Effect of laparoscopic sleeve gastrectomy on upper gastrointestinal symptoms

Sherif M. Mokhtar[a], Shady El-Ghazaly Harb[a], A. Hussein[a], Mohamed Elnady[b]

[a]General Surgery Department, Faculty of Medicine, Cairo University, Kasr Al-Ainy, Egypt, [b]Internal Medicine Department, Faculty of Medicine, Cairo University, Kasr Al-Ainy, Egypt

Correspondence to Sherif M. Mokhtar, MD, General Surgery Department, Faculty of Medicine, Cairo University, Kasr Al-Ainy, Egypt; Tel: 01025242447; e-mail: sherif.mokhtar@kasralainy.edu.eg

Received 3 October 2016
Accepted 6 November 2016

The Egyptian Journal of Surgery
2017, 36:106–118

Background
Laparoscopic sleeve gastrectomy (LSG) is one of the most well-known, safe, and effective bariatric procedures worldwide with the lowest incidence of complications and satisfactory results. Altered gastric anatomy following LSG is likely to induce upper gastrointestinal (UGI) symptoms.
Patients and methods
The validated Rome III criteria symptom questionnaire for UGI symptoms was used for 30 patients who underwent LSG. Before surgery, patients were tested for *Helicobacter pylori* in stool, eradicated and underwent UGI endoscopy for identification of any pathological finding. Symptoms were analyzed separately and UGI endoscopy was performed postoperatively to classify the findings and correlate these with UGI symptoms.
Results
Before LSG, 60% of the patients were asymptomatic, 40% had gastroesophageal reflux disease (GERD), and 6.7% had dyspepsia. All were subjected to UGI endoscopy and no significant finding was found in 40%, gastritis in 60%, esophagitis was found in 20%, duodenitis was found in 13.3%, and duodenal ulcer was found in 6.7% of patients. Forty percent of patients were *H. pylori* positive and 60% of patients were *H. pylori* negative. After a median follow-up of 6 months, 93.3% of the patients complained of UGI symptoms, the most prevalent being dyspepsia (66.7%) ($P<0.001$). The prevalence of GERD did not differ before and after LSG, but GERD symptoms disappeared in 83.3% of patients. Vomiting increased significantly, occurring in 20% ($P=0.030$) of all patients, associated with GERD. A significant correlation was found between GERD and hiatus hernia in all patients ($P<0.001$) and a correlation was also found between vomiting and incompetent cardia in 66.7% of patients ($P=0.029$).
Conclusion
After a median follow-up of 6 months following LSG, dyspepsia, rather than GERD, was the main complaint. Hiatus hernia was strongly related to GERD and incompetent cardia was related to vomiting taking into consideration that all patients who developed vomiting had associated GERD.

Keywords:
dyspepsia, gastroesophageal reflux disease, laparoscopic sleeve gastrectomy, obesity, upper gastrointestinal symptoms

Egyptian J Surgery 36:106–118

1110-1121

Introduction

Obesity continues to be a major public health concern associated with many comorbidities that significantly decrease life expectancy and surgery remains the only effective treatment modality for morbid obesity, resulting in long-term weight loss and sustained improvement in weight-related comorbidities [1].

In Egypt, 30.3% of the adult population is considered obese according to the latest figures, which is the highest percentage of all countries in the Mediterranean region and ranked fourth in the Middle East, preceded only by Saudi Arabia, Kuwait, and the United Arab Emirates. The sex distribution of obesity in Egypt seems to be far from balanced, with the female population (39.5%) being twice as affected compared with the male population (18.2%). There is also quite a discrepancy between urban and rural populations, with the former being more affected by obesity than the latter, possibly as a result of a more sedentary lifestyle and other environmental factors [2].

Bariatric surgery procedures are indicated for patients with clinically severe obesity. Currently, these procedures are the most successful and durable treatment for obesity [3]. Laparoscopic sleeve gastrectomy (LSG) remains one of the safest and most effective modern surgical options for the treatment of morbid obesity [1].

 DOI: 10.4103/1110-1121.204523

Gastroesophageal reflux disease (GERD) is one of the most prevalent chronic gastrointestinal (GI) diseases, with an estimated 20–30% of the US adult population experiencing heartburn or acid regurgitation or both at least once a week. Obesity is considered a major risk factor in the pathogenesis of GERD and ~50% of morbidly obese patients have signs or symptoms of GERD [4]. Epigastric pain syndrome (EPS) and postprandial distress (PPD) dyspepsia are present in 28 and 11% of the obese patients considered for bariatric surgery [5].

Data from large databases suggest that all of the common bariatric procedures usually lead to an improvement in GERD symptoms, with Roux-en-Y gastric bypass being superior to laparoscopic adjustable gastric banding and LSG in this respect. Yet, smaller prospective studies indicate that LSG can induce de-novo GERD in some patients [4].

The removal of the gastric fundus, a large part of the body and a portion of the antrum, leads to significant anatomical and functional alterations that affect both gastric acid secretion and motility, in particular, accommodation, which may give rise to GI symptoms [5].

The onset of gastric motility disorders is related to the extension of the antrum resection (pacemaker). The consequent alterations in gastric emptying or compliance are caused by a greater intraluminal pressure and a reduced volume of the less distendable 'pouch'. These modifications might contribute toward the generation of dyspepsia-like symptoms [5].

Published studies, however, have focused mainly on GERD. This study aims to evaluate the impact of LSG on the prevalence of upper gastrointestinal (UGI) symptoms and to assess the effects of time from surgery, weight loss, and proton pump inhibitor (PPI) therapy.

This study aims to identify the effect of LSG on UGI symptoms after a mean of 6 months of follow-up. It also aims to identify any significant relation between UGI symptoms and UGI endoscopy findings postoperatively. In addition, we attempt to verify whether LSG has a satisfactory outcome of weight loss in terms of excess weight loss% (EWL%) after 6 months.

Patients and methods

This is a prospective case-series descriptive study that included 30 patients. All patients underwent LSG as a bariatric procedure over 12 months duration from June 2015 till June 2016 in general surgery department, Kasr Al-Ainy University Hospital, faculty of medicine, Cairo University.

Preoperative evaluation followed the same standard protocol and included a thorough assessment of personal, medical, and surgical history, complete endocrinal workup, psychological testing, and counseling by a dietician, followed a low-calorie diet in arrange for one up to three weeks according to BMI.

All of the patients underwent a standard evaluation preoperatively for UGI symptoms using Rome III diagnostic criteria [6] (Table 1) and all were tested for *H. pylori* using a noninvasive *H. pylori* antigen rapid test (HpSA) in stool using a combination of the polyclonal anti-*H. pylori* antibody and colloid gold-conjugated monoclonal anti-*H. pylori* antibody to specifically detect *H. pylori* antigens present in the infected patient fecal

Table 1 Rome III diagnostic criteria

1. Functional esophageal disorder
Heartburn (retrosternal discomfort/pain)
Dysphagia (sense of solid and/or liquid sticking, lodging, or passing abnormally through the esophagus)
Globus (intermittent nonpainful sense of a lump/FB in the throat between meals in the absence of dysphagia and odynophagia)
+ absence of upper GI evidence of GERD
2. Functional gastroduodenal disorder
Dyspepsia: either or together
Postprandial distress syndrome (PPD) (postprandial fullness after ordinary meal or early satiation several times/week)
Epigastric pain syndrome (EPS) (pain/burning epigastric intermittent, not generalized or localized to other areas and not relieved by flatus or defecation at least once/week)
N.B.: The copresence of heartburn and/or regurgitation with dyspeptic symptoms implies the exclusion of the diagnosis of dyspepsia
Belching (troublesome repeated belching several times/week)
Nausea and vomiting
Chronic idiopathic nausea (nausea several times/week not assessed with vomiting and no upper GI endoscopic abnormal or metabolic disease)
Functional vomiting (one or more episodes/week with no eating disorder, rumination, psychological disrder, self-induced, cannabinoid use, central nervous system, or metabolic disease)
Rumination (persistent or recurrent regurgitation of recently ingested food into the mouth not preceded by retching or nausea)

specimen with a sensitivity and specificity comparable with those of invasive methods such as biopsies taken for culture and/or a rapid urease test [7]. Patients who were positive for *H. pylori* received a triple-therapy treatment [PPI (lansoprazole 30 mg twice daily, omeprazole 20 mg twice daily, pantoprazole 40 mg twice daily, rabeprazole 20 mg twice daily, or esomeprazole 40 mg once daily), amoxicillin (1 g twice daily), and clarithromycin (500 mg twice daily) for 2 weeks preoperatively.

Blood tests including complete blood picture, fasting blood sugar, lipid profile (cholesterol, low-density lipoprotein, high-density lipoprotein, triglycerides), clinical chemistries (serum albumin, alanine transaminase, aspartate transaminase, γ-glutamyl transferase, urea, and creatinine), and prothrombin time and concentration were performed. Abdominal ultrasonography, chest radiography, pulmonary function tests, and upper endoscopy were performed preoperatively.

Thromboembolic prophylaxis with subcutaneous low-molecular-weight heparin was administered on the evening before surgery and continued daily from the first postoperative day until the patient was ambulant. Comorbidities that increase perioperative risk such as hypertension and diabetes were controlled before surgery as far as possible.

Informed written consent was obtained, with an explanation of the possible complications that could occur in the perioperative period. All patients were informed about the nature of the research, and each patient understood and agreed to the procedure.

The patients were considered appropriate candidates for the present study if they were between 20 and 60 years old willing and able to provide consent, and had BMI greater than or equal to 40 kg/m^2 or BMI greater than or equal to 35 with comorbidities such as hypertension and diabetes.

Patients were excluded if they were pregnant or lactating at the time of screening for surgery, had undergone previous malabsorptive or restrictive procedures for the treatment of obesity, or had an UGI endoscopic finding that required postponing, modification, change, or even cancelation of the procedure. Patients who developed early postoperative complications that could affect the procedure such as primary hemorrhage or leakage that required further interventions were also excluded from the study.

Alternative surgical procedure other than LSG (usually laparoscopic Roux-en-Y gastric bypass procedure (LRYGBP)) was chosen in the case of proven reflux disease, when a significant hiatal hernia was found in the preoperative gastroscopy or if the patient is a sweet eater.

All procedures were performed under general anesthesia with the patient in the supine position and the surgeon positioned between the legs of the patient (French position); compression stockings were applied on the patient's lower legs. The patients were firmly secured to the operating table to allow for placement in the anti-Trendelenburg position as required.

Carbon dioxide insufflation was used to create pneumoperitoneum, using the veress needle in the left hypochondrium for all cases, maintaining a 15 mmHg intra-abdominal pressure and flow rate between 2 and 2.5 l/min.

After the creation of pneumoperitoneum, a five-trocar approach was used. A 5 mm subxiphoid trocar served as a liver retractor. One 12-mm trocar between the subxiphoidal 5-mm trocar and the umbilicus served as an optical port, and two additional 12-mm working ports were placed 3–4 cm under the left and right costal margin pararectal; the left one served as a channel for the linear stapler. Another 5-mm left subcostal anterior axillary line trocar was used for stomach traction.

The vascular supply of the greater gastric curvature was divided starting 6 cm from the pylorus and proceeding to the angle of His. The gastroepiploic vessels along the greater curvature of the stomach and the short gastric vessels were divided using the LigaSure device (Covidien, Cincinnati, Ohio, USA) and the harmonic shears (Harmonic-Scalpel; Ethicon Endo-Surgery Inc., Cincinnati, Ohio, USA). Dissection of adhesions between the back of the stomach wall and the pancreas was performed. A 36 Fr calibrating bougie was introduced by the anesthesiologist into the stomach and advanced along the lesser curvature into the pyloric channel and the duodenal bulb. The stomach was divided using the Echelon Compact Linear Stapler (Ethicon Endo-Surgery Inc.). A combination of green reload (4.1 mm) for the first firing and golden reloads (3.8 mm) for the upper stomach was used. An ~5–10-mm cuff of the stomach was left at the level of the angle of His to avoid including the esophagus in the staple line.

Thereafter, a leak test with methylene blue was used to check the integrity of the stapler line. At the end of the procedure, the calibrating bougie was removed.

In all cases, the resected stomach was removed through the 12 mm port without the need to enlarge it further.

Routine placement of suction drain at the operative bed was performed in all cases.

All patients were subjected to a contrast study 24–48 h postoperatively to ensure the absence of leakage before removal of the drain and discharge.

Patients were instructed to move out of the bed a few hours after surgery. Anticoagulation deep venous thrombosis (DVT) prophylaxis (enoxaparin 40 U/day, subcutaneous) was administered up to 1 week postoperatively. We started administration of IV PPI from the first postoperative day, which was continued orally after patients started oral feeding for the first 2 weeks only.

Patients started oral fluid intake on the second postoperative day after a gastrografin study indicated an intact suture line. A postsurgical progression of the diet from liquids to solids for 6–8 weeks was advised for all patients, with a focus on fulfilling protein and fluid needs, and additional daily intake of micronutrient supplements. Patients were advised to have a liquid diet for the first 15 days, followed by ground foods until the first postoperative month. Subsequently, they were encouraged to eat soft solids and to gradually proceed to consumption of regular food. They were also advised to eat frequent meals in small portions and consume all types of foods, with the exception of high sugar and fatty foods.

All patients were followed up for early postoperative complications (<30 days) such as bleeding, leakage, and superficial and deep infections.

The primary study objective was to assess weight loss after 6 months of LSG. The weight loss assessments included the absolute change in weight, change in BMI, and the percentage of excess body weight loss%. The other main primary outcome was to assess postoperative complications related to UGI symptoms after 6 months of follow-up using Rome III diagnostic criteria and search for a relation between these symptoms and UGI endoscopy findings in the postoperative follow-up period.

The data collected from the patients were analyzed and compared with other variables. Data were recorded prospectively and then retrieved for the purpose of this study.

Statistical analysis

All collected data were revised for completeness and accuracy. Precoded data were entered into the computer using the Statistical Package for Social Sciences (SPSS) computer program (version 21 windows). Data were summarized as mean and SD for quantitative variables and as number and percent for qualitative variables. A comparison between quantitative variables was performed using nonparametric Mann–Whitney tests for variables with two categories and the Wilcoxon test for quantitative variables with more than two categories. Comparison between qualitative variables was carried out using the c^2-test, whereas the McNemar test was used for comparison of two related qualitative variables (pre–post). A *P*-value less than 0.05 was considered to be statistically significant.

Results

Our study included 30 patients who presented with morbid obesity with a BMI range between 38.7 and 55 who were treated surgically by LSG in Kasr Al-Ainy University Hospital during the period from June 2015 till June 2016 in general surgery department, Kasr Al-Ainy University Hospital, faculty of medicine, Cairo University.

Before surgery, patients were categorized according to sex, age, BMI, special habits of medical importance, comorbidities, and evidence of *H. pylori* infection. The female to male ratio was (4 : 1), with most of the patients between 30 and 39 (33.3%) years old, followed by 20–29 and 40–49 (26.7%) year age groups. The highest percentage of patients were in the BMI range of 51–55 (40%), followed by 41–45 and 46–50 (26.7%). The majority of patients were nonsmokers (93.4%) versus smokers (6.6%). 73.5% (22/30) of patients had no comorbidities; 6.6% (2/30) were diabetic, 13.3% (4/30) were hypertensive, and 6.6% (2/30) were asthmatic. On testing, *H. pylori* antigen in stool was negative in 60% of patients, whereas in 40%, it was positive (Table 2).

Table 2 Demographic and comorbidities' distribution of patients

	Categories	*N* (%)
Sex	Female	24 (80)
	Male	6 (20)
Age	20–29	8 (26.7)
	30–39	10 (33.3)
	40–49	8 (26.7)
	50–60	4 (13.3)
BMI	35–40	2 (6.6)
	41–45	8 (26.7)
	46–50	8 (26.7)
	51–55	12 (40)
Special habits	Smokers	2 (6.6)
	Nonsmokers	28 (93.4)
Comorbidities	DM	2 (6.6)
	HTN	4 (13.3)
	Asthma	2 (6.6)
	None	22 (73.5)
Helicobacter pylori	Positive	12 (40)
	Negative	18 (60)

DM, diabetes mellitus; HTN, hypertension.

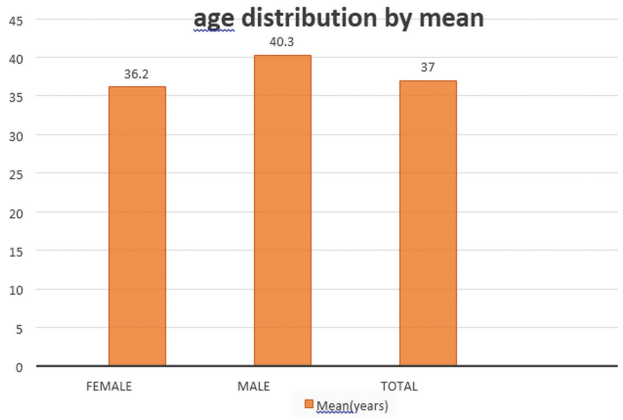
The age of the patients ranged between 25 and 58 years, with a mean of 37 years for all patients. Men ranged in age between 29 and 58 years, mean 40.3 years, and women ranged in age between 25 and 54 years, mean 36.2 years (Fig. 1 and Table 3).

The BMI of the morbidly obese patients included in this study ranged from 38.7 to 55 kg/m^2. The median BMI for women was 49.15 kg/m^2 and that for men was 47 kg/m^2, with a median of 48.7 kg/m^2 for all patients (Fig. 2 and Table 4).

The mean EWL at 6 months following the LSG operation was 63.4%, with 65.2% for men and 62.9% for women. (Fig. 3 and Table 5).

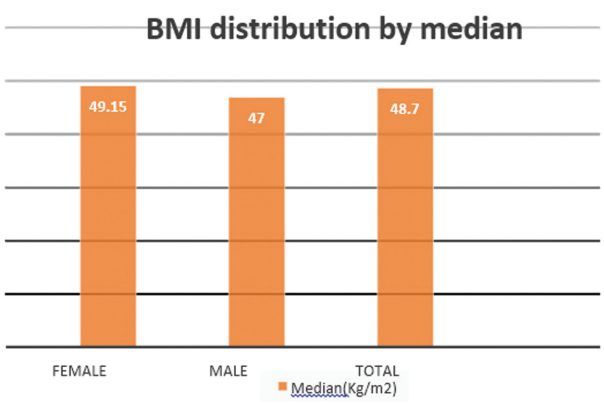
Among our study group of patients (18/30), 60% had no symptoms, whereas 12/30 (40%) had symptoms of GERD in the form of heartburn, regurgitation, or cough; 2/12 patients had dyspepsia in the form of PPD or EPS accompanied by GERD (6.7%) (Fig. 4).

Figure 1



Age distribution by mean.

Figure 2



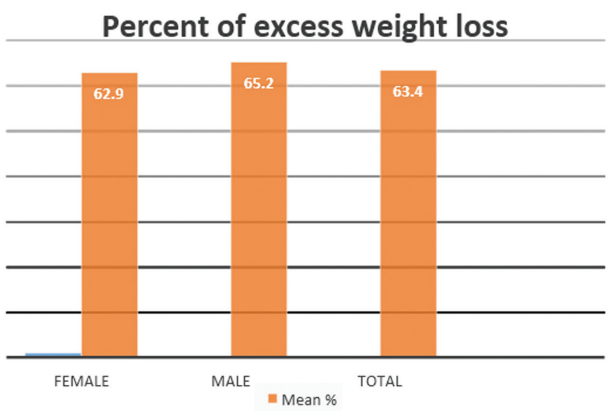
BMI distribution by median.

Among our study group of patients who were all subjected to UGI endoscopy preoperatively, 12/30 patients had no specific finding (40%), whereas 18/30 patients had gastritis (60%). Twenty percent had associated esophagitis (6/18), 13.3% had duodenitis (4/18), and 6.7% also had duodenal ulcers (2/18) (Fig. 5).

Preoperative upper gastrointestinal endoscopy findings

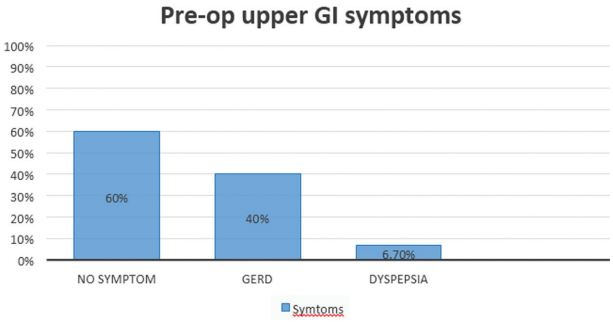
After 6 months of follow-up of UGI symptoms in the group of patients who underwent LSG, there was a

Figure 3



Percent of excess weight loss.

Figure 4



Preoperative upper gastrointestinal (GI) symptoms.

Table 3 Age distribution between men and women

Age	Female	Male	Total
Range of age (years)	25–54	29–58	25–58
Mean (years)	36.2	40.3	37

Table 4 BMI distribution between men and women

BMI	Female	Male	Total
Range (kg/m^2)	38.7–55	42.6–52.7	38.7–55
Median (kg/m^2)	49.15	47	48.7

Table 5 Percent of excess weight loss%

EWL%	Female	Male	Total
Mean	62.9	65.2	63.4

EWL, excess weight loss.

significant increase in the number of patients developing UGI symptoms in the postoperative period, 93.3% (28/30), compared with 40% (12/30) in the preoperative period ($P<0.001$). Only 6.7% of patients had no symptoms in the postoperative period (2/30) compared with 60% of patients who had no symptoms preoperatively. The percentage of patients who developed GERD did not increase significantly ($P=0.454$), with a postoperative percentage of 26.7% (8/30) compared with 40% (12/30) in the preoperative period. The number of patients complaining of dyspepsia increased significantly ($P<0.001$): 66.7% (20/30) compared with 6.7% (2/30) preoperatively. New symptoms developed and remained throughout the follow-up period such as vomiting, which increased significantly, found in 20% ($P=0.030$) of all patients, all associated with GERD (6/8) and dysphagia nonsignificantly ($P=0.125$), with 13.3% also developing dyspepsia (4/20) (Fig. 6 and Table 6).

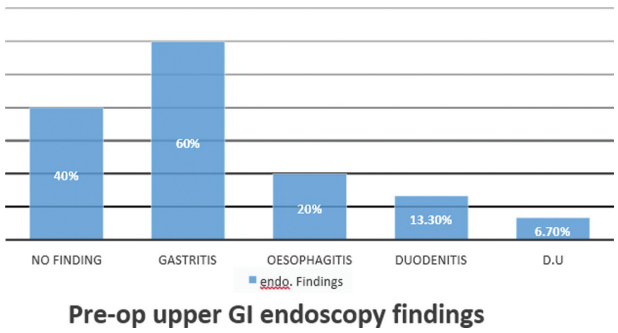
The prevalence of GERD was not significant, with a postoperative percentage of 26.7% (8/30) compared with 40% (12/30) in the preoperative period ($P=0.454$), whereas only 25% (2/8) of patients who developed GERD postoperatively already had GERD symptoms in the preoperative period [16.7% (2/12) of patients with GERD before LSG]. The symptoms of GERD newly developed in 33.3% (6/18) of patients and preoperative GERD symptoms disappeared in 83.3% (10/12) of patients (Fig. 7 and Table 7).

The prevalence of dyspepsia increased significantly in the postoperative period, 66.7% (20/30) compared with 6.7% (2/30) preoperatively ($P<0.001$), whereas 10% (2/20) of patients who developed dyspepsia postoperatively already had dyspepsia in the preoperative period [100% (2/2) of patients with

Table 6 Distribution according to preoperative and postoperative upper gastrointestinal symptoms

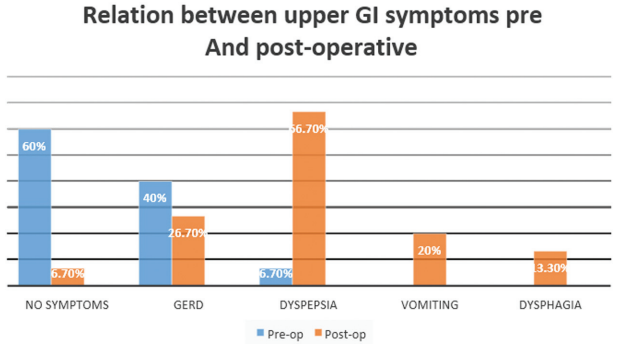
Symptoms	Preoperative [*N* (%)]	Postoperative [*N* (%)]	*P*-value
Free	18 (60.00%)	2 (6.70%)	<0.001 (S)
GERD	12 (40.00%)	8 (26.70%)	0.454
Dyspepsia	2 (6.70%)	20 (66.70%)	<0.001 (S)
Vomiting	0 (0.00%)	6 (20.00%)	**0.030**
Dysphagia	0 (0.00%)	4 (13.33%)	0.125

Figure 5



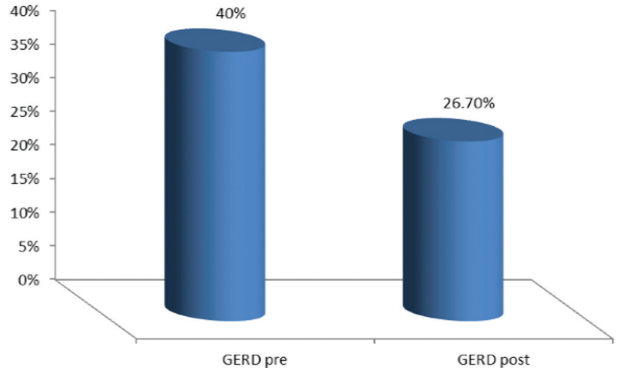
Preoperative upper gastrointestinal (GI) endoscopy findings.

Figure 6



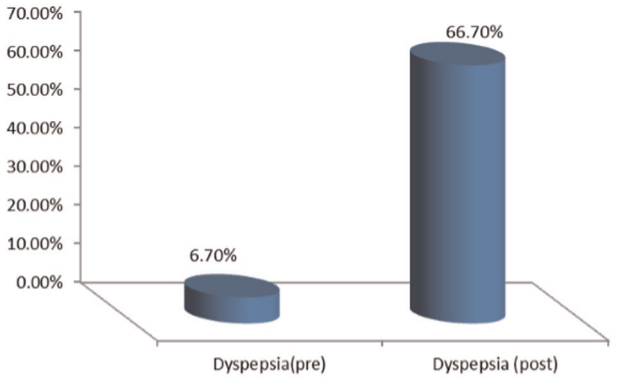
Relation between upper gastrointestinal (GI) symptoms preoperatively and postoperatively.

Figure 7



Distribution of gastroesophageal reflux disease (GERD) preoperatively and postoperatively.

Figure 8



Distribution of dyspepsia preoperatively and postoperatively.

dyspepsia before LSG] and 64.3% (18/28) developed de-novo dyspepsia (Fig. 8 and Table 8).

Vomiting occurred in the postoperative period and persisted throughout follow up with a significant value of 20% (6/30) (P=0.030) where all were associated with GERD (6/8) (Fig. 9 and Table 9).

Another newly developed symptom after LSG was dysphagia, but this was nonsignificant, 13.3% (4/30) (P=125) (Table 10).

On performing UGI endoscopy 6 months postoperatively on all study patients, 20% (6/30) were negative for findings, 46.7% (14/30) showed gastritis, 26.7% (8/30) showed incompetent cardia, and 33.3% (10/30) showed hiatus hernia. A significant relation was found between positive symptoms after 6 months of follow up postoperatively and UGI endoscopy performed after 6 months for correlation with symptoms, where 85.7% (24/28) of the patients with troublesome symptoms had positive findings and 100% (2/2) of patients who had no symptoms

Table 7 Distribution of gastroesophageal reflux disease preoperatively and postoperatively

GERD symptoms preoperatively	GERD symptoms 6 months postoperatively [*N* (%)]		Total	*P*-value
	GERD	No GERD		
GERD	2 (25.00)	10 (45.50)	12 (40.00)	0.454
No GERD	6 (75.00)	12 (54.50)	18 (60.00)	
Total	8 (26.70)	22 (73.30)	30 (100.00)	

GERD, gastroesophageal reflux disease.

Table 8 Distribution of dyspepsia preoperatively and postoperatively

Dyspepsia preoperative	Dyspepsia 6 months postoperative						*P* value
	Dyspepsia		No Dyspepsia		Total		
Dyspepsia	2	10.00%	0	0.00%	2	6.70%	<0.001 S
No dyspepsia	18	90.00%	10	100.00%	28	93.30%	
Total	20	66.70%	10	33.30%	30	100.00%	

Table 9 Distribution of vomiting preoperatively and postoperatively

Vomiting preoperative	Vomiting 6 months postoperative						*P* value
	Vomiting		No Vomiting		Total		
Vomiting	0	0.00%	0	0.00%	0	0.00%	0.030 S
No vomiting	6	20.00%	24	80.00%	30	100.00%	
Total	6	20.00%	24	80.00%	30	100.00%	

Table 10 Distribution of dysphagia preoperatively and postoperatively

Dysphagia preoperative	Dysphagia 6 months postoperative						*P* value
	Dysphagia		No dysphagia		Total		
Dysphagia	0	0.00%	0	0.00%	0	0.00%	0.125
No dysphagia	4	20.00%	26	80.00%	30	100.00%	
Total	4	13.33%	26	86.67%	30	100.00%	

Table 11 Relation between postoperative symptoms and upper gastrointestinal endoscopy after 6 months

UGI endoscopy 6 months postoperatively	Negative postoperative symptoms [*N* (%)]	Positive postoperative symptoms [*N* (%)]	*P*-value
Negative	2 (100.00)	4 (14.29)	0.034 (S)
Positive	0 (0.00)	24 (85.71)	
Gastritis	0 (0.00	14 (50.00)	0.485
No gastritis	2 (100.00)	14 (50.00)	
Incompetent cardia	0 (0.00)	8 (28.57)	1.000
No incompetent cardia	2 (100.00)	20 (71.43)	
Hiatus hernia	0 (0.00)	10 (35.71)	0.540
No hiatus hernia	2 (100.00)	18 (64.29)	

S, significant; UGI, upper gastrointestinal.

had no obvious finding (P=0.034) (Fig. 10 and Table 11).

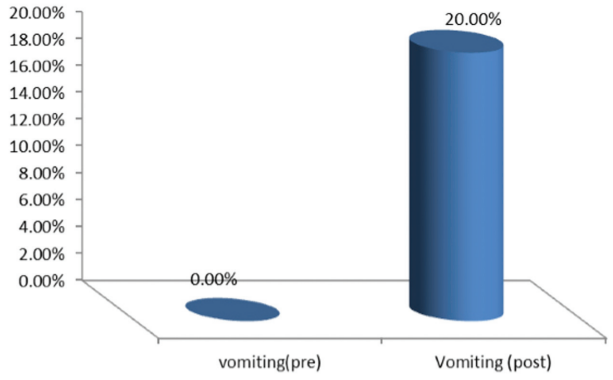
A significant relation was found between patients complaining of GERD 6 months postoperatively and the finding of hiatus hernia on UGI endoscopy, where 100% (8/8) were positive for this finding (P<0.001) (Fig. 11 and Table 12).

A significant relation was found between patients complaining of vomiting 6 months postoperatively and the finding of incompetent cardia on UGI endoscopy, where 66.7% (4/6) were positive for this finding (P=0.029) (Fig. 12 and Table 13).

The mean number of patients that showed no comorbidities when associated to BMI was 47.01 (SD=5.31), whereas for patients with hypertension, it was 52.7, for patients with diabetes, it was 51.55 (SD=3.29), and for patients with asthma, it was 40.6, with no significant correlation between them (P=0.461) (Table 14).

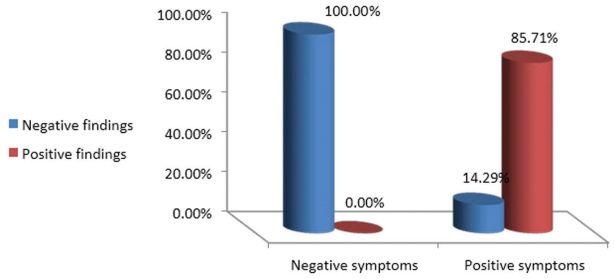
A significant correlation was found between *H. pylori* infection and GERD preoperatively 66.7% (8/12) (P=0.024), whereas no significant correlation

Figure 9



Distribution of vomiting preoperatively and postoperatively.

Figure 10



Relation between postoperative symptoms and upper gastrointestinal endoscopy after 6 months.

Table 12 Relation between gastroesophageal reflux disease and upper gastrointestinal endoscopy finding 6 months postoperatively

UGI endoscopy 6 months postoperatively	GERD symptoms 6 months postoperatively [*N* (%)]		*P*-value
	GERD	No GERD	
Negative	0 (0.00)	6 (27.27)	0.155
Positive	8 (100.00)	16 (72.73)	
Gastritis	2 (25.00)	12 (54.55)	0.226
No gastritis	6 (75.00)	10 (45.45)	
Incompetent cardia	4 (50.00)	4 (18.18)	0.158
No incompetent cardia	4 (50.00)	18 (81.82)	
Hiatus hernia	8 (100.00)	2 (9.09)	<0.001 (S)
No hiatus hernia	0 (0.00)	20 (90.91)	

GERD, gastroesophageal reflux disease; S, significant; UGI, upper gastrointestinal.

Table 13 Relation between vomiting and upper gastrointestinal endoscopy 6 months postoperatively

UGI endoscopy 6 months postoperatively	Vomiting 6 months postoperatively [*N* (%)]		*P*-value
	Vomiting	No vomiting	
Negative	0 (0.00)	6 (25.00)	0.302
Positive	6 (100.00)	18 (75.00)	
Gastritis	2 (33.33)	12 (50.00)	0.657
No gastritis	4 (66.67)	12 (50.00)	
Incompetent cardia	4 (66.67)	4 (16.67)	**0.029 (S)**
No incompetent cardia	2 (33.33)	20 (83.33)	
Hiatus hernia	4 (66.67)	6 (25.00)	0.141
No hiatus hernia	2 (33.33)	18 (75.00)	

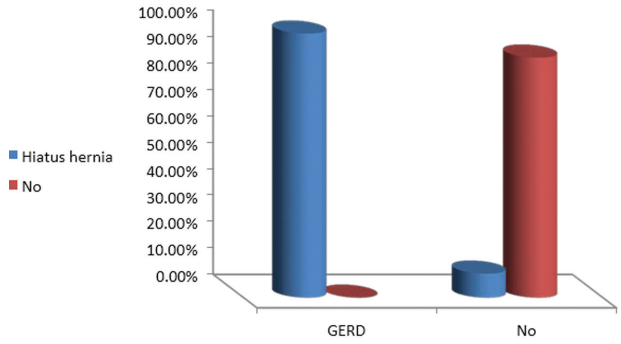
S, significant; UGI, upper gastrointestinal. Bold shows significant *P*-value.

was found between patients with dyspepsia and *H. pylori* infection proven by stool antigen testing (P=0.152). Patients showed negative symptoms were also negative for *H. pylori* infection, with a percentage of 77.8% (14/18), with significant value (P=0.024) (Table 15).

Another significant correlation was found between *H. pylori* infection and findings in UGI endoscopy preoperatively, where 66.7% (12/18) of patients with gastritis had *H. pylori* infection, representing 100% of all patients proven to be *H. pylori* infected (P<0.001). Also, 100% (4/4) of patients with duodenitis had *H. pylori* infection (P=0.018) (Table 16).

Non-significant association was found between special habits of medical importance which is exclusively smoking in our study and UGI symptoms before LSG (Table 17).

Figure 11



Relation between gastroesophageal reflux disease (GERD) and upper gastrointestinal (GI) endoscopy finding after 6 months.

Table 14 Relation between body mass index and comorbidities

Comorbidity	BMI		*P*-value
	Mean	SD	
No comorbidities	47.01	5.31	0.461
HTN	52.70	0.00	
DM	51.55	3.29	
Asthma	40.60	0.00	

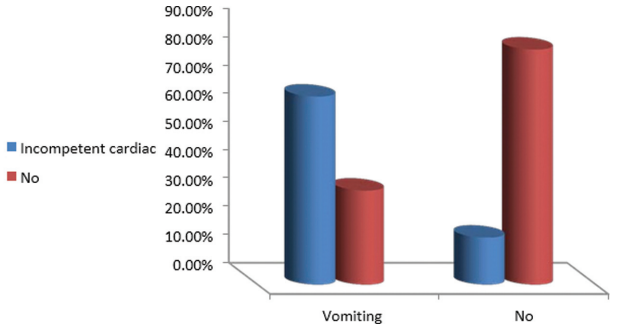
DM, diabetes mellitus; HTN, hypertension.

Discussion

Obesity continues to be a leading public health concern associated with many comorbidities that significantly decrease life expectancy [1]. Middle Eastern countries in general are typical developing countries that have experienced a rapid increase in the prevalence of morbid obesity. According to the WHO, the incidence of obesity has reached an 'alarming level'. The same study pointed out that unlike Europe and North America, obesity is more prevalent among women and in urban areas in the Middle East [8].

Weight reduction can be achieved by several nonsurgical methods that include diet control, physical exercise, and/or drug therapy, but these methods often lead to compensatory changes in appetite and energy expenditure that make weight loss of more than 5–10% unlikely to be sustained for more than 5 years [9].

Figure 12



Relation between vomiting and upper gastrointestinal (GI) endoscopy finding after 6 months.

Table 15 Relation between *Helicobacter pylori* infection and symptoms preoperatively

Preoperative symptoms	*Helicobacter pylori* [*N* (%)]		*P*-value
	Negative	Positive	
Negative	14 (77.80)	4 (33.30)	**0.024**
GERD	4 (22.20)	8 (66.70)	**0.024**
Dyspepsia	0 (0.00)	2 (16.70)	0.152

GERD, gastroesophageal reflux disease. Bold shows significant *P*-value.

Table 16 Relation between Helicobacter pylori infection and upper gastrointestinal findings preoperatively

UGI endoscopy preoperatively	*Helicobacter pylori* [*N* (%)]		*P*-value
	Negative	Positive	
Negative	12 (66.70)	0 (0.00)	<**0.001**
Gastritis	6 (33.30)	12 (100.00)	<**0.001**
Esophagitis	2 (11.10)	4 (33.30)	0.184
Duodenitis	0 (0.00)	4 (33.30)	**0.018**
Duodenal ulcer	0 (0.00)	2 (16.70)	0.152

UGI, upper gastrointestinal. Bold shows significant *P*-value.

Table 17 Relation between special habits (smoking) and upper gastrointestinal symptoms preoperatively

Preoperative symptoms	No special habits [*N* (%)]	Smoking [*N* (%)]	*P*-value
Negative	16 (61.54)	2 (50.00)	1.000
GERD	10 (38.46)	2 (50.00)	1.000
Dyspepsia	2 (7.69)	0 (0.00)	1.000

GERD, gastroesophageal reflux disease.

In contrast, surgery typically leads to considerable long-term sustained weight loss [10]. At the same time, the increasing prevalence of morbid obesity and superobese patients (BMI>50 kg/m^2) who are seeking treatment has led to surgery as the option that provides adequate EWL in comparison with nonsurgical methods [11].

Over the last 20 years, bariatric surgery has come to play a significant role in tackling this problem using either restrictive or mixed restrictive and malabsorptive techniques [12]. LSG has become an increasingly popular restrictive surgical procedure for the treatment of morbid obesity [13,14].

GERD is one of the most prevalent chronic GI diseases, with an estimated 20–30% of the US adult population experiencing heartburn or acid regurgitation or both at least once a week. Obesity is considered a major risk factor in the pathogenesis of GERD, and ~50% of morbidly obese patients have signs or symptoms of GERD [4]. Also, PPD is present in 28 and 11% of the obese patients considered for bariatric surgery [5].

Data from large databases suggest that all of the common bariatric procedures usually lead to improvements in GERD symptoms, with Roux-en-Y gastric bypass being superior to laparoscopic adjustable gastric banding and LSG in this respect. Yet, smaller prospective studies indicate that LSG can induce de-novo GERD in some patients [4]. The removal of the gastric fundus, a large part of the body and a portion of the antrum, leads to significant anatomical and functional alterations that affect both gastric acid secretion and motility, in particular, accommodation, which may give rise to GI symptoms [15].

Our study aimed to evaluate the effect of LSG on UGI symptoms, and whether persistence, disappearance, or development of new symptoms is significant or not. We included 30 patients (24 women and six men) with a mean age of 37±10.1 years (36.2 for women and 40.3 for men) and a BMI of 48.7±5.2 kg/m^2 (49.1 for women and 47 for men), with two patients with diabetes mellitus (6.7%), four (13.3%) patients with hypertension, and two (6.7%) patients with asthma. Twelve patients tested positive for *H. pylori* (40%) and took medications for eradication for 2 weeks.

In the preoperative assessment with the Rome III criteria questionnaire and UGI endoscopy, 60% had no UGI symptoms, 40% had GERD, and 6.7% had dyspepsia. All patients were subjected to UGI endoscopy; no significant finding was in 40% of patients, gastritis was found in 60% of patients, esophagitis was found in 20% of patients, duodenitis was found in 13.3% of patients, and duodenal ulcer (DU) was found in 6.7% of patients. A significant relation was found between GERD as a symptom and *H. pylori* infection (P=0.024) and another strong relation was found between gastritis in preoperative UGI endoscopy and *H. pylori* infection in 66.7% of patients (12/18) (P<0.001) and between duodenitis and *H. pylori* infection in 100% (4/4) of patients (P=0.018).

In a comparative study, Carabotti *et al.* [16] performed UGI endoscopy on 142 morbidly obese patients who filled out the validated Rome III symptomatic questionnaire preoperatively. Symptoms were reported by 43% of patients: GERD was present in 27.9% of patients and dyspepsia was present in 24.6% of patients, with PPD present in 66.7% and epigastric pain present in 33.3%. Of GERD patients, 19.7% presented concomitantly with PPD. Belching was present in 8.2% and nausea and/or vomiting was present in 1.6% of patients. At endoscopy, one or more lesions were present in 47.1% of the patients: erosive esophagitis in 5.6%, hiatal hernia in 23.2%, gastroduodenal erosions in 6.3%, and peptic ulcers in 3.5%. At histology, 24% of patients had *H. pylori* infection, and its prevalence in gastroduodenal erosions and ulcers was 22.2 and 60%, respectively. The presence of symptoms cannot be considered as a useful guide to indicate endoscopy as the majority of endoscopic lesions are asymptomatic and not *H. pylori* related [16].

EWL% after 6 months from LSG showed a mean of 63.4 ±6.58% (62.9% for women and 65.2% for men) compared with Albeladi *et al.* [17], who carried out a comparative study between laparoscopic Roux-en-Y gastric bypass procedure (LRYGP) and LSG where 34 patients had LSG (28 female and six male) and achieved an EWL% mean of 46.6±16.1% after 6 months of follow-up. In a study by Dapri *et al.* [18], a comprehensive review of all English literature on LSG, including 1163 patients, showed a mean excess body weight loss% after LSG ranging from 35 to 71.6% at 6

months and from 45 to 83% at 1 year. In comparative studies, maximum weight loss was observed in the first 6 months, leveling off at 1 year in the majority of cases with satisfactory and long-term effects in terms of weight loss in our study and comparative ones.

After a median follow-up of 6 months' duration, there was significant development of UGI symptoms, mainly dyspepsia in the form of PPD, and only two patients had EPS. De-novo dyspepsia was observed in 64.3% of patients, mostly in the form of PPD, where the prevalence of dyspepsia was highly significant ($P<0.001$). The prevalence of GERD was not statistically different before and after LSG, but GERD symptoms were observed to disappear gradually in 83.3% of patients who had considerable GERD symptoms preoperatively and newly developed in 33.3%. Hiatus hernia was a significant finding after LSG in association with GERD, where 100% of patients complained of GERD had hiatus hernia at endoscopy ($P<0.001$), representing 33.3% of all findings reported by endoscopy after LSG.

In a comparable study by Carabotti *et al.* [5], who used the same questionnaire as that in our study (Rome III criteria) for UGI symptoms on 74 patients with a median follow-up of 13 months, LSG was associated with de-novo dyspepsia-like syndrome, with an odds ratio of 7.00, 95% confidence interval 2.9–18.3, $P<0.0001$. In turn, the prevalence of GERD before and after surgery was not different (odds raio=1.083, 95% confidence interval=0.4652–2.530, $P>0.05$). Presurgical GERD symptoms disappeared in 65% of patients after LSG, worsened or did not change in 35%, and newly developed in 22% [5].

In another study by Howard *et al.* [19] carried out on 28 patients with a mean BMI of 55.5 kg/m^2 using the GERD score questionnaire, all patients were interviewed to evaluate their reflux symptoms; a 64% response rate was achieved, with 22% of patients indicating new-onset GERD symptoms despite receiving daily antireflux therapy.

A study was carried out by Sharma and colleagues on 35 patients undergoing LSG and followed up for 1 year by the GERD questionnaire to assess the symptom–severity (SS) score and the Carlsson Dent Self-administered Questionnaire. A severity score greater than 4 is considered positive for GERD. The Carlsson Dent Questionnaire was administered to the patient and the Carlsson Dent Score was calculated from the responses provided. A patient with a score of 4 was considered to have GERD. GERD symptom score (SS) varied from 0 to 12. There was a statistically significant decrease in the mean values of both Carlsson Dent Score from 2.88 to 1.63 ($P<0.05$) and SS from 2.28 to 1.06 ($P<0.05$), respectively, after a 12-month period, suggesting improvements in GERD symptoms after LSG.

More than one of the pathophysiological mechanisms underlying functional dyspepsia may be involved after LSG [20]. Limited gastric accommodation related to fundus removal may be one of the major factors as the new stomach has a greater luminal pressure and smaller volume, having only one-tenth of the distention Sharma *et al.* [22]. Altered duodenal sensitivity to nutrients could be worsened by faster gastric emptying and this might promote dyspeptic symptoms.

It can then be speculated that the mechanism of UGI symptoms after LSG is mainly because of altered motility patterns rather than acid-related disorders. Some evidence strengthens this hypothesis: the association between dysphagia and LSG, its lack of association with GERD, and the reduced efficacy of PPI on postsurgical GI symptoms [5].

Vomiting was also a significant symptom in our study that appeared totally *de novo* after LSG in 20% of the study patients and continued to be a troublesome symptom for the entire follow-up period, almost always associated with GERD; it was mildly responsive to repetition of PPI therapy and was associated with incompetent cardia at endoscopy in 66.7% of patients ($P=0.029$). Dysphagia also developed *de novo* in 13.3% of patients after LSG and was entirely associated with dyspeptic symptoms.

Carabotti *et al.* [5] found that dysphagia newly developed after LSG in 19.7% of the patients to both solids and fluids in 85.7% of them, and was mainly associated with PPD-like dyspepsia rather than GERD, whereas vomiting was present in 13.6% of dyspeptic patients. Dysphagia in this surgical setting has been described to impair emptying of the gastric pouch rather than altering esophageal motility. It should, however, be noted that this symptom might also be because of the patient's interpretation of feeling full because of the lower distendability of the neostomach. In addition, upper gastrointestinal tract discomfort after LSG might also be influenced by technical pitfall such as the distance from the pylorus (i.e. portion of the antrum resected) and the bougie used to calibrate the sleeve [5].

In terms of postoperative UGI endoscopy findings and relation to symptoms that developed after LSG, our

study found that 20% were negative for findings, 46.7% had gastritis, 26.7% had incompetent cardia, and 33.3% had hiatus hernia. 85.7% of patients with symptoms had positive findings (P=0.034), where a significant correlation was found between GERD and hiatus hernia in 100% of patients (P<0.001) and vomiting and incompetent cardia in 66.7% of patients (P=0.029). The findings of esophagitis, duodenitis, and DU disappeared postoperatively.

In the Sharma *et al.* [22] study, UGI endoscopy was performed preoperatively and postoperatively at 6 months. Preoperatively, six, 18.8%, patients had esophagitis. Postoperatively, the incidence of esophagitis increased to 25% of patients, but this increase was not statistically significant. 34.4% of patients developed hiatal hernia, all small, in the postoperative period [22]. Meanwhile, Carabotti *et al.* [5] performed UGI radiology and endoscopy in post-LSG GERD patients. At endoscopy, 47.4% of patients (9/19) had erosive esophagitis. Among these, 77.8% (7/9) of patients had radiological large hiatal hernia (>3 cm) and/or partial intrathoracic sleeve migration/dilatation [5].

Tai and colleagues reported that the occurrence of erosive esophagitis after LSG is related to the presence of hiatal hernia after the operation. GERD symptoms are not consistent with the presence of erosive esophagitis as 40.1% of patients who did not have postoperative GERD symptoms still had postoperative erosive esophagitis on endoscopy. Therefore, he proposed that postoperative follow-up endoscopy is necessary to identify the actual prevalence of postoperative GERD [23].

In conclusion, our results show that although LSG represents a safe and effective procedure to achieve significant weight loss with satisfactory results, it appears to have a real and significant impact on UGI symptoms, mainly dyspepsia, which increased significantly in prevalence and incidence postoperatively. Meanwhile, GERD symptom that used to be the main side effect of LSG showed no significant change in prevalence. The procedure even appeared to abolish the symptom in a significant number of patients who complained of GERD because of the risk factor of obesity.

Vomiting also showed a significant association with GERD, with a significant correlation to incompetent cardia in UGI endoscopy that should be assessed further using manometry and pH studies. A consistent relation was found between GERD and the finding of hiatus hernia in the postoperative setting, raising the question of additive or alternative procedures that could prevent the incidence of hiatus hernia postoperatively. Further prospective studies should be carried out in larger numbers of patients for a longer period of follow-up for these results to be validated.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1 Jackson TD, Hutter MM. Morbidity and effectiveness of laparoscopic sleeve gastrectomy, adjustable gastric band, and gastric bypass for morbid obesity. Adv Surg 2012; 46:255–268.

2 Finucane MM, Stevens GA, Cowan MJ, *et al.* National, regional, and global trends in body-mass index: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. Lancet 2011.

3 Mechanick JI, Youdim A, Jones DB, Garvey WT, Hurley DL, McMahon M, *et al.* Clinical practice guidelines for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient—2013 update: cosponsored by American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery. Obesity (Silver Spring) 2013; 21:S1–S27.

4 Tutuian R. Effects of bariatric surgery on gastroesophageal reflux. Curr Opin Gastroenterol 2014; 30:434–438.

5 Carabotti M, Silecchia G, Greco F, Leonetti F, Piretta L, Rengo M, *et al.* Impact of laparoscopic sleeve gastrectomy on upper gastrointestinal symptoms. Obes Surg 2013; 23:1551–1557.

6 Tack J, Talley NJ, Camilleri M, Holtmann G, Hu P, Malagelada JR, *et al.* Functional gastroduodenal disorders. Gastroenterology 2006; 5:1466–1479.

7 Gisbert JP, Pajares JM. Stool antigen test for the diagnosis of *Helicobacter pylori* infection: a systematic review. Helicobacter 2004; 9:347–368.

8 Musaiger AO, Al-Awadi AHA, Al-Mannai MA. Lifestyle and social factors associated with obesity among the Bahraini adult population. Ecol Food Nutr 2000; 39:121–133.

9 Bray G, Tartaglia L. Medicinal strategies in the treatment of obesity. Nature 2000; 404:672–677.

10 Mun E, Blackburn G, Matthews J. Current status of medical and surgical therapy for obesity. Gastroenterology 2001; 120:669–681.

11 Bassiony F, Fouad A, Abolfotooh A, Russello D, Randazzo V. Laparoscopic sleeve gastrectomy as a sole procedure for morbid obesity. Kasr El Aini J Surg 2009; 10:23–30.

12 Buchwald H, Avidor Y, Braunwald E, Jensen MD, Pories W, Fahrbach K, *et al.* Bariatric surgery: a systematic review and meta-analysis. JAMA 2004; 292:1724–1737.

13 Kueper MA, Kramer KM, Kirschniak A, Königsrainer A, Pointner R, Granderath FA, *et al.* Laparoscopic sleeve gastrectomy: standardized technique of a potential standalone bariatric procedure in morbidly obese patients. World J Surg 2008; 32:1462–1465.

14 Sammour T, Hill AG, Singh P, Ranasinghe A, Babor R, Rahman H, *et al.* Laparoscopic sleeve gastrectomy as a single-stage bariatric procedure. Obes Surg 2009; 20:271–275.

15 Santoro S. Technical aspects in sleeve gastrectomy. Obes Surg 2007; 17:15345.

16 Carabotti M, Avallone M, Cereatti F, Paganini A, Greco F, Scirocco A, *et al.* Usefulness of upper gastrointestinal symptoms as a driver to prescribe gastroscopy in obese patients candidate to bariatric surgery. A prospective study. Obes Surg 2016; 26:1075–1080.

17 Albeladi B, Bourbao-Tournois C, Huten N. Short- and midterm results between laparoscopic Roux-en-Y gastric bypass and laparoscopic sleeve gastrectomy for the treatment of morbid obesity. J Obes 2013; 2013:934653.

18 Dapri G, Vaz C, Cadière GB, Himpens J. A prospective randomized study comparing two different techniques for laparoscopic sleeve gastrectomy. Obes Surg 2007; 17:1435–1441.

19 Howard DD, Caban AM, Cendan JC, Ben-David K. Gastroesophageal reflux after sleeve gastrectomy in morbidly obese patients. Surg Obes Relat Dis 2011; 7:709–713.

20 Oustamanolakis P, Tack J. Dyspepsia: organic versus functional. J Clin Gastroenterol 2012; 46:175–190.

21 Yehoshua RT, Eidelman LA, Stein M, Fichman S, Mazor A, Chen J, *et al.* Laparoscopic sleeve gastrectomy – volume and pressure assessment. Obes Surg 2008; 18:1083–1088.

22 Sharma A, Aggarwal S, Ahuja V, Bal C. Evaluation of gastroesophageal reflux before and after sleeve gastrectomy using symptom scoring, scintigraphy, and endoscopy. Surg Obes Relat Dis 2014; 10:600–605.

23 Tai CM, Huang CK. Increase in gastroesophageal reflux disease symptoms and erosive esophagitis 1 year after laparoscopic sleeve gastrectomy among obese adults. Surg Endosc 2013; 27:1260–1266.