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Gastrogastric Fistulae Following Gastric Bypass Surgery—Clinical Recognition and Treatment

Eric M. Pauli · Hiba Beshir · Abraham Mathew

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Abstract Gastrogastric fistula (GGF) formation is an uncommon but well-recognized complication following Roux-en-Y gastric bypass for morbid obesity. Patients with GGF may be asymptomatic or have nonspecific problems of abdominal pain, weight regain, or ulcer formation at the gastrojejunal anastomosis. Maintaining a high index of suspicion is the key to diagnosis. Flexible upper endoscopy and upper gastrointestinal fluoroscopy are complementary imaging modalities for securing the diagnosis of GGF. Surgical repair of GGF is generally the most definitive management but is invasive and has the potential for morbidity. Endoscopic methods of closure have gained favor in recent years due to their noninvasive nature despite the lack of long-term data regarding their success. Novel methods of endoscopic closure, including endoscopic suturing, more closely resemble the surgical paradigm and will likely supplant traditional surgical methods for the management of GGF.

Keywords Gastrogastric fistula · Bariatric surgery · Morbid obesity · Roux-en-Y gastric bypass · Complication · Endoscopy · Laparoscopic surgery

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E. M. Pauli
Division of Minimally Invasive and Bariatric Surgery, Department of Surgery, Penn State Hershey Medical Center, 500 University Drive, MC HU33, Hershey, PA 17033, USA

H. Beshir · A. Mathew (✉)
Division of Gastroenterology and Hepatology, Department of Medicine, Penn State Hershey Medical Center, 500 University Drive, MC HU33, Hershey, PA 17033, USA
e-mail: amathew@hmc.psu.edu

Introduction

Surgical intervention remains the best and most durable method of achieving weight loss in morbidly obese populations [1, 2]. Despite an increase in the variety of bariatric surgical options in recent years, laparoscopic Roux-en-Y gastric bypass (RYGB) is still the most commonly performed bariatric operation in the USA [3, 4]. This operation has excellent long-term durability and an acceptably low morbidity; however, anastomotic leaks, strictures, and bowel obstruction are well-recognized surgical complications [2, 5–7].

Although less common, gastrogastric fistula (GGF) formation is another well-described problem following RYGB. GGFs are communications between the gastric pouch (proximally) and the gastric remnant (distally) [8]. In the bygone era of nondivided gastric restrictive procedures, GGFs were one of the most common complications, occurring in upwards of 50 % of patients [9]. With the advent of the divided RYGB (in which the gastrointestinal stapler simultaneously places rows of staples and transects the tissue between the rows), the incidence of GGF has rapidly declined [10]. Present data suggest that GGF complicates 1.2–6 % of RYGB procedures [9, 11–16]. This article reviews the pathogenesis, diagnosis, consequences, and therapy (endoscopic and surgical) for GGF.

Pathogenesis

Multiple factors have been associated with the formation of GGF following RYGB (Table 1). The most common etiology of GGF is poor surgical technique, which results from a failure to completely divide the proximal stomach high on the fundus [10, 13]. Posterior stomach hidden behind intraabdominal fat may be difficult to visualize. Thus, incomplete division of the fundus can occur even

Table 1 Causative factors of GGF following RYGB

Causative factor	Description	Prevention strategy
Iatrogenic	Failure to completely divide the proximal stomach (poor surgical technique)	Visual evaluation (laparoscopic and endoscopic) of complete gastric division
Foreign body	Suture migration	Use of absorbable suture only
	Gastric band related (adjustable gastric bands, Prolene pre-anastomotic rings, Silastic bands from vertical gastroplasty)	Complete removal of all band materials during revisional bariatric procedures
	Bovine pericardial strips	Correct application of the delivery system onto the endostapler
Ischemic	Marginal ulcer perforation	Smoking cessation, ulcer therapy, post-operative measures to prevent hypotension
	Coagulation injury	Cautious use of electrosurgical devices
Staple line leak	Pouch staple line	Appropriate staple load height, stapler compression
	Gastrojejunal anastomosis staple line	Appropriate staple load height, stapler compression, omental wrap
	Gastric remnant staple line	Appropriate staple load height, stapler compression, prevention of gastric remnant distention
Idiopathic	Proclivity for gastric reattachment	None

when transection was thought to be complete. There may also be failure to persist in dissection due to concern of creating an iatrogenic esophageal, splenic, or diaphragm injury. The inexperienced surgeon may limit dissection and fail to recognize incomplete gastric transection [17].

In the absence of a staple line leak, such incomplete division is generally unnoticed in the immediate post-operative period. Carucci et al. noted that only 12 % of early GGF (<2 months post-operatively) had no associated extraluminal leak on upper gastrointestinal (UGI) studies [11]. This complication is avoidable by maintaining a high index of suspicion for incomplete transection and by clear laparoscopic and endoscopic visualization of complete gastric division.

Staple line leak and resulting abscess formation are likely the other major causative factors in the formation of GGF. The local infection and the subsequent inflammatory response may result in breakdown of the nearby staple lines and result in internal decompression of the abscess via the gastric remnant [18, 19]. As noted above, Carucci et al. found that 88 % of early GGF (<2 months post-operatively) had extraluminal contrast identified on UGI studies [11]. Such leak may originate at the proximal or distal gastric staple line or from the gastrojejunal anastomosis (GJA) itself. Indeed, the presence of a GJA leak predisposes the patient to the development of a subsequent GGF. [10].

Similarly, persistent ulceration of the GJA is associated with GGF formation, although the precise etiology here is still debated [10, 13, 14, 20, 21]. Some authors have argued that the inclusion of parietal cell mass within the gastric pouch results in GJA ulceration from acid exposure and establishes a local inflammatory state that culminates in the formation of a GGF [14, 21]. Others have argued the inverse; GGF causes GJA due to the reflux of fluid from the gastric remnant into the gastric pouch (via the GGF) which bathes the vulnerable jejunal mucosa in acid [20].

Signs and Symptoms

Patients with GGF may be asymptomatic or present clinically a myriad of nonspecific symptoms including nausea, vomiting, gas bloat, pyrosis, and abdominal pain. They may report diabetes recurrence, suboptimal weight loss, and/or weight regain. GGF may be associated with GJA ulcers (symptoms of which include pain, hemorrhage, or perforation), gastritis of the pouch, and GJA stricture [22–24]. Unfortunately, none of these symptoms are unique to the presence of a GGF and can be found in patients following RYGB in the absence of a GGF. Interestingly, not all patients with GGF have issues with poor bariatric outcomes; some have no overt symptoms and in fact achieve acceptable,

durable weight loss despite the fistula [10, 14, 25]. Maintaining a high clinical suspicion of GGF is therefore critical in the diagnostic workup.

Weight regain, failure to obtain optimal weight loss, and diabetes recurrence occur as nutrients pass through the gastric remnant and proximal intestine (biliopancreatic limb of RYGB) rather than bypassing the duodenum [26•]. If the GGF is large enough, the content of the gastric pouch may preferentially empty into the gastric remnant and defeat the purpose of the entire bypass surgery. Consequently, patients may report a loss of satiety (or lost post-prandial discomfort) as food rapidly leaves the gastric pouch and into the remnant stomach via the GGF [8]. GGFs, therefore, potentially eliminate both the restrictive and the malabsorptive components of the RYGB. Patients with GGF also demonstrate levels of the gut hormones ghrelin, peptide YY, and glucagon-like peptide-1 similar to pre-RYGB patients [26•]. These alterations likely contribute to the decreased sense of satiety and recurrence of diabetes seen in GGF patients.

Food shunting into the remnant stomach via the GGF may also be exacerbated by the presence of a restricted GJA. This is the case in patients with a GGF and concomitant GJA ulcer or stricture. Ulceration results in edema and can lead to stricture, reducing nutrient flow into the alimentary limb of the RYGB. In rare cases, spontaneous closure of the GJA from ulcer-related inflammation and from complete food shunting through the GGF has been seen. In such cases, the GGF is the only outlet of the gastric pouch.

Diagnosis

The diagnosis of GGF should be sought in patients with new-onset suggestive symptoms (as noted above), lack of weight loss, or weight regain. Because symptoms are nonspecific and weight regain is part of the anticipated post-RYGB process, diagnosis can only be made with further clinical evaluation. An upper endoscopy or barium contrast study is the diagnostic tests of choice; however, GGF may be suggested or identified on other imaging modalities including computed tomography (CT), magnetic resonance imaging (MRI), small bowel follow-through, and on-table/intraoperative fluoroscopy.

Upper Endoscopy

Upper endoscopy plays a critical role in the management of foregut symptoms following RYGB [22, 27]. Endoscopy permits direct visualization of a GGF (Fig. 1) and its sequelae (gastritis, GJA ulceration) and permits size estimation to determine the suitability of endoscopic versus surgical repair [28]. In most circumstances, the GGF will be located on the left side of the gastric pouch along the gastrogastric staple line. Without a high index of suspicion and careful exam of the staple line, one will miss an often small fistula. Once the staple line is identified, it should be traced in its entirety, particularly cranially. Thorough evaluation of all mucosal folds and pits should be undertaken to exclude a small, hidden GGF. Such locations can be probed using a guide wire. A sphincterotome is beneficial in directing the angle of the wire tip and may facilitate more controlled wire passage through the GGF. Fluoroscopy can also be helpful as leakage of the distending gas or injected contrast dye from the pouch into the expected to be isolated gastric remnant may be visualized.

Identification of the GGF may require a retroflex within the pouch itself. Use of a transparent cap on the endoscope tip aids in visualization by flattening musical folds and creating a working space to more easily probe the potential fistula site. As air may rapidly traverse the GGF, distention of the remnant stomach may be observed as a sudden mass-like indentation in the back wall of the gastric pouch which can obscure visualization. A standard diagnostic gastroscope is sufficient for most cases as traversing the GGF is not mandatory for diagnosis. A slim upper endoscope or pediatric gastroscope may be utilized to further evaluate small pits or folds [29, 30•].

Upper GI Contrast Study

It is not unusual for a UGI contrast study to identify an asymptomatic and unsuspected GGF (Fig. 2). Contrast-based evaluation of the upper GI tract is indicated when the presence of a GGF is suspected and may be beneficial prior to endoscopy to confirm the presence of a GGF. The sensitivity and specificity of UGI contrast studies in detecting GGF are not well reported, but in the authors experience, both are high [31, 32]. In the minimally symptomatic patient, the contrast study may provide functional information about the proportion of oral intake that traverses the GGF versus the GJA and may provide information about the potential benefits (in regard to weight loss) of closure. UGI studies may also identify strictures at the GJA and mucosal irregularities that suggest an anastomotic ulceration. The finding of a GGF on UGI contrast imaging warrants follow-up endoscopy to assess for their location, size, number, and sequelae.

Cross-Sectional Imaging

Following RYGP, cross-sectional imaging (CT, MRI) is commonly used to assess foregut symptoms. While not the test of choice, the diagnosis of GGF can be suspected on these studies primarily by the presence of an air-fluid level or food within the remnant stomach. On CT scan, the presence of oral contrast within the remnant stomach, particularly when there is no contrast within the biliopancreatic limb to suggest retrograde reflux, is diagnostic of a GGF (Fig. 3) [16]. Large fistulae themselves may be seen on CT or MRI, but their absence on these studies does not rule out GGF.

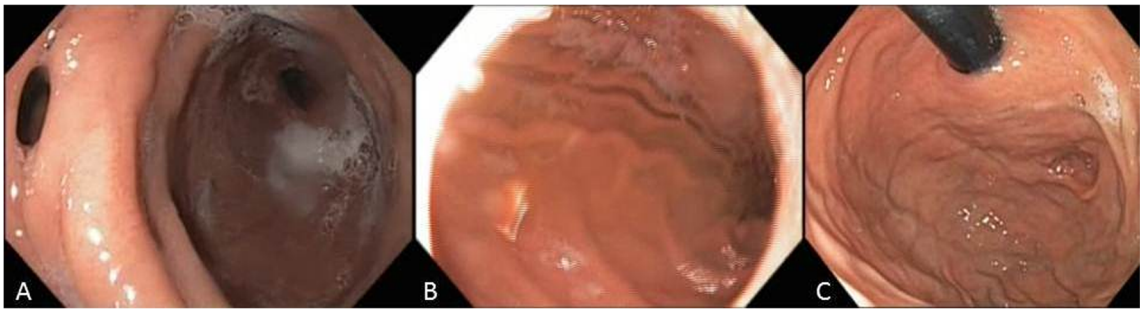

Fig. 1 **a** Upper endoscopy reveals a GGF (*left*) and GFA with ulcer (*right*). **b** View through the GGF demonstrates the air-filled remnant stomach. **c** Retroflexed view after traversing the GGF demonstrates the remaining, intact staple line and the native fundus

Management

The management of GGF depends largely on the symptoms at presentation; incidentally found, asymptomatic GGFs do not warrant any specific treatment while those associated with sequelae (ulcers, bleeding, weight gain) may be managed with medical, endoscopic, or surgical therapies.

Medical Management

Conservative management aims at reducing gastric acid secretion. This may eliminate abdominal pain and reflux symptoms and allow GJA ulceration to resolve (or prevent it from occurring). Acid reduction therapy may also permit small GGF to close spontaneously [28]. *Helicobacter pylori* infection should be sought for and be eradicated if not done prior to RYGB. Sucralfate and smoking cessation are typically added to the regimen if GJA ulceration is present. Older recommendations suggest that if a GGF's symptoms can be controlled with acid reduction, then consideration should be given to long-term proton pump inhibitor (PPI) use as a means of definitive therapy [10]. It should be noted, however, that these recommendations were made in an era prior to many of the therapeutic endoscopic interventions described below as well as before widespread understanding that prolonged PPI use may have potential adverse effects [33].

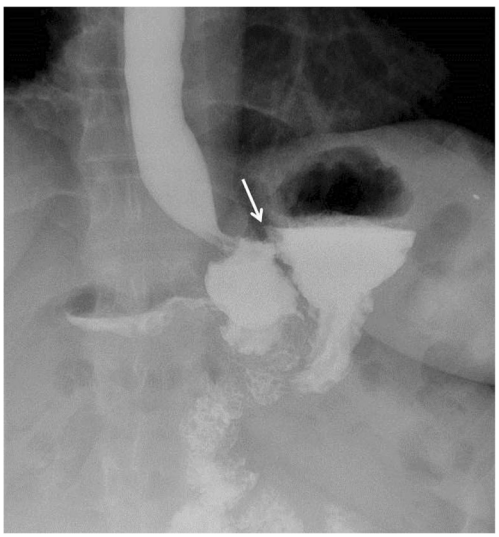

Fig. 2 Barium swallow demonstrates contrast filling the gastric pouch and preferentially traversing the GGF (*arrow*) to fill the remnant stomach

Endoscopic Repair of GGF

Several studies have shown that peroral endoscopic repair of GGF is safe and feasible with best results seen in fistulas ≤10 mm [28, 29, 30•, 34–36]. Durability of GGF closure appears to depend on fistula size as well as the endoscopic method of closure. The best repairs follow sound surgical principles of fistula management and address the underlying processes keeping the fistula open. Foreign body (suture, staples) within the fistula tract must be removed, gastric inflammation should be treated with a PPI, infection from staple line-free perforation should be drained and treated with antibiotics, epithelized tracts between the pouch and the remnant stomach should be ablated, and distal obstruction at the GJA should be managed with endoscopic dilation or stent placement.

A wide variety of endoscopic methods have been described to address GGF, including endoclips, fibrin sealant, covered esophageal stents, and endoscopic suturing systems (many of which were never commercially available) [28, 30•, 34, 36]. Most authors advocate mucosal ablation of the GGF edges using cold biopsy forceps, a biliary brush, or argon plasma coagulation prior to tissue approximation, to promote durable apposition of nonepithelialized tissue.

We previously described the use of endoclips to close GGF as part of a multimodal endoscopic therapy, including mucosal ablation and fibrant sealant application (Fig. 4) [30•]. Endoclips are readily available, familiar to most endoscopists, comparatively inexpensive, and easy to use. Unfortunately, the jaw opening of most endoclips limits their usefulness to GGF less than 1.0 cm in size. Larger GGFs are perhaps better addressed with one of two commercially available endoscopic closure devices, the Overstitch (Apollo Endosurgery, Austin,

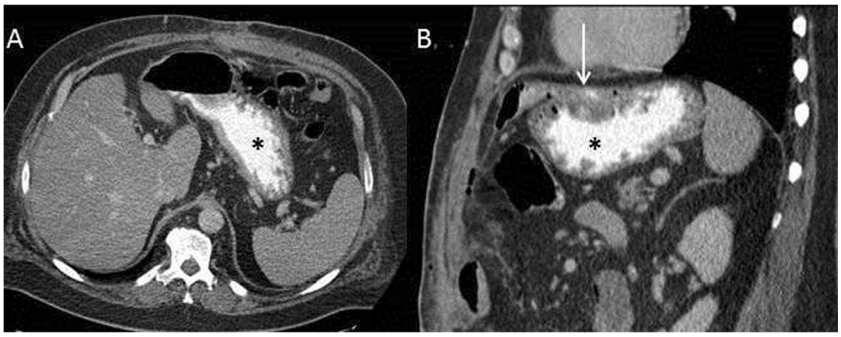

Fig. 3 Axial (**a**) and sagittal (**b**) CT images demonstrate oral contrast and an air-fluid level within the remnant stomach (*asterisk*). The GGF (*arrow*) was visualized posterior and to the left of the gastric pouch

TX) or the Over-the-Scope-Clip System (OTSC, Ovesco, Tübingen, Germany) (Fig. 5), both of which are capable of closing defects above 1.0 cm in size [29, 37•, 38, 39]. Fluoroscopic guidance during the procedure is a useful adjunct and can be used to document immediate procedural success (Fig. 6).

Following endoscopic closure, it is recommended for patients to stay on clear liquid diet for 1–3 days, then soft diet for up to 2 weeks before transitioning to regular diet, but there is no literature to support these recommendations. All patients should continue their PPI therapy for at least 6 weeks in addition to avoiding nonsteroidal anti-inflammatory medications. Follow-up contrast study can be obtained 2 weeks or up to 3 months post-procedure to evaluate the GGF repair [28, 30•]. Further evaluation or studies are guided by recurrence of symptoms or weight regain.

Major endoscopic complications after endoscopic repair are uncommon and include significant bleeding and perforation (esophageal and gastric). Minor complications are more common post-procedure and include nausea, abdominal discomfort, vomiting, and diarrhea. [28]

Surgical Management

Despite great advances in endoscopic techniques, surgery remains the standard of care for large GGF and for those patients who fail endoscopic repair [9, 10, 13, 37•, 40]. However, revisional bariatric surgery (whether open or laparoscopic) has been associated with increased technical difficulty, length of hospital stay, and complication rates (morbidity rate 10–46 % and a mortality rate of >1 %) [37•, 41–43]. Consequently, many practitioners will assure optimized medical management and make repeat attempts at endoscopic repair prior to recommending surgical management. While not evaluated in a randomized trial, this approach is appealing due to the well-documented complication rates following surgical repair and the low complication rates following endoscopic repair. Importantly, failed endoscopic management of GGF does not appear to increase the subsequent complication rate of a revisional surgical procedure [37•].

There are multiple options for surgical correction of GGF. Surgical division of the fistula can be performed

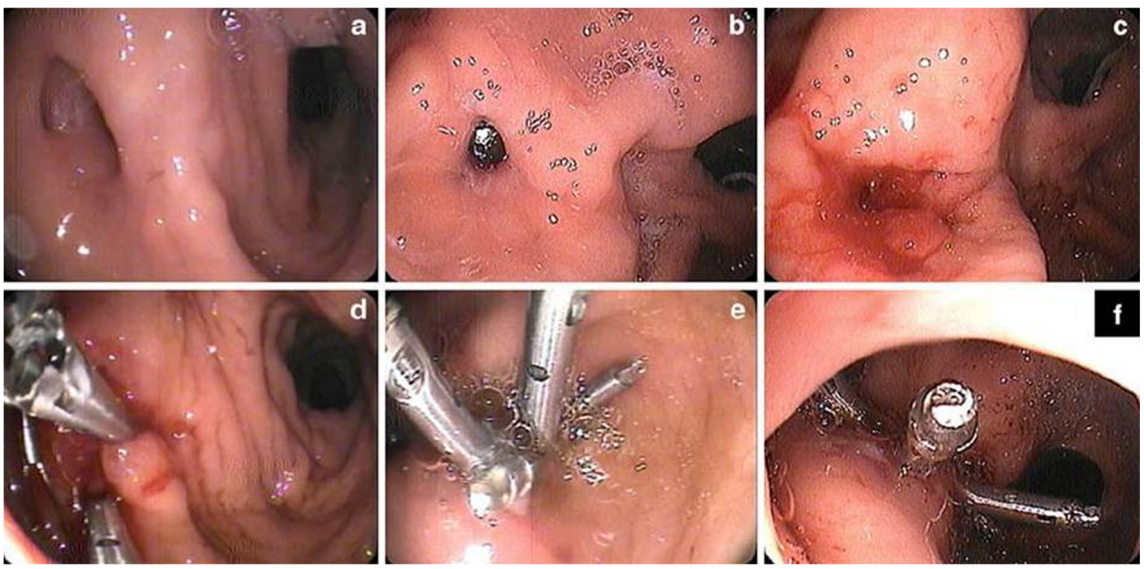

Fig. 4 Endoscopic images of GGF before (**a**–**c**) and immediately after (**d**–**f**) endoclip closure (used with permission from *Obes Surg* 2010;20:1090–5)

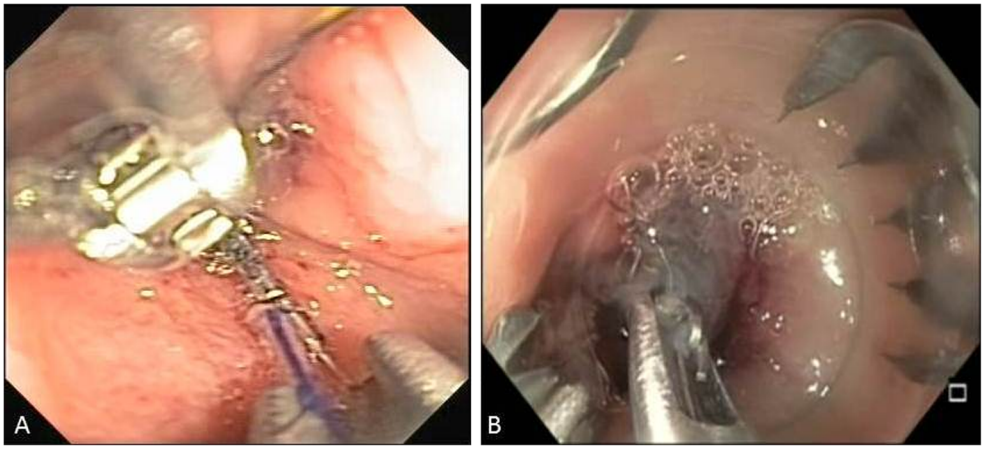

Fig. 5 Endoscopic view of GGF closure using **a** overstitch device and **b** OTSC system and twin grasper

with or without an interposition of omentum or jejunum to support the closure. Operative repair can be challenging due to extensive inflammatory response around the fistulous tract resulting from foreign body or prior walled off perforations [13, 44].

To avoid the hostile environment surrounding the GGF, some authors have reported using laparoscopic instruments to perform the repair via a percutaneous, intragastric route. Here, an endoscope passed through the GGF is used to guide the placement of laparoscopic trocars into the remnant stomach. Laparoscopic suturing is then used to close the GGF [41].

Because of the concern for GGF recurrence, some authors have proposed the more definitive approach of remnant gastrectomy [13, 15]. Here, the greater curve vasculature is taken down. Gastrointestinal staplers are used to divide the remnant stomach just proximal to the pylorus and just lateral to the GGF. When necessary, the gastric pouch can be trimmed to completely excise the GGF. For those patients with processes warranting it (persistent ulceration, stricture or involvement of GJA with GGF), the GJA can be excised and recreated at the same operation. This operation results in symptom resolution in 87 % of patients [13].

Results

While immediate endoscopic closure is frequently attained, it may not translate into long-lasting results [28, 36]. Fernandez-Esparrach et al. reported a long-term endoscopic closure success rate of 19 % with a median follow-up of 359 days. The initial fistula size was the factor associated with a high risk of endoscopic treatment failure at the end of follow-up period. No endoscopic closures of GGFs with an initial size >20 mm were durable at the end of the follow-up period compared with 32 % of fistulas ≤10 mm that remained successfully closed [28]. Similarly, Spaun et al. noted immediate procedural success in five patients [36]. By 3 months, 80 % had recurred and by 6 months, 100 %. It should be noted, however, that these studies were conducted utilizing prototype suturing devices or devices intended for other endoscopic procedures. Our own experience demonstrated intermediate-term success in four of eight (50 %) patients undergoing closure of small GGF utilizing commercially available endoclips [30•]. It is anticipated that as endoscopic technology continues to improve, the long-term success rate of GGF closure will increase.

Long-term results of surgical repair of GGF are similarly lacking in the literature, but reports suggest that good results

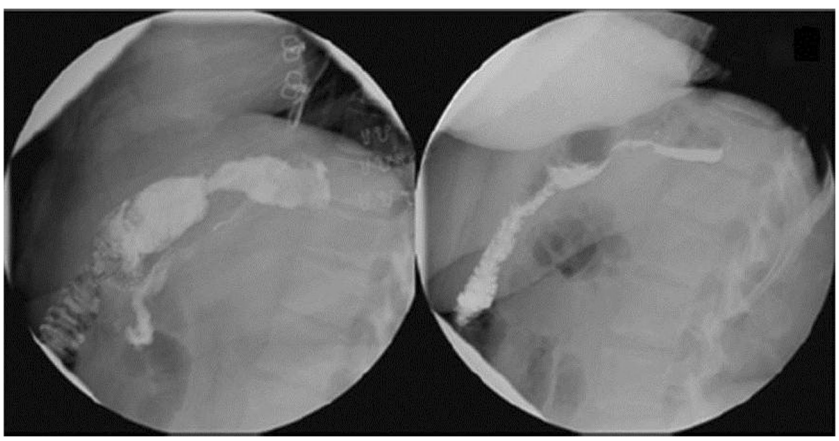

Fig. 6 Lateral images from upper GI series before (*left*) and after (*right*) endoscopic repair of GGF demonstrate contrast only in the alimentary limb following closure (used with permission from *Obes Surg* 2010;20:1090–5)

can be achieved. Torres-Villalobos et al. reported a 33 % recurrence rate at 8 months following transgastric GGF repair [41]. For Tucker et al., the more definitive surgical procedure of remnant gastrectomy (performed laparoscopically or open) resulted in symptom resolution in the majority of patients (87 %), resolution of ulceration in all patients (24 of 24), and weight loss of an average of 27 lb [13]. O'Brien et al. reported a 4-month success rate of 100 % (seven of seven patients) utilizing laparoscopic remnant gastrectomy [26•]. After GGF repair, their subjects lost an average of 6 kg yielded favorable changes in satiety and orexigenic gut hormones. Similar changes in glucose homeostasis and gut hormone levels have also been reported by others following surgical repair of GGF [45].

Conclusion

While uncommon, GGF after RYGB can be a source of morbidity for patients. Diagnosis requires a high clinical suspicion and, once suspected, a dedicated effort to visualize the fistula. Endoscopic repairs, usually performed in the outpatient setting, have grown in popularity due in large part to the high morbidity of revisional bariatric surgery even in expert hands. As endoluminal techniques continue to improve, endoscopic methods will likely become the gold standard method for GGF repair. Presently, however, surgery remains the standard of care for large GGF and for those patients who fail endoscopic repair.

Compliance with Ethics Guidelines

Conflict of Interest Eric M. Pauli, Hiba Beshir, and Abraham Mathew declare no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with animal subjects performed by any of the authors. With regard to the authors' research cited in this paper, all procedures were followed in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000 and 2008.

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