Diagnosis and Contemporary Management of Anastomotic Leaks after Gastric Bypass for Obesity

Rodrigo Gonzalez, MD, Michael G Sarr, MD, FACS, C Daniel Smith, MD, FACS, Mercedeh Baghai, MD, Michael Kendrick, MD, Samuel Szomstein, MD, FACS, Raul Rosenthal, MD, FACS, Michel M Murr, MD, FACS

BACKGROUND: Anastomotic leaks are a dreaded complication of bariatric surgery. The objective of this study was to describe the clinical presentation and outcomes of treatment in patients who develop anastomotic leaks after Roux-en-Y gastric bypass for obesity.

STUDY DESIGN: Prospectively collected data on 3,018 consecutive patients who underwent Roux-en-Y gastric bypass in 4 tertiary referral centers were reviewed.

RESULTS: Sixty-three patients (2.1%) developed anastomotic leaks (open, 2.1%; laparoscopic, 2.1%) at a median of 3 days (range 0 to 28 days) after Roux-en-Y gastric bypass. Symptoms and signs included tachycardia (72%), fever (63%), or abdominal pain (54%). Upper gastrointestinal series and CT demonstrated leaks in only 17 of 56 (30%) and 28 of 50 (56%) patients, respectively; when done jointly, both studies were negative in 30% of patients. The 68 anastomotic leaks occurred at the gastrojejunostomy (49%), excluded stomach (25%), jejunojejunostomy (13%), gastric pouch (9%), and uncertain location (4%). Forty patients (63%) required 58 reoperations for drainage of intraabdominal collections (55%), repair of anastomotic defects (34%), or revision of the leaking anastomosis (11%), with an overall morbidity of 53% and mortality of 10%. Nonoperative treatment was successful in 23 of 26 patients, with an overall morbidity of 61% and no mortality (p = NS versus operative). Operative treatment was more common in patients with hypotension or oliguria ($p < 0.01$).

CONCLUSIONS: Lack of specificity in clinical presentation and imaging studies make diagnosing anastomotic leaks challenging, so operative exploration should be part of the diagnostic algorithm. Nonoperative treatment is safe and effective in a subset of patients who exhibit stable hemodynamic parameters and are known to have controlled leaks. (J Am Coll Surg 2007;204:47–55. © 2007 by the American College of Surgeons)

The incidence of anastomotic leaks after Roux-en-Y gastric bypass (RYGB) is 1% to 5.6%[1-4] and appears similar in large series of open and laparoscopic RYGB.[5] Anastomotic leaks are dreaded complications of RYGB because of the difficulty in diagnosing them and the associated increased morbidity and mortality. So efforts to improve prevention, diagnosis, and treatment of anastomotic leaks after bariatric surgery are paramount.

The clinical presentation of anastomotic leaks after RYGB is similar to that of an intraabdominal infection, yet nonspecific. Additionally, the clinical presentation in obese patients with multiple comorbidities may be delayed or more subtle compared with that in nonobese patients.[4] In addition, many commonly used diagnostic modalities are not applicable or feasible in obese patients because of weight limitations.

As the use of bariatric surgery increases, many centers have not accumulated substantial experience in managing anastomotic leaks because of their relatively low incidence and because many surgeons have not reported these outcomes for fear of litigation.

Competing Interests Declared: None.

Received July 31, 2006; Revised September 27, 2006; Accepted September 27, 2006.

From the Interdisciplinary Obesity Treatment Group, Department of Surgery, University of South Florida Health Sciences Center, Tampa, FL (Gonzalez, Murr); the Division of Gastrointestinal Surgery, Department of Surgery, Mayo Clinic, Rochester, MN (Sarr, Kendrick); the Emory Endosurgery Unit and Bariatric Institute, Department of Surgery, Emory University School of Medicine, Atlanta, GA (Smith, Baghai); and the Division of General and Minimally Invasive Surgery, Department of Surgery, Cleveland Clinic, Weston, FL (Szomstein, Rosenthal).

Correspondence address: Michel M Murr, MD, FACS, Department of Surgery, University of South Florida Health Sciences Center, c/o Tampa General Hospital, PO Box 1289, Tampa, FL 33601.

ISSN 1072-7515/07/$32.00
doi:10.1016/j.jamcollsurg.2006.09.023

Abbreviations and Acronyms

BMI = body mass index
RYGB = Roux-en-Y gastric bypass
TPN = total parenteral nutrition
UGI = upper gastrointestinal

The aim of this study was to review and document the spectrum of clinical presentation, the use and efficacy of diagnostic tests, and outcomes of treatment in patients who developed anastomotic leaks after undergoing RYGB for clinically significant obesity.

METHODS

Participating centers

This study was approved by the respective Institutional Review Board of each of the four participating centers. We analyzed prospectively collected data on all consecutive patients undergoing RYGB for treatment of clinically significant obesity in four academic, tertiary-referral centers (University of South Florida Health Sciences Center, Tampa, FL; Mayo Clinic, Rochester, MN; Emory University School of Medicine, Atlanta GA; and Cleveland Clinic Florida, Weston, FL) from the inception of the respective bariatric programs to January 1, 2004.

Data collection

Collected data included patient demographics, previous medical history, preoperative clinical characteristics, obesity-related comorbidities, and medication use. Operative data included approach (open versus laparoscopic), technique for the gastrojejunostomy, and perioperative outcomes. We also reviewed clinical signs and symptoms, the radiologic and biochemical findings (both routine and specific), and treatment outcomes in each of these patients.

Operative technique

The operative technique was similar in the 4 participating institutions and consisted of a divided 10- to 30-mL vertically oriented gastric pouch. The length of the Roux limb was increased with increasing body mass index (BMI, 100 to 150 cm) except in patients treated at Emory University, where the length of the Roux was standardized at 150 cm. The gastrojejunostomy was undertaken with either a 21-mm circular stapler, a 45-mm linear stapler, or was hand-sewn (two layers around a 34-F calibration catheter). In all patients with a stapled gastrojejunostomy, the anastomosis was reinforced with sutures. The jejunojejunostomy was done using linear staplers; the enterotomies used to introduce the stapler were closed either by stapled or hand-sewn techniques.

Intraoperative leak tests were done by insufflating the gastrojejunostomy with air under water seal either through a nasogastric tube or through a needle into the Roux limb. Closed suction drains were placed routinely around the gastrojejunostomy in all patients after laparoscopic and open RYGB at all institutions, except at the Mayo Clinic, where drains were used selectively in open RYGB.

Radiologic studies

Upper gastrointestinal (UGI) contrast studies with water-soluble contrast (Gastrografin; Bracco Diagnostics) were done routinely within the first 24 to 36 hours postoperatively in 3 institutions (except at the Mayo Clinic). Oral intake was initiated subsequent to a negative UGI series and advanced as tolerated. Surgically placed drains were removed within 24 hours after initializing oral intake.

CT scans were obtained after a UGI study that demonstrated extravasation of contrast to determine if there were any fluid collections or after an inconclusive UGI study in the face of symptoms suggestive of an anastomotic leak.

Statistical analysis

Continuous parametric data were compared using Student's *t*-test, categorical data were compared using either chi-square or Fisher's exact test, and $p < 0.05$ was considered statistically significant. Normally distributed data are reported as mean ± SEM (standard error of the mean); otherwise, data are reported as median and range.

RESULTS

Overall incidence of anastomotic leaks

A total of 3,018 patients underwent open (49%) or laparoscopic (51%) RYGB. Sixty-three patients (2.1%) developed anastomotic leaks (open, 2.1%; laparoscopic, 2.1%; p = NS) and were the subject of this study.

Patient demographics and past medical history

Median age was 46 years (range 22 to 68 years), 55 patients (87%) were women, preoperative weight was

132 kg (range 76 to 225 kg), and body mass index was 49 kg/m^2 (35 to 73 kg/m^2). Thirty-seven patients (59%) had history of previous abdominal procedures, and 15 patients (24%) had a previous bariatric procedure and underwent a revision of or conversion to RYGB, most commonly for a failed or complicated vertical banded gastroplasty.

Fifty-nine patients (94%) had at least 1 comorbidity, but, more commonly, patients had multiple comorbidities, including mechanical arthropathy (69%), hypertension (57%), gastroesophageal reflux disease (48%), obstructive sleep apnea (40%), diabetes (30%), and COPD (10%). Additionally, 10 patients (16%) were taking corticosteroids, and 14 patients (22%) were taking NSAIDs.

Location of anastomotic leaks

Sixty-eight anastomotic leaks developed in 63 patients at the gastrojejunostomy (49%), in the excluded stomach (25%), from the jejunojejunostomy (13%), from the divided staple line of the gastric pouch (9%), and from an uncertain source (4%) (Fig. 1). Five patients had or developed a second staple line leak from the gastrojejunostomy[3] or jejunojejunostomy.[2]

Operative details of the index RYGB

Intraoperative complications occurred in 4 patients (6%), including splenectomy (2 patients), gastrostomy in the excluded stomach (1 patient), and a trocar injury to the transverse colon (1 patient). A routine gastrostomy tube was placed in the excluded stomach in 19 patients (30%). Median operative time was 220 minutes (range 70 to 550 minutes). Estimated blood loss was 200 mL (range 50 to 2,500 mL); consequently, 6 patients (10%) required transfusion of 1 to 4 U of blood perioperatively.

An intraoperative leak test was done in 45 patients (71%); in 4 patients who had an abnormal leak test (air bubbles), the anastomotic defect was identified and closed with sutures.

Technical aspects of the gastrojejunostomy

The Roux limb was antecolic in 34 patients (54%) or retrocolic in 29 patients (46%), and more commonly was antegastric (90%). Anastomotic leaks originating from the gastrojejunostomy occurred in 25 of 1,892 patients (1.3%) with a circular stapler anastomosis, in 7 of 850 patients (0.8%) with a linear stapler anastomosis, in 1 of 276 patients (0.4%) with hand-sewn anastomoses, and in 11 of 850 patients (1.3%) in whom bovine pericardium strips (Peri-Strips Dry; Synovis Surgical Innovations) were used to reinforce the staple lines.

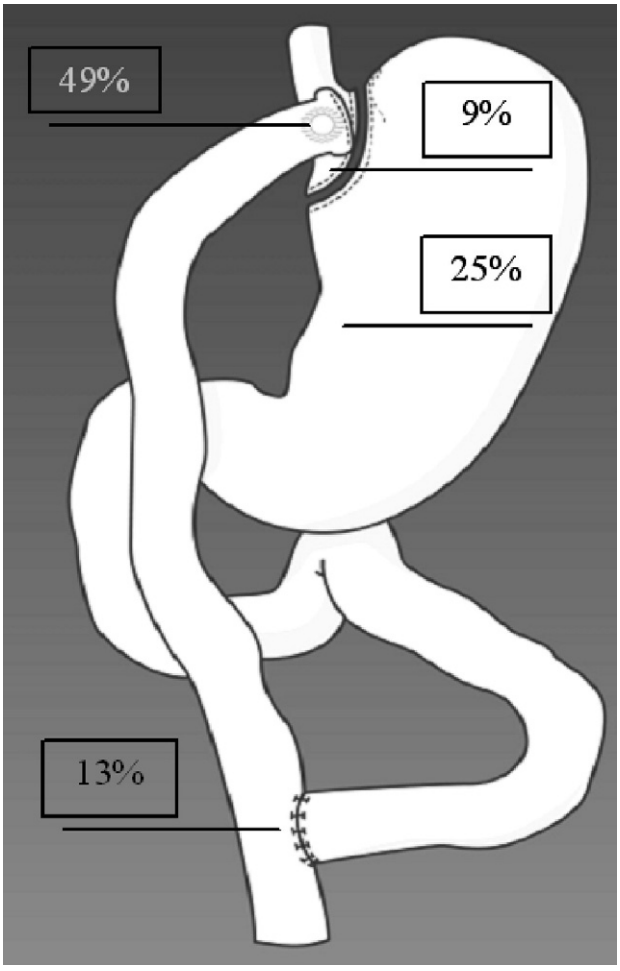

Figure 1. Location of staple line leaks in 63 patients after Roux-en-Y gastric bypass surgery; in 4% of patients the location of the leak was undetermined.

Signs and symptoms of anastomotic leaks

Five patients (8%) were asymptomatic when an anastomotic leak was diagnosed by a routine UGI series on postoperative day 1. The remaining 58 patients became symptomatic at a median of 3 days (range 0 to 28 days) postoperatively. Symptoms developed within the same day of the index RYGB in 5 patients and within 72 hours in 45 patients (71%). More commonly, the clinical presentation included tachycardia (72%), fever (63%), abdominal pain (54%), purulent drain output (24%), oliguria (21%), nausea or vomiting (17%), hypotension

Table 1. White Blood Cell Counts in 63 Patients Who Developed Anastomotic Leaks after Roux-en-Y Gastric Bypass

White blood cell count (K/μL)	Patients, %
<5	8
5–10	17
10.1–15	40
15.1–20	26
>20.1	9

(17%), or shoulder pain (14%). Tachycardia, fever, or abdominal pain were present in only 58 patients (68%).

Laboratory tests

A complete blood count was obtained in all patients. Median white blood cell count was 13.8 K/μL (range 1.5 to 27.4 K/μL). A normal white blood cell count was present in only 11 patients (17%). Five patients (7%) had leukopenia, and 51 patients (75%) had leukocytosis (Table 1). In addition, 17 patients (25%) had serum hemoglobin $<$ 10 g/dL (median 10.9 g/dL; range 7.4 to 14.3 g/dL), 22 patients had serum creatinine $>$ 1 mg/dL (median 0.9 mg/dL; range 0.6 to 6.8 mg/dL), and 24 patients had serum blood urea nitrogen $>$ 20 mg/dL (median 15 mg/dL; range 6 to 98 mg/dL). Arterial blood gases were obtained in 46 patients; 20 patients (43%) had a pH $<$ 7.35 (median 7.36; range 7.11 to 7.51), 34 patients (73%) had partial pressures of carbon dioxide $>$ 35 mmHg (median 43 mmHg; range 21 to 66 mmHg), and 31 patients (67%) had oxygen saturation levels $<$ 95% (median 93%; range 61% to 99%).

Radiologic studies

Noncontrast radiographs of the abdomen obtained in 26 patients (41%) were reported as abnormal in 15 patients (58%). A chest radiograph obtained in 47 patients (74%) was reported as abnormal in 11 patients (23%). Routine UGI studies were done on postoperative day 1 in 56 patients (88%). Extravasation of contrast at the gastrojejunostomy was observed in 17 patients (30%). CT of the abdomen was done in 50 patients (79%) and was reported as abnormal in 28 patients (56%). When done jointly, UGI and CT were negative in 30% of patients. A large intraabdominal abscess was diagnosed by ultrasonography in one patient.

Management of anastomotic leaks

Nonoperative treatment was attempted in 26 patients (41%) and was successful in 23 patients. The mainstay of treatment was maintenance of the surgically placed drains, intravenous antibiotics, and withholding oral intake.

Fifty-eight operations were undertaken in the remaining 40 patients (including 3 patients who had unsuccessful nonoperative treatment) to diagnose and treat anastomotic leaks; 35 patients underwent 1, 7 patients underwent 2, and 3 patients underwent 3 operations. Operative treatment included drainage of intraabdominal collections, washout of the abdominal cavity, and placement of closed suction drains in 17 patients (43%), in addition to repair of anastomotic or staple line defects in 16 patients (40%). The leaking anastomosis was taken down completely and redone in 5 patients (13%) and a partial gastrectomy was undertaken in 2 patients (5%) who developed leaks from the staple line of the excluded stomach. Closed suction drains were placed in all 40 patients and were removed a median of 14 days postoperatively (range 3 to 195 days). A gastrostomy tube was inserted during the first reoperation in 25 patients (63%).

All patients received intravenous broad-spectrum antibiotics, and all patients except one were kept NPO. A postoperative nasogastric tube was used in 28 patients (44%) for a median of 8 days (range 2 to 22 days). Total parenteral nutrition (TPN) was administered to 40 patients (63%) for a median of 15 days (range 2 to 240 days). Additionally, 23 patients (37%) received enteral nutrition through a gastrostomy tube for a median of 24 days (range 4 to 186 days).

ICU admissions

Forty-two patients (67%) were transferred to the ICU for a median of 6 days (range 1 to 75 days). While in the ICU, 26 patients (41%) required endotracheal intubation and mechanical ventilatory support. The remaining one-third of the patients were managed without being transferred to the ICU.

Surgical and percutaneously placed drains

Percutaneous drainage of intraabdominal collections that developed subsequent to reoperation was successful in 8 of 13 patients (62%); additional or recurrent intraabdominal abscesses in 4 of these patients were treated nonoperatively in 1 patient (25%) and operatively in the other 3 patients (75%). Drains for intraabdominal abscess were maintained for a median of 25 days (range 3 to 177 days).

Outcomes

Subsequent to anastomotic leaks, 37 patients (59%) developed 88 major complications (Table 2). As expected,

Table 2. Additional Major Complications in 63 Patients Who Developed Anastomotic Leaks after Roux-en-Y Gastric Bypass

Postoperative complication	n	%
Gastrointestinal		
Gastrojejunostomy stricture	8	13
Gastrogastric fistula	6	10
Small bowel obstruction	5	8
Gastrocutaneous fistula	3	5
Gastrointestinal bleeding	3	5
Gastrojejunostomy anastomotic ulcer	3	5
Jejunojejunostomy stricture	2	3
Wound complications		
Wound infection	12	19
Incisional hernia	6	10
Wound dehiscence and evisceration	4	6
Pulmonary		
Respiratory failure*	6	10
Pleural effusion	3	5
Pneumonia	2	3
Venous thromboembolic events		
Pulmonary embolism	5	8
Deep venous thrombosis	4	6
Other		
Multisystem organ failure	10	16
Atrial fibrillation	3	5
Central venous line infection	2	3
Gastrostomy tube leak	2	3
Internal hernia	1	2
Chronic diarrhea	1	2
Meticillin-resistant *S aureus* sepsis	1	2

*Without multisystem organ failure.

gastrointestinal complications were the most common, followed by wound-related and pulmonary complications. Four patients (6%) died secondary to complications related to the anastomotic leak.

Duration of hospital stay was 18 days (range 5 to 147 days); and 7 patients (11%) were discharged to a long-term care or rehabilitation facility. At a median followup of 18 months (range 1 to 108 months) the percent of excess body weight loss was 71% (range 23% to 115%), weight was 125 kg (range 76 to 157 kg), and BMI was 32 kg/m^2 (22 to 56 kg/m^2).

Operative versus nonoperative treatment

Table 3 summarizes the outcomes of patients who underwent operative (n = 40) versus nonoperative (n = 23) treatment. There were no differences in onset of symptoms, or prevalence of tachycardia, fever, leukocytosis, or abnormal radiologic studies. In contrast, hypotension, oliguria, and leaks from the excluded stomach were more common in patients who underwent operative treatment ($p \leq 0.03$).

Patients undergoing operative treatment were kept NPO and were given TPN for a greater period of time ($p = 0.02$). Additionally, more patients treated operatively were managed in the ICU (54% versus 28%; $p = 0.04$ versus nonoperative treatment) and for a longer duration ($p = 0.003$). More importantly, there was no difference in incidence of postoperative complications, duration of hospital stay, or mortality among patients treated operatively versus nonoperatively.

Early versus late presentation of anastomotic leaks

A total of 27 patients (43%) had an early manifestation of the anastomotic leak (within 48 hours of index RYGB, Table 4). A greater number of these patients were diagnosed by means of a routine, postoperative, UGI series ($p < 0.0001$ versus late presentation) or had leaks originating in the excluded stomach ($p = 0.02$ versus late presentation). A greater percentage of patients with late presentation (> 48 hours) developed fever and abdominal pain ($p \leq 0.04$ versus early presentation) and were treated nonoperatively (47% versus 22%; $p = 0.04$, late versus early presentation).

DISCUSSION

As surgeons embraced bariatric surgery, substantial expertise in the management of anastomotic leaks in bariatric patients was lacking. So we pooled data from four busy academic centers to obtain a meaningful larger number of patients with anastomotic leaks. Our objective was to report the clinical characteristics, use, and efficacy of diagnostic modalities and to describe contemporary trends in the treatment of patients who developed anastomotic leaks after RYGB for clinically significant obesity. Our findings strongly suggest that treating physicians should maintain a high index of suspicion because an objective diagnosis of a leak can be difficult or impossible. Operative treatment remains the mainstay, but nonoperative treatment can be used in a subset of patients. Regardless, morbidity is high, hospitalization is prolonged, and mortality is 10%.

The etiology of anastomotic leaks is probably multifactorial, but there are known local and systemic factors that may impair anastomotic and wound healing.[6] More importantly, surgeon experience varies inversely with

Table 3. Comparison of Clinical Characteristics of Patients Who Underwent Nonoperative Versus Operative Treatment of Anastomotic Leaks

Characteristic	Nonoperative (n = 23)	Operative (n = 40)*	p Value
POD symptoms started (range)	3 (0–19)	3 (0–28)	NS
Tachycardia (> 100/min), n (%)	16 (70)	33 (83)	NS
Fever (> 38°C), n (%)	18 (78)	26 (65)	NS
Hypotension (SBP < 100 mmHg), n (%)	0	14 (35)	0.001
Oliguria (< 30 mL/h), n (%)	1 (4)	14 (35)	0.01
Increased WBC, n (%)	19 (83)	33 (83)	NS
UGI indicated leak, n (%)	6/20 (30)	9/31 (29)	NS
Location of the leak,† n (%)			
Gastrojejunostomy	15 (65)	18 (45)	NS
Excluded stomach	5 (22)	12 (30)	0.03
Jejunojejunostomy	2 (9)	7 (18)	NS
Gastric pouch	0	6 (15)	NS
Uncertain	3 (13)	0	NS
NPO, d (range)	8 (8–186)	13 (3–121)	NS
TPN, d (range)	0 (0–22)	9 (0–240)	0.02
ICU, d (range)	2 (0–14)	6 (0–75)	0.003
Duration of hospital stay, d (range)	15 (6–69)	19 (8–147)	NS
Overall complications, n (%)	14 (61)	21 (53)	NS
Mortality, n (%)	—	4 (10)	NS

*Includes three patients in whom nonoperative treatment was unsuccessful.
†Five patients had an additional or subsequent leak; total anastomotic leaks totaled 68 in 63 patients.
NPO, nothing by mouth; POD, postoperative day; SBP, systemic blood pressure; TPN, total parenteral nutrition; WBC, white cell count.

complications after bariatric surgery.[7] Interestingly, we documented a similar incidence of anastomotic leaks in patients well beyond our learning curve,[8] probably because as our experience increased over time, we started undertaking RYGB in patients at higher risk for anastomotic leaks, specifically, men with higher BMI, patients with previous abdominal operations, and patients with multiple serious obesity-related comorbidities.[3,8]

The overall incidence of anastomotic leaks in this study was 2.1% and did not differ between open or laparoscopic RYGB. As expected, the most common site of anastomotic leak was the gastrojejunostomy, but that site accounted for only 49% of all anastomotic leaks.

Risk factors for anastomotic leaks and complications, as identified in multiple studies, were increasing weight,[3,9,10] male gender,[3,9] multiple comorbidities,[9,10] previous abdominal procedures,[9,10] or revisional surgery.[9] Additionally, in some series,[11,12] anastomotic leaks have been reported in up to 13% of patients undergoing revisional operations, especially after converting a failed vertical banded gastroplasty to RYGB. In this series, 20% of patients were men, 54% had undergone previous abdominal operations, and 24% underwent a revisional bariatric procedure.

Although the Roux limb was more commonly antecolic-antegastric, we could not identify any correlation between positioning of the Roux limb and the incidence of anastomotic leaks at the gastrojejunostomy. The retrocolic, retrogastric route is shorter and may, in theory, be associated with a smaller incidence of leaks because of decreased tension on the gastrojejunostomy; this assertion was not supported by rigorous data. Similarly, this study was underpowered to detect any differences in the incidence of anastomotic leaks among various techniques (circular stapler, linear stapler, or hand sewn), as previously reported.[13]

Although many surgeons, including those in our groups, use adjuncts to anastomotic healing such as Peri-Strips and fibrin sealant, their efficacy has not been tested in large clinical trials.[14] Recent preliminary data suggest that fibrin sealant may reduce the incidence of anastomotic leaks.[15,16]

Many bariatric surgeons maintain that intraoperative leak tests are helpful in identifying anastomotic defects (up to 9%) that require immediate repair. We were not able to ascertain whether subsequent leaks were at the same site of the anastomotic defect that was repaired during the index RYGB. We find it useful to use closed

Table 4. Comparison of Clinical Characteristics and Outcomes in Patients Diagnosed with Anastomotic Leaks < 48 H or > 48 H after Roux-en-Y Gastric Bypass

Characteristic	Diagnosis < 48 h (n = 30)	Diagnosis ≥ 48 h (n = 38)	p Value
UGI indicated leak, n (%)	12/17 (71)	3/26 (12)	< 0.0001
Tachycardia (> 100/min), n (%)	17 (63)	26 (72)	NS
Fever (> 38%), n (%)	13 (48)	27 (75)	0.04
Abdominal pain, n (%)	8 (30)	25 (69)	0.006
Nausea/vomiting, n (%)	2 (7)	10 (28)	NS
Shoulder pain, n (%)	3 (11)	7 (19)	NS
Hypotension (SBP < 90 mm/Hg), n (%)	8 (30)	8 (22)	NS
Oliguria (< 30 mL/h), n (%)	6 (22)	10 (28)	NS
Location of the leak, n (%)			
Gastrojejunostomy	13 (48)	20 (56)	NS
Excluded stomach	12 (44)	5 (14)	0.02
Jejunojejunostomy	2 (7)	7 (19)	NS
Gastric pouch	4 (15)	2 (6)	NS
Uncertain	1 (4)	2 (6)	NS
Treatment, n (%)			
Operative	23 (78)	19 (53)	NS
Nonoperative	7 (22)	19 (47)	0.04
Transfer to ICU, n (%)	21 (78)	21 (58)	NS
Complications, n (%)	16 (59)	20 (56)	NS
Duration of stay, d (range)	16 (5–147)	19 (7–100)	NS

SBP, systemic blood pressure; UGI, upper gastrointestinal.

suction drains routinely at the gastrojejunostomy; in the event of an early and small volume leak, those drains can evacuate effectively leaking enteric content, possibly allowing nonoperative treatment in selected patients.[17] In this study, 23 patients (37%) were managed nonoperatively without an increase in mortality or morbidity.

As expected, the clinical presentation of leaks is not specific; tachycardia, which is generally considered to be the earliest sign of anastomotic leaks, was present in only 72% of patients. Other symptoms were similarly nonspecific and could be extremely difficult to decipher from normal variants in postoperative bariatric patients. So a complete diagnostic workup should be obtained immediately in any patient who develops tachycardia, fever, or abdominal pain, including, but not limited to, diagnostic radiologic studies. Nevertheless, 33% of patients developed signs or symptoms or both 72 hours postoperatively, which coincides with the average time they are discharged from the hospital.

A simple, quick, and inexpensive test to evaluate for anastomotic integrity is a UGI series. Not only can a UGI series be useful for evaluating a leak at the gastrojejunostomy, but it also provides additional information, such as the presence of gastrogastric fistula and anastomotic stenosis. When used routinely on postoperative day 1, a UGI may identify anastomotic leaks from the gastrojejunojejunostomy at an early stage in asymptomatic patients, as demonstrated in 8% of patients in our series, and direct the treating team to withhold oral intake and pursue nonoperative treatment with intravenous antibiotics and maintenance of surgically placed drains.[17] Nonetheless, because of the relatively low yield of UGI, CT may be warranted in hemodynamically stable patients. Notwithstanding the weight limitations of CT in most hospitals (approximately 350 lbs), CT provides useful information about extravasation of contrast material from the gastrojejunostomy or the jejunojejunostomy, and presence of free intraperitoneal gas or fluid, in addition to whether the excluded stomach is dilated. But when UGI and CT were done jointly in patients suspected of developing anastomotic leaks, both studies were interpreted as negative for leaks in 30% of patients in our series. Because of the many confounding variables that may have an impact on the utility of radiologic studies (patient weight, contrast load, ability to use different views, and radiologist experience), the predictive value of such diagnostic testing may be better elucidated with a prospective clinical trial.

Operative exploration has been the mainstay of treatment for anastomotic leaks in bariatric patients. Opera-

tive treatment achieves wide drainage of the abdominal cavity and placement of drains; repair of the leaking staple line may not be feasible, especially in the face of acute inflammatory changes around the gastrojejunostomy. A gastrostomy tube is warranted to decompress the ensuing gastric ileus and to allow early enteral nutrition. Additionally, all patients should receive intravenous broad-spectrum antibiotics and be kept NPO to minimize flow through the anastomosis.

Nonoperative treatment was undertaken successfully in a group of patients who did not exhibit hemodynamic instability, specifically, hypotension or oliguria; in many of these patients, an anastomotic leak was suspected because of tachycardia, purulent effluent in the surgical drains, or was diagnosed by routine UGI studies. Nonoperative treatment consisted of intravenous broad-spectrum antibiotics, NPO, and maintenance of surgical drains; nasogastric tubes were not used routinely. It should be acknowledged that 12% of patients had unsuccessful nonoperative treatment and required subsequent operative treatment as their symptoms worsened or they exhibited signs of systemic toxicity.

The duration of ICU stay of patients treated nonoperatively was lower, but the overall incidence of complications and the overall duration of hospital stay were similar to patients treated operatively. More importantly, judicious practice of nonoperative treatment in a group of patients with controlled leaks did not increase morbidity or mortality in this cohort.

Although the onset of anastomotic leaks cannot be predicted or timed, we stratified patients who had anastomotic leaks to early ($<$ 48 hours) and late ($>$ 48 hours) presentation to assess whether onset of symptoms had any impact on outcomes. Although the characteristics and outcomes of patients with early or late anastomotic leaks are similar, these data should not be misinterpreted to support delaying definitive and operative treatment of anastomotic leaks.

Our study has several limitations; although the data were collected prospectively, our databases were not designed for detailed studies of the in-hospital clinical course. Second, although UGI series were obtained in the majority of patients, we could not ascertain whether some of the radiologic studies were done as a result of change in patient's condition or per routine care. Third, treatment protocols and criteria for nonoperative versus operative treatment were not developed a priori. Notwithstanding, this large series of patients from four busy academic centers reports a realistic incidence and describes the clinical presentation and contemporary treatment of anastomotic leaks.

In conclusion, anastomotic leaks after bariatric operations carry significant morbidity and mortality. A high index of suspicion should prompt a diagnostic workup that includes diagnostic celioscopy or celiotomy. Nonoperative treatment is feasible in a group of patients with controlled and drained leaks who do not exhibit signs of systemic toxicity.

Author Contributions

Study conception and design: Gonzalez, Murr, Sarr
Acquisition of data: Gonzalez, Baghai
Analysis and interpretation of data: Gonzalez, Sarr, Murr
Drafting of manuscript: Gonzalez, Sarr, Smith, Rosenthal, Murr
Critical revision: Gonzalez, Murr, Sarr, Smith, Kendrick, Rosenthal, Szomstein

REFERENCES

1. Schauer PR, Ikramuddin S, Gourash W, et al. Outcomes after laparoscopic Roux-en-Y gastric bypass for morbid obesity. Ann Surg 2000;232:515–529.
2. Marshall JS, Srivastava A, Gupta SK, et al. Roux-en-Y gastric bypass leak complications. Arch Surg 2003;138:520–523; discussion 523–524.
3. Fernandez AZ Jr, DeMaria EJ, Tichansky DS, et al. Experience with over 3,000 open and laparoscopic bariatric procedures: multivariate analysis of factors related to leak and resultant mortality. Surg Endosc 2004;18:193–197.
4. Arteaga JR, Huerta S, Livingston EH. Management of gastrojejunal anastomotic leaks after Roux-en-Y gastric bypass. Am Surg 2002;68:1061–1065.
5. Gonzalez R, Nelson LG, Gallagher SF, Murr MM. Anastomotic leaks after laparoscopic gastric bypass. Obes Surg 2004;14:1299–1307.
6. Dubay DA, Franz MG. Acute wound healing: the biology of acute wound failure. Surg Clin North Am 2003;83:463–481.
7. Nguyen NT, Rivers R, Wolfe BM. Factors associated with operative outcomes in laparoscopic gastric bypass. J Am Coll Surg 2003;197:548–555; discussion 555–557.
8. Gonzalez R, Haines K, Gallagher SF, Murr MM. Does experience preclude leaks in laparoscopic gastric bypass? Surg Endosc 2006 [Epub ahead of print].
9. Livingston EH, Ko CY. Assessing the relative contribution of individual risk factors on surgical outcome for gastric bypass surgery: a baseline probability analysis. J Surg Res 2002;105:48–52.
10. Gonzalez R, Bowers SP, Venkatesh KR, et al. Preoperative factors predictive of complicated postoperative management after Roux-en-Y gastric bypass for morbid obesity. Surg Endosc 2003;17:1900–1904.

11. Khaitan L, Van Sickle K, Gonzalez R, et al. Laparoscopic revision of bariatric procedures: is it feasible? Am Surg 2005;71:6–10; discussion 10–12.
12. Gonzalez R, Gallagher SF, Haines K, Murr MM. Operative technique for converting a failed vertical banded gastroplasty to Roux-en-Y gastric bypass. J Am Coll Surg 2005;201:366–374.
13. Gonzalez R, Lin E, Venkatesh KR, et al. Gastrojejunostomy during laparoscopic gastric bypass: analysis of 3 techniques. Arch Surg 2003;138:181–184.
14. Shikora SA. The use of staple-line reinforcement during laparoscopic gastric bypass. Obes Surg 2004;14:1313–1320.
15. Liu CD, Glantz GJ, Livingston EH. Fibrin glue as a sealant for high-risk anastomosis in surgery for morbid obesity. Obes Surg 2003;13:45–48.
16. Silecchia G, Boru CE, Mouiel J, et al. Clinical evaluation of fibrin glue in the prevention of anastomotic leak and internal hernia after laparoscopic gastric bypass: preliminary results of a prospective, randomized multicenter trial. Obes Surg 2006;16:125–131.
17. Serafini F, Anderson W, Ghassemi P, et al. The utility of contrast studies and drains in the management of patients after Roux-en-Y gastric bypass. Obes Surg 2002;12:34–38.