

The effect of bariatric surgery on gastroesophageal reflux disease

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Obesity is an epidemic that is known to play a role in the development of gastroesophageal reflux disease (GERD). Studies have shown that increasing body mass index plays a role in the incompetence of the gastroesophageal junction and that weight loss and lifestyle modifications reduce the symptoms of GERD. As a method of producing effective and sustainable weight loss, bariatric surgery plays a major role in the treatment of obesity. We reviewed the literature on the effects of different types of bariatric surgery on the symptomatic relief of GERD and its complications. Roux-en-Y gastric bypass was considered an effective method to alleviate symptoms of GERD, whereas laparoscopic sleeve gastrectomy appeared to increase the incidence of the disease. Adjustable gastric banding was seen to initially improve the symptoms of GERD; however, a subset of patients experienced a new onset of GERD symptoms during long-term follow-up. The literature suggests that different surgeries have different impacts on the symptomatology of GERD and that careful assessment may be needed before performing bariatric surgery in patients with GERD.

L'obésité atteint des proportions épidémiques et on sait qu'elle joue un rôle dans l'apparition du phénomène de reflux gastro-œsophagien (RGO). Des études ont montré que l'augmentation de l'indice de masse corporelle contribue à l'incompétence de la jonction entre l'œsophage et l'estomac et que la perte de poids et des modifications de l'hygiène de vie réduisent les symptômes de RGO. Comme méthode pour obtenir une perte de poids efficace et durable, la chirurgie bariatrique occupe une place importante dans le traitement de l'obésité. Nous avons passé en revue la littérature traitant des effets de différents types de chirurgie bariatrique sur le soulagement des symptômes du RGO et ses complications. La dérivation gastrique Roux-en-Y a été considérée comme une méthode efficace pour le soulagement des symptômes de RGO, tandis que la gastrectomie verticale par laparoscopie a semblé faire augmenter l'incidence de la maladie. Quant au cerclage gastrique ajustable, il a semblé améliorer initialement le RGO; toutefois chez une catégorie de patients, le RGO s'est manifesté de nouveau lors du suivi à long terme. Selon la littérature, chaque type d'intervention exerce un impact différent sur la symptomatologie du RGO et une évaluation soigneuse s'impose avant de procéder à une chirurgie bariatrique chez les patients souffrant de RGO.

Obesity, defined by the world health organization as a body mass index (BMI) greater than 30, is an epidemic issue that has major implications on health.¹ It is estimated that more than 200 million men and 500 million women around the world — more than 10% of the world's population — are obese.² Associated with obesity are health conditions that carry significant morbidity and mortality, including cardiovascular disease, osteoarthritis, diabetes, some cancer (breast, colon, endometrial) and gastroesophageal reflux disease.^{3,4} In addition, more than 20% of the world-wide population is overweight (BMI > 25).² It is estimated that in the next 20 years, more than 2.16 billion people will be overweight and that 1.12 billion will be obese — statistics with large implications for health care systems.² In Canada, 60% of the population is considered overweight, and 24.1% is considered obese.⁵

Bariatric surgery

Bariatric surgery has been shown to be the most effective and efficient means of achieving significant and sustainable weight loss in severely obese individuals.⁶ Bariatric surgery is classified as either primarily restrictive or primarily mal-absorptive. With respect to the effect of bariatric surgery on gastroesophageal reflux disease (GERD), it is important to break down the different types of procedures, as anatomy and physiology is altered differently with different procedures. The common restrictive procedures often mentioned are laparoscopic adjustable gastric banding (LAGB) and laparoscopic sleeve gastrectomy (LSG). An LAGB is a procedure that restricts the amount of food entering the stomach by attaching a band around the fundus that can be restricted over time with saline injections. An LSG is an innovative procedure in which a vertical division is made at the larger curvature of the stomach, making the stomach pouch smaller and more restrictive. In addition to its restrictive properties, LSG has an endocrinologic mechanism in that the levels of the hormone ghrelin (an appetite-stimulating hormone) is reduced.⁷ The pyloric sphincter remains intact in both these restrictive procedures, and intestinal absorption is undisturbed.

Malabsorptive procedures include Roux-en-Y gastric bypass (RYGB) and biliopancreatic diversion (BPD). The RYGB, which is the more common of these 2 procedures, has been shown to produce substantial weight loss in morbidly obese patients.⁸ It involves creation of a gastric pouch with the pouch drained by a roux limb from the proximal jejunum. In a controlled clinical trial by Hofso and colleagues,⁹ patients who underwent RYGB were compared with those who underwent lifestyle modifications, and weight loss was found to be 22% greater in the RYGB group.⁹ A BPD involves a sleeve gastrectomy and the creation of 2 enteric limbs: a gastric limb that transports undigested food and a biliopancreatic limb that is attached distally in the small bowel, which creates malabsorption.

Gastroesophageal reflux disease

Gastroesophageal reflux disease is a common comorbid condition in bariatric patients.⁴ It pertains to the exposure of the esophagus to stomach content, leading to esophageal mucosal damage. The etiology is not completely understood but may include a mixture of hereditary and functional factors with a role of abnormal relaxation of the lower esophageal sphincter (LES), increased frequency of transient sphincter relaxation, or from increased pressure from the stomach secondary to a hiatus hernia or increased intra-abdominal pressure.^{10,11,12} This can lead to symptoms including heartburn, regurgitation, dysphagia, odynophagia, increased salivation and chest pain. Long-standing GERD can lead to reflux esophagitis in which the epithelial layer of mucosa in the esophagus is irritated,

causing necrosis and ulcerations to the esophagus. In addition, reflux-induced inflammation can lead to esophageal strictures. Barret esophagus is a condition in which there is intestinal columnar cell epithelium replacing the squamous epithelium usually found in the esophagus. This abnormal metaplasia can eventually lead to adenocarcinoma of the esophagus. It is estimated in 10% of patients with Barret esophagus the condition will eventually transform into adenocarcinoma of the esophagus.¹³

Of important consideration with respect to GERD and its associated symptoms is the difficulty of objectively assessing the severity of symptoms. Because GERD is a subjective clinical entity, actual documentation of the severity of the disease process is difficult to assess in terms of properly correlating subjective symptoms with actual disease process. A recent study by Chan and colleagues¹⁴ demonstrated the difficulty between self-reported symptoms and their correspondence to pathologic gastroesophageal reflux. In their study, the authors asked 336 individuals to complete a self-reported Mayo-GERD questionnaire and referred them to 24-hour esophageal pH monitoring. Using an esophageal pH of less than 4 at the distal esophagus or a DeMeester score greater than 14.7 to demonstrate pathological GERD, the authors identified questions that were associated with GERD using univariate and multivariate analysis. They found that of the 336 patients who underwent this study, 51% of those who stated that they had severe GERD symptoms did not actually have pathologic GERD based on objective testing. In addition, the authors found that male respondents and patients who claimed to have a prolonged history of GERD-like symptoms, nocturnal heartburn and a history of hiatus hernia were more likely to have an abnormal 24-hour pH measure; however, these factors lacked a clinical utility to predict pathologic GERD. The authors concluded that subjective claims of GERD and its associated symptoms were difficult to correlate objectively, making studies based on subjective claims difficult to analyze.

Obesity is an independent risk factor for GERD. Hampel and colleagues⁴ conducted a meta-analysis and described the effect of obesity and the risk for GERD and its associated complications.⁴ In 9 studies assessing the effect of obesity on GERD, 6 studies found significant associations between obesity and the prevalence of GERD. Six of 7 studies found associations between obesity and erosive esophagitis, 6 of 7 found an association with adenocarcinoma of the esophagus, and 4 of 6 found associations between obesity and gastric cardia. It was also found that increasing BMI netted a progressive risk for GERD and its associated complications. In a cross-sectional study, El-Serag and colleagues¹⁵ found an association between BMI and GERD in volunteers who were asked to fill out questionnaires, some of whom had undergone endoscopic analysis. The authors found a positive correlation with BMI and the development of GERD and its associated complications.

In 2006, Pandilfino and colleagues¹⁶ used high-resolution manometry and simultaneous intraesophageal and intragastric transnasal pressure sensors on 285 patients to further analyze the effect of increasing BMI on the gastroesophageal junction. They found a significant correlation between BMI and waist circumference with intragastric pressure ($p < 0.001$) and gastroesophageal pressure gradient ($p < 0.001$). Using multivariate analysis adjusting for age, sex and patient type did not alter the direction or magnitude of this association. The authors also found that obesity was associated with separation of the esophagogastric junction (EGJ) pressure components ($p < 0.001$). The result of this study demonstrated that obesity augments the flow of gastric juice into the esophagus, leading to symptoms consistent with GERD. The study was aimed at the mechanical aspect of how obesity could lead to EGJ incompetence and adversely affect physiologic function.

Effect of bariatric surgery on GERD

Table 1 lists studies that have examined the effect of bariatric surgery on GERD. Although weight loss and lifestyle modifications are important in reducing the symptoms of GERD, different bariatric surgeries have provided varying degrees of symptom alleviation.¹⁷ De Groote and colleagues¹⁷ performed a systematic review of bariatric surgery and GERD and compared the data with lifestyle modification. They found that lifestyle modification led to a decrease in GERD symptoms in 4 of 7 studies. They compared various bariatric procedures and found that RYGB was associated with a notable decrease in GERD symptoms. With vertical band gastroplasty, however, there was either no change in GERD symptoms or an increase in incidence of GERD. They were unable to determine whether gastric bands improved or worsened GERD symptoms. Comparing the RYGB with the lifestyle modification group, it appeared that the patients who underwent RYGB had a better alleviation of GERD symptoms.

Sleeve gastrectomy

Chiu and colleagues¹⁸ performed a systematic review on GERD and its effects following LSG. Analysis showed that 4 studies demonstrated an increase in prevalence and 7 studies showed a reduced prevalence of GERD following LSG. The understanding is that LSG may promote GERD by reducing LES pressure (possibly from division of ligaments and blunting of the angle of His). It was also discussed that the remnant gastric pouch, being much more restrictive, may increase gastric pressure by reducing gastric compliance and emptying, and decreasing volume and dispensability. As for LSG reducing GERD, factors that may contribute to this effect include accelerated gastric emptying and increased weight loss, which decrease abdominal pressure. It was also suggested that long-term resolution of GERD could be explained by increase in compliance and restoration at the angle of His, which occurs about 3 years postoperatively.

In a retrospective review of 28 patients undergoing LSG, Howard and colleagues¹⁹ performed pre- and postoperative upper gastrointestinal radiographic swallow studies to assess for GERD in these patients. The patients had an average excess weight loss (EWL) of 40%, with a mean follow-up time of 32 weeks. Of these patients, 18% were found to have new onset GERD on their postoperative upper GI swallow test after having the LSG procedure. In addition, patients were given follow-up questionnaires, which yielded a 64% response rate; 22% of patients reported having symptoms of GERD. The authors postulated that LSG procedures might in fact increase the prevalence of GERD despite satisfactory weight loss.

In summary, LSG appears to increase the incidence of GERD in patients who undergo the procedure, possibly relating to increased intragastric pressure and changes in the angle of His. However, with increased gastric compliance in the long term there may be an alleviation of symptoms relating to GERD.

Table 1. Effect of bariatric surgery on gastroesophageal reflux disease

Study	Type of bariatric surgery	No. patients*	EWL	Type of assessment or study	Follow-up, mo	Results
Howard et al. ¹⁹ (2011)	LSG	28	40	Upper GI swallow, clinical symptoms	8	18% new onset GERD GI series, 22% clinical GERD symptoms
Chiu et al. ¹⁸ (2009)	LSG	15 studies	NA	Systematic review	NA	4 studies reported increase in prevalence, 7 studies reported reduction in prevalence
Woodman et al. ²⁰ (2012)	LAGB	122	49.8	Quality of life questionnaire	24	80% resolution, 11% improvement, 7% no change, 2% worsening
de Jong et al. ²¹ (2010)	LAGB	3307	NA	Systematic review	NA	Reduction of reflux symptoms from 33.3% to 7.7%, 15% new onset reflux symptoms
Frezza et al. ²³ (2002)	LRYGB	152	64	Questionnaire of symptoms	12	Reduction of heartburn from 87% to 22%.
Perry et al. ²⁴ (2004)	LRYGB	57	NA	Follow-up questionnaire	18	100% reported resolution or improvement of symptoms

EWL = excess weight loss; GERD = gastroesophageal reflux disease; GI = gastrointestinal; LAGB = laparoscopic adjustable banding; LRYGB = laparoscopic Roux-en-Y bypass; LSG = laparoscopic sleeve gastrectomy; NA = not available.

*Unless otherwise indicated.

Gastric banding

In a recent study, Woodman and colleagues²⁰ used the Obesity and Weight-Loss Quality of Life Instrument (OWLQOL-17) to assess the effect of adjustable gastric banding on GERD symptoms. They followed up with 122 patients 2 years postoperatively and found a resolution of GERD symptoms in 80% of the patients questioned. Of the remaining participants, 11% reported an improvement of symptoms, 7% experienced no change in symptoms and 2% reported worsening of symptoms. However, the authors were not able to find a clear correlation between amount of weight lost and reduction in symptom severity. They postulated that the suppression of GERD following the gastric banding procedure could be explained by a combination of weight loss or by reducing intragastric pressure and the frequency of transient LES relaxation as well as anatomic augmentation of the gastroesophageal sphincter.

Other studies have been inconsistent with short- and long-term follow-up. A systematic review by de Jong and colleagues²¹ involving 20 studies with a total of 3307 patients who underwent gastric banding found a significant reduction in symptoms associated with GERD. They found that the prevalence of reflux symptoms decreased postoperatively from 33.3% to 7.7% and medication use decreased from 27.5% to 9.5%. The prevalence of esophagitis was also reduced postoperatively from 33.3% to 27.5%. There was a reduction of pathologic reflux from 55.8% preoperatively to 29.4% postoperatively. The authors did find, however, a subset of patients who experienced a new onset of reflux symptoms (15%) and a new onset of esophagitis (29.4%). In addition, they found that gastric banding LES pressures increased from 12.9 mm Hg to 16.9 mm Hg, LES relaxation decreased from 100% to 79.7%, and the percentage of dysmotility increased from 3.5% to 12%. The authors postulated that with initial weight loss, there was short-term alleviation of GERD and its complications; however, with longer-term follow-up, there is a subset of patients who experience a new onset of reflux and its complications.

Of important consideration when it comes to patients who underwent gastric banding is the difficulty of ascertaining whether symptoms are a result of a prior or a postoperative GERD pathologic process or of a complication relating to their gastric banding surgery. In a prospective review of 257 patients who underwent gastric banding between January 2002 and December 2006, Arias and colleagues²² tried to measure the incidence of megaesophagus. Impaired esophageal peristalsis can cause a lack of relaxation of the LES, which in turn can cause esophageal dilatation and megaesophagus following secondary and tertiary peristalsis, leading to symptoms similar to that of GERD. The authors used symptoms, signs and gastrointestinal series findings to verify the presence of mega-

esophagus and found that of the 257 patients, 5 developed megaesophagus even though 4 of the 5 had previously normal manometry findings before their adjustable band placement and 1 had a nonspecific motility disorder. In all patients, however, band removal was recommended.

In summary, gastric banding appears to provide short-term improvement of reflux symptoms, esophagitis and normalized pH monitoring results. There is, however, a subset of patients who experience a new onset of reflux symptoms and esophagitis in the long term, although it is difficult to ascertain whether these are a result of pathologic GERD or complications from gastric banding.

Roux-en-Y gastric bypass

Several studies have shown consistent alleviation of GERD symptoms in patients undergoing RYGB. In 2002, Frezza and colleagues²³ assessed changes in GERD symptoms following LRYGB.²³ Of 152 patients who participated in the study, follow-up revealed an EWL of 64% and a significant reduction in GERD symptoms at 12-month follow-up (heartburn: 87%–22%, $p < 0.001$; water brash: 18%–7%, $p < 0.05$; wheezing: 40%–5%, $p < 0.001$; laryngitis: 17%–7%, $p < 0.05$; aspiration: 14%–2%; use of proton pump inhibitors: 44%–9%, $p < 0.001$; and use of H₂ blockers: 60%–10%, $p < 0.01$).

In 2004, Perry and colleagues²⁴ assessed 57 patients who underwent a Roux-en-Y gastric bypass pre- and postoperatively. Hiatal hernias or esophagitis was present in 48 patients and Barrett esophagus was present in 2 patients preoperatively. Patients were followed up at a mean of 18 (range 3–30) months, and they attained a mean weight loss of 40 kg. In follow-up all patients reported improvement or no symptoms of GERD.

It is also important to note that some studies have assessed the use of LRYGB as revision surgeries to laparoscopic Nissen fundoplication procedures that have failed to alleviate GERD symptoms. Previous studies have shown equal effectiveness between Nissen fundoplications and LRYGB in alleviating symptoms of GERD in morbidly obese patients.²⁵ Raftopoulos and colleagues²⁶ assessed 7 patients with previous Nissen fundoplications who were undergoing revision LRYGB using the Gastroesophageal Reflux Disease–Health Related Quality of Life (GERD-HRQL) scale.²⁶ Postoperative reassessment with the GERD-HRQL scales showed a significant reduction in GERD scores ($p = 0.006$). Other studies have reported similar results with respect to LRYGB as revision to antireflux surgeries.²⁷

Another important consideration when assessing the effect of bariatric surgery on GERD symptoms is the presence of hiatal hernias. As mentioned by Orlando,¹² hiatal hernias are considered to directly impact LES incompetence. It has been noted that the size of the hiatal hernia inversely affects LES pressure and directly increases

impairment in esophagogastric junction barrier function, thus increasing the amount of GERD-like symptoms. Since the incidence of both GERD and hiatal hernias increases as BMI increases, there has been a recent trend toward bariatric surgeons attempting to combine bariatric surgeries with repair of hiatal hernias. A recent retrospective analysis by Kothari and colleagues²⁸ compared the results of LRYGB and LRYGB combined with laparoscopic hiatal hernia repair (LHHR). Their study involved 3 groups of patients: the first group ($n = 33\ 717$) did not have hiatal hernias and underwent LRYGB alone, the second group ($n = 644$) had hiatal hernias and underwent both LRYGB and LHHR, and the final group ($n = 1589$) had hiatal hernias but did not undergo LHHR. Most patients with hiatal hernias did not undergo hernia repair during their LRYGB, as most surgeons considered the procedure unnecessary owing to the alleviation of GERD symptoms after significant weight loss. As there is a direct correlation between hiatal hernias and the presence of GERD symptoms, it is important to take this trend of concurrent LRYGB and hernia repair into account in order to fully assess the alleviation of GERD symptoms following LRYGB.

In summary, RYGB is an effective procedure for alleviating the symptoms of GERD as it plays a role in significant weight loss without altering the anatomy of the LES and increasing intragastric pressure; however, careful consideration of concurrent RYGB and hernia repair is warranted.

CONCLUSION

Obesity is an important risk factor in the development of GERD and its associated complications. Weight loss following lifestyle modification has been shown to significantly alleviate GERD symptoms. With regards to bariatric surgery and its effect on GERD, studies have shown inconsistencies with different types of bariatric surgery. Laparoscopic sleeve gastrectomy has been associated with an increased incidence of GERD following the procedure; explanations have included the postoperative angle of His and increase in intragastric pressure. Gastric banding has been shown to improve the symptoms of GERD in the short-term; however, a small subset of patients experience new reflux symptoms and esophagitis in the long-term. The most effective bariatric procedure in the alleviation of GERD appears to be RYGB, which has been reported to have a similar efficiency as that of Nissen fundoplication. As bariatric surgeries affect anatomy and physiology of the gastrointestinal tract in different ways, it is important to assess patients' comorbidities when considering the different types of bariatric surgeries. Based on the studies we discussed, it appears that RYGB provides the best alleviation of symptoms associated with GERD and its comorbidities.

Competing interests: S. Karmali is a consultant for Ethicon Endo-Surgery and Covidien. D.W. Birch is a consultant for Johnson & Johnson,

Ethicon Endo-Surgery and Covidien, and he has received speaker fees and educational grants from Johnson & Johnson, Ethicon Endo-Surgery, Covidien and Stryker. No other competing interests declared.

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