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Evolution of gastroesophageal reflux after laparoscopic vertical gastrectomy. A radiographic, manometric and pH-metric study

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ABSTRACT

Introduction: the relationship between laparoscopic vertical gastrectomy (LVG) and gastroesophageal reflux (GER) is still controversial. Therefore, its study is of great interest in order to obtain definitive conclusions. The goal of the study was to establish whether LVG modifies pH-metric GER in obese patients and to analyze the associated factors.

Patients and methods: the first 26 patients who underwent LVG in our institution were enrolled in the study. A barium swallow, 24-hour ambulatory pH-metry and four-channel intraluminal esophageal manometry (IEM) were all performed before and one year after surgery.

Results: among the pH-metric data, there was a significant increase in the DeMeester index after the procedure (p = 0.028), while other parameters remained unchanged. Furthermore, 50% of patients with preoperative pH-metric GER had normal values at one year after surgery. IEM showed a decrease in lower esophageal sphincter (LES) pressure and in the mean wave amplitude at the distal third of the esophagus (p = 0.007 and p = 0.025, respectively). The rate of newly-developed hiatal hernias in the radiographic study was 36.4%.

Conclusion: LVG mildly increases GER, which is likely related to the development of hiatal hernias and a decrease in LES pressure and esophageal sweep. However, LVG should not be contraindicated for patients with preoperative pH-metric GER, as this may clear after the procedure.

Key words: Morbid obesity. Laparoscopic vertical gastrectomy. Gastroesophageal reflux. Esophageal manometry. Ambulatory esophageal pH-metry.

INTRODUCTION

Laparoscopic vertical gastrectomy (LVG) is the most commonly used approach in bariatric surgery worldwide according to the latest reports (1) and represents thousands of procedures yearly. The safety and effectiveness in the short and midterm should be demonstrated (2,3). However, its relationship to gastroesophageal reflux (GER) remains a controversial issue. This is important as the condition is highly prevalent in our setting and results in significant health care expenses (4).

Many reported studies on this subject are based on the use of clinical questionnaires dealing with reflux symptoms or with the use of antisecretory medication before and after LVG (5). However, the correlation between symptoms and actual reflux is imprecise and demands assessment using functional esophageal testing in order to draw definite conclusions.

The goal of the study was to quantify GER using a 24-hour ambulatory pH-metric in obese patients eligible for LVG and then at one year after the procedure. The aim was to establish whether this surgery may be considered as refluxogenic or had the potential to heal pre-extant pathologic reflux. Radiographic assessment with a barium

swallow and a study of esophageal motility with stationary intraluminal esophageal manometry will help to establish the causes of the results obtained.

METHODS

This was a prospective study of the first 26 consecutive patients undergoing LVG in the Esophagogastric Surgery Unit (Hospital Universitario Virgen de la Arrixaca, Murcia, Spain), between March 2013 and July 2014. All patients in the study were accepted by our multidisciplinary committee of morbid obesity. Surgery was performed in appropriately aged patients, with no psychiatric contraindication and a body mass index (BMI) above 40 kg/m^2 or 35-40 kg/m^2 in association with a chronic condition such as type-2 diabetes mellitus, blood hypertension, dyslipidemia or obstructive sleep apnea syndrome.

GER was assessed before and 12 months after surgery using a barium esophagogram, stationary intraluminal esophageal manometry and 24-hour ambulatory manometry. An upper digestive endoscopy was also indicated for all patients before surgery. Typical GER symptoms (heartburn, regurgitation) were recorded at both time points. With regard to the radiographic study, the presence or absence of hiatal hernia during the exam was assessed. The rate of *de novo* hiatal hernias was established by identifying a hiatal hernia one year after surgery in patients who had no such lesion in the preoperative study.

Functional esophageal studies were performed as described previously (6). Stationary intraluminal esophageal manometry was performed with a PC Poligraf HR (Synectics, Stockholm, Sweden) polygraph and four-channel probes with distal orifices 5 cm apart. Probes were connected to a pneumohydraulic capillary continuous perfusion system for distilled water (Arndorfer Specialities Inc, Milwaukee, Wisconsin, USA). All results were analyzed by the same physician using the PC Polygram (Gastrosoft, Irving, Texas, USA) software program and lower esophageal sphincter pressure was considered as normal within the 10-30 mmHg range. Lower esophageal sphincter (LES) length, LES relaxation index and the mean wave amplitude in the distal third of the esophagus were also assessed.

A portable device (Synectics®, Stockholm, Sweden) with an antimony electrode, a reference electrode, and a box for the patient to carry the pH-meter around the clock was used to quantify acid reflux. Data collected during this period were analyzed using a software program (Esophogram; GastroSoft, Irving, Texas, USA). The pathologic reflux was deemed present when the esophageal pH remained below 4 for more than 4.5% of the total recording time and/or the DeMeester score was higher than 14.72. Furthermore, the number of events with a pH below 4, the number of events with a pH below 4 and duration above five minutes, longest event duration (min) and total time (min) with esophageal pH below 4 were also assessed. The *de novo* reflux rate was estimated by identifying patients with positive pH-metric GER in the postoperative period, with a normal reflux preoperatively. GER cure rate was defined as the percentage of patients with pathologic GER preoperatively with normal GER levels at one year after LVG.

Surgery was performed in all cases by the same team of two surgeons. Thirty-degree optics through an 11-mm trocar were used with four additional entry ports of 2 x 12 mm and 2 x 5 mm. A 36-French catheter allowed the configuration of the gastric sleeve from the right side (7), with the cut beginning 5 cm away from the pylorus and ending at 1 cm from the His angle. Four to six purple loads were used with an electric endostapler (iDrive™, Medtronic, Minneapolis, USA). The hiatus was completely dissected in a patient with a moderate hiatal hernia, the gastric hernia was reduced and diaphragmatic pillars were repaired. Surgical complications at 30 days were detailed according to the Clavien-Dindo classification (8).

The IBM-SPSS Statistics V.22 software for Windows was used for the statistical analysis. The mean, standard deviation, median, and range values were estimated for all data. The inferential statistical analysis was performed by using the McNemar's test for qualitative variables. The comparison of the means for normally distributed quantitative variables was performed with the paired Student's t-test and the nonparametric variables with the Wilcoxon's test for paired variables. Statistical significance was established at a p-value lower than 0.05. The study was approved by the hospital ethics committee and all patients provided their informed consent.

RESULTS

The data collected before and one year after surgery were analyzed from the first 26 patients in our series. The demographic parameters are listed in table 1. With regard to the clinical assessment of esophageal reflux, 12 patients (46%) had heartburn preoperatively and ten (38%) had it at one year after the procedure. With regard to regurgitations, nine patients (35%) said they experienced this preoperatively and ten (38%) cases at one year after the procedure. Finally, six patients received chronic therapy with proton pump inhibitors before surgery, whereas 14 took them postoperatively. Preoperative endoscopy showed esophagitis in four patients (15.3%), hiatal hernia in five (19.2%), gastritis in ten (38.4%) and normal findings in eleven patients (42.3%).

Table 2 shows the pH-metric data, both before and one year after the surgery. Only the change in the DeMeester score ($p = 0.028$) was statistically significant. The GER cure rate was 50% and the *de novo* reflux rate was 66%.

With regard to manometric and radiographic data (Table 2), there was a significant decrease in both LES pressure ($p = 0.007$) and the mean wave amplitude in the distal third of the esophagus ($p = 0.025$). However, the postoperative values of both these variables were within the normal limits. The rate of hiatal hernias was significantly higher postoperatively (four *versus* eleven patients; $p = 0.039$), with a rate of newly developed hernias of 36.4%.

One patient had a type-II complication (blood transfusion) and one had a type-IIIa complication (radiographic drainage and antibiotic therapy for a juxtagastric collection without suture dehiscence), but there was no mortality. The percentage of excess weight loss (%EWL) in the series at one year after the procedure was 72.7%.

DISCUSSION

LVG has become the most popular bariatric technique throughout the world, displacing Roux-en-Y gastric bypass in number of yearly procedures (9). This means that both the positive and negative aspects of LVG will affect thousands of people. In this context, GER and long-term results currently represent the most controversial issues associated with this surgery. This deserves an in-depth assessment in order to

draw definite conclusions, even providing solutions when necessary. Initially, LVG was contraindicated in patients with clinical reflux and/or Barrett's esophagus as it may be a refluxogenic procedure. However, there is now a more moderate attitude as results from a number of studies have come to light (10). A truthful analysis of gastroesophageal reflux must include objective tests rather than exclusively clinical questionnaires, as the relationship between symptoms and real GER or GER-associated endoscopic lesions is not always direct or proportional (11,12). Thus, a lack of manometric and GER quantification studies led to a failure to reach a consensus on LVG and GER over the last years (13).

With regard to the data provided by the 24-hour ambulatory pH-metry, there were no significant differences for the majority of test parameters, including the percentage of the day with an esophageal pH below 4 (Table 2). However, the DeMeester score was significantly higher postoperatively, which has also been reported by other authors (14,15). Each item assessed by pH-metry seemed to suggest more GER following the surgery, as Gorodner et al. (16) have acknowledged. In this regard, the sample size represents a study limitation, as a larger size would likely result in statistical significance for some of the parameters herein analyzed. The high rate of *de novo* reflux in our series, while consistent with the literature (17), fosters the notion of LVG as a GER-producing procedure. However, in half of patients with pH-metric GER before surgery, the pH-metry findings normalized after the procedure, as reported by Coupaye et al. (18). This advises against banning the procedure in patients with preoperative pH-metric GER, since the condition may resolve postoperatively.

The pathophysiological mechanisms accounting for pH-metry findings are multiple and interact among themselves. Therefore, determining which one is primarily responsible for reflux or for postoperative reflux normalization is challenging in any given patient. In this respect, while it is clear that obesity increases GER risk, weight loss after LVG does not seem to play a role in GER resolution or prevention. Thus, the general trend in the series is towards GER aggravation when the %EWL rises above 70%. A larger sample size would allow more accurate correlations between these two aspects. Therefore, local factors associated with the new anatomy and functionality of physiological barriers seem to be more relevant. In our case, both the overall rate of

hiatal hernia after surgery (42.3%) and the rate of newly developed hiatal hernia are high, which may partly explain the identified postoperative GER rate. In this regard, Saber et al. described intrathoracic gastric sleeve migration as a common finding associated with GER, epigastric pain, dysphagia and nausea after LVG (19). With regard to manometric data, Braghetto et al showed a significant decrease in LES pressure (20), as in our case. The authors attributed this to the sectioning of sphincter sling fibers during LVG. As we move 1-1.5 cm away from the His angle at the end of the gastric section, this mechanism seems unlikely. With regard to the evolution of esophageal peristaltism, Petersen et al. reported an improved esophageal sweep following LVG (21). In contrast, we observed in our series a significant decrease in the mean wave amplitude along the distal third of the esophagus, which might favor a higher rate of postoperative reflux as a result of reduced esophageal clearing (22). However, wave pressure at one year after surgery is within the normal range, hence this mechanism cannot be definitively attributed to the cause of postoperative GER.

Surgical technique plays a relevant role in the evolution of gastroesophageal reflux after LVG. Thus, the presence of postoperative stenosis in the distal third of the tubularized stomach seems to determine postoperative reflux, independently of an association with upper gastric portion dilation and a hiatal hernia (23). We do not know the potential influence of the learning curve on the results of our study, as we have assessed reflux evolution in the first few patients in our series. From a technical perspective and in contrast with other authors (24), we are not in favor of performing hiatoraphy/hiatoplasty procedures concomitant with LVG in obese patients with preoperative GER. In fact, the only patient in our series with a moderately large hiatal hernia who underwent a pillar closure had a higher percentage of total time daily with esophageal pH below 4 postoperatively (14.8% *versus* 28.4%). Other limitations of the study include a lack of longer-term follow-up and the absence of endoscopic examinations at one year after surgery for an in-depth assessment of the postoperative GER aftermath. Notwithstanding, the preoperative endoscopic never lead to a change in surgical technique in any case, which is in contrast with other studies (25). Finally, we did not quantify alkaline reflux, which is a significant factor in the genesis of end-stage gastroesophageal reflux disease, as is the case with Barrett's

esophagus.

To conclude, LVG has a non-significant tendency toward producing GER for most parameters analyzed. This is likely due to the development of a hiatal hernia, which results in a decreased LES pressure and esophageal sweep. However, it may also normalize pre-extant GER (26) and therefore must not be contraindicated in patients with preoperative pH-metric GER. Further longer-term studies in larger numbers of patients are needed to draw definite conclusions and accurately establish the factors involved in the association of LVG with GER.

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Table 1. Preoperative epidemiological data of all 26 patients included in the study

Age (years)*	45.27 ± 10.14
Gender[†]	
Male	12 (46.1%)
Female	14 (53.9%)
BMI (kg/m^2)*	46.62 ± 5.11
Comorbidities[†]	19 (73.1%)
Diabetes	8 (30.8%)
HT	15 (57.7%)
Hypercholesterolemia	9 (34.6%)
SOAS	9 (34.6%)
ASA[†]	
I	0
II	10 (38.5%)
III	14 (53.8%)
IV	2 (7.7%)

*Mean ± SD. [†]Number of patients (percentage).

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ENFERMEDADES DIGESTIVAS
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Table 2. Radiographic, manometric, and pH-metric data preoperatively and at one year from LVG

		Pre	Post	p
Swallow*	Normal	22	15	0.039
	Hiatal hernia	4	11	
Sphincter length (cm)† *NV: 3-5 cm*		3.83 ± 0.89	4.06 ± 1.21	0.345
Wave amplitude (mmHg)† *NV: 30-180 mmHg*		114.02 ± 41.87	98.38 ± 34.26	0.025
Baseline LES pressure (mmHg)† *NV: 10-30 mmHg*		16.5 ± 5.59	13.2 ± 6.19	0.007
Relaxation index (%)† *NV: > 80%*		150.77 ± 118.6	140.55 ± 51.33	0.695
Time fraction with pH < 4 (%)† *NV: < 4.5%*		6.18 ± 4.66	8.63 ± 7.52	0.099
No. of reflux events† *NV: < 50*		102.84 ± 71.54	135.76 ± 97.79	0.118
No. of reflux events > 5 min† *NV: 1-3*		3.38 ± 3.93	3.92 ± 4.1	0.588
Duration of longest reflux event (min)† *NV: 10 min*		13.19 ± 10.08	21.11 ± 21. 04	0.050
Time with pH < 4 (min)† *NV: 60 min*		82.69 ± 63.38	113.46 ± 100.13	0.128
DeMeester score† *NV: 14.72*		24,02 ± 16.61	37.3 ± 29.77	0.028

*Number of patients. †Mean ± SD. p: level of significance. NV: normal value.