ORIGINAL ARTICLE

Prevalent Esophageal Body Motility Disorders Underlie Aggravation of GERD Symptoms in Morbidly Obese Patients Following Adjustable Gastric Banding

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Hypothesis: Preexisting gastroesophageal reflux disease (GERD) and esophageal motility disorders may affect the outcome of laparoscopic adjustable gastric banding (AGB).

Design: Prospective cohort study.

Setting: Tertiary referral center.

Patients: Between January 1, 1996, and December 31, 2002, AGB procedures were performed in 587 patients (mean body mass index, 46.7 [calculated as weight in kilograms divided by the square of height in meters]). The study population was composed of patients with preoperative GERD (assessed by a symptom-score questionnaire) and was divided into group 1 (those with preoperative GERD symptoms only) and group 2 (those with preoperative and postoperative GERD symptoms).

Interventions: Laparoscopic AGB was performed according to the pars-flaccida technique.

Main Outcome Measures: All patients underwent preoperative and annual postoperative symptom scoring, endoscopy, esophageal barium swallow tests, esophageal manometry, and 24-hour pH monitoring.

Results: Mean follow-up time was 33 months (range, 12-49 months). A total of 164 patients (27.9%) were diagnosed as having preoperative GERD symptoms. In 112 (68.3%) of these patients GERD symptoms vanished postoperatively (group 1), whereas 52 patients (31.7%) remained symptomatic after undergoing laparoscopic AGB implantation (group 2). Preoperatively, group 2 patients showed significantly poorer esophageal body motility compared with group 1 patients (20.8% vs 12.8% defective propagations; $P = .007$). In group 2 the mean symptom scores for dysphagia (0.4 vs 0.9) and regurgitation (0.6 vs 1.4) deteriorated significantly following laparoscopic AGB implantation, respectively. Eighteen patients (34.6%) in group 2 developed esophageal dilatation.

Conclusions: Adjustable gastric banding provides a sufficient antireflux barrier in most of the obese patients with GERD. However, in patients with preoperatively defective esophageal body motility, AGB may aggravate GERD symptoms and esophageal dilatation. Alternative bariatric surgical procedures should be considered in these patients.

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During the last decade obesity has become a health crisis of epidemic dimensions. According to definition, more than 20% of the Western European population and more than 30% of the American population are affected by obesity to some extent.[1,2] Various surgical treatment options have been described, and good results are documented for several laparoscopic restrictive or malabsorptive procedures.[3-6] In Europe, the adjustable gastric band (AGB) has become the preferred method for surgical treatment of morbidly obese patients.[7]

Obesity is often associated with concomitant esophageal disease, such as esophageal motility disorders, hiatal hernia, and, particularly, gastroesophageal reflux, that accounts for 75% of esophageal diseases.[8-11] Generally, at our hospital the AGB was considered for all patients irrespective of coexistent functional disorders of the foregut. Short-term results have demonstrated a beneficial effect of AGB on reflux symptoms, thus providing a sufficient antireflux barrier.[12,13] However, impaired esophageal peristalsis and lacking relaxation of the lower esophageal sphincter (LES) leading to achalasialike esophageal dilatation occurred in a subgroup of patients.[13] The underlying pathomechanism of foregut motility disorders and the development of esophageal aperistalsis is still unknown. A published report in the literature stated that aggravated postoperative GERD symptoms and esophageal

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Table 1. Demographic Data of Patients With Morbid Obesity Undergoing Adjustable Gastric Banding*

Variable	Total (N = 587)	Group 1 (n = 112)†	Group 2 (n = 52)†
Age, y	39 ± 8.8	39 ± 10.4	41.0 ± 9.9
Sex, female/male	499/88	94/18	43/9
Body weight, kg			
Preoperative	129.6 ± 27.2	126.3 ± 19.4	122.2 ± 16.3
Postoperative	86.7 ± 15.7	81.4 ± 15.9	80.3 ± 17.8
BMI			
Preoperative	46.7 ± 9.8	45.5 ± 7.0	43.7 ± 5.8
Postoperative	28.2 ± 5.1	28.2 ± 9.1	28.7 ± 5.6

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters).

*Data are given as the mean ± SD unless otherwise indicated.

†Group 1 is composed of patients having preoperative gastroesophageal reflux disease (GERD) with postoperative symptom clear-out; group 2 patients reported GERD symptoms preoperatively and postoperatively.

dilatation count for the most feared complications during clinical follow-up.[13] Consequently, upper gastrointestinal tract reevaluation, repeated gastric band adjustments, and even AGB removal may be required. We conducted this study to evaluate the effect of laparoscopic AGB implantation on patients with preexisting GERD and to elucidate the influence of esophageal motility disorders.

METHODS

All patients with morbid obesity (N = 587) who underwent AGB at the Medical University Hospital, Innsbruck, Austria, between January 1, 1996, and December 31, 2002, were prospectively enrolled in this study and their data collected in a database. Adjustable gastric banding implantation was considered for patients with a body mass index (BMI [calculated as weight in kilograms divided by the square of height in meters]) of 40 or higher or 35 or higher with obesity-related comorbidities, such as bone and joint problems, cardiovascular diseases, or diabetes mellitus. The study population was defined using a questionnaire that covered preoperative GERD symptoms, in particular heartburn, regurgitation, and dysphagia. Symptoms were scored on a scale ranging from 0 (no symptoms) to 3 (severe symptoms). Each patient underwent a preoperative clinical workup including gastroscopy, stationary esophageal manometry, and 24-hour pH monitoring. All patients were followed up with a standardized protocol to check for weight loss and individual discomfort, including GERD symptoms. In addition, patients with GERD had a second clinical workup to assess GERD symptoms. All patients had endoscopic, radiographic, and manometric evaluation of the esophagus either 1 or 2 years postoperatively. Patients were then divided into 2 groups according to their postoperative GERD symptom status. Group 1 consisted of patients who had GERD symptoms preoperatively but no symptoms after AGB. Group 2 consisted of patients who reported preoperative and postoperative GERD symptoms.

GASTROSCOPY, ESOPHAGEAL MANOMETRY, AND 24-HOUR pH MONITORING

Gastroscopy was performed by using a scope (Olympus GIF-Q; Olympus, Vienna, Austria). Reflux esophagitis was defined according to the Savary-Miller scale. Patients suffering from GERD or reflux esophagitis grade 1 were operated on, while patients with high-grade esophagitis were pretreated with proton pump inhibitors prior to surgery. Stationary esophageal manometry with a water-perfused catheter having 5 channels was performed. Poor LES function was diagnosed when resting pressure measured at the respiratory inversion point was less than 8 mm Hg or intra-abdominal length of the LES was less than 1.2 cm.[14] In addition, relaxation of the LES was evaluated and considered to be incomplete if it was below 90% or the duration was shorter than 7 seconds (95th percentile in our laboratory). Esophageal peristalsis was analyzed in 10 swallows of 5 mL of water. Simultaneous and interrupted waves as well as amplitudes below 30 mm Hg in the distal esophagus were termed "defective propagations." Poor esophageal peristalsis was diagnosed when more than 10% of the contraction waves were defective.[15,16] Twenty-four-hour esophageal pH monitoring was performed as described by DeMeester et al.[17] A DeMeester score of more than 14.7 indicated abnormal acid reflux.

SURGICAL PROCEDURE

All patients were operated on at our department using the Swedish AGB (SAGB; Johnson & Johnson, Obtech, Vienna, Austria). Laparoscopic AGB was performed according to the pars-flaccida technique of Forsell and Hellers,[18] where the band is placed 1 to 3 cm below the lower esophageal junction. A gastric pouch of maximal 15 to 20 mL was created and the band secured with 3 to 4 nonabsorbable gastrogastric sutures.

A total of 13 patients had to be converted from the laparoscopic to an open approach. Mean postoperative hospital stay was 3 days (range, 2-7 days). A swallow test using contrast medium was performed on postoperative day 2 to confirm correct band placement.

STATISTICAL ANALYSIS

Data are provided as mean ± SD. Tests for statistically significant differences between preoperative and postoperative results were conducted using the paired and unpaired *t* test as appropriate. Comparison of categorical and ordinal variables for preoperative and postoperative results was calculated by means of the χ^2 test and Kruskal-Wallis 1-way analysis of variance, respectively. $P<.05$ was considered statistically significant.

RESULTS

DEMOGRAPHICS

Table 1 gives the demographic data of all patients (N = 587). After a complete mean follow-up of 33 months (range, 12-49 months) patients achieved a mean body weight reduction of 42.9 ± 11.5 kg, giving a mean BMI of 28.2 ± 5.1; 164 patients (27.9%) were diagnosed as having obesity-associated preoperative gastroesophageal reflux symptoms (groups 1 and 2). No statistically significant differences in demographic data were seen between the 2 groups (Table 1).

GERD SYMPTOMS

Of 164 patients with GERD, 112 patients (68.3%) no longer reported GERD symptoms (heartburn, dysphagia, regurgitation) postoperatively (group 1), while 52

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patients (31.7%) had ongoing or aggravated GERD symptoms following AGB (group 2).

In group 2 the mean severity score for heartburn initially decreased from 1.3 to 1.1 within 24 months after AGB placement ($P=.03$), but long-term follow-up showed a higher mean severity score (1.7, $P=.44$) vs preoperative. Mean rating of regurgitation (0.6 and 1.4, preoperative vs postoperative, $P=.001$) and dysphagia (0.4 and 0.9, preoperative vs postoperative, $P=.03$) revealed statistically significantly higher scores during long-term follow-up compared with preoperative values.

GASTROSCOPY, ESOPHAGEAL MANOMETRY, AND 24-HOUR pH MONITORING

There were no statistically significant differences in grading of preoperative esophagitis between patients of groups 1 and 2. Preoperative esophageal manometry and pH measurements are summarized in **Table 2**. Statistically significant differences between groups 1 and 2 were found for distal esophageal amplitudes (56.5 vs 45.3, $P=.03$), the percentage of defective esophageal contraction waves (12.8 vs 20.8, $P=.007$), and the percentage of interrupted esophageal waves (3.4 vs 8.5, $P=.047$). No preoperative difference in LES relaxation and pressure or in DeMeester scores was found between the groups.

Postoperatively, LES relaxation significantly deteriorated in group 2 patients (99.1 ± 2.2 vs 82.3 ± 11.7, $P=.02$). In addition, the percentage of simultaneous esophageal waves (2.5 ± 5.8 vs 28.4 ± 30.0, $P=.002$) and interrupted esophageal waves (5.4 ± 9.3 vs 28.5 ± 29.9, $P=.009$) yielded a total of 45.8% ± 32% defective esophageal propagations ($P=.03$ vs preoperative). Lower esophageal sphincter pressure (15.5 ± 6.3 mm Hg) and distal esophageal amplitudes (38.5 ± 18.6 mm Hg) did not significantly differ postoperatively. The DeMeester score was found to be pathological in 43% of the patients.

The frequency of simultaneous esophageal contractions following AGB increased significantly in asymptomatic group 1 patients (2.8 ± 8.0 vs 14.5 ± 22.0, $P=.01$). This resulted in a higher percentage of defective esophageal propagations postoperatively (12.8 ± 19.3 vs 35.9 ± 29.4, $P=.02$). In group 1 patients LES pressure (18.1 ± 11.3 mm Hg), sphincter relaxation (74.2% ± 25.8%), and distal esophageal amplitudes (50.6 ± 20.8 mm Hg) did not reveal significant differences postoperatively. In 23% of the patients the DeMeester score turned to pathological values. In group 1 eleven patients (9.8%) showed impaired preoperative esophageal body motility that remained unchanged in all of these patients after surgery. Defective esophageal propagations were assessed in another 17 patients (15.2%) following AGB.

BARIUM SWALLOW

Postoperatively, 18 patients (34.6%) in group 2 developed esophageal dilatation with an esophageal diameter of at least 3 cm (range, 3-6.5 cm), while 20 patients (17.9%) in group 1 developed esophageal dilatation after AGB. Immediate complete deflation of the balloon resulted in subsequent normalization of the esophageal diameter. Gradual stepwise filling of the device was tolerated anew in all but 3 patients, who required debanding thereafter.

Table 2. Preoperative Manometric Findings and DeMeester Scores in Group 1 and Group 2 Patients*

Variable	Group 1†	Group 2†	*P* Value‡
LES relaxation, %	98.3 ± 4.4	98.0 ± 3.8	.78
LES pressure, mm Hg	11.7 ± 7.4	11.9 ± 4.6	.91
Distal esophageal amplitude, mm Hg	56.5 ± 18.2	45.3 ± 18.4	.03
Defective esophageal contraction waves, %	12.8 ± 19.3	20.8 ± 9.8	.007
Interrupted waves, %	3.4 ± 6.2	8.5 ± 10.1	.047
Simultaneous waves, %	2.8 ± 8.0	6.5 ± 12.8	.24
Low-amplitude waves, %	4.5 ± 11.8	13.0 ± 19.0	.08
DeMeester score	12.6 ± 10.0	13.5 ± 8.8	.74

Abbreviation: LES, lower esophageal sphincter.
*Data are given as the mean ± SD unless otherwise indicated.
†Group 1 is composed of patients having preoperative gastroesophageal reflux disease (GERD) with postoperative symptom clear-out; group 2 patients reported GERD symptoms preoperatively and postoperatively.
‡*P* value was calculated by means of the unpaired *t* test.

COMMENT

Morbidity due to excess body weight is treated most effectively by many bariatric procedures. Only a minority of specialized general and gastrointestinal surgeons perform bariatric surgery. However, most physicians encounter morbidly obese patients who would be considered candidates for operative treatment. In the future, problems or complications that are directly related to a bariatric procedure will be seen more often. Hence, a tailored operative procedure is required for each patient to avoid predictable complications.

In Europe, laparoscopic AGB has gained popularity because it does not involve a gastrointestinal bypass, is technically easy to perform and adjustable to the individual patient's demands, and is effective in terms of stable weight loss.[4,7,18] Concerns have been voiced about whether patients having GERD are suitable candidates for this treatment.[19-21] There is little evidence in the literature that alternative bariatric procedures such as the Roux-en-Y gastric bypass, the vertical banded gastroplasty, and the biliopancreatic diversion are superior to AGB regarding gastroesophageal reflux control. Although randomized control studies comparing these procedures by means of 24-hour pH manometry and esophageal manometry are lacking, single reports discuss the value of bypass procedures after failure of AGB.[3,6,8] The observation that GERD is common among obese patients[8,9,22,23] is confirmed by our data that reveal 27.9% of patients reporting preoperative GERD symptoms.

Postoperatively, 68.3% of these patients were asymptomatic. Vanishing of GERD symptoms might be explained by the strengthened LES after laparoscopic AGB implantation as described by our group.[13] Therefore, implantation of the AGB probably acts directly to reduce gastroesophageal reflux. Rapid and major improvement in GERD symptoms occurred after laparo-

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scopic AGB placement in a series reported by Dixon and O'Brien.[12]

We were, however, particularly interested to learn why 31.7% of the patients with symptomatic GERD reported the same or even worse symptoms postoperatively. Initially, the symptom heartburn received lower postoperative scores in these patients but worsened during long-term follow-up, while the degree of regurgitation and dysphagia increased during short- and long-term observation. Owing to strengthening of LES pressure after banding,[13] less acid may be present in the esophagus after short-term follow-up. During long-term follow-up esophageal stasis may, nevertheless, be responsible for higher heartburn scores in these patients. This is supported by the fact that more patients were initially seen with pathological DeMeester scores postoperatively in the long run. However, there is a lack of data that could help predict the course of GERD symptoms after gastric banding. To our knowledge, our study demonstrates for the first time that esophageal body motility plays a predominant role in the processing of GERD symptoms, because patients who remain symptomatic after AGB showed a significantly higher preoperative incidence of altered esophageal body motility. Korenkov et al[24] reported no effect of gastric reduction surgery on postoperative esophageal function or GERD symptoms. They prospectively followed up patients who underwent gastric banding and gastric bypass and exhibited neither statistically significant differences in postoperative esophageal motility nor GERD symptoms. The discrepancy between their results and ours may be explained by the short follow-up of 22 months and few patients (n=53) in the study population.[24]

The prevalence of defective esophageal contraction waves in morbidly obese patients, in particular interrupted propagations, may account for the esophagus not building up enough pressure to overcome the outflow resistance created by the implanted AGB. This observation is similar to that made in antireflux surgery, where it is recommended that patients with altered body motility be treated by partial Toupet fundoplication instead of a complete 360° Nissen fundoplication to prevent dysphagia.[25,26]

Higher postoperative LES pressure prevents gastric juice from entering the esophagus. A previous report describes a reduction in the amount of acid in the esophagus after uncomplicated AGB in morbidly obese patients with abnormal preoperative esophageal acid exposure.[27] The symptom of heartburn in our patient population may be caused by esophageal stasis rather than acid reflux.

During long-term follow-up, a significant worsening of esophageal body motility as well as of LES relaxation was observed in patients with symptomatic as well as asymptomatic GERD who had preoperative GERD. We can only speculate why patients became asymptomatic despite partially altered postoperative esophageal body motility. Eleven patients in asymptomatic group 1 were initially seen with impaired preoperative motility disorders and had ongoing interruption of propagation after AGB. This indicates that our grouping of patients according to their postoperative symptom score is not quite correct, but instead should be based on preoperative esophageal body motility to predict functional outcome following AGB. This fact stresses the value of a comprehensive preoperative gastrointestinal workup including upper gastrointestinal tract functional testing in patients undergoing laparoscopic AGB. The patients include, however, another 15% whose GERD symptoms improved after AGB but whose esophageal motility worsened from normal preoperative values. To date, we have no predictive factors that would foretell changes in esophageal function in this subgroup of patients. These patients should be considered asymptomatic refluxers, and other tests are warranted to select this subpopulation of morbidly obese patients. On the other hand, a sophisticated postoperative follow-up including dietary advice, prevention of stoma stenosis by overfilling of the balloon, and repeated barium swallow tests will diminish the risk for functional alterations in patients with primarily normal esophageal motility.

Although a variety of complications can be demonstrated by radiological means, Mortele et al[28] concluded that AGB meets the criteria for a low-risk laparoscopic alternative treatment for morbid obesity since a low postoperative complication rate was found radiologically in a comparably short follow-up period. One of the most severe complications following AGB is esophageal dilatation that was found in 34.6% of postoperatively symptomatic patients in our study. This is in accord with the manometric findings of defective esophageal contractions. Most of the patients develop dilatation within the first 2 postoperative years, as described in a short follow-up study of our patient population.[13] In asymptomatic patients a dilatation rate of 17.9% was observed and can be attributed to altered esophageal motility. This underlines the importance of preoperative gastroesophageal functional testing. Band deflation caused a reduction in esophageal diameter within 3 months in all but 3 patients, who finally required debanding and alternative bariatric procedures.

CONCLUSIONS

We demonstrate that GERD is common in morbidly obese patients and that symptoms diminish in most of these patients following AGB. However, patients with preoperative alteration of esophageal body motility have poor postoperative outcome with regard to GERD symptoms and esophageal function. Therefore, in all morbidly obese patients considered as candidates for AGB, a profound medical history and a comprehensive gastroesophageal function test is warranted. Alternative bariatric procedures, primarily laparoscopic gastric bypass, should be considered in patients with defective preoperative esophageal body motility.

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