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Reflux and bariatric surgery: a review of pre-operative assessment and post-operative approach

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Abstract

Bariatric surgery is the cornerstone of treatment for severe obesity. In evaluating patients for such procedures, surgeons must be aware of the potential complications, including post-operative gastroesophageal reflux disorder (GERD). This review article outlines the current literature regarding GERD prior to and after bariatric surgery. It aims to establish a framework for evaluating and managing GERD in both the pre- and post-operative setting for common bariatric procedures such as the sleeve gastrectomy, Roux-en-Y gastric bypass, adjustable gastric band, duodenal switch type procedures as well as one-anastomosis gastric bypass. This review also outlines the latest recommendations from major international bariatric societies for screening prior to surgery, the incidence of GERD after each respective procedure and a summary of current trends in the management of post-operative GERD after bariatric surgery.

Keywords: Acid reflux, Barrett's esophagus, esophagitis, GERD, sleeve gastrectomy, Roux-en-Y gastric bypass, duodenal switch, bariatric surgery

INTRODUCTION

Gastroesophageal reflux disease (GERD) is considered a motility disorder wherein reflux of stomach contents into the esophagus or structures more proximal causes symptoms[1]. The most common symptoms of GERD include heartburn and acid regurgitation, while atypical symptoms include dysphagia, chronic

cough, and asthma[1-3]. GERD is a very common concern at a population level, affecting 27% of adults[4]. Obesity increases the risk of GERD[5,6].

In the United States, obesity is now affecting over 40% of the population and is projected to reach 50% by 2030[7,8]. In the obese population, GERD can be found in up to 61% of subjects, and it has been demonstrated that increasing body mass index (BMI) also leads to erosive esophagitis[5,9]. Furthermore, chronic erosive esophagitis has been linked to Barrett's esophagus (BE), and subsequent esophageal and gastro-esophageal junction (GEJ) cancers[10,11]. The mechanism by which obesity leads to an increase in GERD is multi-factorial, including increased intra-abdominal pressure, higher incidence of hiatal hernia, transient lower esophageal sphincter (LES) relaxations and a slowed esophageal acid clearance which all contribute to increasing in reflux[5,6,12].

Bariatric surgery is the most effective treatment for severe obesity[13]. However, there is also an inherent risk of developing reflux including BE after bariatric surgery. In fact, as per the 2020 position statement by the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO), the overall risk of developing *de novo* BE after bariatric surgery, irrespective of the type of procedure, is 1.9% with the incidence as high as 6% up to 5 years after sleeve gastrectomy (SG)[10]. This is important to note, as the SG is now the most performed surgery encompassing nearly 60% of all bariatric procedures performed worldwide[10].

Therefore, this article will explore the recommendations for the pre-operative assessment of patients with GERD presenting for bariatric/metabolic surgery, considerations for operative selection in this patient population, and finally the post-operative management of GERD after commonly performed bariatric procedures.

REFLUX BEFORE BARIATRIC SURGERY

The prevalence of GERD in patients being evaluated for bariatric surgery is difficult to ascertain given the variable presentation of reflux in the obese population. Moreover, there is a high prevalence of "asymptomatic" or silent GERD in this population with rates as high as 45%[14-17]. In a prospective study by Kristo *et al.*[14], patients without any GERD symptoms prior to bariatric surgery were objectively assessed using 24 h pH impedance monitoring, high-resolution manometry, and upper endoscopy, and the diagnosis of GERD was made in 31% of patients, and 26% were found to have esophagitis. Another study by D'Silva *et al.*[17] reported that nearly 80% of upper endoscopies revealed abnormal findings, including 17% reflux esophagitis (60% of whom were in asymptomatic subjects) and 1.8% rate of BE. More importantly, the pre-operative upper endoscopy resulted in a change in the planned surgical procedure in nearly 10% of patients, leading the authors to conclude that upper endoscopy should be a mandatory pre-operative investigation prior to all bariatric surgeries[17]. A systematic review of 12,261 patients that underwent routine upper endoscopy before bariatric surgery, reported similar rates of reflux esophagitis and BE (14.4% and 2.1%, respectively)[18]. Similarly, the authors reported that those findings led to changes in management in 7.8% of cases; however, after removing benign findings with controversial impact on management (hiatal hernia, gastritis, peptic ulcer), the change in surgical management was found to be only in 0.4% of cases[18]. Thus, the authors have advocated that for an average-risk, asymptomatic patient, routine upper endoscopy prior to bariatric surgery could be optional.

Access to routine objective testing like upper endoscopy remains a significant hurdle. Therefore, GERD remains a challenging medical condition at baseline without the added complexity of the changes that occur following bariatric surgery. The true pre-operative incidence of reflux in patients who undergo bariatric

surgery is difficult to ascertain, and recommendations regarding screening pre-operatively and management of post-operative reflux continue to evolve.

The American Society for Metabolic and Bariatric Surgery (ASMBS) 2021 guidelines state that patients with clinically significant gastrointestinal symptoms should be evaluated before bariatric procedures with imaging studies including upper gastrointestinal series (UGI) or upper endoscopy[19]. The latest official IFSO position recommends upper endoscopy to be *considered* for all patients *with* upper GI symptoms prior to bariatric surgery and those *without* upper GI symptoms due to the high rate (25.3%) of unexpected findings that may alter management or contraindicate surgery[20]. IFSO also recommends *routine* upper endoscopy to be considered in populations where the community incidence of significant gastric and esophageal pathology is high, particularly when the procedure will lead to part of the stomach being inaccessible [i.e., Roux-en-Y gastric bypass (RYGB), one-anastomosis gastric bypass (OAGB)][20]. The European guidelines provided a conditional recommendation for routine upper endoscopy prior to bariatric surgery, given that the literature on the topic is prone to bias and stating that "selective endoscopy in patients with upper abdominal symptoms might be more appropriate"[21].

Operative planning and procedure selection surrounding bariatric surgery can be complex with many factors to consider. In obese patients (BMI > 35 kg/m^2) with GERD, RYGB is considered the procedure of choice compared to both fundoplication and other bariatric procedures providing there are no contraindications and is shown to lead to regression of BE in 63% of patients[10,22]. Some of the commonly considered relative contraindications to RYGB are active smoking, dependence on regular non-steroidal anti-inflammatory drugs, complex abdominal wall hernia(s), active inflammatory bowel disease, especially Crohn's disease involving small bowel, considerations for absorption of certain medications e.g., immunosuppressants. Hence, the process of procedure selection should involve the risk/benefit ratio of a given bariatric procedure while considering surgeon/center expertise and patient choice.

REFLUX AND TYPE OF BARIATRIC SURGERY

Reflux-prone procedures

Sleeve gastrectomy

Sleeve gastrectomy (SG) is the most commonly performed procedure as it provides similar weight loss results with a better safety profile compared to the RYGB[23-26]. Despite its popularity, a long-term concern after SG is *de novo* GERD. Various mechanisms have been hypothesized, including removal of the gastric fundus, transection of the sling muscular fibers of GEJ and the ensuing negative impact on LES, decreased antral pump function, and reduced gastric volume leading to elevated intra-luminal pressure[27]. In a recent meta-analysis by Yeung *et al.*[28], which included data from 10,718 patients with medium to long-term follow-up after SG, *de novo* GERD and BE were reported in 23% and 8% of patients up to 11 years after surgery. On the contrary, there are other studies that have shown improvements in GERD after SG[27,29], demonstrating delayed esophageal emptying without impairing LES function using objective assessment tools, including high-resolution manometry and 24 h pH impedance monitoring[27]. Furthermore, in a meta-analysis evaluating the need for revisional surgeries long-term after SG (≥ 7 years after surgery), Clapp *et al.*[30] reported that refractory GERD-alone was found to be the reason for revision in only 2.9% of cases. Despite the existing controversy in the literature, many experts would offer SG as their preferred surgical option to patients who have symptoms of GERD at baseline when accompanied with a normal pre-operative upper endoscopy, especially for patients with severe obesity (BMI > 60 kg/m^2) as evident from the First International Consensus Conference held in France in 2019[31]. There is also the emerging idea of SG combined with Nissen fundoplication (N-Sleeve) that has gained attention for patients desiring SG with baseline GERD symptoms[32]. While most patients who received N-Sleeve had a hiatal hernia (90%) at the

time of SG with a history of esophagitis (99%), the sample size was small with a very short follow-up time of only one year[32].

Standardizing the technique in performing the SG has been instrumental in improving its outcomes and minimizing the risk of GERD after surgery[33,34]. Some of the key technical elements in performing SG include (1) ruling out and repairing a hiatal hernia if present; (2) starting the gastric resection within 4-6 cm from the pylorus; (3) using a 40 Fr bougie catheter (avoiding < 38 or > 60 Fr calibers); (4) avoiding narrowing at the level of incisura angularis; (5) avoiding the twisting of the staple line; (6) resecting the fundus/ avoiding large retained gastric fundus; and (7) preserving the integrity of the sling fibers of Helvetius[27,33-35].

Therefore, the presence of GERD before surgery is not considered an absolute contraindication for SG. However, the patient requires appropriate pre-operative counseling regarding the possible outcomes of SG with respect to their GERD symptoms and the risk of long-term complications such as erosive esophagitis and BE and the potential risk for progression to dysplastic disease. These concerns highlight the importance of the need for pre-operative upper endoscopy, especially in patients with GERD-like symptoms as recommended by the prominent international bariatric societies, including IFSO and ASMBS in their latest position statements[19,20]. Nevertheless, given the current evidence of GERD outcomes following RYGB and SG, patients with objective evidence of GERD at baseline (either endoscopic finding of esophagitis Los Angeles Classification grades C and D and/or a 24 h or 48 h pH test or pH-impedance testing with total acid exposure time greater than 6%) or those suffering severe GERD symptoms, given the risk of progression to dysplastic BE are likely better served by RYGB rather than SG[19].

In terms of post-operative endoscopic surveillance for GERD, both IFSO and ASMBS recommend routine upper endoscopy 2-3 years after SG irrespective of GERD symptoms to detect any *de novo* BE and if normal again every 5 years[19,20]. Patients with GERD-like symptoms are also recommended to undergo screening upper endoscopy after any type of bariatric surgery[19,20]. Despite the concern of progression of GERD after SG to dysplastic BE and subsequent carcinoma, the reported incidence of esophageal cancer after bariatric surgery including SG, is extremely low and as per two recent large observational studies including a population-based investigation, no significant difference in the incidence of esophageal carcinoma was observed after SG compared to RYGB[36,37].

As for the management of GERD after SG, the 2019 ASMBS guidelines clearly suggest that patients with *de novo* GERD or worsened symptoms after SG should be first treated with acid suppression using proton pump inhibitors (PPIs), and only those with symptoms refractory to medical therapy should be considered for a conversion to an RYGB[38]. An upper endoscopy, radiologic testing (UGI series, computed tomography volumetrics), and if indicated other functional tests including 24 h impedance and manometry should be carried out prior to any revisional surgery. The upper endoscopy as well as UGI series help rule in/out the potential cause(s) for refractory GERD symptoms after SG (i.e., retained fundus, sleeve twist, narrowing at incisura, hiatal hernia, and intrathoracic sleeve migration[39]) and facilitate operative planning. These suggestions are echoed in a recent study by Curell *et al.*[40], who carried out a retrospective analysis of 1751 patients who had various bariatric surgeries performed at a single high-volume institution during 2010-2018; 41% of patients had undergone SG (none had GERD at baseline), but 5% of them required a conversion to RYGB for refractory GERD symptoms during the study period. The UGI series preformed prior to revision demonstrated the 4 complications mentioned earlier as directly contributing to the observed GERD: 77% were found to have a hiatal hernia that was repaired during revision, 35% had stenosis at the incisura, 32% had twisting of their gastric sleeve, and 19% had a retained fundus. After conversion to

RYGB 74% experienced a complete remission of their GERD symptoms and another 20% demonstrated some improvement in their *de novo* reflux symptoms post SG[40].

While a conversion to RYGB remains the optimal definitive treatment for refractory GERD after SG, there remains a subset of patients who cannot undergo RYGB due to the presence of relative contraindications (i.e., active smoking, active Crohn's disease involving small bowel with previous resections) or patient preference. For patients with refractory GERD post SG in whom pre-operative testing has revealed only a hiatal hernia could benefit from a hiatal hernia repair alone to manage their GERD symptoms[41]. Others have shown that if pre-operative testing mainly reveals a significant retained fundus, a re-sleeve procedure can help mitigate the GERD symptoms as well as improve other outcomes like further weight loss[42,43]. The LINX® magnetic sphincter augmentation system has also been studied in patients with refractory GERD after SG with some improvements in reflux symptoms, but these studies are limited by small sample sizes and short-term follow-up and are far from being considered standard of care[44,45].

Duodenal switch and single-anastomosis derivatives

The classic duodenal switch (DS) surgery (Roux-en-Y configuration) and its single-anastomosis derivatives consisting of single anastomosis duodeno-ileal bypass and stomach intestinal pylorus sparing surgery are also considered reflux-prone bariatric procedures. The reflux-prone status is due to SG being an inherent component of these procedures. As such, most discussions in the literature regarding GERD after DS type procedures are extrapolated from studies on SG as a stand-alone procedure.

Hence, similar pre- and post-operative recommendations and concerns regarding surveillance and management of GERD symptoms discussed for SG apply to DS type procedures and will not be repeated here with a view to brevity. However, regarding definitive treatment of refractory GERD symptoms after DS type procedures, unlike SG as a stand-alone operation, a conversion to RYGB, while theoretically possible, is not considered a surgical option. Moreover, revisional surgeries after classic DS procedure with Roux-en-Y configuration are very rare (< 5%) and if happen are mainly for surgical correction of severe malnutrition[46,47].

For single-anastomosis DS (SADS) procedures, some have speculated that in light of the loop configuration of the duodeno-ileostomy, these procedures are prone to bile reflux. However, in a large multi-center study evaluating the incidence of complications associated with duodeno-ileostomy anastomosis in 1328 patients who underwent SADS, Surve *et al.*[48] reported an incidence of bile reflux at 0.1%. The low incidence of bile reflux after SADS is also intuitive since the location of duodeno-ileostomy is post-pyloric. Nevertheless, on the rare occasion that bile reflux would become an issue, the SADS can be converted to the classic Roux-en-Y DS procedure that will re-route the bile from the duodeno-ileostomy.

Adjustable gastric band

Despite its popularity in the early 2000s, due to its inferior long-term outcomes and high rates of delayed complications, adjustable gastric band (AGB) should be considered obsolete and accounts for < 1% of bariatric procedures performed in the United States[49]. Here we will briefly discuss reflux after AGB given the ongoing need for removal of AGB and revisional surgery due to either inadequate weight loss/regain and complications including clinically significant dysphagia, GERD often due to erosion and/or slippage.

While at short-term follow-up, some studies have shown improvements in reflux symptoms speculating certain anti-reflux properties for AGB, GERD has consistently been described as a late complication of AGB with worsening or *de novo* reflux in up to a third of patients[50]. Studies with long-term follow-up have

identified GERD to be the reason for reoperation or AGB removal in 3%-44% and dysphagia in 49%-63%[51,52]. However, the literature on the association between GERD and AGB placement and removal is controversial and heterogenous likely due to the subjectivity of GERD symptoms and regurgitation due to dysphagia caused by AGB. Moreover, in a large observational study using a state-wide database from New York evaluating the incidence of GERD after various types of bariatric surgery, the authors found that up to 10 years after surgery, AGB was associated with the highest cumulative incidence of GERD and esophagitis irrespective of the baseline status of GERD and when compared to SG, RYGB, and classic DS procedures[36].

In terms of management of GERD after AGB procedure, the presence of persistent regurgitation that could also be a symptom of reflux should be investigated by fluoroscopy or an upright abdominal X-ray to assess for band slippage, esophageal dilatation and/or upper endoscopy that can also rule out any band erosion. If either is present, the band can be emptied with a *definitive* plan of removal of AGB with or without consideration to convert to another bariatric procedure[38]. Current recommendations do not differentiate between conversion to SG *vs.* RYGB for these cases, but all recommendations are non-conclusive evidence and/or based on expert opinion (Grade D)[38]. In a large cohort study using the 2015-2017 data from the metabolic and bariatric surgery accreditation and quality improvement program, Janik *et al.*[53] concluded that a single-stage conversion of AGB removal to either SG or RYGB procedure is safe; however, conversion to RYGB was associated with higher 30-day post-operative complications including leak and the need for reoperation. Despite these findings, most authors would agree that revisional procedure selection for conversion of a failed AGB and the plan for a staged approach is multifactorial and should again take into account the presence of GERD, burden obesity including related co-morbidities, risk/benefit ratio of a given bariatric procedure while taking into account surgeon/center expertise and patient choice.

Reflux-protective procedures

Roux-en-Y gastric bypass

As mentioned earlier in this review, RYGB is the bariatric/metabolic procedure of choice in patients with obesity and pre-operative GERD[9,29,54]. RYGB is the preferred primary bariatric surgery especially for patients with severe GERD symptoms (i.e., endoscopic finding of esophagitis Los Angeles Classification grades C and D and/or a 24 h or 48 h pH test or pH-impedance testing with total acid exposure time greater than 6%) and despite acid suppression[19].

The post-operative improvements in GERD symptoms after RYGB can range between 57%-97%[25,29]. There is also a positive impact on both esophagitis and BE with one study demonstrating an 80% and 75% resolution of erosive esophagitis and short-segment non-dysplastic BE respectively up to two years after RYGB, albeit in a small sample size[55]. The amelioration of the histologic changes caused by GERD has also been shown in a recent systematic review of studies involving patients with documented BE who underwent RYGB with at least one year of follow-up, which found endoscopic evidence of regression in BE in 36%-62% of patients; moreover, no patients had progression of their BE after surgery[56].

Both anatomic and physiologic mechanisms contribute to a reduction in GERD symptoms after RYGB. Anatomically, the small longitudinal gastric pouch created bypasses the vast majority of acid-secreting parietal cells located in the fundus and the body of the stomach. In addition, the Roux-en-Y configuration is such that the exposure of the pouch to bile reflux is largely non-existent. Physiologically, the small gastric pouch contains far less acid-producing cells to contribute to pathologic reflux. The effective post-operative weight loss and the decline in intra-abdominal pressure that ensues also contribute to the betterment of GERD symptoms after RYGB[56,57]. Nevertheless, the phenomenon of *de novo* GERD is also reported after RYGB (as high as 22%) albeit less frequently than the reflux-prone bariatric procedures[36,58,59].

The current recommendations from both IFSO and ASMBS societies state that only symptomatic patients should undergo endoscopic surveillance after RYGB and in cases with persistent symptoms should likely be repeated every 5 years[19,20]. Like reflux-prone procedures, acid suppression using PPIs and lifestyle modifications are the first lines of therapy for GERD after RYGB. Further work-up is warranted for subjects with refractory symptoms. Conditions such as a gastro-gastric fistula between the pouch and the remnant stomach, stricture at gastro-jejunostomy anastomosis, hiatal hernia, and enlarged gastric pouch can present with GERD-like symptoms and should be investigated with an upper endoscopy primarily followed by radiologic testing (UGI series, computed tomography), and if indicated other functional tests including 24 h impedance and manometry prior to any undergoing any surgical intervention. Apart from surgical or endoscopic correction of these conditions, there are limited operative options for the management of refractory reflux after RYGB. Small case series and case reports have been reported using various novel surgical techniques including iterations of fundoplication utilizing various tissues including the remnant stomach with some success[60-63]. However, these merely represent attempts at symptomatic reduction in individuals and have not been validated in any large series or subjected to long-term examination.

One-anastomosis gastric bypass

There are several names that essentially allude to this procedure, including titles such as mini-gastric bypass, omega loop gastric bypass, and single-anastomosis gastric bypass. In order to standardize the nomenclature, especially to allow for comparative studies, IFSO has recommended OAGB to be used as the identifier for this procedure[64]. Despite its popularity around the world especially in Asia, North Africa, and parts of Europe, OAGB is not commonly performed in North America. Hence, in 2018, IFSO assembled a taskforce to determine the safety and efficacy of OAGB procedures (given the various names used), which ultimately recognized it as an acceptable primary bariatric/metabolic surgery given that its surgical risk profile was comparable to RYGB with similar weight and co-morbidity outcomes up to medium-term follow-up[64].

OAGB involves creating a long and narrow gastric pouch which is then anastomosed to a loop of jejunum with varying biliary lengths (most commonly around 180-220 cm) similar to a Billroth II anastomosis. One major post-operative concern after OAGB has always been bile reflux, which is poorly documented and screened for in the existing literature with post-operative incidence ranging from 7.8%-55.5%[65]. The concern regarding bile reflux is due to the established link between esophageal/gastric cancer and bile reflux dating back to gastric surgery for peptic ulcer disease[66]. As a result, given the lack of long-term data on the rates of BE after OAGB, the IFSO recommends against OAGB as primary bariatric surgery in patients with long-segment or dysplastic BE[10]. Post-operative GERD is also reported after OAGB and ranges from 0%-30% and higher compared to reflux symptoms after RYGB[67,68].

The IFSO recommendations for upper endoscopy following OAGB are the same as after SG (upper endoscopy at 1 year for all patients followed by repeat surveillance every 2-3 years regardless of symptoms)[20]. These recommendations are due to the theoretical risk for bile reflux following this procedure despite the lack of substantial evidence especially at long-term follow-up.

The reported need for operative management of significant reflux symptoms after OAGB is less frequent when compared to SG but higher than RYGB[69]. While a downstream Braun entero-enterostomy has been reported to improve refractory GERD symptoms after OAGB, a conversion to RYGB is considered a superior revisional option which also addresses the bile reflux if present. While the literature on the incidence of objectively diagnosed bile reflux long-term after OAGB is significantly lacking, several large single-center case series have reported a minor need for revisional surgery to address bile reflux after OAGB (< 1%)[70-72]. Regardless, given the aforementioned concern with bile reflux and the lack of long-term

outcomes combined with the emergence of SADS as a highly effective and robust bariatric procedure (where the loop DI anastomosis is post-pyloric limiting such reflux), has led to ASMBS not officially endorsing OAGB as of yet[38].

CONCLUSION

In patients who undergo bariatric surgery, GERD remains an important comorbid condition. Surgeons who perform these procedures should understand the implications of each surgery on pre-operative symptoms of GERD as well as the risk of new-onset GERD. While many patient and surgeon factors come into play when deciding the optimal bariatric surgical procedure, GERD is not something that should be overlooked, given complications of GERD such as esophagitis and BE. Surgeons should be aware that there are silent histologic changes that may occur after these procedures requiring close endoscopic surveillance particularly after SG and OABG.

RYGB is the procedure of choice for patients presenting for bariatric surgery in the presence of GERD, EE and BE providing there are no competing contraindications. Persistent reflux symptoms, EE or BE despite medical management following SG or OAGB requires consideration of surgical conversion - when conversion is indicated the optimal conversion is to RYGB. Reflux following RYGB, while rare, is challenging to manage and investigations into complications of RYGB should be initiated prior to determining the appropriate surgical management. Further studies need to be completed utilizing objective measurements of GERD as upper GI symptoms following bariatric surgery can be difficult to differentiate from true GERD. While some of the studies reviewed here utilized objective data (such as pH studies/endoscopy), many were based on PPI use, self-reported symptoms or other scores which are somewhat subjective. Despite the amount of literature on this topic, recommendations from expert societies remain based on expert opinion given the heterogeneity in the findings.

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Authors' contributions

Performed literature review, analysis and writing of the manuscript: Hanson MN, Dennis S
Made contributions to conception/design and editing of the manuscript: Andalib A, Altieri MS

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