ΜΕΤΑΠΤΥΧΙΑΚΟ ΠΡΟΓΡΑΜΜΑ ΣΠΟΥΔΩΝ:

‘‘ΕΛΑΧΙΣΤΑ ΕΠΕΜΒΑΤΙΚΗ ΧΕΙΡΟΥΡΓΙΚΗ,

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ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ

ΙΑΤΡΙΚΗ ΣΧΟΛΗ

ΔΙΠΛΩΜΑΤΙΚΗ ΕΡΓΑΣΙΑ

ΘΕΜΑ:

LAPAROSCOPIC HIATAL HERNIOPLASTY AND SLEEVE GASTRECTOMY AS A COMBINE PROCEDURE FOR MORBID OBESITY COMPLICATED WITH GERD. REVIEW OF THE LITERATURE.

ΜΕΤΑΠΤΥΧΙΑΚΟΣ ΦΟΙΤΗΤΗΣ

ΚΥΡΑΜΑΡΓΙΟΣ ΦΩΤΙΟΣ

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ΤΗΣ ΣΥΝΕΔΡΙΑΣΗΣ ΤΗΣ ΤΡΙΜΕΛΟΥΣ ΕΞΕΤΑΣΤΙΚΗΣ ΕΠΙΤΡΟΠΗΣ

ΓΙΑ ΤΗΝ ΑΞΙΟΛΟΓΗΣΗ ΤΗΣ ΔΙΠΛΩΜΑΤΙΚΗΣ ΕΡΓΑΣΙΑΣ

Του Μεταπτυχιακού Φοιτητή ΚΥΡΑΜΑΡΓΙΟΥ ΦΩΤΗ

Εξεταστική Επιτροπή

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- Θεόδωρος Διαμαντής, Καθηγητής Χειρουργικής

Η Τριμελής Εξεταστική Επιτροπή η οποία ορίσθηκε από την ΓΣΕΣ της Ιατρικής Σχολής του Παν. Αθηνών Συνεδρίαση της.....ης ..... 20.... για την αξιολόγηση και εξέταση του υποψήφιου κου Κυραμαργιού Φώτη, συνεδρίασε σήμερα .../.../....

Η Επιτροπή διαπίστωσε ότι η Διπλωματική Εργασία του κου Κυραμαργιού Φώτη με τίτλο: ***«LAPAROSCOPIC HIATAL HERNIOPLASTY AND SLEEVE GASTRECTOMY AS A COMBINE PROCEDURE FOR MORBID OBESITY COMPLICATED WITH GERD. REVIEW OF THE LITERATURE»***—είναι πρωτότυπη, επιστημονικά και τεχνικά άρτια και η βιβλιογραφική πληροφορία ολοκληρωμένη και εμπεριστατωμένη.

Η εξεταστική επιτροπή αφού έλαβε υπ' όψιν το περιεχόμενο της εργασίας και τη συμβολή της στην επιστήμη, με ψήφους ..... προτείνει την απονομή του Μεταπτυχιακού Διπλώματος Ειδίκευσης (Master's Degree), στον παραπάνω Μεταπτυχιακό Φοιτητή.

Στην ψηφοφορία για την βαθμολογία ο υποψήφιος έλαβε για τον βαθμό «ΑΡΙΣΤΑ» ψήφους ....., για τον βαθμό «ΛΙΑΝ ΚΑΛΩΣ» ψήφους ....., και για τον βαθμό «ΚΑΛΩΣ» ψήφους ..... Κατά συνέπεια, απονέμεται ο βαθμός «.....».

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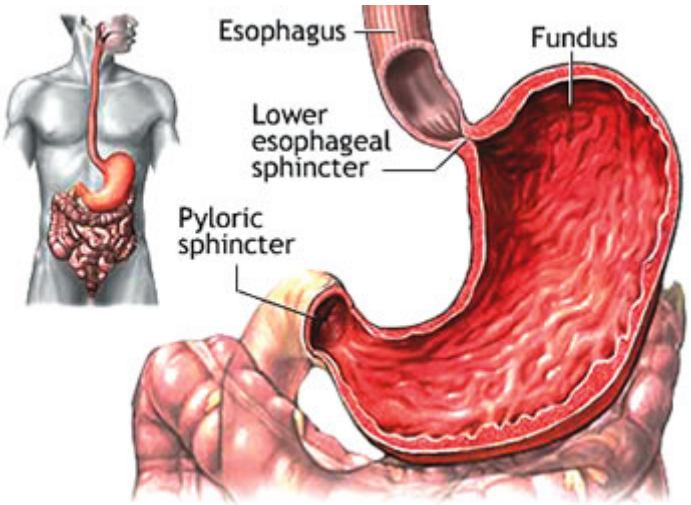
1. PROLOGUE

Laparoscopic Sleeve Gastrectomy (L.S.G.) has increased in popularity as both a definitive and a staged procedure for morbid obesity. Gastroesophageal reflux disease (GERD) with or without hiatal hernia (HH) is now recognized as an obesity-related co-morbidity.

Roux en Y gastric by-pass has been proved to be the most effective bariatric procedure for the treatment of morbidly obese patients with GERD and hiatal hernia.

The effect of L.S.G. and hiatal hernioplasty on GERD has not been well studied and is still unclear.

Our objective was to report the review of the literature, and our experience (165 obese patients) in patients who underwent L.S.G and hernia repair (HHR) on GERD symptoms pre e post surgery.



2. INTRODUCTION

Laparoscopic Sleeve gastrectomy (LSG) has gained popularity as both a staged and a definitive procedure for morbid obesity [1, 2].

The original biliopancreatic diversion with duodenal switch was designed for high-risk bariatric patients. To increase the safety of the overall operation, the operation was broken into 2 stages, of which LSG was the first step. Many patients, however, were losing sufficient weight with LSG alone. Consequently, isolated SG is now generally accepted as a definitive bariatric operation [3].

In LSG, the stomach is divided vertically, reducing the volume to approximately 25% of the original. This leaves the pyloric valve at the distal end of the stomach intact and preserves the continuity of the digestive tract. Thus, at first glance, LSG appears to be a restrictive procedure. However, on closer study, the fundus is the main source of ghrelin, which is the hormone that regulates appetite and satiety.

Thus, the biochemical changes from reducing the source of ghrelin could be a significant weight loss mechanism in SG [4]. Melissas et al [5, 6] suggested that increased gastric emptying and alterations in the gut hormones might be the mechanisms responsible for weight loss after SG.

The American Society for Metabolic and Bariatric Surgery had previously approved this procedure as the first stage of biliopancreatic diversion but most recently has updated its position on LSG and has approved it as an independent procedure [7].

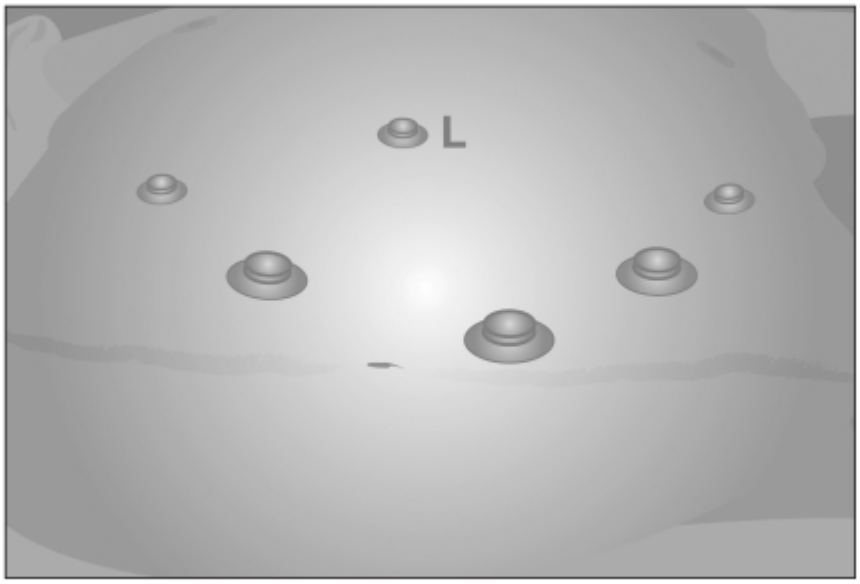
2.1 LSG Surgical Technique

Although there are minor variations of LSG procedure, in general 75% - 85% of the greater curvature is excised, leaving a narrow stomach tube. The key phases of the procedure are summarized in Table 1. A point on the greater curve, on the antrum, is chosen as the starting point, ranging from 2 to 10 cm from the pylorus. The lesser is entered by opening the gastrocolic ligament. The short gastric vessels and the greater curvature ligaments (gastrosplenic and gastrocolic) are then divited with ultrasonic dissection to the left crus. A 32-60 French bugie is then passed transorally into the

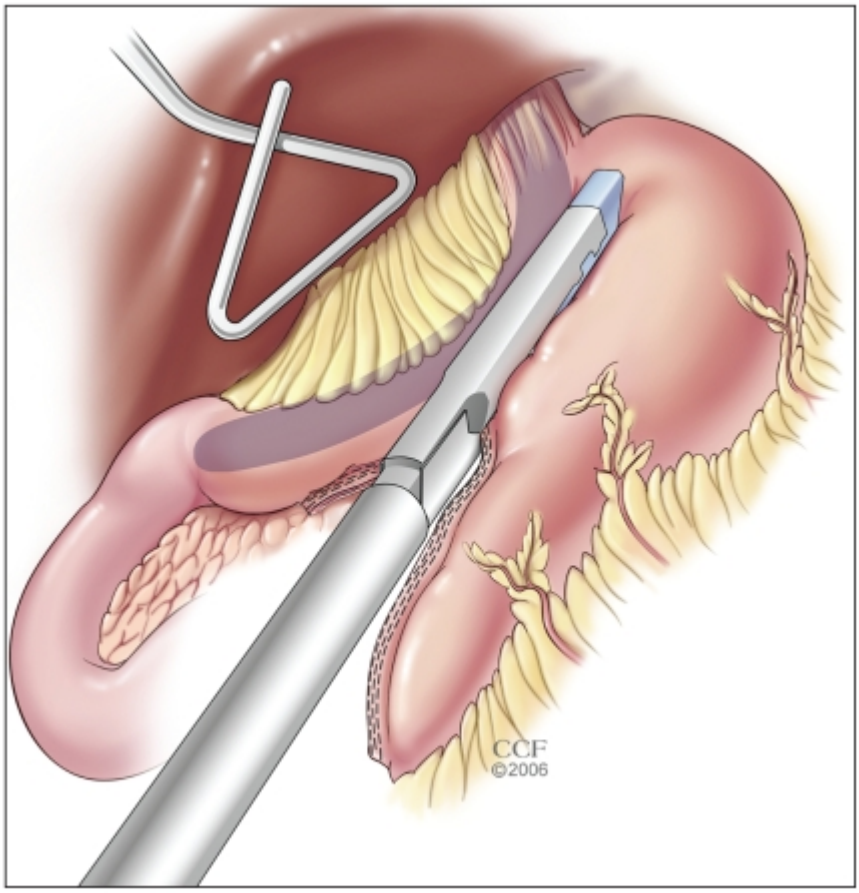
pylorus, placed against the lesser curvature. Technically, there appears to be no short-term weight loss difference in the choice of dilator size to create the lesser curve conduit [8]. A laparoscopic stapler with a green cartridge followed by gold, and then multiple, blue staplers (4.8 mm) is introduced and is fired consecutively along the length of the bugie until the angle of Hiss is reaced. At this point, about 75% - 80% of the stomach has been separated. The specimen is removed by enlarging one of the 12-mm ports. A drain is then placed alongside the staple line.

TABLE 1

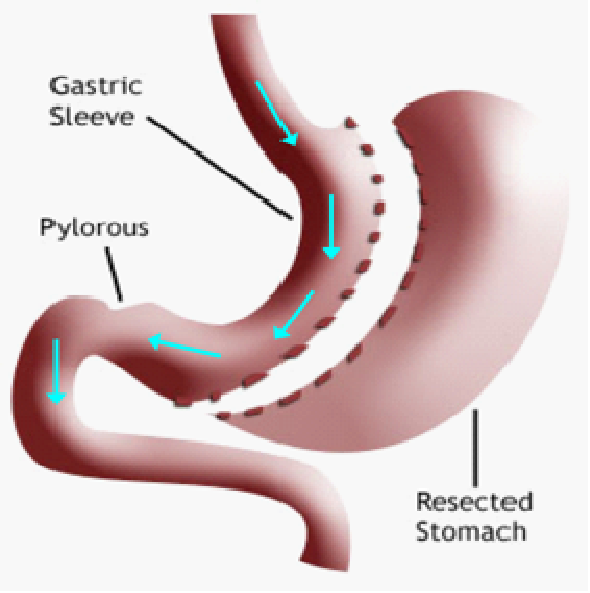
Phase	Goals	Pearls and pitfalls
Access or port placement Identification of the distal point of transection on the stomach	Safe access; optimize ports for stapling Avoid pylorus/distal antrum	• Veress needle (left upper quadrant) • Require 3 × 10- or 12-mm ports to facilitate stapling and camera visualization • Most surgeons commence dissection 5–10 cm proximal to the pylorus • If dissection is too close to the pylorus, the thick area can crack and become predisposed to leaks and/or the antral pumping mechanism will be affected
Mobilization of the greater curvature	Full mobilization of the greater curvature and posterior aspect of stomach (division of retrogastric adhesions)	• Mobilize the greater curvature inside the epiploic arcade, close to the gastric wall, which will be removed; this reduces the specimen size • Lack of adequate retrogastric mobilization increases the risk of leaving a large posterior stomach
Bougie insertion	Size the pouch to an adequate size (32–60 French bougie may be used)	• Ensure that the bougie lies on the lesser curve and that it is distal to the point of transection
Staple transection	Creation of a uniform gastric tube	• Ensure good lateral traction on the stomach by the assistant and good visualization anteriorly and posteriorly to ensure that a large posterior stomach is not left behind • Do not include the esophagus in the transection (direct the last staple fire away from esophagus) because the tissue is too thin for the cartridge load, and high gastric leaks are very difficult to manage
Staple line reinforcement	Reduce leaks and bleeding from the staple line	• Buttressing material is used on all staple loads • Reinforce crossing/overlapping staple lines with an absorbable monofilament figure-of-8 suture and place sutures at the start point and end points of the transection
Staple line testing/drain placement	Identify leaks	• Intraoperative leak testing with air (gastroscope) and methylene blue dye • Place a blake drain along the staple line



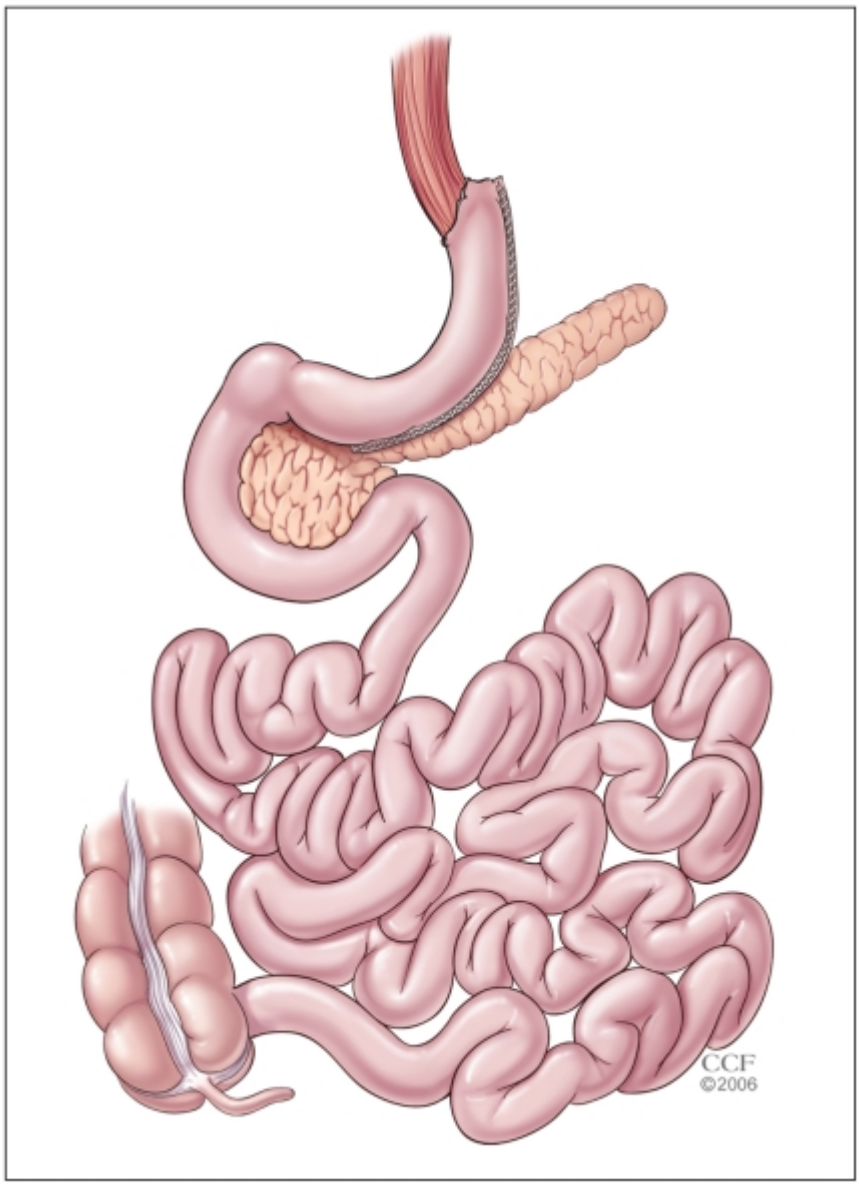
Port setup for LSG



Stapling [9]



Specimen after LSG



Completed LSG [9]

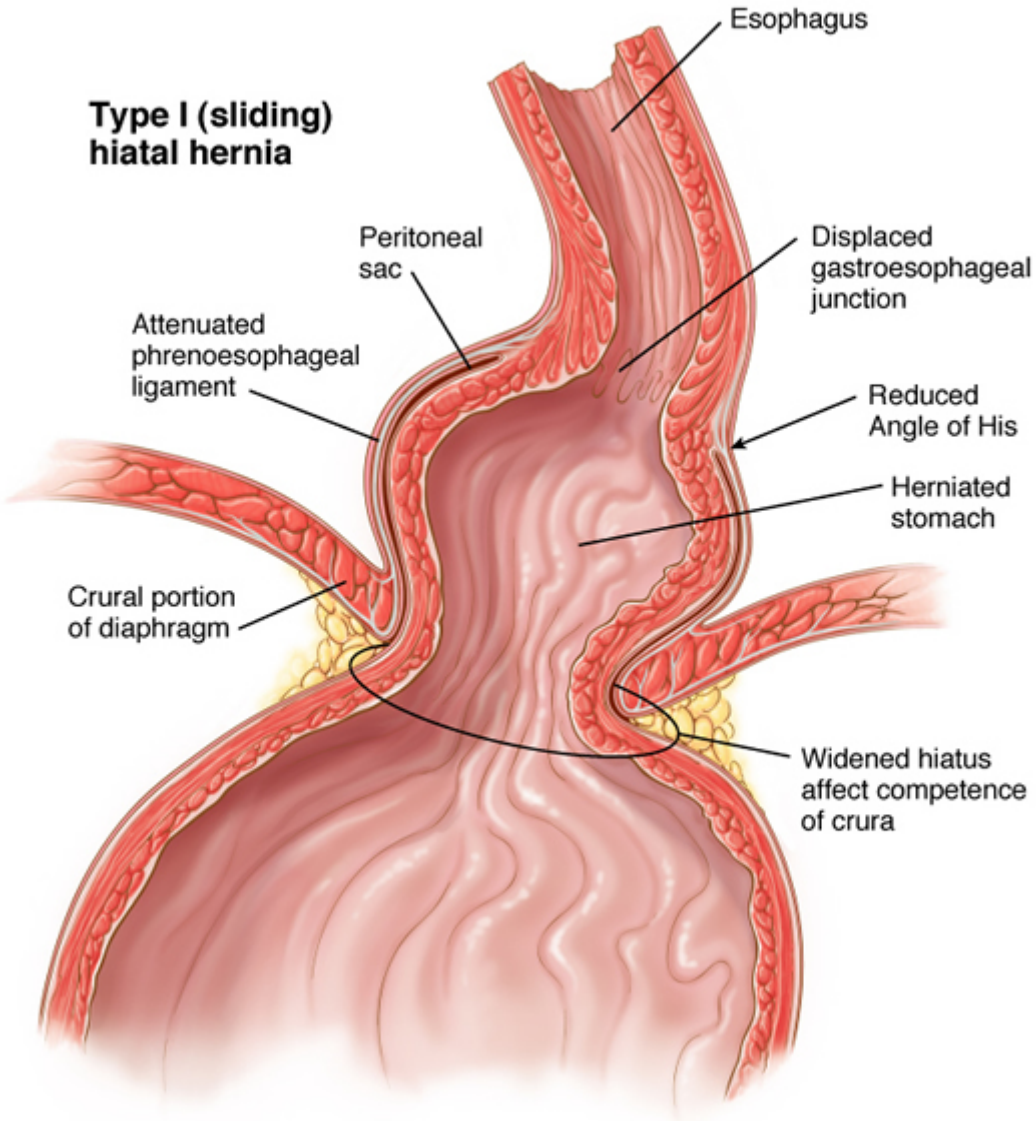
2.2 GERD and hiatal hernia

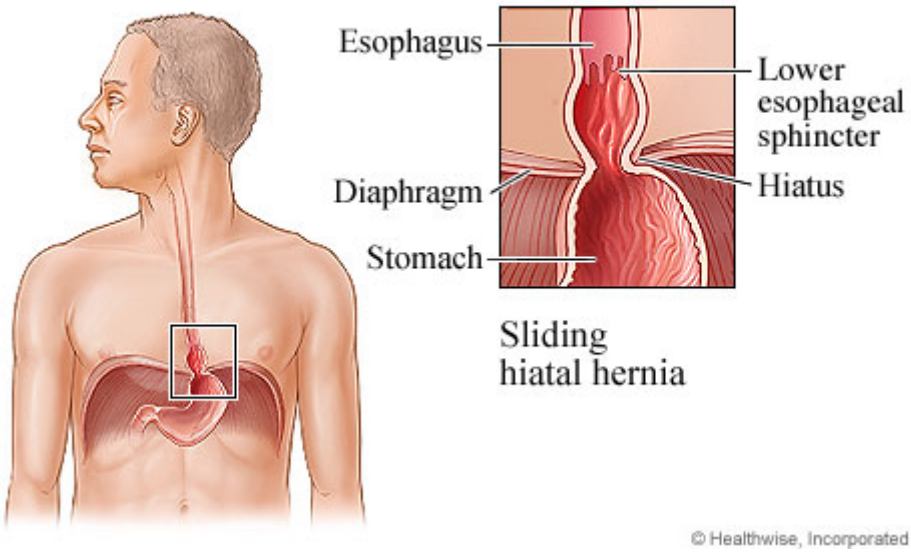
Gastroesophageal reflux disease (GERD) is a complex disease with multiple anatomic derangements that can cause minor discomforts or major pathologic features. Approximately 30–40% of the general population has some component of GERD [10]. The prevalence of GERD is markedly increased in the obese population. Some studies have reported as many as 70% of patients who present for bariatric surgery have symptomatic GERD [11, 12].

Several studies have demonstrated that obesity impairs the competence of the antireflux barrier through different mechanisms, such as delayed gastric emptying owing to increased abdominal pressure, an association with esophageal motility disorders, in particular hypotensive lower esophageal sphincter pressure (<10 mm Hg), and, finally, the development of hiatal hernia (HH), the prevalence of which in the obese population is significantly greater than in non obese patients [13-20].

The presence of HH is frequent in obese patients [21, 22], and obesity is considered an independent risk factor for GERD.

It has been suggested that a higher BMI causes an increased prevalence of GERD by increasing the risk of developing HH [23].


Type I (sliding)
hiatal hernia
Esophagus
Peritoneal
sac
Displaced
gastroesophageal
junction
Attenuated
phrenoesophageal
ligament
Reduced
Angle of His
Herniated
stomach
Crural portion
of diaphragm
Widened hiatus
affect competence
of crura


Esophagus
Lower
esophageal
sphincter
Diaphragm
Hiatus
Stomach
Sliding
hiatal hernia
© Healthwise, Incorporated

3. REVIEW OF THE LITERATURE

3.1 STUDY No 1 [24]

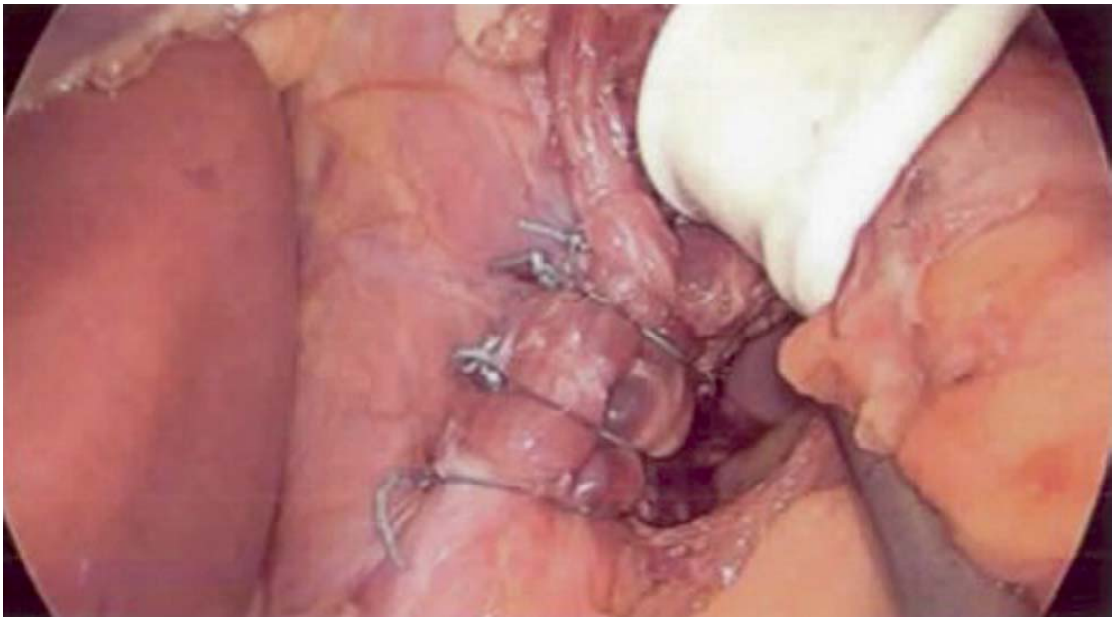
Methods

All patients undergoing laparoscopic sleeve gastrectomy combined with a paraesophageal hernia repair from May, 2011 to February, 2013 were included in the study. These procedures were all completed laparoscopically by 2 surgeons. Patients with type I hiatal hernias (sliding) were excluded from this study. The age, gender, body mass index (BMI), length of surgery, length of stay, and complications were evaluated.

Procedure

Laparoscopic repair of the paraesophageal hernia was done with complete hernia sac excision, followed by posterior crural closure after insertion of a 36 French bougie. There was approximately 1 cm of laxity around the bougie. A biologic mesh was placed in patients who were felt to have attenuated tissues. All sleeve gastrectomies were performed using glycolide copolymer staple-line reinforcement (GORE SEAM- GUARD Bioabsorbable Staple Line Reinforcement, W. L. Gore & Associates, Inc, Flagstaff, AZ)

Complete hernia sac excision.



Posterior crural approximation

Results

There were a total of 23 cases of a simultaneous laparoscopic repair of a paraesophageal hernia and sleeve gastrectomy. All patients had a type III paraesophageal hernia. All patients were female except for one, with an average age of 53.4 years (37–66 years) and an average BMI of 41.9kg/m2. The average operative time was 165 minutes (115–240 minutes), and the average length of stay of 2.83(2–6) days. A biologic mesh was used in 17 of 23 patients for additional posterior crural reinforcement. Four patients underwent revisional surgery after failure of a laparoscopic adjustable gastric band. Preoperative EGD was able to detect only 4 patients with a large (45 cm) hiatal hernia. Five patients were incorrectly found to have no hiatal hernia on EGD. The rest had a small hiatal hernia or the size was not noted. They found that 20 of 23 patients had a hernia 45 centimeters and 3 had a hernia of 5 centimeters intraoperatively. The mean length of follow-up was 6.16 months (range, 1– 19 months). The mean percent of excess weight loss was 39%. There were no intraoperative complications and no postoperative complications, including DVT, pulmonary embolism, wound infections, urinary tract infections, leaks, or major bleeding events, during their admission. No patients complained of dysphagia at follow-up. Two patients complained of nausea at their follow-up visit (6 weeks and 5 months), but neither were readmitted. Two patients were readmitted (8.7%) within 30days of surgery; one for chest pain after surgery with no gastrointestinal complaints and the other for persistent nausea and vomiting. This patient was found to have stenosis of the sleeve on upper endoscopy and was converted to a Roux-en-y gastric bypass. At 6 months follow-up, this patient was asymptomatic and had 73% excess weight loss.

Discussion

Several studies have shown that obesity predisposes patients to increased intraabdominal pressures due to a direct mass effect from the intraperitoneal adipose

tissue [25, 26, 28, 29]. This can result in the formation of a hiatal or paraesophageal hernia [25, 26, 28]. In one retrospective study, 38% of morbidly obese patients undergoing bariatric surgery had the presence of some type of hiatal hernia compared with normal-weight individuals [30]. Controversy exists regarding the indication for laparoscopic sleeve gastrectomy in patients with concomitant hiatal or paraesophageal hernia, with most surgeons opting to perform a Roux-en-Y gastric bypass instead [28, 31]. One advantage of Roux-en-Y gastric bypass is that it achieves the highest reduction of intraabdominal pressure by causing the greatest excess weight loss of the commonly practiced bariatric procedures [32].

Preoperative EGD often is inaccurate at diagnosing a hiatal hernia, as evidenced in numerous laparoscopic sleeve gastrectomy studies [27, 28]. Daes et al. describe a negative EGD finding before laparoscopic sleeve Gastrectomy in 69 patients, of whom 6 patients actually had a hiatal hernia discovered intraoperatively [27]. Daes et al. also reported the inaccuracies of preoperative EGD, in a study in which a hiatal hernia was found in 117 (50%) patients undergoing laparoscopic sleeve gastrectomy, of which only 58 (25%) patients had a confirmed hiatal hernia at time of surgery [27].

Preoperative work up for laparoscopic sleeve gastrectomy was performed on 378 morbidly obese patients, of whom 42 patients (11.1%) were diagnosed with a hiatal hernia on endoscopy [28]. All 42 cases were confirmed at the time of surgery, with an additional diagnosis of 55 hiatal hernias [28]. Both of these studies demonstrate the difficulty in accurately diagnosing a hiatal or paraesophageal hernia. Because of the lack of consensus on the matter, some surgeons may exclude patients from laparoscopic sleeve gastrectomy with a preoperative diagnosis of a hiatal hernia [27]. If a hiatal hernia is diagnosed intraoperatively, some surgeons may abort the operation or perform an insufficient repair. According to the guide lines from the international sleeve Gastrectomy consensus statement, aggressive identification of a hiatal hernia should be done and should always be repaired if found [33]. The consensus also recommends that if a hiatal hernia is identified, dissection should be carried posteriorly to allow appropriate posterior crural closure [33]. Failure to repair a hiatal hernia at the time of surgery can lead to significant morbidity as GERD and erosive esophagitis have been found to increase after sleeve gastrectomy [34–36]. We believe that all hiatal hernias should be repaired after posterior dissection, because it allows the best visualization of the extent of the hernia that is not always visible anteriorly.

Multiple sources have reported on the simultaneous repair of hiatal hernia and sleeve gastrectomy [27, 28, 37]. Hiatal hernia repair in all these studies did not include mesh reinforcement, but consisted of crural reapproximation with non absorbable, interrupted sutures. Soricelli et al. describe a hernia orifice diameter greater than or equal to3 cm as being abnormal; Daes et al. describe a large hiatal hernia as being 42 cm, and Angrisani et al. do not provide a metric for hiatal hernia measurement [27, 28, 37]. There have been few reports to date of paraesophageal hernia repair in the setting of sleeve gastrectomy. Cuenca- Abente et al. described an obese patient who underwent repair of a recurrent paraesophageal hernia that was treated with a concomitant sleeve gastrectomy [38]. Rodriguez et al. recently presented the large study comprised of 19 patients who underwent treatment of a large or recurrent paraesophageal hernia with concomitant sleeve gastrectomy in non bariatric surgical patients [32]. Fifteen patients had a type 3or 4 paraesophageal hernia, which was repaired with primary hiatal closure and mesh overlay reinforcement, followed by laparoscopic sleeve gastrectomy [32]. The authors concluded that simultaneous large paraesophageal hernia repair with laparoscopic sleeve Gastrectomy is feasible but technically challenging [32]. In the present study, 23 patients undergoing sleeve gastrectomy for morbid obesity were found, intraoperatively, to have a paraesophageal hernia. Many of these patients were asymptomatic. Only 4 patients were found on preoperative EGD to have a large hiatal hernia. Five patients did not have a hiatal hernia on EGD. This is important because a paraesophageal hernia repair is more complex than a hiatal hernia repair, and if not done properly, can lead to recurrence. All surgeons do not have the skill set to repair large paraesophageal hernias. Considering the high incidence in bariatric patients, surgeons need to beaware of the possibility of finding a paraesophageal hernia and be prepared to repair it. All 23 procedures were completed without intraoperative or postoperative complications and had an average length of stay of 2.83days (2–6 days). Surgeons should especially be aware of the possibility of a hiatal hernia in patients who are undergoing revisional surgery after having previously failed an adjustable gastric band. Studies have found that gastric banding increases the risk of developing a hiatal hernia [39].

Conclusions

Obesity is an independent risk factor for the development of paraesophageal hernias. Preoperative EGD is not accurate in diagnosing large hiatal hernias. Surgeons should be aware of the possibility of finding a paraesophageal hernia when doing a bariatric procedure because improperly repairing these can lead to significant morbidity. Surgeons with the skill set to repair these large paraesophageal hernias should do so simultaneously with the weight loss procedure. With no significant increase in length of stay or procedure time, we found that this method is well-tolerated, feasible, and can reduce the cost of multiple hospitalizations.

3.2 STUDY No 2[40]

Methods

A retrospective chart review was performed of all LSG patients from January 2006 to August 2009. The charts were reviewed for demographics, preoperative GERD symptoms, preoperative GERD medication use, body mass index, age, preoperative and postoperative upper gastrointestinal (UGI) radiographic findings, and weight loss amount. A telephone survey was performed to assess for postoperative GERD complaints, including heartburn, regurgitation, medication use specifically for GERD, and immediate postoperative symptoms versus persistent symptoms that lasted > 30 days.

The LSG technique used one 15-mm port, four 5-mm ports, and one liver retractor. LSG was started by dividing the cardiophrenic ligament/angle of His. The greater omentum was preserved by dividing the gastrocolic ligament close to the stomach. A 34F Bougie was passed into the stomach and through the pylorus. A linear cutting stapler reinforced with a synthetic bioabsorbable material was used to divide the stomach. The division of the stomach started 5 cm proximal to the pylorus. The first stapling cartridge was green (4.1 mm) for the thicker tissue at the antrum, followed by gold (3.8 mm), and then multiple, blue (3.5- mm) staplers. Near the fundus and cardia, care was taken to angle the stapler between the spleen and diaphragm to avoid narrowing the gastroesophageal junction. A leak test was performed with endoscopy and staple line saline submersion

Results

During the study period, 206 patients underwent LSG. Of these 206 patients, 176 charts were reviewed and 124 patients completed the telephone survey. Of the 176 patients, 85.7% were women, with an average age of 45 years (range 22–65). The preoperative average body mass index was 46.6 kg/m2 (range 33.2–79.6). The average percentage of excess body weight lost at approximately 6, 12, and 24 months was calculated as 54.2%, 60.7%, and 60.3%, respectively. Of the 176 LSG patients, 34.6% had preoperative GERD complaints and 22% of patients surveyed were taking medication specifically for GERD. Postoperatively, 49% complained of immediate (within 30 d) GERD symptoms, 47.2% had persistent GERD symptoms that lasted > 1 month after LSG, and 33.8% were taking medication specifically for GERD after LSG. The most common symptoms were heartburn (46%), followed by heartburn associated with regurgitation (29.2%; **Fig 1**). The patients with preoperative GERD symptoms were more likely to have persistent postoperative GERD symptoms. More patients were taking GERD-specific medication postoperatively than preoperatively. Patients with a greater preoperative body mass index were more likely to have postoperative GERD. The presence of reflux identified on preoperative or postoperative UGI radiographs did not correlate with the presence of postoperative GERD symptoms. The risk of developing postoperative GERD symptoms in patients who had not had preoperative GERD symptoms was 30–51% (95% confidence interval).

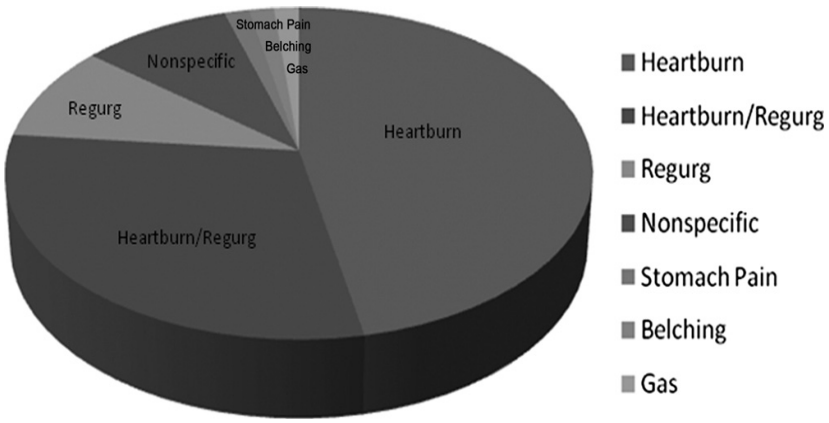


Fig. 1. Distribution of postoperative LSG GERD symptoms.

Discussion

In the present study, the use of LSG correlated with the persistence of GERD symptoms in patients with GERD preoperatively. Multiple studies have shown improvement in GERD complaints after LSG. These improvements have been routinely seen during follow-up at 2–3 years postoperatively and might be related to an improvement in overall gastric compliance [41, 42]. However, a recent study by Himpens et al. [43] revealed a biphasic pattern in the symptoms of GERD during longer term follow-up. In a subgroup of 30 patients followed up for 6 years after LSG, GERD complaints were present in 23% of patients. Previously, this group of patients demonstrated a 22% GERD incidence at 1 year and then a decrease to 3% at 3 years. The investigators commented that the development of a neofundus in longterm LSG patients, as well as a "relative midstomach stenosis," contributed to increased acid production and might be the explanation for the increased incidence of GERD [43].

The results also revealed that patients without GERD preoperatively had an increased risk of postoperative GERD symptoms that included heartburn, regurgitation, and medication use to manage reflux symptoms. This was a result similar to that seen by Fedenko et al. [44], who reported on antireflux sleeve gastroplasty. In their initial assessment of their postoperative LSG patients, they observed an increase in GERD symptoms, with all their patients requiring proton pump inhibitors to control their symptoms. In an attempt to prevent these symptoms, they combined multiple components of both the LSG and the Magenstrasse and Mill procedure with techniques from a laparoscopic Nissen fundoplication. The postoperative GERD complaints were resolved after this procedure [44].

The antireflux mechanism is a multianatomic arrangement of muscular fibers from the stomach and esophagus, including the high-pressure zone of the lower esophageal sphincter, the diaphragmatic crura, and ligamentous structures, such as the phrenoesophageal and cardiophrenic ligaments. Manipulation of any part of these structures can perpetuate reflux or cause reflux. LSG might anatomically compromise the antireflux mechanism [45].

LSG, as a novel procedure, has shown a postoperative GERD incidence of 2–25% in some studies [12]. The definition of GERD, however, makes the known incidence of GERD difficult to quantitate. The Second International Consensus Summit on Sleeve Gastrectomy reported a 6.5% incidence of GERD at 3 months after LSG, with a range of 0–83% [46]. This study's postoperative incidence was 47%. Although the incidence was within the range of the Consensus Summit, the numbers were greater than the average, which might have been because surgeons specifically asked about these symptoms. We do know that the antireflux barrier is changed by LSG. This was confirmed by a prospective analysis of 20 LSG patients. All patients had normal preoperative lower esophageal sphincters, as shown by manometry. However, after LSG, hypotensive lower esophageal sphincter pressures were seen in 85% of patients, with a mean value of 8.3 + - 2.6 mm Hg [11].

Conclusion

GERD is a complex disease caused by anatomic derangements to the antireflux barrier. Multiple patient factors might perpetuate reflux in LSG patients, such as pre-existing hiatal hernia [12], gastric emptying after LSG [41], and esophageal dysmotility [11]. Some have advocated antireflux procedures combined with LSG [12, 43]. Overall, the results have shown that GERD did not resolve after LSG in most of the patients with preoperative symptoms, even with significant weight loss. This is a unique first step in addressing the concern about postoperative GERD in LSG patients. Prospective analysis is needed to definitively assess this topic.

3.3 STUDY No 3[47]

Methods

The studies were selected if GERD was a primary or secondary study outcome. A broad definition of GERD was accepted for the present study because of the limited number of studies available. Thus, GERD outcomes included 24-hour pH measurements, motility assessments, manometry, validated symptom questionnaire findings, informal symptom reporting, and medication use.

Results

Data search results

A total of 15 reports met the inclusion criteria. Of the 15 reports, 2 had included GERD as a primary outcome of SG [11, 48] and 13 had studied GERD as a secondary outcome. However, the diagnosis and evaluation of GERD was not standardized across the studies [5, 6, 49-59]. Three studies compared laparoscopic SG with other bariatric operations [52, 53, 56]. The duration of follow-up ranged from 6 months to 5 years. The method for evaluating GERD included manometry in 1, questionnaires in 4, proton pump inhibitor use in 2, and was not stated in 8 studies.

Results of effect of SG on GERD

The reviewed studies reported differing results on the effect of SG on GERD. Of the 15 studies, 4 found an increased prevalence of GERD after SG [49,53,54,59], 7 showed reduced prevalence of GERD after SG [5,6,51, 52,55,56,58], and 3 included only the postoperative prevalence of GERD [148,50,57]. A manometry study by Braghetto et al. [11] found reduced lower esophageal sphincter (LES) pressure after

SG that might have resulted in reflux symptoms. They did note that in their experience (unpublished data) of 250 patients, 15% had positive acid reflux found on the 24-hour pH measurements.

Discussion

The object of the present systematic data review was to consolidate the evidence on the effect of SG on GERD. More established bariatric operations have been previously studied for their effect on GERD. Because SG is a relatively new operation, it has not been well examined in this regard.

Prevalence of GERD after SG

The 15 reports retrieved from a systematic data search of GERD after SG reported diverging results. Of the 15 studies, 4 [49,53,54,59] found an increased prevalence of GERD symptoms after SG, but 7 [5,6,51,52,55,56,58] showed a reduced prevalence. From the studies in which an overall reduced prevalence was reported, the investigators had noted that patients with pre-existing GERD had shown improvement but that new cases of GERD had developed after SG [6, 52]. Himpens et al. [52] noted that of the patients with pre-existing GERD, 75% had had resolution. However, 21.8% new cases had developed at 1 year after SG [52]. Melissas et al. [6] noted the same trend of a reduction in pre-existing GERD but also 2 new cases. However, the studies did not report the statistical significance of the new cases. The studies by Himpens et al. [52], Weiner et al. [55], and Melissas et al. [5] found worsening GERD symptoms early after SG but resolution at 2–3 years. Finally, 3 studies included only the postoperative prevalence of GERD [48, 50, 57]. Although not included in the present analysis, the Second International Consensus Summit for Sleeve Gastrectomy surveyed attendees and reported that their prevalence of postoperative GERD ranged from 0% to 83% (average 6.5%) [31]. Because of the diverging results, it would be difficult to synthesize a definite conclusion with numeric data regarding the effect of SG on GERD. A meta-analysis would also be impractical, given the heterogeneity of the results and the limited number of studies. Despite these limitations, some conclusions can still be drawn, particularly from the discussion of the effect of SG on

the physiology and anatomy from these studies and comparing the GERD prevalence after SG with that after other bariatric procedures.

Comparison of GERD after LSG and other bariatric operations

Of the 15 studies, 3 compared LSG with other bariatric procedures. Himpens et al. [52] noted that patients without GERD who had undergone gastric banding had an increase in the prevalence of GERD that continued to increase with time. In contrast, the prevalence of GERD in patients who had undergone LSG peaked at 1 year and had declined by 3 years. Furthermore, the prevalence of GERD in patients with pre-existing GERD had decreased by 75% after SG and 83.3% after gastric banding [52]. In contrast, the study by Omana et al. [56] showed a non statistically significant reduction in the prevalence of GERD of only 22% after laparoscopic SG and 33% after laparoscopic adjustable gastric banding at 15 months. Finally, the study by Lakdawala et al. [53] reported a reduction in the prevalence of GERD from 13% to 0% after laparoscopic Roux-en-Y gastric bypass and from 5% to 0% after SG. However, they noted that the incidence of GERD was 9% at 1 year in the SG group (the statistical significance was not reported) [53]. Without statistically significant results, it would be difficult to draw conclusions; however, superficially it appears that SG is at least as good as gastric banding at reducing the prevalence of GERD.

Physiologic and anatomic effects of SG on GERD

Several investigators commented on the anatomic and physiologic effects of LSG and postulated their effect on GERD. Using manometry, Braghetto et al. [11] demostrated that the pressure in the LES was reduced after LSG, which could cause reflux symptoms and esophagitis. Klaus and Weiss [60] reasoned that esophageal manometry might be a useful criterion in deciding whether to offer SG. Himpens et al. [52] hypothesized that the lack of gastric compliance and emptying and the blunting of the angle of His inherent in LSG at 1 year was responsible for the increase GERD

symptoms at 1 year after LSG. They postulated that an increase in gastric compliance and clearance after 3 years likely accounted for the resolution of GERD symptoms at 3 years [52]. Finally, they also noted that barium swallow testing after 3 years revealed restoration of the angle of His, which might have accounted for the decrease in GERD [52]. Hamoui et al. [50] also noted the alteration in the anatomy of the angle of His and recommended exercising caution when offering open SG to patients with GERD. In contrast to the findings from Himpens et al. [52], Melissas et al. [5, 6] noted an acceleration of gastric emptying in both the short term (6 months) and long term (24 months) after SG. They ventured that weight loss might be the mechanism for improved GERD symptoms and that surgical division of the ligaments around the abdominal esophagus and destruction of the cardioesophageal junction might account for worsening GERD symptoms [5, 6]. Yehoshua et al. [61] measured and compared the volumes and pressures in the stomach before and after SG. They found that the sleeve was 10 times less distensible than the resected section. They also found that the remaining sleeve had a greater luminal pressure and smaller volume [61]. It is conceivable that these changes in stomach pressure, volume, and distensibility contribute to worsening GERD symptoms in the context of reduced LES pressure. The hypothesized anatomic and physiologic effects of SG on GERD are summarized in Table 2. The relationship between GERD and LSG is multifactorial.

The factors that increase GERD after SG include a reduction of LES pressure (possibly from division of ligaments and blunting of the angle of His), a reduction in gastric compliance and emptying, increased sleeve pressure and decreased sleeve volume and distensibility. These GERD exacerbating factors can be countered by accelerated gastric emptying and weight loss. Finally, the resolution of GERD in the long term can be accounted for by the increased gastric compliance and emptying and restoration of the angle of His at 3 years after LSG.

LSG modifications

Multiple novel modifications to LSG have been proposed to resolve the problems of GERD after SG. Fedenko and Evdoshenko [62] proposed an antireflux sleeve gastroplasty, which is a combination of vertical gastroplasty and Nissen fundoplication. Alexander et al. [63] described a banded LSG, in which a band of processed human dermis was placed around the upper part of the sleeve to prevent

late dilation and weight gain and improve GERD symptoms. Korwar et al. [64] combined laparoscopic hiatal hernia repair with SG, with good results in controlling GERD symptoms and promoting weight loss.

Table 2

Anatomic and physiologic factors affecting GERD

Worsening GERD

- Decreased gastric emptying
- Lower LES pressure
- Blunting angle of His
- Decreased gastric compliance and volume
- Increased gastric pressure

Improving GERD

- Accelerated gastric emptying
- Weight loss
- Reduced acid production
- Removal of fundus (source of relaxation waves to lower esophageal sphincter)
- Reduced wall tension (LaPlace's law)

Conclusion

The present review aimed to present a systematic assessment of the best available evidence on the effect of SG on GERD. Of the 15 studies we found, 4 showed an increase in prevalence and 7 showed a reduced prevalence of GERD after LSG. Given the poor quality of the evidence, it was impossible to consolidate the data into a consensus. However, even with the limitations of the present study, some useful conclusions can still be drawn. The relationship between GERD and LSG is

multifactorial. LSG might promote GERD by reducing LES pressure (possibly from the division of ligaments and blunting of the angle of His). Furthermore, the inherent properties of the sleeve (reduced gastric compliance and emptying, increase gastric pressure, and decreased volume and distensibility) might worsen GERD. The factors that reduce GERD after SG include accelerated gastric emptying and weight loss. The resolution of GERD in the long term might result from the increased gastric compliance and emptying and restoration of the angle of His 3 years after LSG.

3.4 STUDY No 4[65]

Methods

From January 2007 to April 2011, 180 obese patients eligible for bariatric surgery [69] underwent LSG. Seventy eight consecutive patients, in whom sliding HH was intraoperatively disclosed, underwent LSG with concomitant HHR (LSG + HHR group), and 102 obese patients, similar for age and gender distribution in whom no HH was intraoperatively disclosed, underwent only LSG (LSG-group).

Protocol

The preoperative evaluation included a careful medical history, evaluation of co-morbidities (i.e., hypertension, dyslipidemia, diabetes [70]), a dc-BS, an UGIE, and an assessment of GERD symptoms. The postoperative evaluation was performed at least 6 months after the bariatric surgery and included a reassessment of GERD symptoms. If a patient was positive for GERD, he underwent a second dc-BS.

Surgical technique

The presence of HH was identified according to the following protocol: upon incision of the lesser omentum but before incision of the peritoneum over the pillars, the hiatus was examined for a HH with paraesophageal involvement to exclude these patients from the study. After incision of the peritoneum, gastroesophageal junction and its relationship to the hiatus were carefully identified to disclose the presence of sliding HH [71]. Whenever intraoperative HH was found it was always posteriorly repaired on the basis of the following technique: the esophagus was encircled, and the diaphragmatic crura were completely dissected to the mediastinal space. The gastric herniation was reduced into the abdomen. Reconstruction was performed using non absorbable (0 Ethibond) interrupted sutures reinforced with a 1x1 pledget of Marlex (Bard ®, Murray Hill, NJ), Vascu-Guard ® and Veritas ® (Collagen Matrix, Synovis Surgical Innovations, St Paul, MN), calibrated on a 40-French orogastric bougie. The gastric greater curvature was freed up to the cardioesophageal junction close to the

stomach with the use of a vessel-sealing device (Ultracision Harmonic Scalpel, EES, Cincinnati, OH; LigaSure, Covidien, Mansfield, MA) sparing the gastroepiploic vessels. The final surgical preparation was a mobilized stomach tethered at the celiac axis. The stomach was resected with the linear stapler parallel to a 40-French orogastric tube along the lesser curve. The calibrating bougie was replaced by a nasogastric tube positioned in the distal stomach to perform the methylene blue dye test for determination of staple-line integrity then, the resected stomach was removed. Concomitant cholecystectomy was performed in all patients with preoperative ultrasound evidence of lithiasis.

GERD symptoms assessment

Participants underwent an assessment of GERD symptoms using a standardized questionnaire evaluating the prevalence of typical GERD symptoms (heartburn and/or regurgitation).

Results

GERD symptoms assessment and HH detection

The prevalence of typical GERD symptoms did not differ between LSG + HHR and LSG patients (Fig. 1). Heartburn and regurgitation frequency-intensity scores were similar between the LSG + HHR and LSG groups (**Fig. 2**). The dc-BS showed a significantly higher presence of HH in LSG + HHR patients compared with LSG patients (28.9% versus 6.4%). Using UGIE, no differences in the presence of HH (29.5% LSG+HHR versus 25.0% LSG groups) and esophagitis (18% LSG + HHR versus 7.1% LSG groups were disclosed between groups). Heartburn and regurgitation frequency-intensity scores did not differ between patients with or without HH, as shown by double contrast barium swallow and/or upper GI endoscopy.

Postoperative evaluation

All patients underwent a reassessment of anthropometric characteristics and co-morbidities. No differences in the interval after bariatric surgery were shown between the LSG+HHR and LSG group.

GERD symptoms assessment

All patients underwent the reassessment of GERD symptoms. The prevalence of typical GERD symptoms in LSG + HHR group did not show any significant change compared with that evaluated before surgery (within group comparison presurgery versus postsurgery 30/78 (38.4%) versus 24/78 (30.8%). A significant decrease in the prevalence of typical GERD symptoms was found in LSG group compared with before surgery (within-group comparison presurgery versus postsurgery 40/102 (39.2%) versus 20/102 (19.6%). **Fig. 1** illustrates a schematic flow diagram of patients with or without GERD symptoms before LSG and LSG + HHR and during the follow-up process; it shows, after surgery in the 2 groups (LSG and LSG + HHR), the frequency of patients who still complained of GERD symptoms and of those who referred a new onset of GERD symptoms. In addition, heartburn and regurgitation intensity-frequency scores significantly decreased within LSG group, and no improvement was shown within LSG + HHR group (**Fig. 2**).In the comparisons between groups, LSG + HHR patients showed significantly higher heartburn frequency-intensity scores, and the regurgitation frequency-intensity score just failed to reach a statistical significance compared with LSG patients (**Fig. 2**). Multiple linear regression analysis was performed with heartburn and regurgitation frequency-intensity scores as dependent variables and with the presence of GERD before surgery and surgical techniques as covariates. Higher heartburn intensity-frequency score postoperatively was significantly associated with LSG + HHR. All patients who referred GERD typical symptoms were scheduled for a second dc-BS, but 3 patients (12.5%) in the LSG + HHR group and 9 patients (45%) in the LSG group refused. Heartburn and regurgitation frequency-intensity scores were significantly higher in patients with HH recurrence compared with those without HH recurrence.

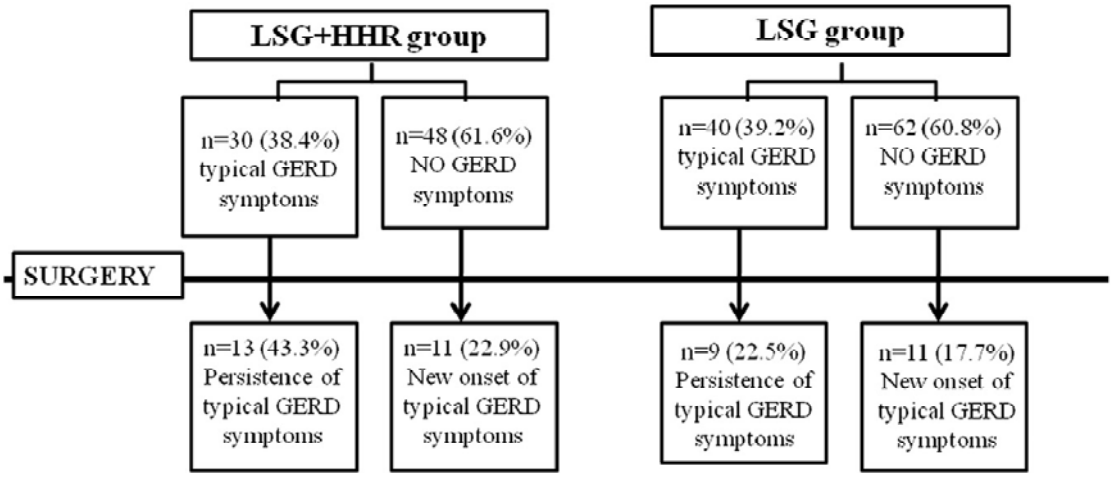


Fig 1. Prevalence of typical Gastroesophageal reflux disease (GERD) symptoms before and after surgery in laparoscopic sleeve gastrectomy with concomitant hiatal hernia repair group (LSG + HHR group) and laparoscopic sleeve gastrectomy (LSG group).

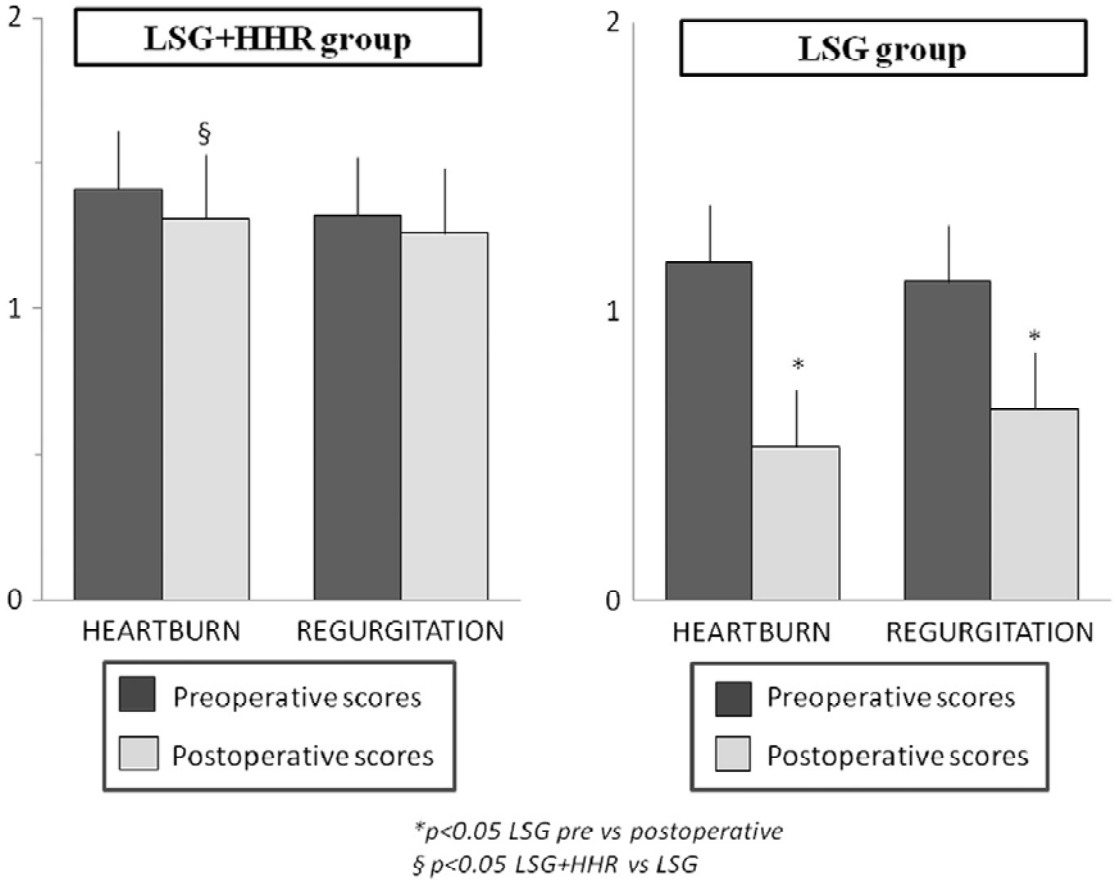


Fig. 2. Heartburn and regurgitation frequency-intensity scores before and after surgery in laparoscopic sleeve gastrectomy with concomitant hiatal hernia repair group (LSG+HHR group) and laparoscopic sleeve gastrectomy (LSG group)

Discussion

The obese patients, who underwent LSG, achieved a significant postoperative decrease in the prevalence and intensity-frequency scores of typical GERD symptoms compared with patients who underwent LSG combined with HH repair. Moreover, after bariatric surgery the LSG patients with concomitant HHR had a significantly higher heartburn intensity-frequency score than patients who underwent LSG alone. In our study, we confirmed the efficacy of the 2 surgical techniques in reducing excess of weight and co-morbidities, although LSG alone showed a further beneficial effect on decreasing GERD symptoms. Data about the effect of LSG on GERD are still controversial [66], showing either an improvement or a worsening [72, 73, 74]. Another study that reported long term results at least 6 years after LSG, revealed a biphasic pattern in GERD symptoms: the first peak developed during the first follow-up year, related to the lack of gastric compliance and the blunting of the angle of His; the second peak showing up later and linked with the appearance of a neo-fundus, caused by the dilation of the stomach, with a relative midstomach stenosis [75]. The authors hypothesized that the consequent stasis of food and a growing surface of acid production might promote the GERD onset [75]. Recently, Petersen et al. [76] suggested that LSG might be a beneficial procedure to reduce GERD in obese patients, reporting an increase in the lower esophageal sphincter pressure after
LSG, but the weakness of this study was the lack of a standardized GERD symptoms evaluation after surgery [77]. It should be taken into account that the surgical procedure of LSG modifies the upper GI anatomy, which could affect its function [73]. The effect on GERD symptoms of LSG combined with HHR has not been extensively studied. Some authors reported an improvement of GERD symptoms [67, 68] after LSG with concomitant HHR. The novel result of the present study was that patients who underwent LSG + HHR did not show any improvement in the prevalence and intensity-frequency scores of typical GERD symptoms and had significantly higher heartburn frequency-intensity scores than patients who underwent LSG alone. This finding confirms that LSG has a beneficial effect on relieving GERD symptoms, as previously suggested [66], although the underlying mechanisms are still unclear; conversely, the procedure of HH repair did not produce any improvement in GERD symptoms. We might suppose that HH repair, modifying the antireflux mechanism, which is a very complex multianatomic arrangement of muscular fibers

from the stomach and esophagus, including the high-pressure zone of the lower esophageal sphincter, the diaphragmatic crura, and ligamentous structures, such as the phrenoesophageal and cardiophrenic ligaments, might perpetuate reflux or cause reflux. This is a very interesting as well as controversial area in bariatric surgery, and the result of this study is a warning against a very aggressive attitude toward HH management.

Conclusion

LSG has a beneficial effect on relieving GERD symptoms, although the underlying mechanisms are still unclear; conversely, the procedure of HHR did not produce any improvement in GERD symptoms.

3.5 STUDY 5[78]

Methods

Patients

From July 2009 to December 2011, 378 LSGs were performed. All patients underwent a preoperative workup, including history and physical examination, routine laboratory evaluation, esophagogastroduodenoscopy, abdominal ultrasonography, a nutritional and psychiatric evaluation, and additional examinations (upper gastrointestinal contrast study) and/or consultations, as indicated. Manometry and 24-hour pH recording were performed when GERD symptoms were present.

Surgical procedure

The patients, under general anesthesia, were positioned in a 30° anti Trendelenburg position with their legs abducted. After induction of the pneumoperitoneum, 5 trocars were placed. Inspection of the hiatal area was performed carefully. A macroscopically evident fingerprint indentation of the diaphragm just above the esophageal emergence from the diaphragm was considered suspicious for HH, indicating the need for a careful exploration of the hiatal crura. The vascular supply of the greater gastric curve was divided, starting 6 cm from the pylorus and proceeding upward to the angle of His, using the LigaSure Vessel Sealing device (Valleylab, Boulder, CO) or the UltraCision Harmonic Scalpel (Johnson & Johnson, Cincinnati, OH). After complete mobilization of the gastric fundus and the posterior gastric wall, dissection of the hiatal crura was performed from a left approach. When present, the hernia sac and the gastroesophageal fat pad were dissected and reduced within the abdominal cavity. The hernia orifice diameter was estimated, taking as the reference the opening jaws of a centimeter clamp (Tyco Healthcare, Gosport, Hampshire, UK). A diameter >3 cm was considered abnormal. The hiatal crura defect was repaired with 2 interrupted non absorbable sutures between the right and left diaphragmatic pillars. Hiatoplasty was always posterior; after completion, a 48F orogastric bougie was passed through it in all cases. LSG was

then performed according to the classic technique. Pexy of the gastric remnant was never performed. The resected stomach was grasped at the antral tip by a laparoscopic grasper and retrieved through 1 of the trocar sites [45]. An intraoperative methylene blue dye test was routinely performed using an orogastric tube at the end of the procedure in all cases, and the capacity of the residual stomach was ascertained (60 mL). The orogastric tube was removed at the end of the procedure. No drains were placed. An upper gastrointestinal contrast (Gastrografin) study was performed on the first postoperative day, 1 month and 1 year after surgery.

Results

From July 2009 to December 2011, 378 morbidly obese patients (body mass index 44 +_ 3.5 kg/m2) underwent the preoperative workup for LSG. A total of 60 patients (15.8%) presented with symptomatic GERD and 42 patients (11.1%) with an endoscopic diagnosis of HH. At surgery, HH was confirmed in all cases, and, in 55 patients (14.5%), it was diagnosed intraoperatively. The groups with a preoperative and intraoperative diagnosis of HH underwent LSG and crural repair for a total of 97 patients (**Fig. 1**), with an increasing rate of an intraoperative diagnosis (from 31% to 67.6%) from the first period (June 2009 to December 2010) to the second period (January to December 2011; **Table 1**). GERD symptoms were reported in 41 (42.2%) of the 97 patients who underwent SG and HHR (**Table 2**), 29 in the group with a preoperative diagnosis of HH and 12 in the group with an intraoperative diagnosis of a crural defect (**Fig. 1**). Preoperative GERD symptoms were present in 19 (6.7%) of the 281 patients who underwent LSG alone (**Table 2**). The severity of GERD symptoms is listed in (**Table 3)**. Esophagitis was diagnosed in 35 (58%) of the 60 patients with GERD symptoms at preoperative endoscopy. Severe esophagitis occurred in 7 cases (20%).The median operative time of LSG with HHR was 75 minutes (range 60–120). Mortality was nil, and no peri- or postoperative complications occurred.

At hospital discharge, all patients were instructed to consume a semiliquid diet and received PPI therapy (30 mg/d for the first 30 d and 15 mg/d for the subsequent 2 mo). After a mean follow-up period of 18 months, the median body mass index had

decreased to 32.8 +_ 5.5kg/m2. GERD remission, characterized by symptom resolution and medication (PPI) discontinuation, occurred in 33 (80.4%) of the 41 patients with preoperative symptomatic reflux who underwent LSG with HHR. In the remaining 8 patients (19.6%), the PPI medications were continued at a diminished dose (15 mg/d versus 40 mg/d) with complete control of symptoms in 5 patients (**Table 2**). No complications developed related to the crural repair. No HH recurrences were found from the upper gastrointestinal contrast study (Gastrografin) performed in all 97 patients 1 month after the procedure and in 47 patients 1 year after surgery. In the group of patients who underwent LSG alone, the remission of GERD symptoms occurred in 11 (57.8%) of the 19 patients with a preoperative GERD diagnosis, and the GERD symptoms persisted in 8 patients (42.2%; **Table 2**). The postoperative development of "de novo" GERD reflux symptoms occurred in 60 (22.9%) of the 262 patients who underwent SG without HHR. No cases of "de novo" GERD symptoms were registered when SG was associated with crural hiatoplasty (**Table 2**). Reflux symptoms always developed within the first 6 months after the procedure.

Table 1

Incidence of HHR and intraoperative HH diagnosis

	June 2009 to December 2010(n=223)	January 2011 to December 2011(n=155)
LSG + HHR	29 (13%)	68 (43.8%)
Intraoperative HH diagnosis	9/29 (31%)	46/68 (67.6%)

Table 2

Clinical outcome (n = 378 SG with or without HHR)

Variable	LSG (n = 281)	LSG + HHR (n = 97)
Preoperative GERD	19	41
GERD remission	11/19 (57.9%)	33/41 (80.4%)
GERD improvement	0	5/41 (12.1%)
GERD persistence	8/19 (42.2%)	3/41 (7.5%)
GERD “de novo”	60/262 (22.9%)	0

Table 3

GERD symptom score

Symptoms	Patients (n)
Grade 1, mild symptoms, no PPIs	22
Grade 2, moderate symptoms, periodic PPIs	8
Grade 3, severe symptoms, continuous PPIs	30

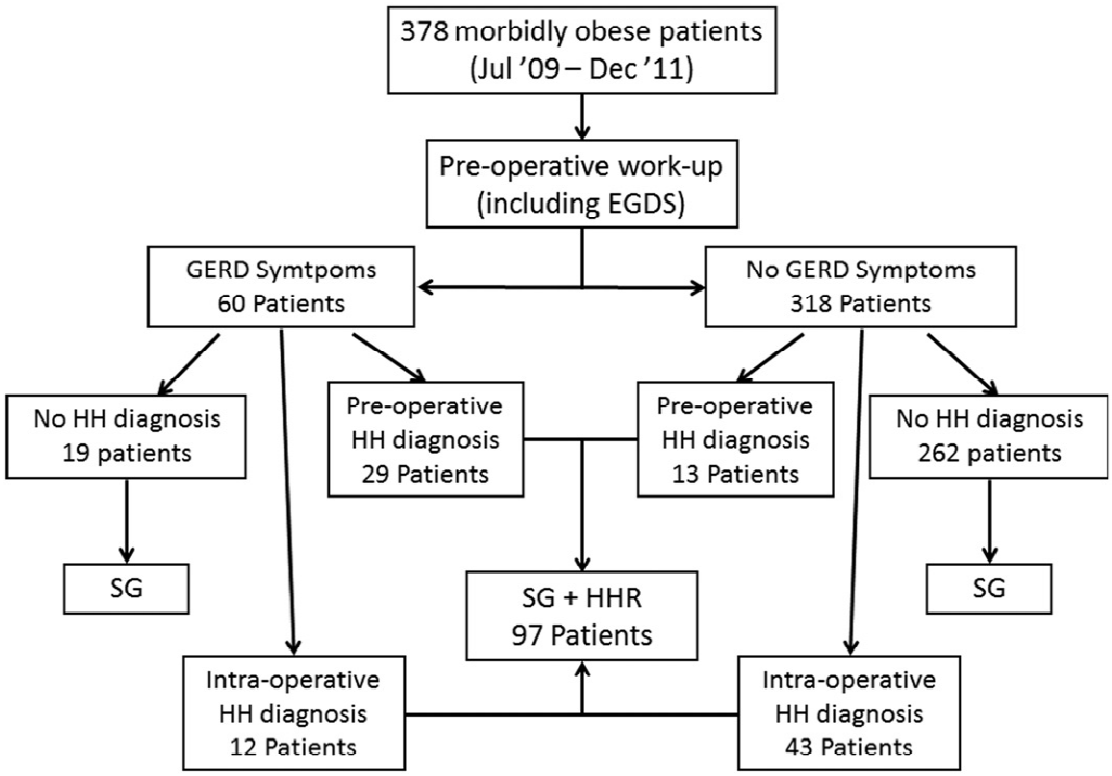


Fig. 1. Diagnostic algorithm

Discusion

Bariatric surgery has been demonstrated to be the treatment of choice compared with antireflux surgery for the management of GERD and/or HH in morbidly obese patients. Its effectiveness is due, not only to the significant weight loss, but also to specific changes in the anatomy and in the functional configuration of the crural complex [79, 80]. RYGB appears to have a very favorable effect on GERD symptoms, possibly related to the limited acid production in the small (15–30 mL) gastric pouch and the reduction of esophageal refluxate owing to the Roux limb [81, 82]. Concerning LSG, some investigators have hypothesized that this procedure can promote the development or worsening of GERD symptoms, such that the

preoperative diagnosis of GERD and/or HH might represent a contraindication to LSG [83]. During the Second International Consensus Summit for Sleeve Gastrectomy (Miami, FL, March 2009) [83], a mean incidence of 6.5% +_ 14.3% (range 0–83%) of GERD symptoms 3 months after LSG was reported. Himpens et al. [84] registered the "de novo" appearance of GERD in 21.8% of patients 1 year after surgery. However, 3 years later, GERD was present in only 3.1% because of the restoration of the angle of His, according to Himpens et al. Furthermore, 75% of patients affected by reflux symptoms before surgery noted its disappearance 1 and 3 years after surgery. Nocca et al. [85] reported a GERD incidence of 11.8% after LSG, explaining this complication occurred from the too-radical antral resection. Arias et al. [86] recently reported a very low rate (2.1%) of reflux symptoms. Concerning the effectiveness of SG in reducing the symptoms or complications of GERD, Almogy et al. [89] reported only a3% rate of symptom resolution, but in 13% of patients, GERD developed "de novo" after surgery. In contrast, Moon Han [90] reported a decrease in the incidence of reflux symptoms in 70% of cases after LSG. These conflicting data can be explained by the different mechanisms that can promote or impair the competence of the antireflux barrier in patients who undergo SG and, possibly, by the different technical details when performing SG. Gastric transection performed near the angle of His, owing to partial section of the sling fibers, plays an adverse role in lower esophageal sphincter effectiveness. Braghetto et al. [91] reported a significant decrease in lower esophageal sphincter pressure 6 months after surgery in 85% of patients who underwent LSG with no pathologic results found on preoperative testing. Moreover, after SG, the intragastric pressure was markedly increased compared with that of the intact stomach, especially in cases with a very narrow gastric tube or stricture in the middle portion and gastric emptying delay [84, 88]. Thus, some investigators have advocated conversion to RYGB in patients complaining of persistent GERD symptoms after LSG [83]. Furthermore, the impaired function of the gastric remnant, after an early postoperative period, can undergo significant changes, including dilation of the gastric remnant with a decrease in the intragastric pressure, acceleration of gastric emptying, and reduction of acid secretions. These factors could play a beneficial role in GERD symptom improvement after SG [85,87,92,93]. Concerning the presence of HH, the indication to perform crural closure in addition to SG is still debated and studies analyzing the clinical outcomes of this procedure are lacking. Most investigators RYGB, rather than LSG, with HHR if a crural defect is

diagnosed preoperatively [83]. The present series has indicated that HHR associated with LSG is feasible, with no postoperative complications related to the procedure. The approach to the diaphragmatic pillars and repair of the crural defect can be easily performed from the left pillar before or after performing gastric resection. Furthermore, this approach, compared with the right dissection of the hiatal area, allows better sparing of the anterior vascularization of the esophagogastric junction, whose impairment could be involved in the development of staple line leaks after LSG. In the present study, the intraoperative diagnosis of HH occurred in 56.7% of the overall crural defects undergoing repair, with an incidence of 67.6% in the last 68 cases performed from January 2011 to December 2011 (Table 1). The "fingerprint" indentation of the diaphragm just above the esophageal emergence can indicate suspicion for a crural defect, suggesting an accurate crural examination. The significant increase of HHR was related to the more extensive and thoroughly dissection of the hiatal area. The complete freeing of the posterior wall of the stomach, not only allows careful exposure of the hiatal area to ascertain more precisely the presence of crural defects, but also ensures adequate fundusectomy, which is of great importance in terms of weight loss and hormonal changes.

When present, an HH might be associated with anatomic patterns such as more intimate adhesions between the upper portion of the posterior surface of the stomach and the posterior wall of the abdomen. Therefore, we believe that the prevalence of HH in obese patients undergoing bariatric surgery could be underestimated and preoperative diagnostic tests excluding its presence might not be accurate. Furthermore, small hiatal defects can be underdiagnosed pre and intraoperatively because of the presence of conspicuous gastroesophageal fat pads. When considering the clinical outcome, HHR associated with LSG has been shown to be an effective option for the management of morbidly obese patients with GERD, with remission or improvement of reflux symptoms in 92% of patients. In addition, the incidence of the postoperative development of "de novo" reflux symptoms was significantly greater in patients who underwent SG without HHR compared with the "de novo" symptoms in patients undergoing SG with HHR (22.9% versus 0%; *P* _.01).

Conclusion

In morbidly obese patients, the presence of a crural defect should not be considered a contraindication to LSG. It requires surgical repair in conjunction with SG. Preoperative endoscopic and radiologic assessments cannot ensure a sufficiently correct diagnosis of HH; thus, a complete and careful examination of the crura is always recommended in patients undergoing LSG. Extensive dissection of the hiatal area ensures more radical fundusectomy, and it is of importance for a more accurate diagnosis of the crural defects, reducing the incidence of a missed diagnosis of a HH and the development of "de novo" reflux symptoms after LSG. In patients undergoing LSG, HHR is feasible and safe, providing resolution of reflux symptoms in 80% of patients at a mean follow-up of 18 months. The more liberal use of HHR might be advantageous in the treatment of obese patients undergoing SG. However, prospective randomized studies and longer follow-up are needed.

4. OUR EXPERIENCE

Methods

In our department (2nd Surgical Department, Tzaneio G.H.Piraeus) from January 2009 to December 2013 we performed 165 LSG in obese patients. The preoperative evaluation included a careful medical history, evaluation of co-morbidities (i.e., hypertension, dyslipidemia, diabetes) heart triplex, spirometry, Us H-P-B, thyroid function tests an UGIE and an assessment of GERD symptoms. The severity of GERD symptoms:

- **Grade 1**, mild symptoms, no PPIs
- **Grade 2**, moderate symptoms, periodic PPIs
- **Grade 3**, severe symptoms, continuous PPIs).

The postoperative evaluation was performed at least 6 months after the bariatric surgery and included a reassessment of GERD symptoms.

Fifty five patients (33.3%) had GERD with consisting symptomatology. Eight patients (3 %) had a sliding hernia > 3 cm. Five of them (62.5 %) underwent to LSG + HHR and the rest 3 (37.5 %) to LSG only.

Surgical Technique

The patients, under general anesthesia, were positioned in a 30° anti-Trendelenburg position with their legs abducted. After induction of the pneumoperitoneum, 5 trocars were placed. Inspection of the hiatal area was performed carefully. The vascular supply of the greater gastric curve was divided, starting 5 - 6 cm from the pylorus and proceeding upward to the angle of His, using the UltraCision Harmonic Scalpel (Johnson & Johnson, Cincinnati, OH). After complete mobilization of the gastric fundus and the posterior gastric wall, dissection of the hiatal crura was performed from a left approach. When present the hernia sac and the gastroesophageal fat pad were dissected and reduced within the abdominal

cavity. The hernia orifice diameter was estimated. A diameter > 3 cm was considered abnormal. The hiatal crura defect was repaired with 2 interrupted non absorbable sutures (Ethibond) between the right and left diaphragmatic pillars. Hiatoplasty was always posterior.

After completion, a 36Fr orogastric bougie was passed through it in all cases. LSG was then performed using a linear cutting stapler. The first stapling cartridge was green then gold and then multiple blue. Near the fundus and cardia, care was taken to angle the stapler between the spleen and diaphragm to avoid narrowing the gastroesophageal junction. The resected stomach was grasped at the antral tip by a laparoscopic grasper and retrieved through 1 of the trocar sites. An intraoperative methylene blue dye test was routinely performed using an orogastric tube at the end of the procedure in all cases, and the capacity of the residual stomach was ascertained (130 mL).

The orogastric tube was removed at the end of the procedure. One drain was placed (penrose). An upper gastrointestinal contrast (Gastrografin) study was performed on the first postoperative day.

Results

165 patients underwent to LSG. 55 patients (33.3%) had GERD (grade > 2). 8 of all patients (4.8%) had hernia. 5 (62.5%) of the patients with hernia underwent to LSG + HHR and the rest 3 (37.5%) to LSG only. Every patient after the surgery take PPI"s and liquid diet.

6 months later only 3 patients (1.8%) had GERD (grade > 2) symptoms. These 3 patients had HH and underwent to LSG only without HHR. The rest of 162 (98.2%) had no GERD symptoms. No "de novo" case was registered.

The 3 patients with recurrence GERD symptoms has to be operate again (HHR or even better RYGB).

Discussion

165 patients underwent to LSG of which 5 with combination of HHR. The average time was 115 minutes, and the length of stay 4-5 days. The ratio M : F was 1:3 and the average BMI was 43.2 kg/m2.

Of the 55 patients (33.3%) with GERD symptoms (grade >2) 8 (14.5%) had a hernia. 5 of them (62.5 %) underwent to LSG + HHR and the rest 3 (37.5 %) to LSG only.

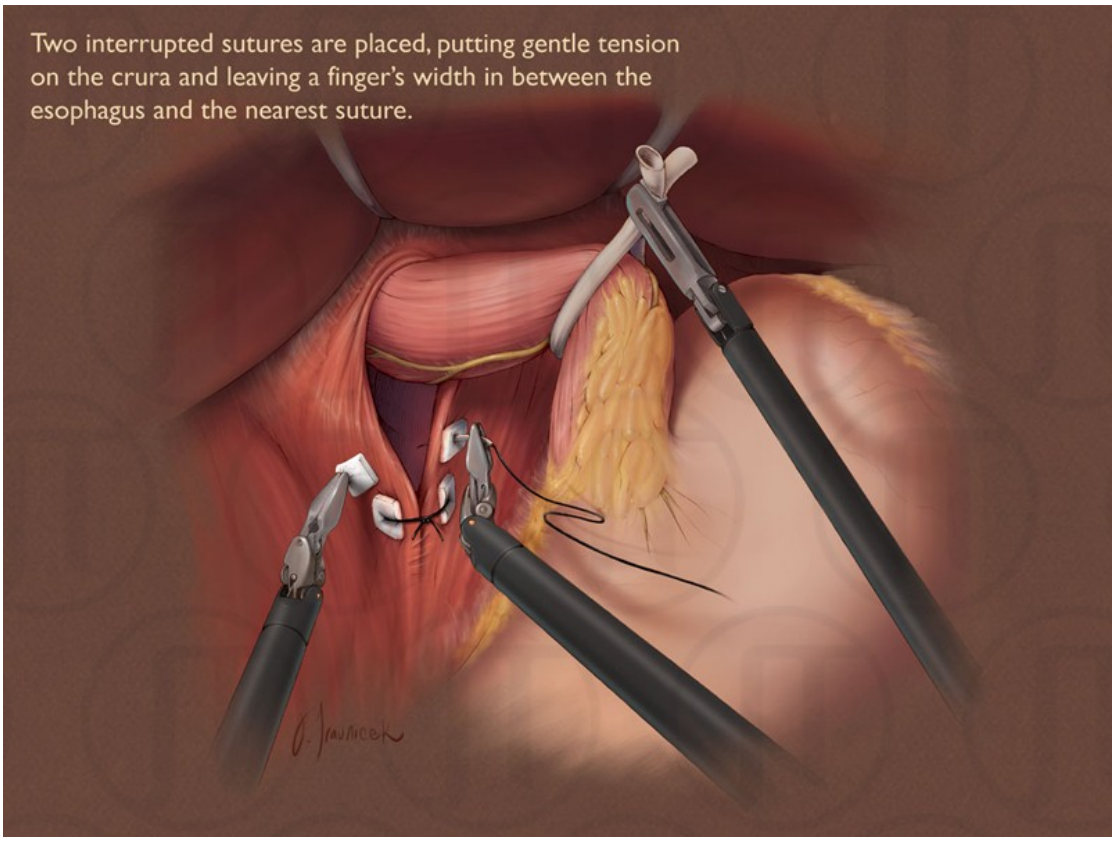
There were no intraoperative complications. Five (3 %) patients had postoperative complications, bleeding and leak from the long suture line after the operation. Only 1 (0.6%) was re operated (running suture to the suture line with Vicryl No 3-0). The others 4 (2.4 %) were treated with percutaneous drenage.

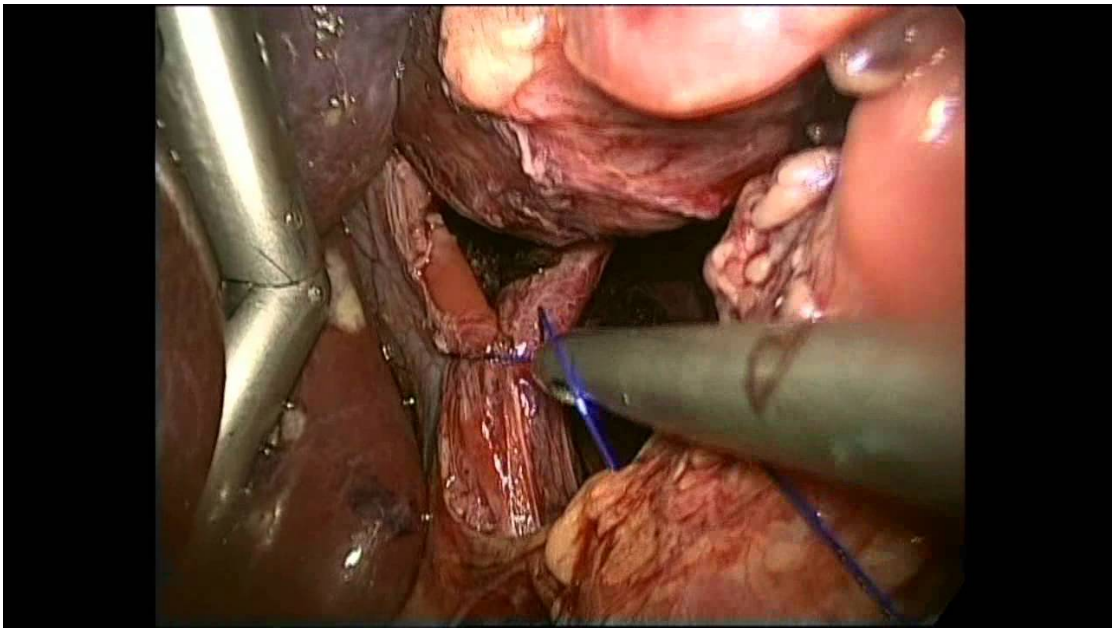
162 patients have no GERD symptoms 6 months after the LSG or LSG + HHR. Only the 3 patients with hernia who underwent to LSG without HHR are still symptomatic (heartburn and regurgitation) and have to be re operated most probably with RYGB.

The mean percent of excess weight loss was 45% after one year. All others co-morbidities (hypertension, dyslipidemia, diabetes) are getting better with decreasing all laboratory values, and need for less medicines.

Conclusion

The objective of this study was to make clear if LSG with HHR is feasible and safe. LSG with or without HHR decrease the GERD symptoms. If we know that the patients have a hernia or if we understand it intraoperatively the additional procedure has to be HHR.


Two interrupted sutures are placed, putting gentle tension on the crura and leaving a finger's width in between the esophagus and the nearest suture.



5. Conclusions

The aim of this study was to evaluate the feasibility and the benefits of a combinated LSG and HHR in morbidly obese patients.

The effect of LSG on GERD with or without HHR has not been well studied, it's still unclear.

In this review of the literature over 2900 patients who underwent to LSG or LSG + HHR, were studied. The results are debated and different from a surgical center to another or from a surgeon to another. This conflicting data can be explained by the different mechanisms that can promote or impair the competence of the antireflux barrier in patients who undergo LSG or LSG + HHR and possibly by the different technical details when performing LSG.

Anatomic and physiologic factors affecting GERD

Worsening GERD

- Decreased gastric emptying
- Lower LES pressure
- Blunting angle of His
- Decreased gastric compliance and volume
- Increased gastric pressure

Improving GERD

- Accelerated gastric emptying
- Weight loss
- Reduced acid production
- Removal of fundus (source of relaxation waves to lower esophageal sphincter)
- Reduced wall tension (LaPlace's law)

Technical details

According to the guide lines from the international sleeve gastrectomy consensus statement, aggressive identification of a hiatal hernia should be done and should always be repaired if found. The consensus also recommends that if a hiatal hernia is identified, dissection should be carried posteriorly to allow appropriate posterior crural closure. Failure to repair a hiatal hernia at the time of surgery can lead to significant morbidity as GERD and erosive esophagitis have been found to increase after sleeve gastrectomy. We believe that all hiatal hernias should be repaired after posterior dissection, (crural reapproximation with non absorbable, interrupted sutures, Ethibond) because it allows the best visualization of the extent of the hernia that is not always visible anteriorly.

Use a bugie bigger than 36Fr. So the stomach is not to narrow and we reduce the wall tension (LaPlace's Law). We don't degrease the gastric emptying.

Start stapling 5-6 cm from pylorus along the bugie. Remove carefully the fundus (source of relaxation waves to LES). Near the angle of His we must staple the fundus without blunting the angle. So we don't reduce the pressure of LES. In this way we decrease "de novo" appearance of GERD. Gastric transection performed near the angle of His owing to partial section of the sling fibers, plays an adverse role in LES

Weight loss is improving GERD symptoms to all patients because there is restoration of the anatomy of the angle of His and of the functionality of the stomach who undergo significant changes including dilatation of the gastric remnant with a decrease in the intragastric pressure, acceleration of gastric emptying and reduction of the secretions.

LSG + HHR are feasible and safe as a combine procedure for the obese patient complicated with GERD.

6. ABSTRACT

Laparoscopic Sleeve Gastrectomy (L.S.G.) has increased in popularity as both a definitive and a staged procedure for morbid obesity. Gastroesophageal reflux disease (GERD) with or without hiatal hernia (HH) is now recognized as an obesity-related co-morbidity.

Roux en Y gastric by-pass has been proved to be the most effective bariatric procedure for the treatment of morbidly obese patients with GERD and hiatal hernia.

The effect of L.S.G. and hiatal hernioplasty on GERD has not been well studied and is still unclear.

Our objective was to report the review of the literature, and our experience (165 obese patients) in patients who underwent L.S.G and hernia repair (HHR) on GERD symptoms pre e post surgery.

In this review of the literature over 2900 patients who underwent to LSG or LSG + HHR, were studied. The results are debated and different from a surgical center to another or from a surgeon to another. This conflicting data can be explained by the different mechanisms that can promote or impair the competence of the antireflux barrier in patients who undergo LSG or LSG + HHR and possibly by the different technical details when performing LSG.

Technical details as: the repair of the hiatal hernia, the size of bugie, the suture stapling line, the angle of His and the remnant fundus seems to be the answer on GERD symptoms.

Laparoscopic Sleeve Gastrectomy and Hiatal Hernia Repair are feasible and safe as a combine procedure for the obese patient complicated with GERD.

7. ΠΕΡΙΛΗΨΗ

Η Λαπαροσκοπική Γαστρεκτομή Δίκην Μανικιού (LSG) έχει αυξηθεί σε δημοτικότητα, τόσο ως οριστική όσο ως σταδιακή διαδικασία για νοσηρή παχυσαρκία. Η Γαστροοισοφαγική παλινδρόμηση (ΓΟΠΝ), με ή χωρίς διαφραγματοκήλη αναγνωρίζεται πλέον ως μια συνοσηρότητα της παχυσαρκίας.

Η Roux en Y γαστρική παράκαμψη έχει αποδειχθεί ότι είναι η πιο αποτελεσματική χειρουργική διαδικασία για τη θεραπεία των νοσηρά παχύσαρκων ασθενών με ΓΟΠΝ και διαφραγματοκήλη.

Η επίδραση της L.S.G. και της αποκατάστασης της διαφραγματοκήλη για ΓΟΠΝ δεν έχει μελετηθεί καλά και είναι ακόμα ασαφής.

Στόχος μας ήταν, μέσα από την ανασκόπηση της βιβλιογραφίας, και την εμπειρία μας (165 παχύσαρκους ασθενείς) σε ασθενείς που υποβλήθηκαν σε LSG και αποκατάσταση της διαφραγματοκήλης (HHR), να αναλύσουμε τα αποτελέσματα στη ΓΟΠΝ πριν και μετά την εγχείρηση.

Σε αυτή την ανασκόπηση της βιβλιογραφίας πάνω από 2900 ασθενείς που υποβλήθηκαν σε LSG ή LSG + HHR, μελετήθηκαν. Τα αποτελέσματα είναι συζητήσιμα και διαφορετικά από το ένα χειρουργικό κέντρο στο άλλο ή από τον έναν χειρούργο στο άλλο. Αυτά τα αντικρουόμενα στοιχεία μπορούν να εξηγηθούν από τους διάφορους μηχανισμούς που μπορούν να προωθήσουν ή να βλάψουν την ικανότητα του φράγματος της παλινδρόμησης σε ασθενείς που υποβάλλονται σε LSG ή LSG + HHR και, ενδεχομένως, από τις διάφορες τεχνικές λεπτομέρειες κατά την εκτέλεση LSG.

Τεχνικές λεπτομέρειες, όπως: η αποκατάσταση της διαφραγματοκήλης, το μέγεθος του ορογαστρικού σωλήνα, η γραμμή συρραφής , η γωνία του His και ο εναπομείναντας θόλος του στομάχου, φαίνεται να είναι η απάντηση στη ΓΟΠΝ.

Λαπαροσκοπική γαστρεκτομή δίκην μανικιού και πλαστική αποκατάσταση της διαφραγματοκήλη είναι εφικτή και ασφαλής ως συνδυασμένη τεχνική για τον παχύσαρκο ασθενή που περιπλέκεται με ΓΟΠΝ.

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