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Review Article

Postoperative Imaging of Bariatric Surgery: What Radiologists Need to Know

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Abstract

Morbid obesity is a serious health problem and in the last 10 years the treatment of severe obesity has radically changed. Bariatric surgery has become an increasingly popular form of treatment for morbid obesity. The purpose of this pictorial essay is to familiarize radiologists with the surgical techniques, postoperative anatomy, and common radiological findings of bariatric surgery complications.

Keywords: *Bariatric Surgery; Obesity; Roux-en-Y Gastric Bypass; Sleeve Gastrectomy; Mini-Gastric Bypass*

Introduction

Obesity has become a serious problem with increasing prevalence worldwide. As an alternative for patients with morbid obesity, bariatric surgery which is accepted as the only long-lasting treatment for morbid obesity has been increasingly performed [1]. Therefore, radiologists have a high probability to encounter such patients in daily practices. Furthermore, complicated anatomy after surgery in these patients makes evaluation tough.

The aim of this pictorial essay is to illustrate postoperative anatomy and the most frequently encountered complications of laparoscopic sleeve gastrectomy, mini gastric bypass, and Roux- en- Y gastric bypass (LRYGBP).

Laparoscopic Roux- en-Y Gastric Bypass

The technique combines both restrictive and malabsorptive approaches, which is more successful to provide sustainable weight loss than the other bariatric procedures. However, restrictive effect of the technique with surgically created gastric pouch is mainly responsible for weight loss [2]. In spite of the advantages of technique over long term weight loss, postsurgical complications followed Roux- en-Y technique are higher [3].

Surgical Procedure

The procedure includes dividing the stomach into a small fundal component (gastric pouch) and a larger excluded component (excluded stomach) using a surgical stapler to create a small gastric pouch. The gastric pouch includes portion of stomach distal to gastroesophageal junction and provides just a 30 ml or less volume. The jejunum subsequently is splinted 25 - 30 cm distal to the Treitz ligament and the distal limb (efferent limb or Roux- en-Y limb) which is distal portion of jejunum is anastomosed to the gastric pouch. Thus, the duodenum and the proximal jejunum are bypassed completely as well as excluded stomach. The proximal limb of the divided jejunum

(biliopancreatic limb, afferent limb) is anastomosed to the more distal jejunum approximately 75 - 150 cm distal to the gastrojejunal anastomosis by means of usually a side to side anastomosis, creating a Y-shaped configuration. Distal to jejunojejunal anastomosis, there is a common channel continuing into the ileum (Figure 1). Roux limb could be anastomosed to the gastric pouch anterior (antecolic) or posterior (retrocolic) the transverse colon [4].

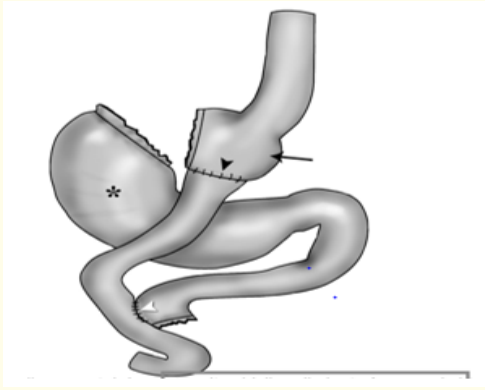

Figure 1: *Diagram shows normal surgical anatomy after Roux-en-Y gastric bypass. A staple line divides the stomach into a small gastric pouch (black arrow) and a much larger excluded stomach (asterisk). The roux limb is joined proximally to the gastric pouch via a gastrojejunal anastomosis (black arrow head) and distally to the biliopancreatic limb via a jejunojejunal anastomosis (white arrow head).*

Imaging

In the upper gastrointestinal examination, the gastric pouch is seen as a small structure with a volume of approximately 15 - 20 ml. If not obstructed, contrast material passes freely into the Roux limb. The examination should not be finished until small bowel is opacified beyond the jejunojejunostomy to assess the jejunojejunal anastomosis. In some patients, a blind small outpouching can be seen, known also as rabbit ear, at the gastrojejunal anastomosis, which is a small part of efferent limb in the patients who have end-to-side anastomosis with gastric pouch. It is possible to differentiate rabbit ear from leak by observing no increase in size of blind ending efferent limb over the time during the fluoroscopy. In addition, seeing bowel signature in the structure is useful to cope with this pitfall imaging. The Roux limb might be antecolic (in front of the transverse colon) or retrocolic (behind the transverse colon) [5]. In the retrocolic approach, efferent limb may be seen slightly narrow on postoperative images because it passes through the mesentery of transverse colon. Mesenteric hematoma also can cause obstruction of efferent limb in early postoperative period, but occlusion of efferent limb completely is seldom [6].

On CT scan, the oral contrast media normally should not be seen in the excluded stomach which is collapsed in these patients. Additionally, it is critical to identify this fluid filled structure to avoid a misdiagnosis of abscess (Figure 2).

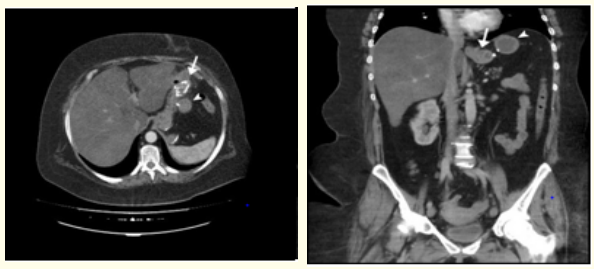

Figure 2 a, b: *Normal CT appearance of the Roux-en-Y gastric bypass. Axial CT image (a) shows the gastrojejunal anastomosis anteriorly (arrow) and the excluded stomach (arrow head) in the left upper abdomen. Coronal reformatted CT image demonstrates the gastric pouch with a suture line (arrow) dividing the small pouch from the excluded stomach laterally (arrow head).*

Complications

Presence of extraluminal oral contrast is an obvious evidence of the leak on CT scan in addition to suspicious findings such as pneumoperitoneum, fluid collection, and abscess. Early diagnosis of the leakage is vital because abscess, peritonitis and sepsis may cause high mortality. Moreover, CT scan is essential in detecting the other potential complications such as internal hernia and small bowel obstructions.

In postoperative early period, a focal narrowing at the gastrojejunal anastomosis may be detected on upper gastrointestinal series (UGI), which results from edema or spasm, and after a short period it resolves. Additionally, strictures can occur at the gastrojejunal anastomosis in 3 - 9% of patients secondary to scarring at anastomosis site or ischemia caused by tension at the gastrojejunostomy [6]. Patients would present with nausea, recurrent vomiting, and dysphagia. UGI reveals focal stenosis at the gastrojejunostomy anastomosis with dilation of oesophagus and gastric pouch but not in the excluded stomach [7].

The incidence of internal herniation through the mesenteric defects ranges from 1.7 - 3.5%. It is a major problem following Roux-en-Y gastric bypass and classical duodenal switch procedure which also uses a Roux-en-Y reconstruction of the biliary limb. Although closure of the mesenteric defects reduces the incidence it is still a main trouble in obese patients. Imaging findings may be inconclusive and clinical findings are often nonspecific. Therefore, the physician should have a high degree of suspicion for this fatal complication and use of the operating room in necessary cases judiciously [8].

Venous thromboembolism (VTE), which includes deep vein thrombosis and pulmonary embolism, is a common cause of postoperative morbidity and mortality in patients undergoing bariatric surgery. Patients with advanced age, priory history of VTE, higher preoperative body weight, and male gender at higher risk of postoperative VTE [9].

Laparoscopic Sleeve Gastrectomy

Laparoscopic sleeve gastrectomy (LSG) is a relatively new, (introduced in 1999), and an increasingly used bariatric surgery technique [10]. The technique consists of the greater curvature gastrectomy in order to form a narrow gastric pouche along the lesser curvature of the stomach (Figure 3). It promotes weight loss by means of restrictive effect while maintaining of normal pathway of food [11]. The procedure is irreversible in which the excluded part of stomach is removed. Owing to the long staple line, leak and hemorrhage are the potential complications of the technique. However, these complications have been reported only in less than 1% of the cases [10]. In contrast to the other techniques there is no risk for malabsorption.

Figure 3: *Diagram demonstrates normal surgical anatomy after sleeve gastrectomy. Note a narrow gastric pouch (black arrow) along lesser curvature and excluded stomach (asterisk).*

Surgical Procedure

The stomach is divided along its long axis and the great curvature of fundus, corpus, and proximal antrum is resected to produce a long tubular gastric remnant [11,12]. Approximately 70 - 85% of the stomach is removed while the distal gastric antrum and pylori are preserved (Figure 3). The remnant stomach volume is only about 100 - 150 ml [9].

Imaging

The UGI is usually performed 1 to 2 days after surgery to rule out staple line leak and sleeve obstruction before starting oral intake. A normal postoperative examination demonstrates a long tubular gastric pouch in patients with a laparoscopic sleeve gastrectomy (Figure 4). However, sleeve can be different shapes. Occasionally, as distal antrum is preserved a widened segment at the distal end of pouch may be seen [12,13].

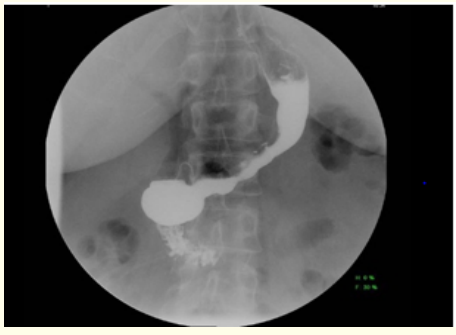

Figure 4: *Normal imaging findings after sleeve gastrectomy. UGI study demonstrates a tubular gastric pouch.*

CT scan is carried out only when a complication is suspected. CT examination displays a tubular narrowed stomach and staple line which is identified along greater curvature of the remaining stomach. Abundant mesenteric fat is seen in the expected location of the resected stomach.

Complications

Main complications of the technique are leaks and bleeding along the staple line. Leak usually occurs at the proximal end of staple line near the gastroesophageal junction [10,14,15]. On UGI, it is detected as extraluminal water soluble contrast material or collections in the left upper quadrant (Figure 5). The two main outcomes are abscess and fistula. Rarely, UGI series may be normal when the leak originates from the upper part of the sleeve because of fast passage of contrast material. Besides, CT scan shows the site of leakage and collections or abscesses which are located in the sub phrenic space (Figure 6a, 6b) [15].

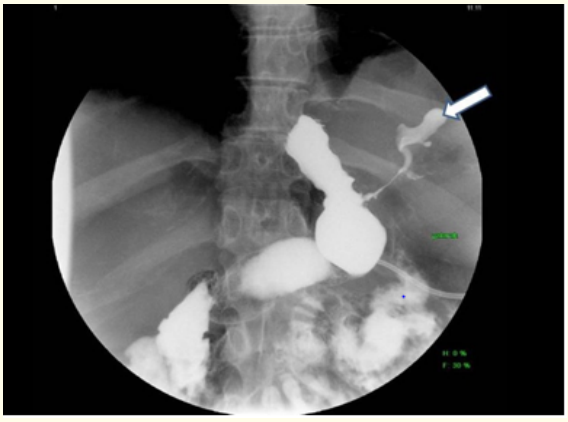

Figure 5: *Common site of leakage following sleeve gastrectomy. UGI series show leak (arrow) at the proximal end of the staple line.*

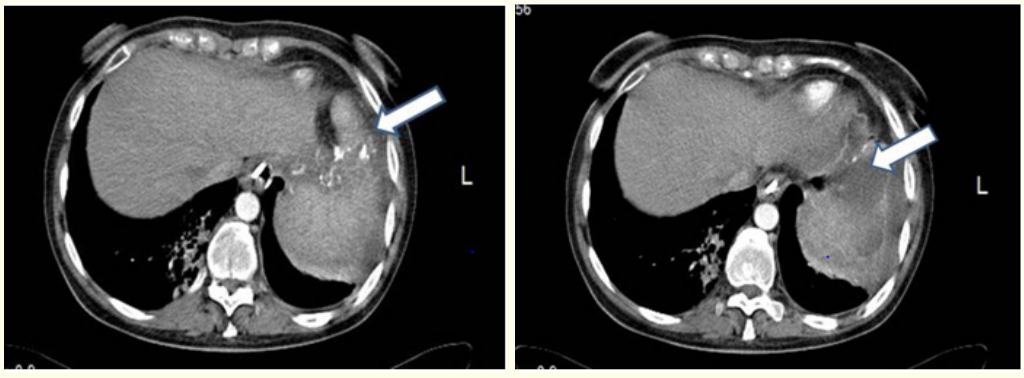

Figure 6 a, b: *Sleeve gastrectomy with postoperative leak. Axial CT images after oral and intravenous contrast material illustrate extravasated contrast material in the left upper quadrant (arrow) (a) and subdiaphragmatic abscess (arrow) adjacent to the upper part of staple line (b).*

Gastric outlet obstruction as a result of scarring along the staple line may develop in some patients which is usually treated endoscopically with dilatation [2,15,16]. Scarring with stricture may occur at the upper, mid, or distal end of the staple line or involve the whole stomach [17]. UGI series show delayed transit of contrast material. Focal strictures also can be encountered in early period, which is secondary to ischemia or edema.

In addition, splenic infarction can develop after sleeve gastrectomy, which is caused by an injury of peripheric splenic arterial branches of short gastric artery close to the spleen. It is identified as a triangular shaped well demarcated peripheral hypodense area on CT images (Figure 7).

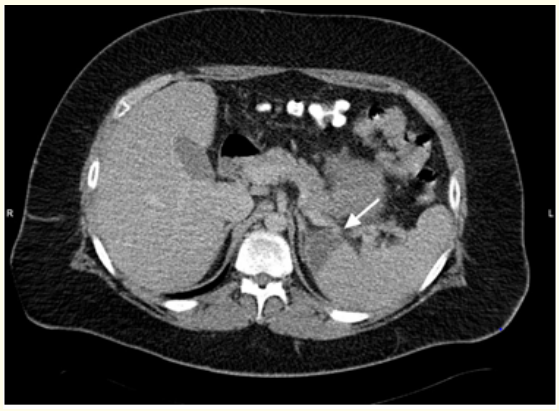

Figure 7: *Splenic infarction. Axial CT image shows a regular peripherally based low attenuation triangular area consistent with splenic infarction (arrow).*

Strangulated hernia through the trocar orifice and abdominal wall hematoma also may be seen following surgical procedure (Figure 8).

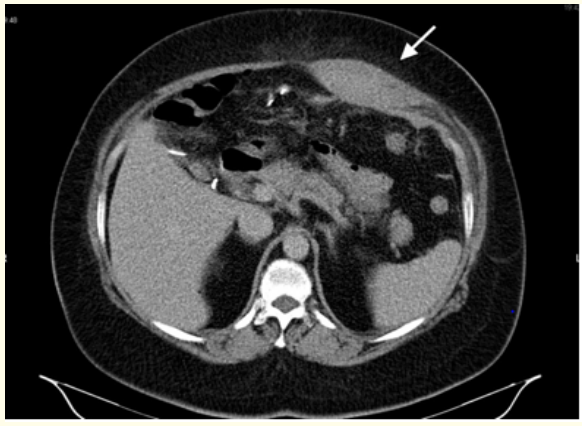

Figure 8: *Abdominal wall hematoma. Axial CT image demonstrates an abdominal wall hematoma (arrow) over the trocar insertion site.*

Portomesenteric vein thrombosis is not a rare complication of laparoscopic bariatric surgery and develops more frequently in the patients with LSG. A high degree of suspicion is particularly important because if diagnosis and treatment of this complication are delayed it can be fatal. Obese patients at high risk for venous thrombosis should be screened for genetic predisposition for hypercoagulable state and considered to be extended thromboprophylaxis postoperatively [18].

Symptomatic cholelithiasis develops in 3.3% of the patients undergoing bariatric surgery. Multivariate analysis reveals that symptomatic cases are usually the patients having sleeve gastrectomy. Body weight loss rate after bariatric surgery plays a significant role in development of biliary pathology in these patients [19].

Laparoscopic Mini-gastric Bypass

In 1990, Rutledge., *et al.* described single anastomosis gastric bypass (Minigastric bypass) as an alternative novel bariatric procedure. Mini-gastric bypass was first performed laparoscopically in 2002 and it has been popularized since 2006 as an effective bariatric surgery [20]. Laparoscopic mini gastric bypass (LMGBP), also known as omega loop gastric bypass, provides weight loss by means of restrictive effect of a small surgically created gastric pouch and malabsorptive effect of small bowel bypass.

The procedure has relatively lower complication rates when compared to the LRYGBP. Lee., *et al.* have compared LMGBP to LRYGBP and indicated that early postoperative rates 3 times higher when compared to LMGBP [21]. In another study by Ozmen., *et al.* no major complications were reported in their series [22]. Furthermore, few studies evaluating the efficacy of LMGBP over LRYGBP have shown that it to be comparable or superior to the LRYGBP [1,23-25].

Surgical Procedure

The stomach is divided from the angle of His to 2 cm proximal to the pylorus through the lesser curvature in order to create a narrow and long gastric tube. Then, the jejunal segment located approximately 200 cm distal to the ligament of Treitz is anastomozed to the gastric pouch via side-to-side anastomosis (Figure 9). As a result, the gastric antrum, duodenum, and proximal jejunum are bypassed. The volume of remnant stomach usually is 150 - 180 ml but it can be adjusted according to the patient's body mass index [26].

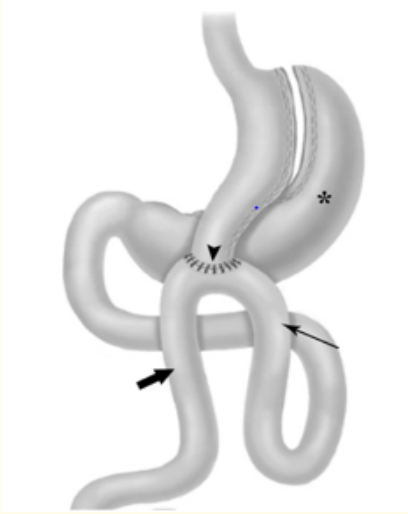

Figure 9: *Schematic representation of a minigastric bypass.*

The main difference between the standard LRYGBP procedure and MGBP is that there is only one anastomosis in MGBP while two anastomosis, an upper and a lower, in LRYGBP.

Imaging

UGI shows relatively easy and fast passage of oral contrast via side-to-side gastrojejunostomy anastomosis and subsequent filling of both afferent and efferent loops with contrast resembling an omega shape (Figure 10). Afferent loop is usually unidentified through the its course because of the angulation at the afferent loop made by an anchoring suture to prevent reflux from bypassed segments.

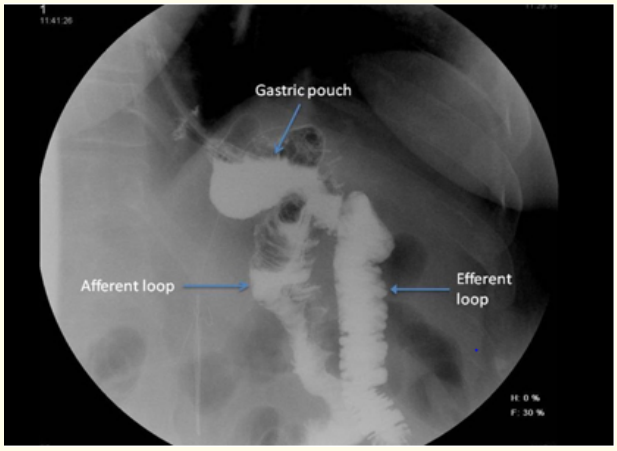

Figure 10: *Mini-gastric bypass. Normal anatomy on UGI study.*

Oral contrast passage might be a little bit slow in early postoperative period due to various factors such as oedema around anastomosis line, postoperative transient motility disorders and ileus.

CT imaging remains as a problem solving diagnostic tool that demonstrates postoperative anatomical relationships and complications.

Complications

Leaks are uncommon, which only occur in 0.5 - 1.9% of the patients, but extremely crucial complications. The most common site of leakage is the gastro-jejunostomy site. Water soluble contrast agent spread into the extraluminal space and create a perigastric soft tissue during a UGI study. In addition, localized fluid collection in an unexpected site and abscess are highly suspicious findings of leakage on a CT scan.

Marginal ulcers are found in 0.6 - 8% of the patients following gastric bypass surgery. The causes of marginal ulcers are exposure to acid and large gastric tube. Endoscopy is more reliable than UGI series or CT scan for diagnosis of the ulcers.

Stricture or stenosis at gastrojejunostomy site is a relatively frequent complication of the procedure (Figure 11) [24]. Early stricture or severe edema should be considered when contrast material remains static in the esophagus longer than one minute. Constant distension and air-fluid in the remnant stomach and the esophagus on follow up studies indicates a stricture that requires balloon dilatation using endoscopy [25].

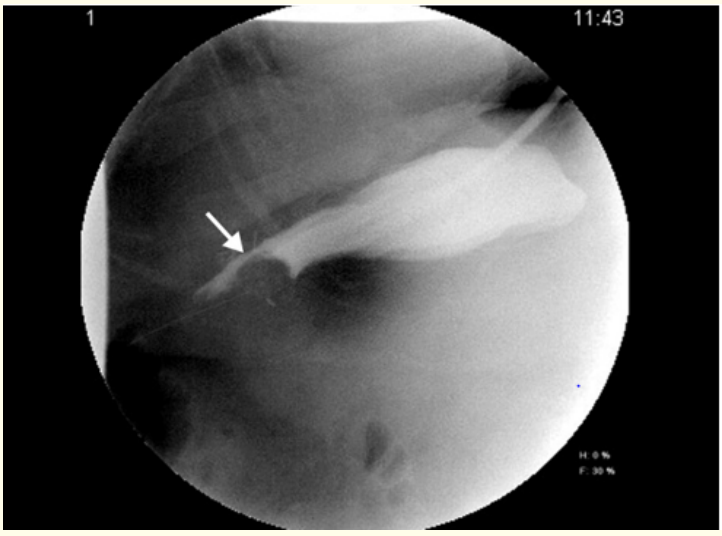

Figure 11: *Stricture after mini-gastric bypass. UGI study shows short segment of marked narrowing (white arrow) at gastrojejunostomy site. Also noted the gastric dilatation.*

Hematoma also may exist in the surgical field, such as staple line and gastrojejunostomy site. CT shows a high-density fluid or hemoperitoneum [26].

Conclusion

Currently, radiologists have encounter with patients having bariatric surgery much more than before in their daily practice. In this regard, surgical procedures, postoperative normal findings and associated complications of these frequently performed bariatric procedures should be known for accurately interpretation.

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