Chapter 47
Esophageal Reflux Disease Before and After Bariatric Surgery

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Introduction

The aim of this chapter is to review esophageal reflux disease in the bariatric patient before and after weight loss surgery. It is well known that obesity is a risk factor for the development of esophageal reflux disease (GERD). The impact of bariatric surgery and GERD is an evolving topic of discussion, as incidence and improvement of GERD may be dependent upon the type of bariatric procedure performed. One of the main questions is, "What is the effect of different bariatric procedures on GERD?" There is a rationale for different pathways of reflux management based on surgery type. They can be creative depending on the procedure, including intragastric balloon (IGB), adjustable gastric banding (AGB), sleeve gastrectomy (SG), Roux-en-Y gastric bypass (RYGB), as well as biliopancreatic diversion with duodenal switch (BPD-DS).

We will review the physiology and prevalence of reflux in the bariatric patient population. We will also discuss the evaluation and treatment options of esophageal reflux disease following bariatric surgery. In most patients, the treatment of GERD involves dietary and lifestyle intervention along with proton pump inhibitors (PPIs) which are effective in controlling reflux symptoms. However, for those bariatric patients with GERD refractory to PPIs, surgical options will need to be investigated and personalized. As understood, fundoplication for treatment of GERD has been associated with higher failure rates in the severely obese patients, although results are conflicting [1].

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When it comes to bariatric patients and GERD, much of the treatment effort is focused on weight loss. Bariatric surgical procedures (AGB, SG, RYGB, BPD-DS) can be used to treat not only obesity but also GERD. However, each surgery poses certain challenges in the obese patient with GERD. For this reason, a bariatric surgeon should be prepared to diagnose and treat new and worsening GERD before and after weight loss surgery. As more endoscopic and surgical options become available, as well as the possibility of combining two techniques for the same patient, it is important to keep abreast of the different possibilities in treating obese patients with GERD before and after weight loss surgery.

Prevalence of Reflux in Bariatric Patients

Gastroesophageal reflux disease is a common problem in the West. Approximately 10–20% of the general population suffers from reflux-related symptoms [2]. Another study quotes a prevalence of GERD in the general population as high as nearly 30% [3]. In obese patients, the prevalence of GERD is even higher. Hong and colleagues found that in morbidly obese patients being evaluated for bariatric surgery, with a mean BMI of 50.1, 38% of patients complained of reflux-related symptoms with a total of 54% of patients having abnormal manometric findings, consisting of LES dysfunction and other esophageal dysmotility issues [4]. The Houston VA Medical Center Study found that 39% of obese patients (BMI > 30 kg/m^2) demonstrated reflux-related symptoms of heartburn or regurgitation [5]. Another study quoted the prevalence of reflux symptoms in the morbidly obese to be over 50%, with greater than 70% of the morbidly obese demonstrating evidence of reflux disease on pH monitoring [6]. Additional smaller studies as well as larger, population-based studies have demonstrated similar findings, with one population-based study indicating an odds ratio for GERD to be 2.6 for obese individuals as compared to the nonobese [7]. Interestingly, the risk of reflux symptoms has also been linked to waist-to-hip ratio in a dose-responsive fashion [2], and the 2006 data from the Nurses' Health Study demonstrated that incremental weight gain among women with normal body mass indices is associated with a proportionate increase in reflux symptoms [8]. Other studies have demonstrated that overweight patients (BMI 25–29) and obese patients (BMI > 30) are at a higher risk for the development of GERD [2, 9].

The high prevalence of GERD in the obese patient is linked to many pathophysiologic mechanisms, most notably to the presence of hiatal hernia and to extrinsic gastric compression. As compared to the general population, obese patients have a threefold increase in the prevalence of hiatal hernia [2], and therefore it is not surprising that we see an increase in the prevalence of GERD in this population, given the known link between hiatal hernia and GERD symptoms.

The prevalence of GERD after bariatric surgical procedures is quite variable and is dependent on the type of bariatric procedure that the patient undergoes. A higher prevalence of new or worsened GERD symptoms after laparoscopic sleeve gastrectomy (SG) has been shown [2, 10, 11]. On the contrary, one prospective cohort

study on approximately 260 patients demonstrated at least a significant early benefit from SG on GERD symptoms, when hiatal hernias were repaired, if identified, at the time of the SG. Follow-up after surgery, however, was poor (7%) after 36 months, and so long-term benefit or symptom recurrence was not able to be assessed [12]. Adjustable gastric banding (AGB) has been shown to provide a short-term benefit in the reduction of GERD symptoms [13–16], with long-term worsening and loss of benefit due to the link between AGB and esophageal dysmotility [2, 13, 17]. Newly developed GERD symptoms after AGB are quoted as high as 50% and range from 6% to 50% [13]. The prevalence of GERD after RYGB is quite low, and overall RYGB is linked to a decreased incidence of GERD [2, 13, 18]. In fact, RYGB is offered with success to patients with de novo GERD symptoms after AGB or SG [13, 19] and is offered as a viable option for persistent GERD after failed fundoplication [13, 20].

Pathophysiology of GERD in Obese Patients before Bariatric Surgery

The pathophysiology of GERD in the bariatric patient is multifactorial and includes mechanical, anatomical, and biochemical considerations. Essentially, GERD arises when the normal gastroesophageal pressure gradient is altered and intragastric pressure becomes greater than that of the distal esophagus [21]. This can occur from the failure of endogenous anti-reflux mechanisms, namely, lower esophageal sphincter tone and spontaneous esophageal clearance. There are several proposed theoretical mechanisms linked to the failure of endogenous anti-reflux mechanisms in the general population: (1) hiatal hernia causing disruption of the gastroesophageal junction, (2) incompetence of the lower esophageal sphincter, and (3) transient lower esophageal sphincter relaxations (TLESRs) or spontaneous LES relaxations [2, 21]. Hiatal hernias decrease the efficacy of the LES, causing a hypotensive LES and promoting increased intragastric pressure, and thereby leading to the development of GERD symptoms. TLESRs are longer-duration relaxations than those observed during normal deglutition and are generated by vagovagal reflexes that are relatively poorly understood and have been shown to be present in those with GERD as well as in healthy individuals [3]. However, some evidence suggests that there is an increase number of TLESR and reflux during the postprandial period in obese patients [22–24].

Aside from the mechanical and anatomical impact of hiatal hernia on the development of GERD symptoms, the increased intra-abdominal adiposity often seen in obese patients contributes to extrinsic gastric compression and subsequently promotes a gradient favorable for reflux to occur [2]. Anatomic displacement of the esophagus into the chest in obese patients may also play a role in the failure of intrinsic anti-reflux mechanisms and the development of reflux symptoms. In this setting, there is a decreased impact of the diaphragm on the LES, decreasing the overall LES pressure, which promotes an increased gradient across the GE junction and production of GERD symptoms [2].

Several biochemical mechanisms linking GERD and obesity are also important to consider. Studies have demonstrated a link between fatty food intake and the development of GERD symptoms as well as the positive effect of endogenous and exogenous gastrin release on LES pressures [3, 5, 23, 25]. Increased fatty food intake reduces the effects of endogenous and exogenous gastrin release on the LES, thus leading to decreased LES pressures in the postprandial period and the development of reflux symptoms.

Evidence also suggests a link between high carbohydrate intake and the development of GERD symptoms [3, 26]. In the general population, approximately 2–20% of all carbohydrates consumed remain undigested and are metabolized by colonic microflora into short-chain fatty acids. In the setting of excessive carbohydrate intake, common among obese individuals, a humoral pathway, mediated by regulatory peptides, is described by which exposure of the ileum and proximal colon to increased short-chain fatty acids creates a dose-dependent relaxation of the proximal stomach, triggering TLESRs [26].

Altered regulatory pathways with respect to the hormones ghrelin and leptin may also be important biochemical, pathophysiologic mechanisms that contribute to the development of GERD in the bariatric patient, with ghrelin having an effect on gastric motility and leptin on LES tone. However, the exact mechanisms for this effect remain to be elucidated [2, 3].

Additionally, significant work is being conducted to evaluate the link between the autonomic nervous system, obesity, and GERD. Evidence exist demonstrating a link between autonomic dysregulation and obesity, particularly in relation to the parasympathetic nervous system, but the direct link to GERD has not been defined [3, 23, 24].

Pathophysiology of GERD in Post-bariatric Surgery Patients

As mentioned previously, with regard to AGB, a short-term benefit has been demonstrated, likely related to the alteration of the LES. The gastric band creates a longer, intra-abdominal pressure zone and prevents against hiatal hernia due to its physical presence. These mechanisms, as a result, create a reduction in GERD symptoms. However, in the long term, distal esophageal dilatation proximal to the band has been shown, due to narrowing of the esophageal outlet and as a result reduced flow across the banded area. In turn, this decreases esophageal clearance of food, leading to food stasis, reflux of ingested material, and dilatation of the distal esophagus [2, 13]. In addition to this, proximal gastric pouch formation has been shown to occur after AGB. Similar to hiatal hernia, a proximal pouch creates a reservoir for food, causing frequent regurgitation and thereby pathologic reflux and reflux esophagitis. Unlike esophageal dilatation due to AGB, proximal pouch formation is often permanent and can lead to infarction of the pouch with overdistention [2].

With regard to SG, pathophysiologic mechanisms both for the improvement and worsening of GERD symptoms have been shown. The finding of new or worsened GERD symptoms after SG is multifactorial but has been linked to the alteration created at the angle of His after SG. This angle is often blunted as a result of SG. There is also an increased prevalence of hiatal hernia (6–27%) after SG [2, 27–29]. Some studies [10, 11] have shown that this effect is transient and resolves after approximately 3 years. Additionally, the overall weight loss and decreased intra-abdominal adiposity as well as the increased gastric emptying and removal of the acid-producing parietal cells of the gastric fundus with SG have been shown to cause an improvement in GERD symptoms [13, 30].

Contrary to these findings, dysfunction of the LES after SG is seen, due to division of gastric fundal sling fibers, which causes decreased LES pressures. There is also an increased prevalence of hiatal hernia after SG as previously mentioned, and migration of the proximal sleeve above the diaphragmatic hiatus has also been described. In both cases, there is decreased influence of the diaphragm on the LES resulting in worsening GERD symptoms. Additionally, after SG, the stomach can become conical rather than cylindrical, with tapering near the pylorus. This can create a "neofundus" that serves as a reservoir for food storage leading to gastric stasis and increased acid production, both contributing to worsened GERD symptoms. Finally, the resection of the gastric fundus removes an important portion of the stomach responsible for ghrelin production, which can result in slowed gastric emptying and worsening of GERD symptoms [2]. There are many other proposed pathophysiologic mechanisms linking SG to GERD, many very clearly outlined and referenced by Altieri and colleagues [13].

Worsening of GERD symptoms after RYGB is highly uncommon. The majority of patients see a drastic improvement in GERD symptoms after RYGB. Decreased acid production after RYGB due to the proximal gastric division, the small gastric pouch created (20–30 mL) that minimizes any reservoir creation for food stasis, and regurgitation and rapid gastric emptying in addition to the rapid weight loss that is observed in these patients are the primary pathophysiologic means for the improvement in GERD symptoms after RYGB [2]. Additionally, an anti-reflux effect from diverting bile from the Roux limb contributes to decreased reflux symptoms [13]. RYGB is overall associated with decreased GERD incidence and is the procedure of choice for obese patients undergoing bariatric surgery who have a history of GERD [2, 13].

Rationale and Management of Reflux in Bariatric Patients

Morbidly obese patients who have symptoms of GERD and have chosen to undergo bariatric surgery should be counseled regarding the full range of options for bariatric procedures and their respective effects on GERD. As DuPree and colleagues discussed in their review of the Bariatric Outcomes Longitudinal Database (BOLD),

all bariatric patients need to be evaluated for the presence and severity of GERD and counseled regarding the relative efficacy of weight loss operations before surgery [27]. For the purpose of this section, we will consider fundoplication, the intragastric balloon (IGB), adjustable gastric banding (AGB), sleeve gastrectomy (SG), Roux-en-Y gastric bypass (RYGB), and biliopancreatic diversion with duodenal switch (BPD-DS).

Fundoplication

Laparoscopic Nissen fundoplication is a safe and effective treatment for GERD, but several studies have questioned the efficacy for patients with obesity and GERD. The purpose of the anti-reflux operation is to correct the competence of the lower esophageal sphincter and to repair the hiatal hernia. In a small study of 12 patients divided to 2 groups, namely, laparoscopic Nissen fundoplication and laparoscopic gastric bypass groups, both surgeries were effective in treating heartburn symptoms and objective acid reflux in morbidly obese patients [31]. At follow-up, they found no statistical difference between the outcomes of both groups. The study was unable to conclude if both procedures produced equal results, but it was able to conclude that they were both effective, particularly with regard to symptoms. Other studies have also demonstrated outcomes in obese patients that are comparable to those in non-obese patients [32–35].

However, it still remains controversial with regard to the long-term efficacy and durability of fundoplication in the setting of obesity. In a study of 224 patients with 3-year follow-up who underwent laparoscopic fundoplication, overall symptomatic recurrence was 31.3% in obese patients (22.9% Nissen, 53.8% Belsey Mark IV), compared to 4.5% in normal-weight patients [36]. Another study showed preoperative severe obesity was associated with a higher rate of fundoplication failure [37]. Preoperative morbid obesity (BMI > 35 kg/m^2) was associated with failure ($p = 0.036$), while obesity (BMI 30–34.9 kg/m^2) was not.

Intragastric Balloon

The intragastric balloon (IGB) typically is inserted endoscopically and left in place for 6 months. During that time, the patient is kept on proton pump inhibitor (PPI) therapy for ulcer prophylaxis. In spite of this, one study showed that more than 50% of patients required increased dosage of PPI to control worsening GERD symptoms [38]. Early during the period in which the balloon is indwelling, patients often have symptoms of nausea, vomiting, and GERD, up to 70% in some studies [39]. The incidence of GERD symptoms can be affected by balloon positioning, with the antral position associated with a higher risk of prolonged GERD than the fundal position, but the antral position was associated with slightly more weight loss [39].

While GERD, unless severe and intractable, is not a contraindication to placement of an intragastric balloon, patients should be counseled as to the risk of increased GERD during the time the balloon is indwelling. In addition, a greater than 5 cm hiatal hernia on endoscopy is a contraindication to balloon placement, regardless of preoperative GERD symptoms.

Adjustable Gastric Banding

The effect of AGB on GERD symptoms is not entirely clear. While multiple studies have shown an improvement in symptoms after surgery independent of percent excess weight loss (%EWL), several have shown marked increased symptoms and new symptoms [7, 13, 40, 41]. Authors who looked specifically at esophageal motility and esophageal dilation have found that AGB is associated with impaired motility and an increased risk of dilation in a significant percentage of patients [7, 13, 40–42]. These effects are not immediate, therefore, it seems that there is a short-term barrier effect of AGB that improves reflux symptoms, but a longer-term effect that negatively affects motility and can lead to worsening or new symptoms, even in the absence of band prolapse or overfilling. Patients with GERD who are seeking AGB should be counseled that their GERD may improve in the short term, but worsen in the future.

Sleeve Gastrectomy

SG was officially endorsed by the ASMBS in 2012 as a stand-alone procedure for the treatment of obesity [2]. SG has significantly increased in popularity over the past several years. This is due in part to the SG being a technically simple procedure to perform; however, one could describe this procedure as "easy to perform but easy to perform poorly." There is a wide variability in the procedure from surgeon to surgeon and patient to patient, in terms of size of bougie, distance of the staple line from the pylorus, shape of the sleeve, dissection of the hiatus, and repair of hiatal hernia.

There exists literature showing a significant proportion of patients with improved GERD symptoms and severity of esophagitis [43–45], but other studies show high percentages of patients with worsening or persistent GERD, or de novo GERD after surgery [29, 46–48], and worsening of objective tests of esophageal function and reflux, including decreased resting lower esophageal sphincter pressure and increasing DeMeester score [46]. In a nationwide analysis of the Bariatric Outcomes Longitudinal Database (BOLD), DuPree and colleagues noted 44.5% of patients undergoing SG had symptoms of GERD preoperatively. Only 15.9% of patients with preoperative GERD who underwent SG experienced resolution of symptoms, while 84.1% continued having symptoms, with 9% having symptom increase. In

addition, 8.6% of patients who did not have GERD symptoms preoperatively developed them after SG. Preoperative GERD was associated with a statistically significant increase in the risk of complications after SG (15.1% vs. 10.6%) as well as an increased risk of failure to achieve at least 50% excess weight loss (34% vs. 28%) [27].

A study of 110 patients by Genco and colleagues with specific attention to preoperative and postoperative upper endoscopy showed an increase in GERD symptoms from 33.6% preoperatively to 68.1% postoperatively, increased daily PPI use from 19.1% preoperatively to 57.2% postoperatively, and increased findings of esophagitis and increased severity of esophagitis on upper endoscopy. Perhaps most concerning in this study was the new diagnosis of Barrett's esophagus in 17.2% of patients, with 26.4% of those patients having no GERD symptoms. All 110 patients had undergone preoperative upper endoscopy with biopsies and none had been found to have Barrett's preoperatively [49].

The mechanisms for an increase in GERD symptoms following SG are thought to be related to multiple factors. These include impairment of the valve mechanism at the angle of His, decreased gastric compliance, missed hiatal hernia at surgery, development of new hiatal hernia after surgery, and formation of a "neofundus" [2, 13, 37].

As the above findings would suggest, some have found that GERD symptoms can be managed with proper operative technique. The study by Genco and colleagues showed lower rates of all classes of esophagitis and Barrett's in patients with concomitant hiatal hernia repair, though these numbers did not reach statistical significance [49]. Studies by Lyon and coworkers and Daes and coworkers suggest that aggressive investigation for hiatal hernias and repair of these when present could result in improved GERD symptoms after SG [12, 50].

Patients with severe GERD preoperatively were treated by SG with anterior fundoplication in an article by Moon and colleagues [51]. In a study of 31 patients, they found a statistically significant decrease in the GERD scores preoperatively to 3–4 months postoperatively. The technique involves preservation of extra stomach lateral to the angle of His which is used to wrap anteriorly and is sutured to the right crus, with the left side of the upper sleeve being sutured to the left crus (Fig. 47.1). Another study with variation on the standard sleeve technique to add a fundoplication was by Nocca and colleagues. This was a small study of 25 patients followed for 1 year who all had GERD preoperatively. A full 360-degree fundoplication was added along with the sleeve (Fig. 47.2). Only 3 of 25 had reflux symptoms at 1 year [52].

While it appears there are measures that can be taken to mitigate the effects of SG on patients who have GERD preoperatively, these are still investigational, and the studies on these techniques are small. Aside from these studies, there is a large body of evidence showing increased GERD symptoms and changes in the distal esophagus related to GERD in patients who have undergone SG. It would therefore be the safest course of action to offer RYGB to patients with preexisting GERD, as discussed below. However, if one does choose SG in a patient with GERD, it is of utmost importance to pay close attention to the hiatus with repair of any defects found.

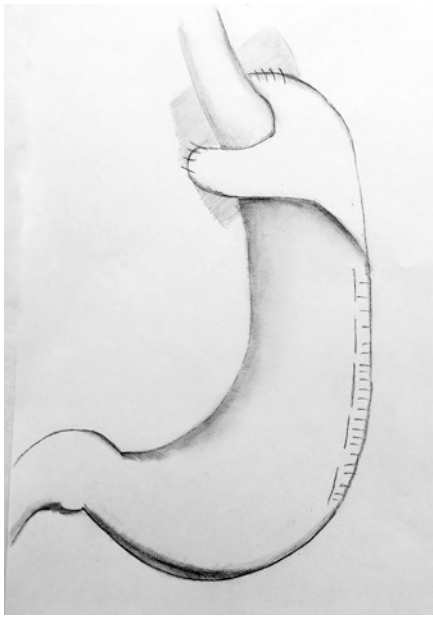

Fig. 47.1 Sleeve gastrectomy with anterior partial fundoplication (Illustrator: Jonathan S. Pincus, MFA)

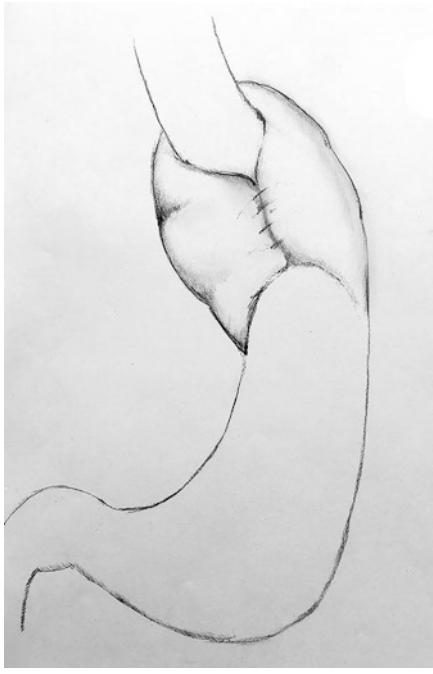

Fig. 47.2 Sleeve gastrectomy with a full 360-degree fundoplication (Illustrator: Jonathan S. Pincus, MFA)

Gastric Bypass

The Roux-en-Y gastric bypass has long been regarded as the gold standard not only for bariatric procedures but specifically for bariatric procedures in patients with preexisting GERD [31, 41]. In addition to weight loss, the mechanisms for GERD improvement after RYGB include decreasing abdominal pressure over the LES, diversion of bile from the roux limb, promoting weight loss, low or no gastric acid production in the pouch, and decreased reservoir capacity of the pouch for regurgitation [1, 2, 7, 13, 38, 41, 48, 53].

The overwhelming evidence supports the use of RYGB for treatment of GERD in obese patients, showing extreme reductions in typical and atypical GERD symptoms, antisecretory medication use, and DeMeester score [7, 41, 53–55]. Not only does the RYGB improve these measures when comparing preoperative and postoperative values, multiple studies have shown superiority of the RYGB in treating GERD when compared with SG [27, 40, 48, 56] and DS [1, 56]. In the DuPree study detailed above, preoperative GERD symptoms were associated with an increased risk of complications and inadequate weight loss after SG, but these risks were not present in the RYGB group.

RYGB has also been shown to positively affect Barrett's esophagus (BE). Because of the low incidence of Barrett's in terms of power for clinical studies, the published data are based on smaller case series. Gorodner and Csendes published series of 25 patients or less who underwent preoperative and periodic postoperative upper endoscopy with standard biopsies for BE. Both of these studies showed no progression of BE, regression in 20–57%, decrease in the length of the BE segment, and even resolution of low-grade dysplasia in some patients [57, 58].

The RYGB is a significantly effective procedure for both weight loss and GERD. The chance of improvement in symptoms and objective measures is high, and the chance of persistent, worsening, or new symptoms is low. In terms of GERD and BE, RYGB outperforms all other bariatric procedures currently performed [56]. Morbidly obese patients whose main or only co-morbid condition is GERD should therefore be counseled that the procedure most likely to improve their GERD and produce adequate weight loss is the RYGB.

There are several studies that have investigated the outcomes of RYGB used for revision of Nissen fundoplication. Hallowell and colleagues described their experience with 11 patients who underwent RYGB following previous foregut surgery. 81.1% patients presented with preoperative GERD, and 9.1% had persistent GERD after RYGB [22]. The study was small and not all 11 patients had previous Nissen fundoplication, but the study showed some patients with reduction in symptoms of GERD as well as weight loss. The possible risks of increased complications should be addressed with this subpopulation of patients.

Biliopancreatic Diversion with Duodenal Switch (BPD-DS)

The BPD-DS is an effective procedure for weight loss and comorbidity reduction but is performed less frequently than the other procedures discussed above [41]. Weight loss after BPD-DS has been shown to be superior to AGB, SG, and RYGB [56]. Its effects on diabetes mellitus and several other comorbidities are greater as well [1, 41]. However, the same studies showing superiority of BPD-DS in weight loss and most comorbidities still show less resolution of GERD when compared to the RYGB. Prachand and colleagues directly compared 198 BPD-DS and 152 RYGB performed at a single institution by 2 surgeons over 3 years. They showed that while resolution of diabetes mellitus, hypertension, and dyslipidemia was statistically significantly higher for BPD-DS than for RYGB, resolution of GERD was higher for RYGB (76.9% vs. 48.57%, $p < 0.05$) [1]. Sudan and colleagues queried a large database of AGB, SG, RYGB, and BPD-DS over 4 years and found BPD-DS to be superior to all other procedures in percent excess weight loss and resolution of type II diabetes mellitus and hypertension. BPD-DS also performed better than AGB and SG for resolution of GERD. Using AGB as the reference for odds of disease remission at 1 year, the authors found an odds ratio of 1.53 for RYGB and 1.20 for BPD-DS ($p < 0.0001$). Interestingly, SG performed more poorly than AGB, with an OR of 0.87.

The mechanism for resolution of GERD in BPD-DS has been hypothesized to involve not only weight loss but diversion of biliopancreatic secretions [41]. This would account for the greater effect of BPD-DS on GERD than SG alone. In super-obese patients with multiple comorbidities including diabetes mellitus as well as GERD, BPD-DS seems to be an acceptable option for surgeons who readily perform this procedure.

Evaluation for Reflux Following Bariatric Surgery

Initial treatment of GERD in the post-bariatric patient is medical therapy similar to that used in the general population. If symptoms continue or worsen despite pharmacologic therapy, further evaluation is needed. In case weight loss surgery is performed at another institution, information regarding previous studies can be helpful. Several tests aid the diagnosis of GERD after bariatric surgery, such as the 24-hour pH study, an upper endoscopy, and manometry. And of these studies, the 24-hour pH study is the gold standard for detection of GERD. Specifically, impedance studies can differentiate acid and nonacid reflux. Manometry evaluates esophageal motility dysfunction. Gastrointestinal radiographic images may also be helpful for detection of hiatal hernia and to help identify an outlet problem as well as gastro-gastric fistula. A real-time fluoroscopy can detect reflux events. A standard

fluoroscopic examination can include standing, prone oblique, and other provocative maneuvers for reflux. An endoscopy can evaluate for Barrett's esophagus, esophagitis, gastro-gastric fistula, patency of the anastomosis, or presence of a hiatal hernia. When performing an endoscopy, the gastroenterologist or surgeon should be aware of the weight loss surgery performed with attention to gastric pouch or sleeve size, anastomotic characteristics, and potential fistulae.

Mion and colleagues assessed the usefulness of high-resolution impedance manometry (HRIM) in patients with upper gastrointestinal (GI) symptoms after sleeve gastrectomy (SG). In their study, they were able to describe the HRIM patterns after SG, identifying impedance reflux episodes after SG [59]. The combination of high-resolution manometry (HRM) and intralumenal impedance monitoring (HRIM) allowed the assessment of pressure as well as bolus clearance and reflux episodes within the esophagus and proximal stomach. HRIM has potential usefulness for diagnostic workup of patients with GERD "de novo" after SG. It will be interesting if future studies could compare results of HRIM with prolonged esophageal pH-impedance monitoring on patients after SG.

Anti-reflux Treatment Options after Bariatric Surgery

In spite of some data sets showing lack of resolution of GERD symptoms following SG, there is a significant amount of data showing improvement in symptoms in all bariatric surgical procedures. Therefore all four bariatric surgical procedures (AGB, SG, RYGB, BPD-DS) can be used to treat not only obesity but also GERD. But the risk of new or worsening GERD is not zero for any of these procedures. GERD symptoms are common complaints for any bariatric surgeon to address, both preoperatively and postoperatively, and thus the bariatric surgeon should be prepared to diagnose and treat new or worsening GERD after surgery.

Evaluation of the postoperative bariatric surgical patient with symptoms of GERD should establish the etiology of the symptoms in order to tailor treatment appropriately. Postoperative complications from any of the above procedures can mimic GERD and thus require careful attention and a high index of suspicion. Ruling out band prolapse, anastomotic ulcer or stricture, sleeve stenosis, gastro-gastric fistula, and new or recurrent hiatal hernia can avoid further complications and narrow the diagnosis.

Control of GERD symptoms when possible should include acid reducing medications and anti-reflux behavior changes. Titrating dosage and frequency of proton pump inhibitors (some advocate opening the capsules), addition of H2 blockers, and avoidance of food and position triggers can all be undertaken to treat GERD symptoms. If the diagnosis of GERD is established with other complications ruled out and symptoms are refractory to medical therapy, then further surgery can be planned.

As new techniques continue to develop, such as the LINX device, the MUSE system, Stretta procedure, and EsophyX, among other endolumenal therapies,

new choices emerge. These procedures may be performed either postoperatively in patients with newly developed reflux or concurrently in patients desiring procedures such as a sleeve; however, only limited data are available currently for these approaches.

Treatment Options for GERD after AGB

AGB has been shown to have mixed to favorable results for GERD [13, 38, 41]. Overall, AGB carries with it a high risk for reoperation over the life of the device [60], for various indications, mostly for weight gain/regain and mechanical problems. Development of GERD with evidence of relative obstruction or dilated esophagus on contrast swallow should be first treated with removal of fluid from the band [61]. If there is evidence of slippage or no resolution of obstruction, surgical management is warranted. Unfortunately, completely emptying the band can lead to weight regain and patient dissatisfaction for other reasons. If the primary indication for revision surgery is to treat GERD, conversion to a gastric bypass would be the procedure of choice, as optimizing chances of GERD remission would be the highest priority [56]. When undertaking a revision from AGB to RYGB, dissection at the left lobe of the liver and hiatus can be impaired by adhesions, but restoration of normal anatomy must be achieved. All imbricating sutures should be identified and divided to ensure adequate pouch size and tissue thickness on the lateral aspect of the pouch.

Treatment Options for GERD after SG

GERD is a common problem after SG [27, 29, 46–48]. This can result in spite of normal anatomy in a well-performed sleeve but often occurs due to errors in technique and anatomical factors that develop after surgery [2, 13, 38]. If a patient develops GERD symptoms after SG, standard workup should include contrast swallow and upper endoscopy and should rule out technical factors such as a neofundus, narrowing at the incisura, twisting of the sleeve, and new or recurrent hiatal hernia. Manometry and pH probe can also be useful to evaluate esophageal function and determine acid versus bile reflux.

In the patient without anatomical abnormalities resulting from surgery who has severe GERD refractory to maximal medical management, further procedures can be offered. A new technology that has shown promise in treatment of GERD refractory to medical management is the LINX® magnetic sphincter augmentation device [62]. This has been studied in small case series with good results in patients status post SG [63]. As this would be currently (2017) off-label use, it should be undertaken by a surgeon experienced with the procedure after an extensive workup. A clinical trial is pending enrollment at this time.

The indications for revision surgery after SG most often involve weight regain or inadequate weight loss [19, 64–66]. GERD as primary or secondary indication for revision ranges from 2% to 27% [12, 19, 64–66]. While re-sleeve has been performed for weight regain [67, 68], this is less advisable in patients whose primary reason for revision is GERD.

Conversion of sleeve gastrectomy to RYGB has been well described as an option in controlling reflux symptoms. Several authors have reported revision of SG to RYGB for GERD [65]. In particular, Parmar and colleagues reported their outcomes of conversion of SG to RYGB in 22 patients. Five of their patients also underwent anterior crural approximation for a hiatal hernia. Their study demonstrated that conversion of SG to RYGB was effective for eight of their ten patients with GERD symptoms [19].

While conversion to BPD-DS is a good option for inadequate weight loss, converting SG to BPD-DS without addressing problems with the sleeve that led to GERD would leave the patient with continued symptoms. In the case of revision for GERD, revision to RYGB is the procedure of choice [65, 66, 68].

Treatment Options for GERD after RYGB

Although RYGB is the best of the currently available procedures in terms of resolution of GERD, there are still patients who have persistent symptoms or new symptoms after surgery. Post-RYGB patients should have a workup to evaluate for marginal ulceration, stricture, or gastro-gastric fistula, which often includes upper endoscopy. A contrast swallow study can also be used to evaluate the size of the pouch and patency of the anastomosis and can detect genuine reflux events when using real-time fluoroscopy. Manometry and pH probe can also evaluate for esophageal acidity and esophageal motility dysfunction.

One relatively new piece of technology available for treatment of GERD which has been used sparingly in post-RYGB patients is radiofrequency energy, or Stretta® (Mederi Therapeutics, Norwalk, CT, USA) [69]. Mattar and colleagues reported five of six patients with resolution of GERD symptoms and improvement in DeMeester scores after post-RYGB Stretta®. The LINX® (Torax Medical Inc., Shoreview, MN, USA) magnetic sphincter augmentation device has also been used in a few patients (Fig. 47.3) with good success after RYGB [70, 71].

Operative revisional strategies for post-RYGB GERD include pouch resizing, lengthening the alimentary limb if short enough to allow for bile reflux, and fundoplication with the remnant stomach. Case reports have shown favorable results, and there is unpublished experience that has been reported to be favorable as well [72, 73]. A case of conversion to a Belsey Mark IV fundoplication has been described in the literature, although that is not standard. Surgeons have applied Hill gastroplasty utilizing the gastric pouch and pre-aortic fascia [74]. Others have proposed fundoplication using the bypassed stomach. Kawahara and colleagues described their experience of performing a loose, short 3 cm wrap using the excluded stomach.

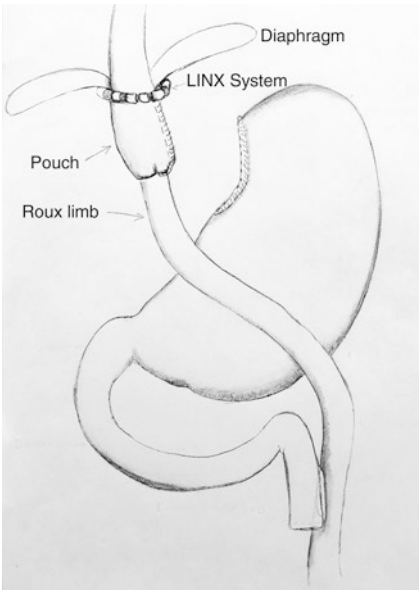

Fig. 47.3 LINX magnetic sphincter augmentation device after a Roux-en-Y gastric bypass (Illustrator: Jonathan S. Pincus, MFA)

Approximately 6 cm of the excluded stomach was passed behind the esophagus, and the anterior and posterior excluded stomach lips were sutured together with three interrupted 3-0 polypropylene sutures [73]. They were able to compare 24-hour pH testing and manometry pre- and postoperatively. Patient remained asymptomatic without reflux or dysphagia 6 months later. We are unaware of any prospective clinical trials regarding the long-term effects of Nissen fundoplication as a surgical option for treating persistent reflux after RYGB.

Treatment Options for GERD after BPD-DS

Assessment and management of GERD after BPD-DS is similar to the SG. Treatment in a patient with normal sleeve anatomy can involve LINX® or Stretta®. Re-sleeve and hiatal hernia repair has also been described in patients post BPD-DS [75].

Conclusion

GERD is a significant comorbidity in bariatric patients preoperatively and postoperatively. Several studies have shown that up to 70% of weight loss surgery patients have GERD [29, 76]. Surgeons should be aware of appropriate evaluation, procedure choices, and management options. Revision surgery for reflux symptoms is not uncommon, and appropriate anatomy and outcomes should be

considered when offering these interventions to our patients. Patient selection is important to avoid postoperative development or worsening of GERD. As more endoscopic and surgical options become readily available, this will allow surgeons to safely and efficiently address challenging situations when it comes to esophageal reflux disease and bariatric patients before and after weight loss surgery.

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