

# Bariatric/Metabolic surgery for the radiologist: Clinical insight, normal post-operative imaging and imaging of complications

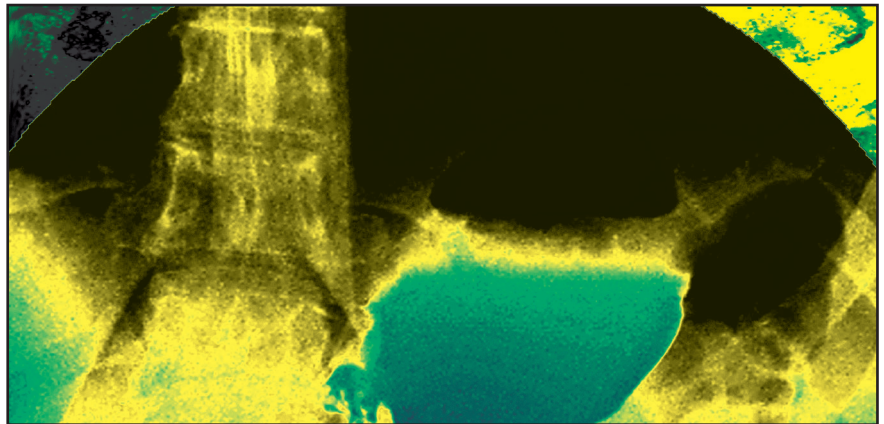
## Part 2: Laparoscopic Roux-en-Y gastric bypass

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*Editor's note: This is the second installment of a two-part article. The first part was published in the November 2016 issue of Applied Radiology.*

**T**he current obesity epidemic in the U.S. is associated with major medical and social problems accompanied by increased morbidity and mortality, which is proportional to the degree of excess weight.<sup>1</sup> In “Bariatric/Metabolic Surgery for the Radiologist: Clinical Insight, Normal Post-Operative Imaging and Imaging of Complications. Part 1 - Gastric Restrictive Surgery,” the body mass index (BMI), the BMI obesity scale, and the indications for bariatric procedures were reviewed.

Bariatric procedures are classified as restrictive, malabsorptive or a combination of both. Laparoscopic adjustable



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gastric banding and laparoscopic sleeve gastrectomy are purely restrictive procedures, which rely on decreased food intake and dietary modification for weight loss. Laparoscopic Roux-en-Y gastric bypass (LRYGB), presently the most commonly performed bariatric operation in the U.S., combines gastric restriction and malabsorption to achieve weight loss, by creating a small gastric pouch and a jejuno-jejunal bypass. Bilio-pancreatic diversion with duodenal switch, another type of bypass, is technically more challenging and commonly reserved for the super obese pa-

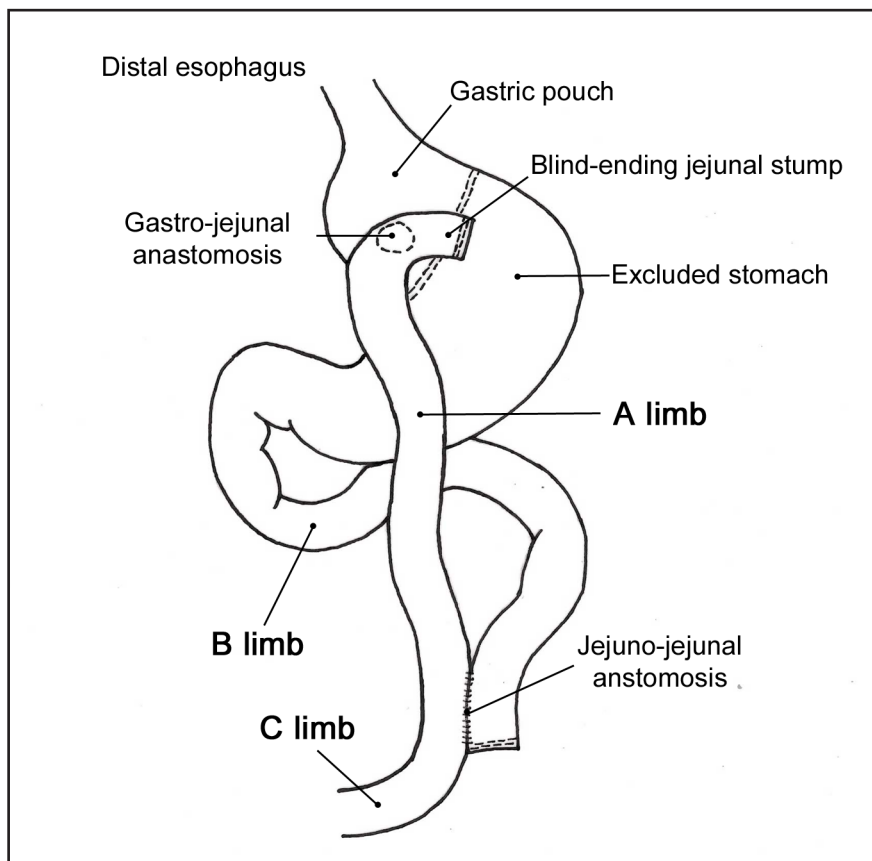
tient with BMI > 55 or for revision of failed bariatric procedures. LRYGB can result in control of diabetes and hypertension within weeks of surgery. This article highlights and reviews the clinical and radiological features of normal LRYGB; in addition, it reviews the radiologic appearances of complications, which are summarized in Table 1.

### Laparoscopic Roux-en-Y gastric bypass (LRYGB)

With LRYGB, a small fundal pouch with a 15-30 ml capacity is created by dividing the stomach from the lesser

**Table 1. Complications specific to laparoscopic Roux-en-Y gastric bypass**

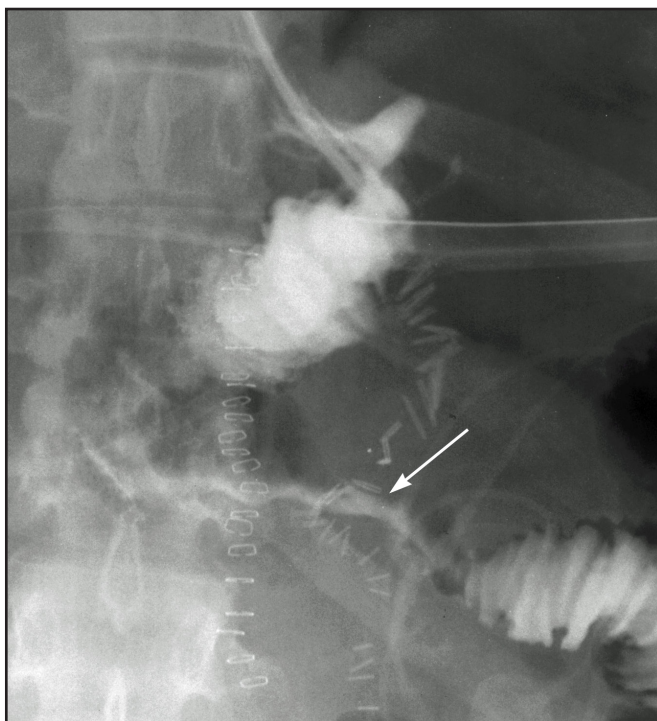
Complication	Clinical Factors	Imaging Findings
Leak	<ul style="list-style-type: none"> <li>Time of occurrence post surgery               <ul style="list-style-type: none"> <li>Early (1-3 days)</li> <li>Intermediate (4-7 days)</li> <li>Late (&gt; 8 days)</li> </ul> </li> <li>Types:               <ul style="list-style-type: none"> <li>I – contained without dissemination or fistula to abdominal or pleural cavities</li> <li>II –dissemination to abdominal or pleural cavity or contrast appearing in a drain</li> </ul> </li> <li>Clinical indicators: tachycardia, respiratory distress, fever, abdominal pain, leukocytosis</li> <li>Chronic late contained leaks may be asymptomatic</li> <li>High clinical index of suspicion is crucial (sensitivity of fluoroscopic exam varies from 22 to 75%)</li> </ul>	<ul style="list-style-type: none"> <li>Upper GI series/CT scan: Extra-luminal oral contrast in a track, collection, free in peritoneal cavity and/or in a drain.</li> <li>If not apparent on UGI series, CT scan may be helpful in demonstrating subtle leaks, abscess, pneumoperitoneum and/or inflammatory changes</li> <li>Sites:               <ul style="list-style-type: none"> <li>GJ anastomosis (majority)</li> <li>gastric pouch</li> <li>blind jejunal stump</li> <li>JJ anastomosis</li> <li>excluded stomach</li> </ul> </li> <li>Pitfall: attention to differentiate a leak from gastro-gastric fistula</li> </ul>
Small Bowel Obstruction (SBO)	<ul style="list-style-type: none"> <li>Occurs in 5% of patients</li> <li>Etiology: adhesions, internal hernias, anterior abdominal wall hernias, stricture at JJ anastomosis, bezoar at the JJ anastomosis, intussusception</li> <li>CT has the highest sensitivity to detect SBO, however diagnosis may be difficult due to post-surgical anatomy</li> <li>The imaging findings of SBO due to adhesions and internal hernia overlap</li> <li>Closed loop obstruction and ischemic bowel are more common with internal hernias</li> <li>Internal hernias can occur without bowel obstruction or dilatation and they may be intermittent making the diagnosis more challenging</li> <li>Clinical presentation of internal hernia: acute or chronic abdominal pain and vomiting. Pain out-of-proportion to the physical findings suggests ischemia.</li> <li>Intussusception, usually at the JJ anastomosis, is often a transient finding on CT scan and rarely cause SB</li> </ul>	<ul style="list-style-type: none"> <li>ABC Classification System:               <ul style="list-style-type: none"> <li>Type A: dilated A limb with decompressed B-limb (A-limb obstructed above JJ anastomosis)</li> <li>Type B: dilated B-limb (closed-loop obstruction) obstruction at or above JJ anastomosis</li> <li>Type C: SBO at the common channel with dilated A- and B-limbs</li> </ul> </li> <li>Adhesions: abrupt transition of small bowel caliber with upstream bowel dilatation</li> <li>CT findings of internal hernia:               <ul style="list-style-type: none"> <li>Clustered small bowel loops, particularly in the left upper quadrant</li> <li>Displacement of the JJ suture line to the left upper quadrant or right abdomen</li> <li>Closed loop obstruction pattern with 2 small bowel transition points close to each other</li> <li>Stretching and swirling of the vessels with mesenteric vascular engorgement</li> <li>Ascending course of tightly clustered small bowel mesenteric vessels</li> <li>Dilatation of the A-limb</li> </ul> </li> <li>UGI series findings of internal hernia:               <ul style="list-style-type: none"> <li>Clustered small bowel loops, particularly in the left upper quadrant (but may be in any abdominal location)</li> <li>Displacement of the JJ suture line to the left upper quadrant or right abdomen</li> <li>Visualization of loops of bowel entering and exiting the clustered segment; in and out sign</li> <li>± small bowel obstruction</li> </ul> </li> </ul>
Gastro-gastric fistula	<ul style="list-style-type: none"> <li>Breakdown of gastric staple line</li> <li>Early: associated with extra-luminal leak in 90%</li> <li>Late: weight gain and loss of sensation of early satiety</li> </ul>	<ul style="list-style-type: none"> <li>UGI series:               <ul style="list-style-type: none"> <li>Contrast seen entering the bypassed excluded stomach</li> <li>Contrast in excluded stomach but not in the B-limb raises suspicion of fistula</li> </ul> </li> <li>CT scan:               <ul style="list-style-type: none"> <li>Contrast in excluded stomach but not in the B-limb raises suspicion of fistula</li> </ul> </li> </ul>
Hemorrhage	<ul style="list-style-type: none"> <li>Majority occur at the GJ staple line but may occur at JJ anastomosis, a port site, mesentery or solid viscera due to surgical trauma</li> <li>Majority are self-limited</li> <li>Staple line hemorrhage:               <ul style="list-style-type: none"> <li>Intra-luminal: manifests with upper GI bleeding (diagnosed and may be treated with endoscopy)</li> <li>Intra-abdominal: drop in hematocrit without upper GI bleeding</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>CT scan:               <ul style="list-style-type: none"> <li>Hyperdense (60 to 80 HU) fluid collection adjacent to the staple line, other abdominal site, abdominal wall</li> </ul> </li> </ul>
Transient post-operative anastomotic edema	<ul style="list-style-type: none"> <li>Resolves in one week</li> </ul>	<ul style="list-style-type: none"> <li>Narrowing of the GJ anastomosis</li> <li>Contrast fails to exit the gastric pouch</li> </ul>
Anastomotic stricture	<ul style="list-style-type: none"> <li>Typically 4 weeks post surgery due to scarring / chronic ischemia from excessive tension on the gastrojejunostomy</li> <li>Nausea, vomiting, pain and rapid weight loss</li> <li>Can be treated with endoscopic dilatation</li> </ul>	<ul style="list-style-type: none"> <li>Pouch dilatation</li> <li>Delayed or lack of emptying of the gastric pouch</li> <li>Short segment smooth stricture at the GJ anastomotic site</li> </ul>
Marginal ulcer	<ul style="list-style-type: none"> <li>Epigastric pain and GI bleeding</li> <li>Multifactorial pathogenesis; diagnosis often made on endoscopy</li> <li>May not be apparent on fluoroscopic imaging</li> </ul>	<ul style="list-style-type: none"> <li>Collection of contrast in the ulcer crater at the GJ anastomosis or A-limb adjacent to the GJ anastomosis</li> </ul>
Ischemia of the Roux-en-Y limb (A-limb)	<ul style="list-style-type: none"> <li>Vascular supply of A-limb is compromised</li> <li>Mild (self limited) or severe (can lead to bowel infarction)</li> <li>Pain, nausea, vomiting, and pain shortly after surgery</li> </ul>	<ul style="list-style-type: none"> <li>Spiculated folds and thumb-printing of the affected bowel (due to edema and hemorrhage)</li> <li>Chronic ischemia: stricture or giant ulcer in the A-limb</li> </ul>



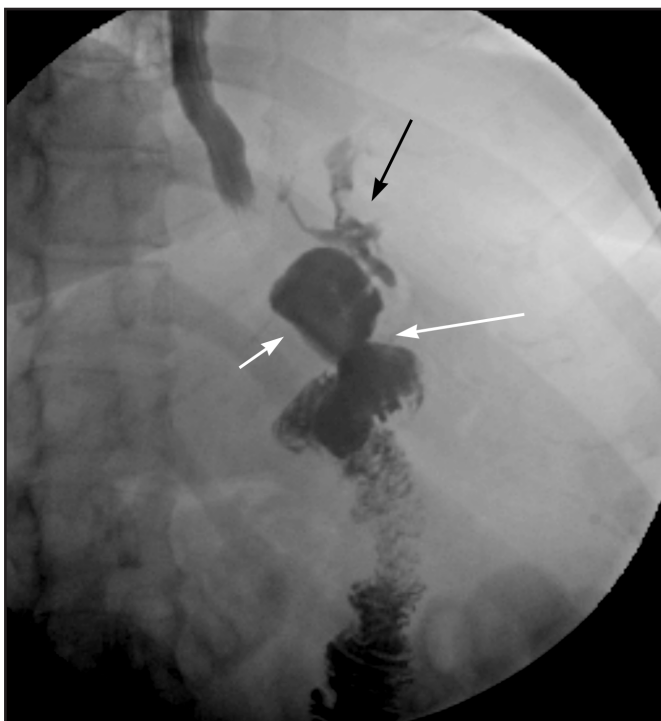
**FIGURE 1.** Schematic drawing of Roux-en-Y gastric bypass.

curvature in a cephalad direction using a linear stapler-cutter device. The jejunum is divided 25 to 100 cm from the ligament of Treitz. The distal limb [Roux limb or alimentary (A) limb] is mobilized superiorly, either anterior or posterior to the transverse colon, for a gastro-jejunal (GJ) anastomosis. For the posterior approach, a small window is created in the transverse mesocolon. The gastro-jejunosomy is usually an end-to-side anastomosis, resulting in a blind jejunal stump, with a small stomal diameter ranging from 8 to 12 mm to provide gastric restriction. The proximal limb of jejunum [biliopancreatic (B) limb] is anastomosed, usually in side-to-side fashion with a linear stapler-cutter device, to the small bowel 75 to 150 cm from the GJ anastomosis, leading to a common (C) limb that continues into the ileum (Figure 1).<sup>2,3</sup> The length of bypassed bowel is determined by the degree of malabsorption desired.

On fluoroscopy, the gastric pouch should be small, approximately 4 cm in diameter. Also on fluoroscopy, optimal imaging of the GJ anastomosis without

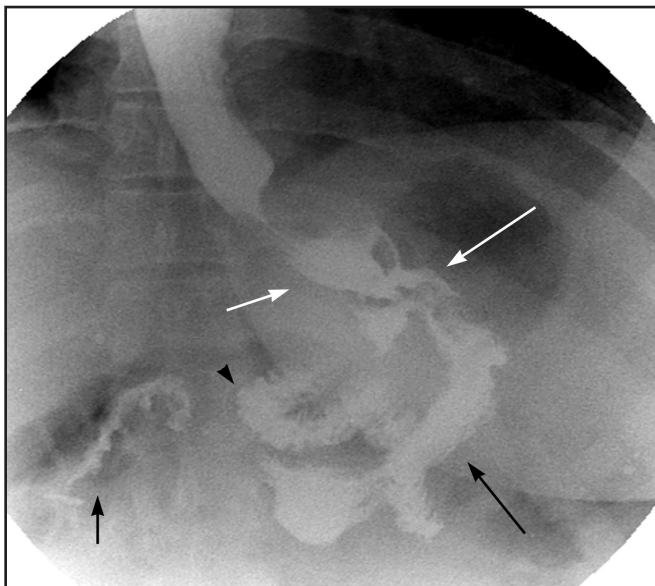


**FIGURE 2.** Upper GI series. Transmesocolic narrowing of the A limb (white arrow) after open Roux-en-Y gastric bypass.

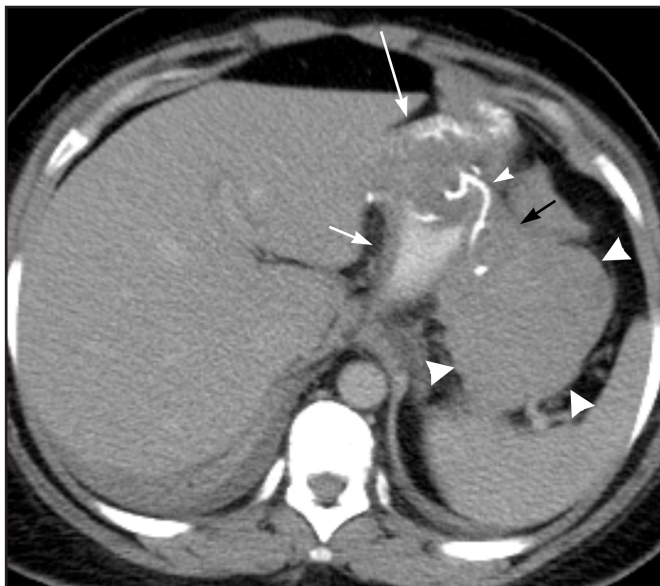


**FIGURE 3.** Upper GI series. Leak from the gastric pouch (short white arrow) with irregular extraluminal contrast tracks (black arrow). The gastro-jejunosomy is shown in profile (long white arrow).

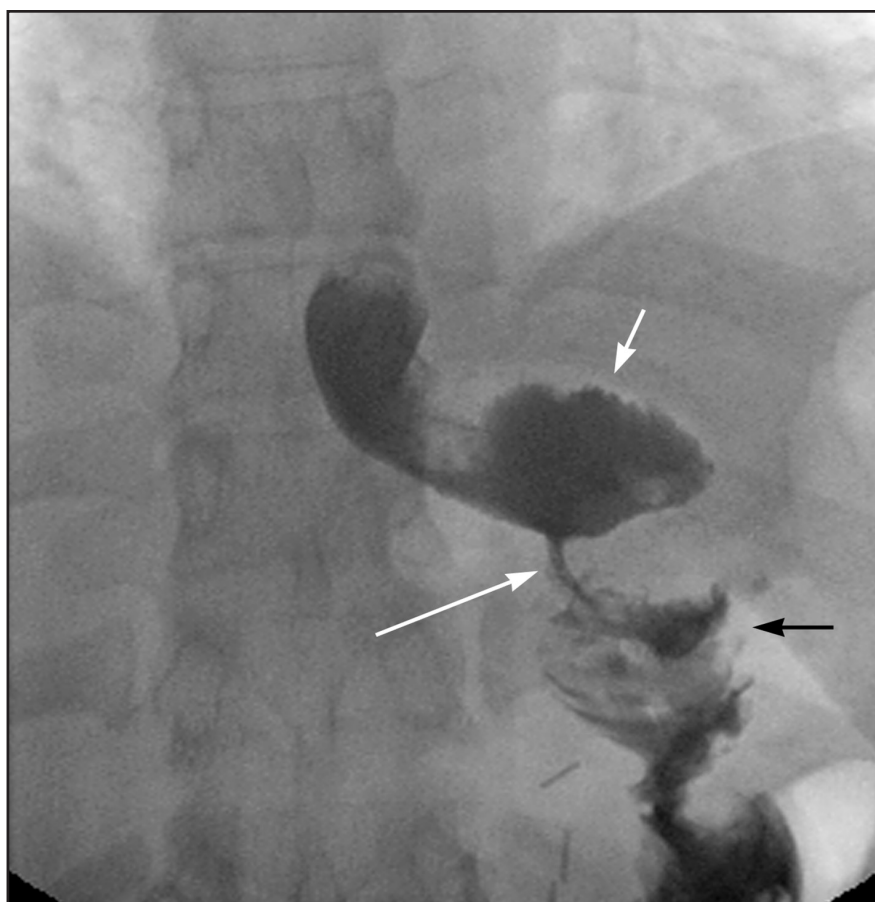




**FIGURE 4.** Upper GI series. Staple line dehiscence with gastro-gastric fistula. Contrast track (long white arrow) from the pouch (short white arrow) into the excluded stomach (long black arrow) and duodenum (short black arrow). The A limb (black arrowhead) is demonstrated.



**FIGURE 5.** Axial CT scan. Portion of a large perigastric hematoma (large white arrowheads) inseparable from the excluded stomach (black arrow) following RYGB. Gastric pouch (short white arrow), staple line (small white arrowhead) and Roux-en-Y limb (A limb) (long white arrow) are demonstrated.



**FIGURE 6.** Upper GI series. Early postoperative edema with narrowing of the gastro-jejunostomy (long white arrow) without obstruction of flow between the gastric pouch (short white arrow) and the Roux-en-Y limb (A limb) (short black arrow).

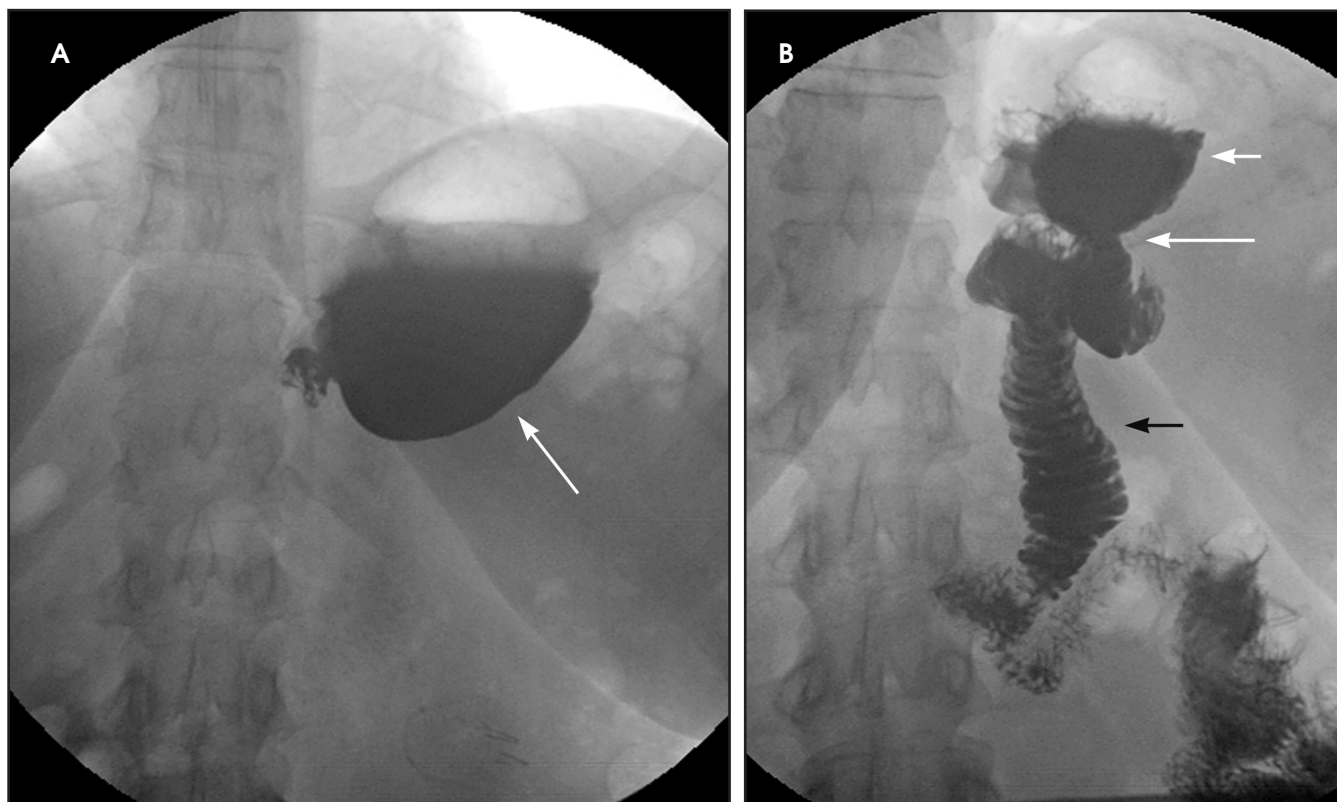
overlapping loops is obtained on AP projection for an anastomosis inferior to the pouch, or in steep oblique or lateral projections for anterior or posterior pouch anastomoses.<sup>4</sup> By following the leading edge of the contrast column fluoroscopically, the examiner can prevent overlapping bowel from obscuring pathology.<sup>4</sup> The retro-colic A-limb may have a short segment of circumferential narrowing at the transverse mesocolon window, which should not be mistaken for an ischemic or adhesive stricture (Figure 2).<sup>4,5</sup>

## Appearance of complications

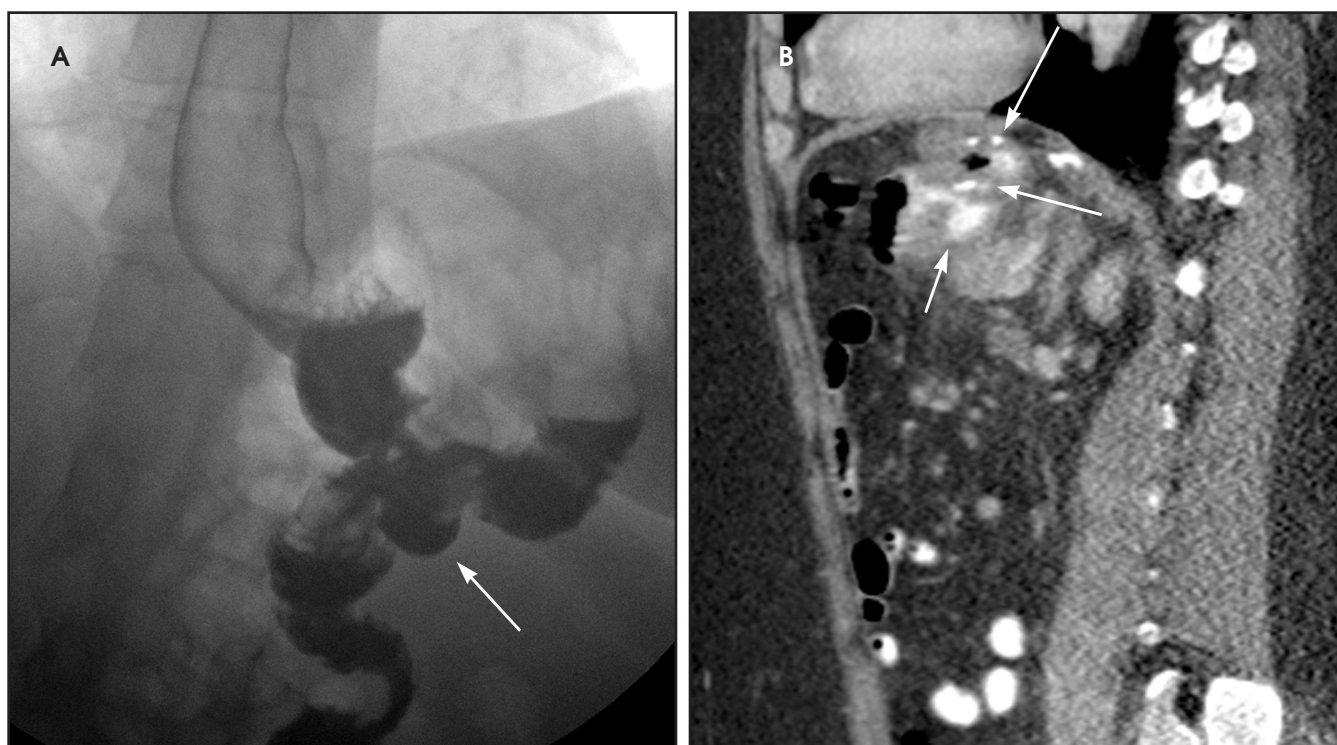
### Leak

Leak is one of the most feared complications, occurring in up to 6% of patients,<sup>6,7,8</sup> with the potential to rapidly progress to sepsis and death. Delayed diagnosis is associated with high mortality.<sup>9,10</sup> Most leaks occur at the GJ anastomosis; other potential sites of leak are the gastric pouch, blind jejunal stump, excluded stomach and the jejuno-jejunal (JJ) anastomosis.<sup>6,10,11</sup> Tachycardia, with heart rate > 120 bpm, is the earliest and most reliable clinical sign of a leak.<sup>4,10</sup> Some centers perform a routine upper GI exam with water-soluble





**FIGURE 7.** A.B> Upper GI series. (A) Dilated gastric pouch with air-fluid level (arrow) and no passage of contrast into the Roux-en-Y limb (A limb) due to stricture at the gastro-jejunosomy. (B) After successful endoscopic dilatation of the gastro-jejunosomy (long white arrow), contrast passes from the gastric pouch (short white arrow) to the Roux-en-Y limb (A limb, black arrow).



**FIGURE 8.** (A) Upper GI series shows contrast pooling in giant ulcer (white arrow) at the level of the gastrojejunostomy. (B) Sagittal CT scan shows contrast pooling in the giant ulcer crater (short white arrow); gastro-jejunosomy suture lines (long white arrows).



**FIGURE 9.** Coronal CT scan. Type B obstruction at the jejunio-jejunal anastomosis with dilated excluded stomach (long white arrow) and B limb (short white arrows). Oral contrast is seen in the C limb (black arrow) below the jejunio-jejunal anastomosis (white arrowheads).



**FIGURE 10.** Coronal CT scan. Internal hernia through the transverse mesocolon defect. Obstructed and herniated A-limb (white arrows), transverse mesocolon suture line (white arrowhead) and transition point in the narrowed Roux-en-Y limb (A limb, black arrow) passing through the transverse mesocolon defect.

contrast 1 to 2 days following surgery to exclude an early leak, though leaks from the bypassed portion of the stomach cannot be ordinarily diagnosed with GI series and JJ anastomotic leaks may be difficult to demonstrate.<sup>2</sup> As a result, even if the GI series is negative, a high index of suspicion for leak may result in surgical exploration.<sup>10,12</sup> Radiographically, a leak is detected when extraluminal contrast is identified in a track (Figure 3), collection, free in the peritoneal cavity and/or in a drain. Leaks are classified chronologically as: early (1 to 3 days), intermediate (4 to 7 days) and late (> 8 days). Clinically, leaks are classified as: (a) Type I - contained, with no dissemination or fistulae to abdominal or pleural cavities or lack of contrast material in the drain, and (b) Type II - disseminated to the abdominal or pleural cavities, and/or with appearance of contrast material in the drain. CT scan can show intra-abdominal fluid, pneumoperitoneum, extraluminal contrast, abscess, and/or inflammatory changes suggestive of a leak.<sup>2</sup> Most leaks require surgical exploration, closure of the site of leakage, washout of

the abdominal cavity, and placement of a drain and an enteral feeding tube. In some cases, contained leaks may be treated successfully with percutaneous drainage and antibiotics.<sup>2</sup>

### **Gastro-gastric fistula**

A gastro-gastric fistula is differentiated from an extraluminal leak by observing progression of the barium from the pouch directly into the excluded stomach (Figure 4). Gastro-gastric fistula occurs in up to 3.5% of patients.<sup>13</sup> Early fistulae are associated with extraluminal leak in 90% of patients and may heal spontaneously. Upper GI series better demonstrates a fistula with the excluded stomach because contrast is followed in real time.<sup>2</sup> On CT scan the excluded stomach is normally collapsed, but it may contain a combination of air, fluid and oral contrast, which may have refluxed from the jejunio-jejunostomy into the B-limb.<sup>14</sup> Gastro-gastric fistula is suspected on CT scan when contrast is seen in the excluded stomach, but not in the B-limb. Late gastro-gastric fistulae are associated with flattening of the weight loss curve

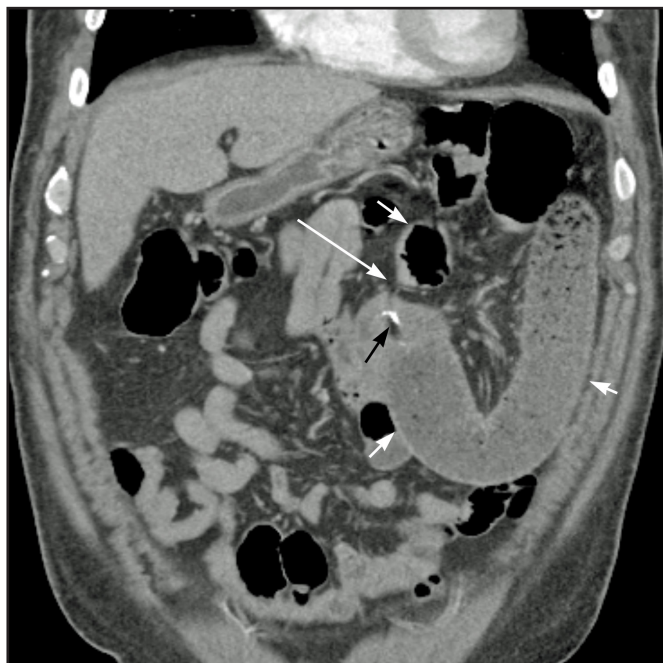
or weight gain and present with loss of early sensation of satiety, often requiring surgical revision.<sup>13, 14</sup> Repeated pouch over-distention may be a predisposing factor.<sup>14</sup> Weight gain may also be due to dietary indiscretion with widening of the GJ anastomosis.

### **Hemorrhage, strictures, edema**

Hemorrhage after LRYGB occurs in 0.6 to 4%<sup>8,15</sup> usually at the gastric staple line or GJ anastomosis. Intraluminal hemorrhage presents with upper GI bleeding and is usually diagnosed and treated with upper endoscopy whereas intra-abdominal hemorrhage presents with a drop in hematocrit without upper GI bleeding.<sup>2</sup> Extraluminal hemorrhage is usually self-limited, managed conservatively and diagnosed with CT scan (Figure 5). Continued bleeding and hemodynamic compromise may require an intervention.

Transient postoperative edema or spasm with narrowing at the GJ anastomosis usually resolves in the first week (Figure 6). Fixed strictures of the GJ anastomosis occur in 3 – 9 % of patients, typically 4 weeks after surgery,

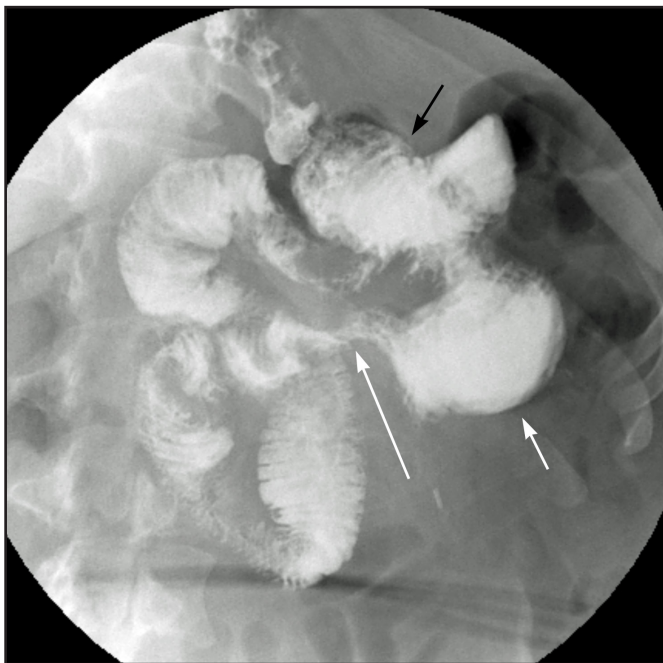




**FIGURE 11.** Coronal CT scan. Internal hernia in the small bowel mesenteric defect with closed loop obstruction. The C-shaped dilated small bowel loop (short white arrows) with two adjacent transition points in the small bowel mesenteric defect (long white arrow) adjacent to the mesenteric defect suture line (black arrow).



**FIGURE 12.** Coronal CT scan. Small-bowel obstruction due to internal hernia. Cluster of non-dilated bowel loops converging to a single point in the mesentery (short white arrow) with dilated contrast-filled proximal small bowel (long white arrows). The gastrojejunostomy anastomotic site (black arrow) is demonstrated.



**FIGURE 13.** Upper GI series. Internal hernia of the Roux-en-Y limb (A limb) (short white arrow) with in-and-out sign (long white arrow). The gastric pouch (black arrow) is indicated.



**FIGURE 14.** Coronal CT scan. Intussusception (between black arrowheads) at the jejuno-jejunal anastomosis (black arrows) causing obstruction. Dilated proximal bowel containing oral contrast (short white arrow) and decompressed distal small bowel (long white arrow).

due to scarring or chronic ischemia from excessive tension on the gastrojejunostomy.<sup>2,4,8</sup> The clinical presentation includes postprandial vomiting, bloat-

ing, pain, and sometimes, rapid weight loss. On upper GI series, a short-segment of smooth narrowing of the GJ anastomosis with a dilated pouch and

delayed emptying of the pouch is observed. Strictures are generally treated successfully with endoscopic dilatation (Figure 7).<sup>16</sup>





**FIGURE 15.** Axial CT scan. Non-obstructing bezoar mixed with oral contrast at a patulous jejuno-jejunostomy site (white arrow).

### **Ulcers, small-bowel obstruction, hernia**

Marginal ulcers at the gastrojejunostomy occur in 3 to 16% of cases.<sup>17,18</sup> Ulcers are often solitary, variable in size, and present with epigastric pain and GI bleeding. Possible etiologies include excessive acid production, tobacco and NSAIDs use, suture material irritation, and surgical issues such as the configuration of the pouch, or tension and ischemia of the A-limb.<sup>17</sup> Bleeding ulcers are frequently diagnosed and treated with upper endoscopy.<sup>2</sup> When visible on the upper GI study, the ulcer crater appears as an outpouching at the GJ anastomosis or abutting the A-limb (Figure 8).<sup>4</sup> Ulcers are treated with proton pump inhibitors or with surgery if medical therapy fails.

Ischemia of the A-limb may develop when there is increased tension and presents with upper abdominal pain, GI bleeding or nausea and vomiting soon after surgery. The degree of ischemia and radiographic findings are variable. UGI series may show spiculated folds

or thumb-printing of the A-limb due to submucosal edema and hemorrhage. Chronic ischemia can lead to stricture and presents with intractable nausea and vomiting or rarely a giant ulcer in the A-limb.<sup>4</sup>

Small bowel obstruction (SBO) occurs in 5%<sup>2</sup> of patients. It may be due to adhesions, internal hernias, abdominal wall hernias, and stricture, bezoar or intussusception at the JJ anastomosis. CT scan has the highest sensitivity to diagnose and determine the cause of SBO.<sup>2</sup> Internal hernias are common after LRYGB.<sup>19</sup> The ABC Classification System differentiates the 3 types of SBO based on the point of obstruction relative to the JJ anastomosis: Type A is an obstruction above the JJ anastomosis with a dilated A-limb, Type B is an obstruction at or above the JJ anastomosis with a dilated B-limb and excluded stomach (closed loop obstruction with high risk of perforation) (Figure 9), and Type C is an obstruction at the level of the common small bowel channel distal to JJ anastomosis with dilatation of

both the A and B-limbs.<sup>4</sup> Acute gastric distention due to edema or obstruction of the JJ anastomosis can cause gastric staple line dehiscence or GJ anastomosis disruption causing leaks.<sup>1</sup>

Internal hernias following LRYGB are reported in 1.6 to 5% of patients and occur at the: (a) transverse mesocolon defect (Figure 10), (b) between the mesenteric leaflets at the JJ anastomosis (mesenteric hernia) (Figure 11, or (c) at Peterson's space behind the A-limb between the transverse mesocolon and the A-limb mesentery.<sup>2</sup> Rapid weight loss with decreased intra-abdominal fat and enlargement of the mesenteric defects can predispose to internal hernias.<sup>6,20</sup> Internal hernias may be asymptomatic or cause closed loop obstruction, which has a higher propensity of ischemia, infarction and perforation of the strangulated loop. The diagnosis of internal hernia may be challenging when bowel obstruction or dilatation is absent or intermittent.<sup>11,20</sup> Symptoms of internal hernias include acute or chronic abdominal pain and vomiting. Pain out of proportion to the physical findings suggests the presence of ischemia. Differentiation of SBO due to adhesions from an internal hernia may be difficult due to overlapping imaging features on CT scan.

Findings of internal hernia on CT scan are: small bowel loops clustered in the left upper quadrant, or in other abdominal locations (Figure 12), JJ suture line displaced to the left upper quadrant or right mid abdomen (normally located in the left mid abdomen), closed-loop obstruction pattern with two small bowel transition points adjacent to each other (Figure 11), stretching and swirling mesenteric vessels with vascular engorgement, ascending course of tightly clustered small bowel mesenteric vessels and dilatation of the A-limb (Figure 10).<sup>4,20</sup> Internal hernia findings on SB series include: small bowel clustered in the left upper quadrant, mid abdomen, and less commonly in other sites, displacement of bowel and suture line, visualization of loops of bowel entering and exiting the clustered segment (Figure 13), and small bowel dilatation in

case of associated obstruction.<sup>21</sup> There should be a high index of suspicion for an internal hernia in any post-gastric bypass patient presenting with abdominal pain due to the potential for ischemic bowel, which is associated with high morbidity and mortality.

### Other complications

Intussusception usually occurs at the JJ anastomosis, which can act as a lead point, with altered bowel mobility as a contributing factor. Intussusception most commonly is transient and non-obstructing; occasionally persistent and large intussusceptions cause small bowel obstruction (Figure 14).

Food stasis and bezoars in a patulous JJ anastomosis can lead to blind pouch syndrome with bacterial overgrowth and malabsorption (Figure 15). Bezoars can also form in the gastric pouch.

Other complications of LRYGB that can be diagnosed with CT scan, include abscess unrelated to anastomotic leak, splenic infarction, hepatic infarction, incisional or port hernias, gallstone formation and pulmonary embolism. PE is the leading cause of perioperative mortality and can occur up to 6 months following the procedure.<sup>1</sup>

### Conclusion

Bariatric procedures are being increasingly performed to treat the growing population of obese Americans. This

article highlights the procedure-specific complications of LRYGB, which are summarized in Table 1. Knowledge of the normal post-operative appearance of RYGB and imaging of its complications are indispensable for timely diagnosis and efficient patient management.

### REFERENCES

1. Merkle EM, Hallowell PT, Crouse C, et al. Roux-en-Y Gastric bypass for clinically severe obesity: normal appearance and spectrum of complications at imaging. *Radiology*. 2005; 234(3):674-683.
2. Herron D, Roohipour R. Complications of Roux-en-Y gastric bypass and sleeve gastrectomy. *Abdom Imaging*. 2012; 37(5):712-718.
3. Scheirey CD, Scholz FJ, Shah PC, et al. Radiology of the laparoscopic Roux-en-Y gastric bypass procedure: conceptualization and precise interpretation of results. *RadioGraphics*. 2006; 26(5):1355-71.
4. Levine MS, Carucci LR. Imaging of bariatric surgery: normal anatomy and postoperative complications. *Radiology*. 2014; 270(2):327-341.
5. Smith TR, White AP. Narrowing of the proximal jejunal limbs at their passage through the transverse mesocolon: A potential pitfall of laparoscopic Roux-en-Y gastric bypass. *AJR Am J Roentgenol*. 2004; 183(1):141-143.
6. Blachar A, Federle MP, Pealer KM, et al. Gastrointestinal complications of laparoscopic Roux-en-Y gastric bypass surgery: clinical and imaging findings. *Radiology*. 2002; 223(3):625-632.
7. Himpens J, Dapri G, Cadière GB. A prospective randomized study between laparoscopic gastric banding and laparoscopic isolated sleeve gastrectomy: results after 1 and 3 years. *Obes Surg*. 2006; 16(11):1450-1456.
8. Podnos YD, Jimenez JC, Wilson SE, et al. Complications after laparoscopic gastric bypass: A review of 3464 cases. *Arch Surg*. 2003; 138(9):957-961.
9. Ballesta C, Berindoague R, Cabrera M, et al. Management of anastomotic leaks after laparoscopic Roux-en-Y gastric bypass. *Obes Surg*. 2008; 18(6):623-630.
10. Gonzalez R, Sarr MG, Smith CD, et al. Diagnosis and contemporary management of anastomotic leaks after gastric bypass for obesity. *J Am Coll Surg*. 2007; 204(1):47-55.
11. Carucci LR, Turner MA, Conklin RC, et al. Roux-en-Y gastric bypass surgery for morbid obesity: evaluation of postoperative extraluminal leaks with upper gastrointestinal series. *Radiology*. 2006; 238:119-127.
12. ASMBS Clinical Issues Committee. ASMBS guideline on the prevention and detection of gastrointestinal leak after gastric bypass including the role of imaging and surgical exploration. *Surg Obes Relat Dis*. 2009; 5(3):293-296.
13. Carucci LR, Conklin RC, Turner MA. Roux-en-Y gastric bypass surgery for morbid obesity: evaluation of leak into excluded stomach with upper gastrointestinal examination. *Radiology*. 2008; 248(2):504-510.
14. Yu J, Turner MA, Cho SR, et al. Normal anatomy and complications after gastric bypass surgery: helical CT findings. *Radiology*. 2004; 231(3):753-760.
15. Bakhos C, Alkhouri F, Kyriakides T, et al. Early postoperative hemorrhage after open and laparoscopic Roux-en-Y gastric bypass. *Obes Surg*. 2009; 19(2):153-157.
16. Ahmad J, Martin J, Ikramuddin S, et al. Endoscopic balloon dilatation of gastroenteric anastomotic stricture after laparoscopic gastric bypass. *Endoscopy*. 2003; 35(9):725-728.
17. Dallal RM, Bailey LA. Ulcer disease after gastric bypass surgery. *Surg Obes Relat Dis*. 2006; 2(4):455-459.
18. Rasmussen JJ, Fuller W, Ali MR. Marginal ulceration after laparoscopic gastric bypass: an analysis of predisposing actors in 260 patients. *Surg Endosc*. 2007; 21(7):1090-1094.
19. Husain S, Ahmed AR, Johnson J, et al. Small-bowel obstruction after laparoscopic Roux-en-Y gastric bypass: etiology, diagnosis, and management. *Arch Surg*. 2007; 142(10):988-993.
20. Reddy SA, Yang C, McGinnis LA, et al. Diagnosis of transmesocolic internal hernia as a complication of retrocolic gastric bypass: CT imaging criteria. *AJR Am J Roentgenol*. 2007; 189(1):52-55.
21. Carucci LR, Turner MA, Shaylor SD. Internal hernia following Roux-en-Y gastric bypass surgery for morbid obesity: evaluation of radiographic findings at small-bowel examination. *Radiology*. 2009; 251(3):762-770.