Roux-en-Y Gastric Bypass Surgery for Morbid Obesity:
Evaluation of Postoperative Extraluminal Leaks with Upper Gastrointestinal Series

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Purpose:
To retrospectively evaluate the radiographic features of extraluminal leak after Roux-en-Y gastric bypass (RYGBP) surgery at upper gastrointestinal (GI) examinations in a large series of patients and to determine morbidity and mortality in those patients with leak.

Materials and Methods:
The investigational review board approved this HIPAA-compliant study, and the need for patient informed consent was waived. Radiologic database review revealed 1202 upper GI studies performed over a 4-year period in 906 patients after RYGBP. Extraluminal leak was identified in 50 patients. Two patients with leaks that occurred before the study period were excluded. Of the remaining 48 patients, 12 were men and 36 were women (mean age, 45 years; range, 26–64 years). Surgery had been laparoscopic in 23 patients and open in 25. Upper GI studies were analyzed by two radiologists in consensus for the origin, extent, and severity of leaks and associated findings. Chart review was performed to determine clinical course, treatment, and outcome.

Results:
Fifty extraluminal leaks were detected in 48 of 904 patients (5.3%) at upper GI examinations. All leaks were identified within 28 days, and, in 37 of 48 patients (77%), leakage was diagnosed within 1 week of surgery. The majority of leaks (n = 37) originated from the gastrojejunal anastomosis. Leaks also occurred at the distal portion of the esophagus (n = 5), the gastric pouch (n = 5), the oversewn jejunum (n = 2), and the distal anastomosis (n = 1). Leaks extended into the left upper quadrant in 30 patients. Obstruction or ileus was present in 35 of 48 patients (73%). Leak into the excluded stomach was observed in 15 of 48 patients. The occurrence of extraluminal leak prolonged hospital stays; organ failure occurred in 14 (29%) and death in three (6%) of the 48 patients.

Conclusion:
Extraluminal leak was identified on upper GI series in 48 of 904 patients (5.3%) after RYGBP for morbid obesity. Extraluminal leak most commonly arises from the gastrojejunal anastomosis and extends into the left upper quadrant. Extraluminal leak affects morbidity and mortality.

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Morbid obesity is a major health problem in the United States and is increasing in epidemic proportions (1,2). Currently, more than 50% of adults in the United States are considered to be overweight or obese (body mass index, >25 kg/m²) (1,3–5). Furthermore, owing to the associated increased risks of comorbidity, disability, and early mortality, obesity places a tremendous burden on U.S. health care (2,4–9).

Nonsurgical approaches to weight loss have had limited long-term efficacy for the treatment of morbid obesity (1,9–11). The most effective treatment of morbid obesity in terms of sustained weight loss, decreased morbidity, and prolonged life expectancy is bariatric surgery (1,3,9,12–14). Accordingly, rates of bariatric surgery have dramatically increased in recent years. For patients in whom other methods of weight reduction have failed, bariatric surgery is considered if the body mass index is greater than 40 kg/m² or greater than 35 kg/m² with the presence of associated comorbidities (9,13,15). Roux-en-Y gastric bypass (RYGBP) surgery is the most successful bariatric procedure in terms of sustained weight loss and decreased obesity-related morbidity (9,16–20). It is currently the procedure of choice for the management of morbid obesity in the United States (1,8,10,11,14,21).

The surgical procedure consists of forming a small gastric fundal pouch to exclude the remainder of the stomach and duodenum. Next, a jejunal Roux loop is anastomosed to the gastric pouch with a small stoma (typically 8–12 mm in diameter). This creates a blind-ending jejunal limb and an antegrade-flowing jejunal limb. Finally, a distal side-to-side anastomosis of the excluded jejunal limb and the antegrade-flowing jejunal limb is created (Fig 1a, 1b).

The most serious complication of bariatric surgery is postoperative ex-

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**Figure 1**

**Figure 1:** Images depict normal postoperative anatomy after RYGBP. (a) Diagram of surgical procedure shows creation of a small gastric pouch with a gastrojejunal anastomosis, a blind-ending jejunal limb (arrows), and a distal side-to-side jejunojejunal anastomosis. (b) Diagram of postoperative anatomy depicts the expected course of food and liquid. G-J = gastrojejunal, J-J = jejunojejunal. (c) Diagram and (d) corresponding fluoroscopic spot image obtained at upper gastrointestinal (GI) examination with the patient in the supine left posterior oblique (LPO) position show the pouch (P), the gastrojejunal anastomosis (A), the antegrade-flowing jejunal limb (J), and the blind-ending jejunal limb (BL). Region-of-interest circles in b and c show sites of possible postoperative leaks.
traluminal leak with resultant peritonitis. Therefore, upper GI examinations are routinely performed 1–2 days after surgery to assess for such leaks, as well as anastomotic narrowing and obstruction. At upper GI examinations performed after RYGBP, contrast material is seen to flow from the esophagus into the gastric pouch and to exit through a small stoma to enter both the blind-ending and antegrade-flowing jejunal limbs (Fig 1c, 1d). The presence of extravasated contrast material, which often fills an extraluminal collection or communicates with a drain, is diagnostic of a free leak, while filling of the excluded stomach at initial evaluation is indicative of staple-line leak (SLL).

The radiology literature to date focuses on general complications after RYGBP and emphasizes computed tomographic (CT) findings. The location and pattern of postoperative extraluminal leaks on upper GI series have not been well described in the literature. Furthermore, other reports describe complications seen on fluoroscopic studies with contrast material enhancement obtained after other bariatric procedures and other types of gastric bypass procedures that are no longer performed (ie, loop gastric bypass) (15,22–26). Because RYGBP surgery is increasingly being performed and patients treated with this procedure are routinely evaluated with contrast-enhanced studies, radiologists must be aware of the typical postoperative anatomy and findings after RYGBP, as well as the potential complications of this procedure. Therefore, the purpose of our study was to retrospectively evaluate the radiographic features of extraluminal leak after RYGBP surgery at upper GI examinations in a large series of patients and to determine morbidity and mortality in those patients with leak.

**Materials and Methods**

Review of the radiology database at our institution revealed that 1202 upper GI studies were performed in 906 patients after RYGBP during a 4-year period (October 1998 to October 2002). During this period, upper GI studies were performed on a routine basis 1–2 days postoperatively to assess potential surgical complications. The present study was conducted in accordance with all guidelines set forth by the approving institutional review board. Given the retrospective nature of the study, the requirement for patient informed consent was waived. Our study was compliant with the Health Insurance Portability and Accountability Act.

**Patients with Extraluminal Leak**

Review of reports of upper GI studies revealed that postoperative extraluminal leaks occurred in 50 of the 906 patients. Two of these 50 patients were excluded from the study because they had experienced a documented postoperative leak before the onset of the study period (October 1998). Therefore, our study group consisted of 48 patients (12 men, 36 women; mean age, 45 years; age range, 26–64 years) in whom extraluminal leaks were identified at upper GI examinations. Upper GI studies were performed a mean of 2.1 days after surgery (range, 1–18 days). Three patients underwent initial upper GI examinations. Upper GI studies were performed on a mean of 2.1 weeks after surgery (on postoperative days 8, 9, and 18) because their clinical status prohibited earlier examinations. Follow-up upper GI or CT studies were performed to assess any change in clinical status or symptoms, to monitor treatment of a leak, and to assess extraluminal collections.

Patient weight ranged from 230 to 563 lb (103.5–253.4 kg); the mean weight was 324 lb (145.8 kg). The body mass index ranged from 40 to 82 kg/m² (mean, 51 kg/m²). Surgery had been performed laparoscopically in 23 of the 48 patients (48%) and as an open procedure in the remaining 25 patients. One of the 48 patients underwent the initial RYGBP procedure at an outside institution. Of the 48 patients, 11 had previously undergone the following gastric surgical procedures: RYGBP (n = 7), anti reflux fundoplication (n = 2), laparoscopic gastric banding (n = 1), and vertical banded gastroplasty (n = 1). In the nine patients who had previously undergone bariatric surgery, surgical revision was performed owing to failure to maintain weight loss (n = 7) or obstruction/anastomotic stenosis (n = 2). No patient in our study group underwent surgical revision owing to a previous leak.

**Upper GI Examination Technique**

After a preliminary overhead radiograph was acquired with the patient in the supine position, upper GI examinations were initially performed with the patient in the supine LPO position so that the gastrojejunal anastomosis could be optimally assessed. Examinations were performed with an EPS 30 digital fluoroscopy system (Toshiba Medical Systems, Tokyo, Japan), and additional views were obtained as necessary. Each patient was given approximately 50–100 mL of water-soluble contrast material (Gastrografin; E-Z-Em, Anjou, Quebec, Canada), and fluoroscopic spot images of the distal portion of the esophagus, the proximal anastomosis, the gastric pouch, and the proximal small bowel were obtained. If no leak was identified with the water-soluble contrast material, low-density (60% wt/vol) barium suspension (Baroporise; Lafayette Pharmaceuticals, Lafayette, Ind) was administered to enable assessment of more subtle leaks. Overhead radiographs were obtained with the patient in the supine position immediately after the fluoroscopic examination and at 20–30-minute intervals until contrast material was seen to pass the distal small-bowel anastomosis.

**Image Analysis**

The radiologic studies performed in the 48 patients were analyzed in consensus by two abdominal radiologists (L.R.C., with 7 years of experience; and M.A.T., with more than 25 years of experience with upper GI and CT studies). The studies consisted of 308 upper GI series and 98 CT examinations. Each patient underwent a mean of 5.4 upper GI studies and 2.2 CT examinations (ranges, 1–16 and 0–24, respectively).

Upper GI studies were analyzed to determine the origin and extent of free leaks. Leaks were graded as mild, mod-
erate, or severe on the basis of the size of the extraluminal collection of contrast material (<3 cm for mild leaks, 3–6 cm for moderate leaks, and >6 cm for severe leaks). The sizes of the gastric pouch and stoma were measured in the LPO view. The upper GI studies were also assessed for the presence of a fistula and/or SLL. Associated findings on the upper GI study, including pneumoperitoneum, obstruction, and severe ileus, were documented. Obstruction was diagnosed when upper GI studies revealed dilated proximal bowel with a transition point to decompressed distal bowel, proximal stasis, and prolonged transit time. Ileus was diagnosed when diffusely dilated bowel without a transition point was present. Pleural effusion and parenchymal changes in the visualized lung bases were assessed. Correlative cross-sectional CT and follow-up fluoroscopy studies were reviewed after initial interpretation of the upper GI study was performed.

Clinical Chart Review

Clinical chart review was performed by two authors (L.R.C., R.C.C.) to determine if there were any complications that occurred during the surgical procedure, the clinical presentation of leaks, the time of onset of leaks, treatment, and patient outcome. The effect of a leak on hospital resources, including the number of procedures performed, critical care requirements, the length of the hospital stay, and the number of hospital admissions, was assessed. Additional complications that occurred after a leak, such as infection, thromboembolic events, bleeding, organ failure, and death, were documented.

Results

Extraluminal Leaks

In two of the 48 patients with extraluminal leakage, leaks were identified at two sites simultaneously. Hence, there were 50 leaks in 48 patients. The mean gastric pouch size was 3.5×5.0 cm (range, 0–7×0–8 cm), and the mean stomal size was 6 mm (range, 0–15 mm). All leaks were identified within 28 days after surgery (mean, 5.5 days; range, 1–28 days), and, in 37 of 48 patients (77%), the leak was diagnosed within 1 week after surgery. In 12 patients, the initial upper GI series did not reveal a leak but a leak was diagnosed with follow-up upper GI studies performed 4–28 days (mean, 11.9 days) after the initial surgery. In 11 of 12 patients, leakage occurred after bowel obstruction. Six of these 12 patients underwent surgical exploration between the time of the initial upper GI study and the diagnosis of leak. In one patient, the leak was diagnosed after the patient was ini-

Table 1

<table>
<thead>
<tr>
<th>Leak Location</th>
<th>No. of Patients*</th>
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<tbody>
<tr>
<td>Left</td>
<td>36 (75)</td>
</tr>
<tr>
<td>Anterior</td>
<td>9 (19)</td>
</tr>
<tr>
<td>Right or medial</td>
<td>8 (17)</td>
</tr>
<tr>
<td>Posterior</td>
<td>4 (8)</td>
</tr>
<tr>
<td>Inferior</td>
<td>3 (6)</td>
</tr>
<tr>
<td>Above gastroesophageal junction</td>
<td>2 (4)</td>
</tr>
<tr>
<td>Lower abdomen or pelvis</td>
<td>1 (2)</td>
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</table>

* Data in parentheses are percentages. Leaks occurred in more than one location in some patients.
tially discharged from the hospital, and there were corresponding acute symptoms.

Leak severity was assessed on the basis of the size of the extraluminal collection of contrast material. In 11 patients, leak was classified as mild—that is, resulting in a collection smaller than 3 cm (Fig 2a). The leak was severe (ie, resulted in a collection larger than 6 cm) in 24 patients (Fig 2b). The remaining 13 leaks resulted in 3–6-cm collections and were classified as moderate.

The majority (75%) of extraluminal leaks (Table 1) extended to the left of the stoma (Fig 3), and left upper quadrant collections (Fig 4) occurred in 30 of 48 patients (62%). Leaks that extended anteriorly, medially, or posteriorly (Fig 5) relative to the stoma occurred less often. Rarely, collections of contrast material extended inferior to the stoma, above the gastroesophageal junction, or in the pelvis.

The leak (Table 2) originated from the gastrojejunal anastomosis in the majority of patients (n = 37, 77%) (Fig 6). Leaks from the distal esophagus occurred in five of the 48 patients (10%). In two of these five patients, leaks from both the gastrojejunal anastomosis and the distal esophagus were identified.

Table 2

<table>
<thead>
<tr>
<th>Leak Origin</th>
<th>No. of Patients</th>
</tr>
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<tbody>
<tr>
<td>Gastrojejunal anastomosis</td>
<td>37 (77)</td>
</tr>
<tr>
<td>Distal esophagus*</td>
<td>5 (10)</td>
</tr>
<tr>
<td>Gastric pouch</td>
<td>5 (10)</td>
</tr>
<tr>
<td>Blind jejunal limb</td>
<td>2 (4)</td>
</tr>
<tr>
<td>Jejunoojejunal anastomosis</td>
<td>1 (2)</td>
</tr>
</tbody>
</table>

Note.—Data in parentheses are percentages.

* In two of these five patients, leaks from both the gastrojejunal anastomosis and the distal esophagus were identified.

Figure 4

(a) Supine frontal spot image from upper GI examination in 55-year-old woman shows a leak from the gastrojejunal anastomosis (arrow) filling a large collection (L). (b) Transverse CT image in same patient shows the leak (arrow) and a left upper quadrant collection of extraluminal contrast material (L). Also note the associated left pleural effusion, P = pouch.

Figure 5

(a) Left lateral upper GI spot image in 39-year-old woman shows a leak (arrow) that extends posteriorly from the gastrojejunal anastomosis. (b) Transverse CT image in same patient shows a left upper quadrant collection of fluid and gas (arrow).

Upper GI Examination Findings Associated with Free Leak

Extraluminal leak was identified at the same time as or after obstruction or ileus was diagnosed at upper GI examinations in 35 of 48 patients (73%). Moderate to severe ileus was identified in seven patients. Partial postoperative obstruction was identified in 28 patients in the following locations: jejunojejunal anastomosis (n = 17), gastrojejunal anastomosis (n = 8), and at the site where the surgically mobilized jejunum...
crosses the transverse mesocolon (n = 3). Left pleural effusion was observed in 22 of 48 patients (46%). The effusion required drainage and/or chest tube placement in 11 patients (23% of the 48 patients with free leak). Free air was noted in 24 patients (50%). Left lower lobe atelectasis was present in 44 patients (92%).

Chronic cutaneous fistulas were diagnosed after extraluminal leak at follow-up fluoroscopic contrast studies in five of 48 patients (10%). Four of these patients had enteroabdominal fistulas; the remaining patient had a colocutaneous fistula. SLL was diagnosed at upper GI examinations in 15 of the 48 patients with extraluminal leak (31%) (Fig 11). In six of these 15 patients, SLL occurred simultaneously with a free leak at the time of initial diagnosis of the leak; in the remaining nine patients, SLL was diagnosed at follow-up upper GI examinations a mean of 21 days (range, 4–45 days) after the diagnosis of free leak. Of the 15 patients with leak into the excluded stomach, 10 had undergone an open surgical procedure and five had undergone a laparoscopic procedure. In four of the five patients with SLL after laparoscopic surgery, an extraluminal leak preceded the development of leak into the excluded stomach. Because the stomach is transected in the laparoscopic technique, communication with the excluded stomach presumably occurs via a fistula. Follow-up upper GI studies in the 15 patients with SLL revealed chronic SLLs in seven patients and healing of the SLL without intervention in four patients. Three patients ultimately underwent reversal of the gastrojunostomy because of complications caused by the extraluminal leak, and one patient underwent successful surgical revision. According to findings at follow-up upper GI examination, this latter patient had a good result.

**Review of Initial Surgical Reports**

Review of surgical reports revealed complications at the time of initial surgery in 23 of 48 patients (48%). Anastomoses were tested intraoperatively in all patients with either methylene blue dye or endoscopy. Extraluminal leak was found and repaired intraoperatively in 12 of the 48 patients (25%). A single leak site was found at the time of initial surgery in seven patients; in six patients, the leak occurred at the gastrojejunal anastomosis, and in one patient, it arose from the distal esophagus. In five patients, leaks were found to originate from more than one site, including the stoma, esophagus, gastric pouch, and/or the excluded stomach. Other problems occurred at the time of initial surgery in 11 of the 48 patients (23%) and included the following: mild solid organ injury (n = 6), abnormal bowel requiring resection (n = 3), extensive adhesions requiring lysis (n = 2), prolonged bleeding (n = 2), difficulty creating the gastrojejunal anastomosis (n = 2), small-bowel ischemia (n = 1), hypotensive shock (n = 1), and equipment failure that inadvertently resulted in massive dilatation of the excluded stomach (n = 1). (More than one com-
Complication occurred in five of the 11 patients.)

Clinical Presentation of Extraluminal Leak
Clinical findings of postoperative leak included elevated white blood cell count, fever, and/or tachycardia in 44 of 48 patients (92%). Severe hypotension as a sign of leak occurred in seven patients (15%). Substantial pain at one or more sites occurred in 26 of 48 patients (54%) and included left shoulder pain (n = 9), generalized abdominal pain (n = 5), back pain (n = 4), epigastric pain (n = 4), left flank pain (n = 4), and retrosternal chest pain (n = 3). Additional clinical signs associated with leak included the following: shortness of breath (n = 8), hiccups (n = 2), increased drain output (n = 3), and syncope (n = 1). Nausea and vomiting occurred in 39 of 48 patients (81%).

Clinical Consequences of Extraluminal Leak
As a consequence of postoperative leak, 39 of 48 patients (81%) required repeat surgery. The number of surgical procedures per patient in our study group ranged from one to 10; the mean number of surgical procedures was 3.1 (Table 3). Four patients ultimately required reversal of the gastrojejunostomy owing to extensive complications. The seven patients who did not require repeat surgery were treated with a combination of bowel rest, the administration of intravenous fluids and antibiotics, and percutaneous drain placement. Two of the 48 patients had very small leaks that were seen at upper GI examinations but were believed to be clinically unimportant.

Postoperative leaks had a substantial effect on the duration of the hospital stay and the use of services (Table 3). The majority (n = 45, 94%) of the 48 patients with leak required long-term tube feeding or total parenteral nutrition. Of the 48 patients, 22 (46%) required at least one fluoroscopic procedure, including feeding tube manipulations and drainage catheter treatment of abscesses or distention of the excluded stomach. Patients with leaks after RYGBP had a prolonged hospital stay (mean duration of stay, 42.4 days). Multiple complications occurred as a consequence of the long hospital stay. Leaks resulted in intensive care unit stays of longer than 1 week and/or ventilator dependence in 30 patients (62%). Severe wound infection occurred in 15 patients (31%). Infection with multidrug-resistant organisms developed in 15 patients (31%). Thromboembolic events, including pulmonary embolism or deep venous thrombosis, occurred in six patients (12%). Gastrointestinal bleeding occurred in five patients (10%). One or more kinds of organ failure, including acute respiratory distress syndrome (n = 14) and acute renal failure (n = 5), occurred in 14 patients (29%). Cardiopulmonary arrest occurred in four patients (8%) who subsequently survived; death occurred in an additional three patients (6%).

Discussion
Extraluminal leak is the most common serious early complication of RYGBP and bariatric surgery in general (11,19,24,25,27–29). Extraluminal leak was identified in 5.3% of patients in our series. The incidence of leak in our study included the occurrence of leak in some patients who underwent revision surgery and is similar to the incidence rates reported in the literature, which range from 1.0%–5.6% (1,5,20,21,27–29). If not recognized early and treated promptly, postoperative leak is a potentially lethal complication of gastric bypass surgery (19,28). In our series,
death after extraluminal leak occurred in 6% of the 48 patients with postoperative leak and in 0.3% of all patients who underwent RYGBP in the study period. Therefore, early detection of postoperative leak is critical for minimizing morbidity and preventing mortality (24,25,27).

Evidence has shown that radiologic evaluation is important in the early detection of leak in the postoperative setting (25,29). Clinical symptoms are often nonspecific, and physical examination is difficult owing to the large size of the patient; therefore, routine early postoperative upper GI examinations are advocated for the detection of leaks (20,25,26,29,30). The use of planned early upper GI examinations may minimize the morbidity caused by a leak after bariatric surgery (30). However, if there is strong clinical evidence of a leak, surgical exploration should not be delayed until a confirmatory upper GI study is performed.

The performance and interpretation of upper GI studies after RYGBP requires knowledge of the surgical procedure, the normal appearance of the upper GI tract after RYGBP, the technical aspects of upper GI studies, and the potential pitfalls of study interpretation. We routinely evaluate patients within 1–2 days after RYGBP with upper GI examinations that are performed initially with patients in the supine LPO position. In our experience, this position enables optimal visualization of the proximal anastomosis in the majority of patients. Other views are obtained as necessary. Delayed abdominal radiographs are obtained until contrast material passes distal to the jejunojejunal anastomosis because obstruction or leak may occur at this site.

Radiologists must be aware of the presence and pattern of leaks on upper GI studies because postoperative leaks have drastic implications for patient morbidity and mortality. In this series, extraluminal leak most often occurred at the gastrojejunal anastomosis (77%); however, leaks may also originate from the gastric pouch, the distal esophagus, the blind-ending jejunal limb, or even the distal anastomosis. Leaks from the distal anastomosis may be difficult to recognize on upper GI studies and will be missed unless overhead radiographs are obtained until the point at which contrast material has passed distal to this site. In addition, leaks may very rarely arise from the bypassed or excluded stomach, a finding that would not be diagnosed with upper GI studies unless there was communication with the excluded stomach (as in SLL). Therefore, if there is a high clinical index of suspicion for a leak, surgical re-exploration should be strongly considered.

We found that the majority (75%) of leaks seen on upper GI studies extended to the left of the gastrojejunal stoma; resultant left upper quadrant collections were identified in 62% of all patients with leak. Leaks are often associated with intestinal obstruction or severe ileus that may affect treatment strategies. The presence or absence of free air is not a reliable sign of a postoperative leak because it was seen on upper GI studies in only 50% of patients and may have been related to the recently performed surgical procedure.

As previously noted, the diagnosis of postoperative leak in this patient population has important implications for morbidity and mortality after RYGBP. The majority of patients require repeat surgery. In the present study, communication with the excluded stomach and chronic cutaneous fistulas occurred as a consequence of leak in 31% and 10% of patients, respectively. Chronic SLL may lead to failed weight loss and subsequent failure of the RYGBP procedure.

Extraluminal leak as a complication of RYGBP has a tremendous effect on both the patient and on health care resources. Patients with postoperative leak undergo multiple radiologic studies (both diagnostic and therapeutic), hospital admissions, and surgeries. In addition, a lengthy hospital stay is a common consequence of leak. Whereas the average hospital stay after routine laparoscopic RYGBP is 2 days (18), the length of the hospital stay increased to an average of 42.4 days in the setting of an extraluminal leak.

This study was limited by its retrospective nature. In addition, patients with leaks in this study were identified through review of a radiology database of upper GI series. It is therefore probable that the sickest patients, including patients who died early in the postoperative period, never underwent upper GI imaging. Patients with the most severe...
leaks may therefore have not been included in our study, and our calculated mortality rate may therefore be slightly low. Future prospective studies could be performed to adequately address these issues. In conclusion, extraluminal leak is the most common serious complication of RYGBP surgery for morbid obesity, resulting in an associated mortality rate of 6% in our series of patients in whom leak was diagnosed with upper GI studies. Although the frequency of leak after RYGBP was low in this series (5.3%), it is important for radiologists to recognize the presence and pattern of leaks on upper GI studies because postoperative extraluminal leaks affect patient morbidity and mortality.

References