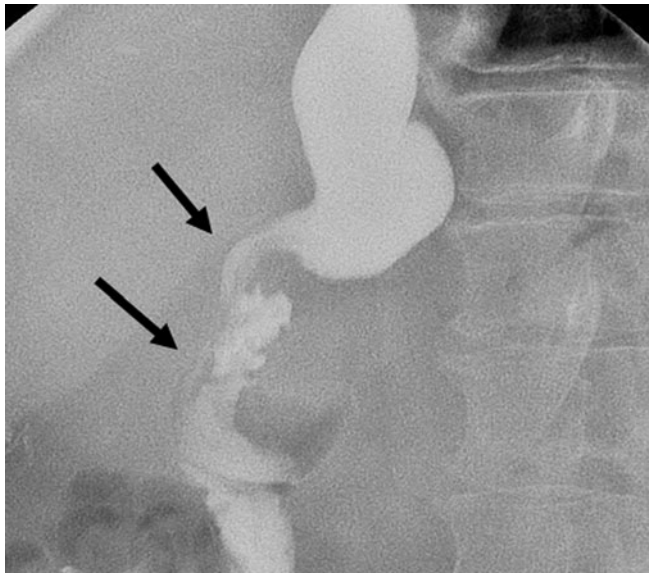

Fig. 2. Normal sleeve gastrectomy. Note the diffuse narrowing of the stomach following resection of the greater curve (*arrows*).

nal Roux limb. The lower stomach, or gastric remnant, is completely bypassed, as are the duodenum and proximal jejunum (Fig. 1).

In SG, a surgical stapler is used to remove the left side, or greater curvature, of the stomach. Typically, a 10–13 mm diameter sizing bougie is placed transorally during surgery, and held in place along the lesser curvature of the stomach. A surgical stapler is then serially fired along the edge of the bougie, starting at the gastric antrum and finishing near the angle of His.

In SG, the excluded portion of the stomach is removed from the patient, leaving a narrow, crescent-shaped stomach based on the lesser curvature, roughly 150 mL in volume (Fig. 2). This is in contrast to the RYGB, in which the gastric remnant is left in situ.

Complications of gastric bypass and sleeve gastrectomy

Enteric leak

Enteric leak is one of the most feared complications following RYGB and SG, as it may rapidly lead to sepsis and potentially death. A delay in diagnosis or treatment in this setting is associated with high mortality [12, 13]. In the RYGB, the most common site for enteric leak is at the proximal anastomosis (gastrojejunostomy) or distal anastomosis (jejuno-jejunostomy). However, enteric leaks may occur at any site along any staple line or elsewhere.

The reported rate for anastomotic leak after RYGB ranges from 0 to 6% in recent studies [14–17]. Enteric leak should always be considered in early postoperative patients with fever, tachycardia, hypotension, or low urine output. Most patients present with an initially unexplained tachycardia which does not respond appropriately to resuscitation. Enteric leak after SG generally occurs as a result of the disruption of the staple line. A review of 12 studies with 1589 patients reported an incidence of 0.9% [18]. The most common site of the leak is at the uppermost end of the staple line, at the angle of His (Fig. 3) [19]. As with RYGB patients, SG patients with leak usually present with abdominal pain, tachycardia, and fever.

In many cases, clinical suspicion of enteric leak is sufficient to warrant return to the operating room for re-exploration. If the diagnosis is equivocal, imaging may be very helpful in confirming the presence of a leak. An upper gastrointestinal (UGI) series with water-soluble contrast is generally felt to be the most useful test in demonstrating enteric leakage after RYGB and SG. The reported sensitivity of the UGI contrast study is variable, ranging from 22 to 75% [13, 20, 21]. Thus, importantly, a negative UGI contrast study should not rule out the indication for re-exploration if clinical suspicion is high [22].

It is imperative to remember that contrast in an UGI series will not fill the bypassed gastric remnant in the RYGB patient. Thus, the study is not able to evaluate whether there is an enteric leak in the gastric remnant. Additionally, a leak at the distal anastomosis may be too far downstream to be clearly demonstrated by UGI

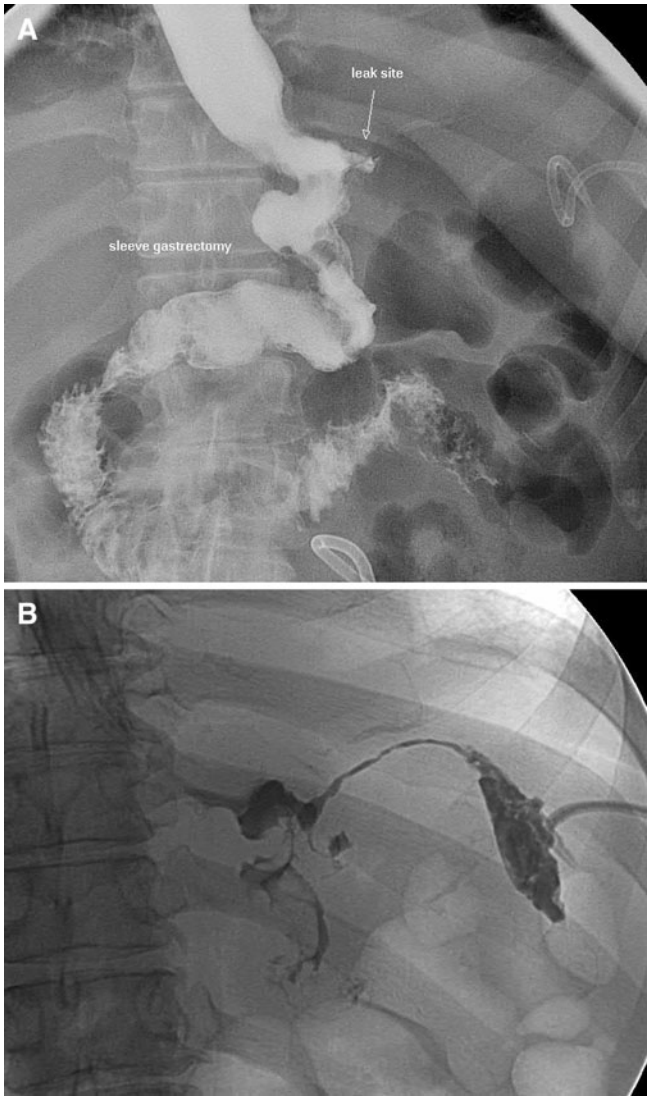

Fig. 3. Leaking sleeve gastrectomy. **A** The water-soluble contrast UGI shows a small leak from the upper border of the sleeve gastrectomy. It is not clear from this single image whether the leak is contained or diffuse. **B** The fistulogram confirms that the leak communicates with the drain.

series. In these situations, CT scanning may be helpful by demonstrating free intra-abdominal air or fluid, abscess formation, or inflammatory changes suggestive of leakage [23]. In contradistinction, the SG stomach may be fully evaluated with an UGI, since there is no bypassed stomach or intestine.

Generally, the presence of an enteric leak warrants surgical re-exploration with washout of the abdominal contamination, closure of the leak, drainage of the area, and placement of an enteral feeding access. However, in the stable patient with a contained leak, non-operative management may occasionally be considered. Some recent reports suggest that staple line leaks after SG may be effectively treated with endoscopic stenting [24, 25].

Hemorrhage

Bleeding after RYGB and SG most commonly occurs at a staple line or anastomosis, and may be intraluminal or intra-abdominal. GI bleeding generally presents with hematemesis if the source is located proximally and with bright red blood per rectum if the site is more distal. A dropping hematocrit in the absence of GI bleeding may suggest a bleeding site in the abdominal wall (trocar insertion site) or an injury to the liver, spleen, omentum, or other intra-abdominal organ. Since the abdominal wall may be quite thick in the morbidly obese patient, many units of blood may be lost into the subcutaneous space without this becoming clinically evident on physical exam. Additionally, it should be remembered that staple lines may bleed into the abdominal cavity as well as intraluminally. The reported rate of early bleeding following RYGB ranges from 0.6 to 4% [26, 27]. As bleeding after bariatric surgery is frequently self-limiting, the decision as to whether operative intervention in necessary needs to be individualized [28].

Generally, significant postoperative hemorrhage with hemodynamic instability is best managed with prompt return to the operating room. The stable patient may frequently be observed [27]. Active hematemesis strongly suggests a proximal source of bleeding and is a reasonable indication for upper endoscopy. This will usually demonstrate the source of GI bleeding if it is located in the esophagus, stomach pouch, or proximal jejunum. Radiologic imaging is not generally useful in the initial management of hemorrhage after bariatric surgery, although abdominal CT scan with oral and IV contrast may demonstrate intra-abdominal bleeding in the form of an intra-abdominal hematoma, an abdominal wall hematoma, contrast blush from a solid organ, or free blood inside the abdominal cavity [29].

Late bleeding in the RYGB patient is usually caused by marginal ulcer formation at or just distal to the gastrojejunostomy site. Such ulceration is thought to be secondary to excessive acid production, tobacco use, irritation from suture material, or non-steroidal anti-inflammatory drug use [30]. In this setting upper endoscopy is most useful as it can be both diagnostic and therapeutic. If upper endoscopy is negative then other imaging modalities such as bleeding scan or capsule endoscopy may be considered, as these will reveal those areas of the GI tract beyond the reach of the flexible endoscope.

As a general rule, the postoperative patient with hemodynamic instability usually requires prompt re-exploration, while stable patients with delayed bleeding can be successfully managed with resuscitation and close observation. In the bleeding patient, it is wise to stop prophylactic anticoagulation agents such as heparin as well as other medications (i.e., NSAIDs) that can potentially increase the risk of bleeding.

Deep vein thrombosis and pulmonary embolus

Deep vein thrombosis (DVT) occurs in 0.4% of bariatric surgery patients and contributes to the overall mortality rate of 0.3%. Bariatric patients suffer from multiple risk factors for this complication including severe obesity, general anesthesia, postoperative status, and decreased mobility [9]. Most bariatric surgeons use multiple methods of DVT prophylaxis including sequential compression devices and heparin, either non-fractionated or low-molecular-weight.

The symptoms of PE include shortness of breath, chest pain, and tachycardia, and overlap considerably with those of enteric leak [31]. In this situation, CT angiography of the chest combined with CT imaging of the abdomen may be very helpful in clarifying the diagnosis. Duplex ultrasound of the lower extremities may demonstrate DVT, but is often technically difficult to perform in patients with significant obesity.

Gastrointestinal obstruction

Early obstruction after RYGB is uncommon, but important to diagnose early, since elevated intraluminal pressure may lead to disruption of a new staple line or anastomosis. Gastrointestinal obstruction is a relatively uncommon complication after RYGB, with a reported incidence of 1.5–5.0% [32–37]. There are many potential causes of obstruction, including anastomotic edema or kinking, peritoneal adhesive bands, internal hernia, jejunal intussusception, and bezoar formation in the gastric pouch [38, 39]. Depending on the level of the obstruction, duration, and the degree of the obstruction patients may present with signs and symptoms of incomplete or complete bowel obstruction. Common symptoms include nausea, vomiting, and abdominal pain [32].

Regardless of the severity of the symptoms, these patients require prompt attention and resuscitation. A high index of clinical suspicion is critical in diagnosing bowel obstruction in this patient population. Compared with UGI and plain abdominal X-rays, CT has the highest sensitivity in identifying small bowel obstruction in gastric bypass patients. CT scan can show the dilated gastric remnant and biliopancreatic limb that may be invisible on plain abdominal X-rays or UGI study. Although useful, the plain abdominal X-ray and CT can yield negative findings even in the presence of life-threatening conditions. In one series, up to 20% of CTs were negative despite clear clinical evidence of bowel obstruction [40]. Adhesive bands cause bowel obstruction more commonly after open bariatric procedures while internal hernias are more frequently seen after laparoscopic approach [32].

Internal hernias may occur in the RYGB patient in three different potential spaces. First is the Petersen space, which in bariatric surgery is described as the space between the transverse mesocolon and Roux-limb mesentery. If the surgeon has placed the Roux limb behind the transverse colon (i.e., retrocolic position), it necessarily passes through an opening in the mesocolon which may enlarge, resulting in a mesocolic hernia (Fig. 4). The third potential internal hernia site is the space between

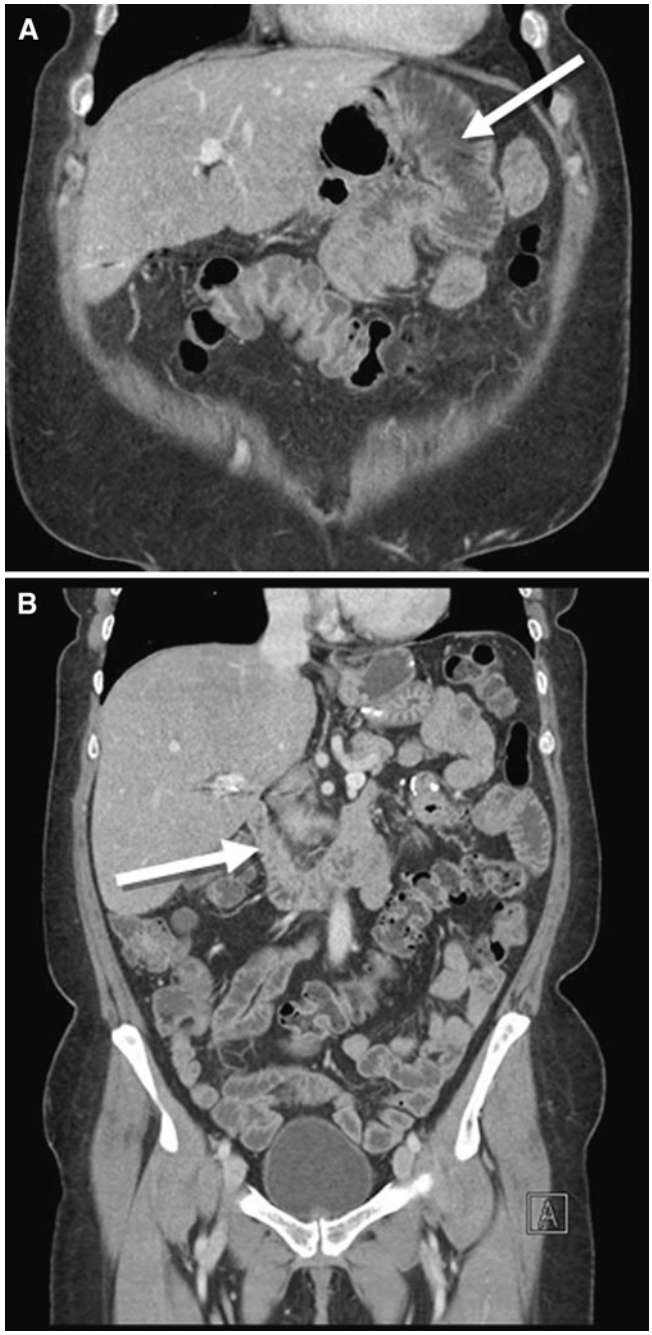

Fig. 4. RYGB with an internal hernia through the mesocolic defect. **A** Coronal CT image showing dilation of the proximal Roux limb (*arrow*). **B** The duodenum (*arrow*) and remainder of the small bowel are not dilated.

the mesenteric leaflets of jejunojejunostomy anastomosis, frequently referred to as a mesenteric hernia [41]. Although internal hernias can cause bowel obstruction, they more commonly lead to compression of the mesentery with resultant intestinal ischemia, resulting in abdominal pain out of proportion to physical exam findings which may be acute or chronic, post-prandial or colicky [42]. Many surgeons advocate suture closure of these potential spaces at the initial operation to prevent future occurrence of internal hernias [37, 41, 43]. Radiographic findings include the characteristic "swirl sign" where the blood vessels of the twisted mesentery form a swirled spiral on contrast-enhanced CT. However, the presence of the swirl sign is neither sensitive nor specific and it should be considered to be an unreliable finding [44]. In general, management of symptomatic internal hernias is surgical intervention with assessment of bowel viability and closure of hernia defects.

Anastomotic stricture can occur in RYGB patients both at the proximal (gastrojejunostomy) and distal (jejunojejunostomy) anastomotic sites with a rate ranging from 3% to 9% and 0.8% to 2%, respectively [38, 45]. Proximal strictures most commonly present with nausea, vomiting, post-prandial pain, and dysphagia [46] and usually present 3–6 weeks postoperatively. Some of the proposed mechanisms for anastomotic stricture formation include ischemia, scar formation, and use of smaller size circular stapler [47–49]. Immediate postoperative stenosis is caused by edema at the anastomotic site and is usually a self-limiting condition.

An upper GI contrast study is a useful tool to demonstrate the level of the stricture. Imaging findings can vary depending on the level of the stricture. For example, a dilated gastric pouch with accumulation of the contrast above the level of the gastrojejunostomy is an indication of stricture at the proximal anastomosis, while a distended gastric remnant and biliopancreatic limb or a dilated alimentary limb represents a strictured jejunojejunostomy [23]. Large quantities of water-soluble contrast should be avoided in the setting of suspected proximal stricture due to possible aspiration and subsequent severe pneumonitis which can be lethal [50]. Upper endoscopy may be preferred to upper GI series, as it allows not only prompt diagnosis but also and effective management of the stricture by through-the-scope balloon dilatation [51].

Intussusception is a rare cause of bowel obstruction following RYGB. Patients commonly present with intermittent abdominal pain. It is sometimes difficult to prove this condition radiologically as the intussusception may spontaneously reduce prior to CT scan. The intussusception generally occurs in a retrograde fashion, where the distal segment of the jejunum intussuscepts into the proximal segment, however antegrade intussusception has also been reported [52]. Once this condition is suspected, surgical intervention is warranted. If the bowel viability is not compromised, then reduction of the intussusception and fixation of the bowel may suffice. If bowel viability is compromised, then bowel resection is mandatory [52, 53].

Gastro-gastric fistula is an uncommon complication of the gastric bypass and occurs in less than 1% of cases [27, 54]. It occurs when the proximal gastric pouch reconnects to the gastric remnant. The cause of the fistula is often an adjacent inflammatory source such as a leak or marginal ulcer. Depending on the size of the fistula, it may be identifiable during an upper endoscopy. However, upper GI contrast study is generally considered to be the most useful tool as it can demonstrate the presence of the contrast inside the gastric remnant. Gastro-gastric fistula can cause failure of weight loss by increasing gastric pouch emptying providing a second means of egress of food from the gastric pouch. Also, it allows gastric acid from the remnant to reflux into the pouch, causing pouch gastritis and marginal ulcer formation. In symptomatic patients, gastro-gastric fistula should be managed surgically [27, 54]. In asymptomatic patients a fistula may be followed and does not necessarily mandate surgical intervention [55, 56].

Complications specific to sleeve gastrectomy

Many complications of SG are identical to those found in RYGB, such as staple line leak, hemorrhage, and DVT/PE. However, there are several issues unique to the sleeve. Patients may develop nausea and vomiting in the early postoperative period which may be due to functional or mechanical obstruction of the sleeve. With functional obstruction, UGI series generally reveals normal post-sleeve anatomy [57]. Mechanical obstruction most commonly occurs at the level of the incisura, and may be caused by excessive narrowing of the stomach by the staple line itself or by postoperative edema (Fig. 5). Upper endoscopy may be helpful for both diagnosis and treatment, as the dilatory effect of the endoscope may relieve the obstruction [58]. High-grade stricture my preclude passage of an endoscope and may require endoscopic balloon dilatation or even surgical revision.

Late-onset gastric sleeve dilatation occurs when the stomach enlarges over time, resulting in failure of weight loss or weight regain [23]. The true incidence of gastric sleeve dilatation is unknown but up to 4.5% of these patients may require re-operation secondary to weight gain [59]. The gastric dilatation can be easily demonstrated by an upper GI contrast study and most commonly occurs at the upper end of the sleeve, often due to retained fundus. UGI will demonstrate a significant dilatation at the upper stomach relative to the lower portion of the sleeve [57]. Surgical intervention may be indicated in the case of significant weight gain or failure of weight loss. Surgical options include sleeve revision, in

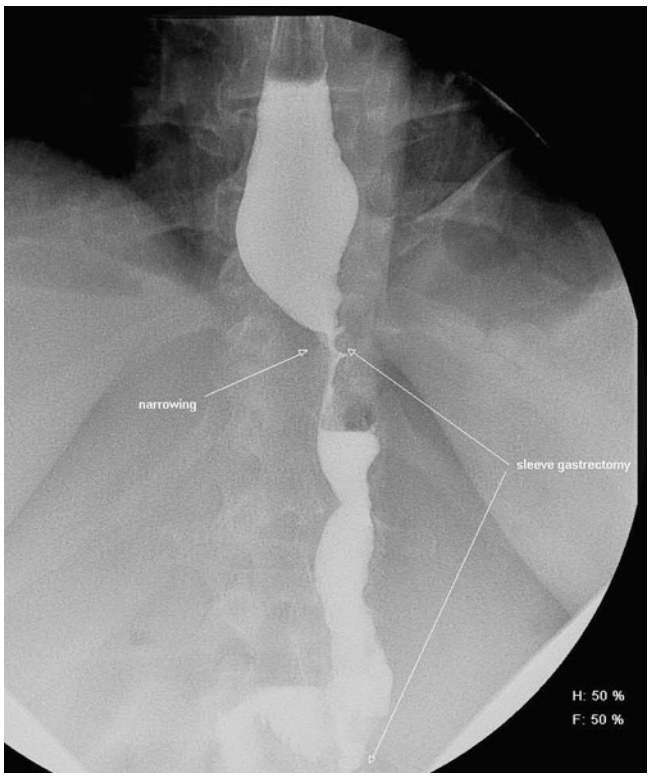

Fig. 5. One month post-sleeve gastrectomy with nausea and vomiting. Note the tight stricture in the proximal aspect of the sleeve.

which the sleeve is made narrower, or conversion to a mal-absorptive procedure like gastric bypass or biliopancreatic diversion with duodenal switch [60, 61].

Summary

RYGB and SG are two of the most common bariatric procedures performed in 2011. Although the complication rates associated with these procedures are low, the consequences of these complications are significant and can be associated with high morbidity and mortality. Timely diagnosis and proper management of these complications are extremely important. The most commonly used radiologic studies in bariatric surgery are the upper GI contrast study and the CT scan, which are used to rule out leak, obstruction, perforation, anastomotic stricture or pouch dilatation. As with all imaging studies, a negative result should not override strong clinical suspicion of a complication.

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