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CLINICAL REPORT

# Manometric Changes of the Lower Esophageal Sphincter After Sleeve Gastrectomy in Obese Patients

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**Abstract**
*Introduction* Laparoscopic sleeve gastrectomy has been accepted as an option for surgical treatment of obesity. After surgery, some patients present reflux symptoms associated with endoscopic esophagitis, therefore PPI's treatment must be indicated.
*Purpose* This study aims to evaluate the manometric characteristic of the lower esophageal sphincter (LES) before and after sleeve gastrectomy
*Material and Method* This prospective study includes 20 patients submitted to esophageal manometry in order to determine the resting pressure, and total and abdominal LES length before and after the sleeve gastrectomy. Statistical variations on the LESP were validated according to Student's "*t*" test.
*Results* Seventeen female and three male patients were included, with a mean age of 37.6±12.6 years. All patients reduced their body weight, from an initial BMI of 38.3 kg/m$^2$ to 28.2 kg/m$^2$ 6 months after surgery. No postoperative complications were observed in these patients. Preoperative mean LESP was 14.2±5.8 mmHg. Postoperative manometry decreased in 17/20 (85%), with a mean value of 11.2±5.7 mmHg ($p$=0.01). Seven of them presented LESP <12 mmHg and ten patients <6 mmHg after the operation. Furthermore, the abdominal length and total length of the high pressure zone at the esophagogastric junction were affected.
*Conclusion* A sleeve gastrectomy produces an important decrease in LES pressure, which can in turn cause the appearance of reflux symptoms and esophagitis after the operation due to a partial resection of the sling fibers during the gastrectomy.

**Keywords** Manometry · Bariatric surgery · Sleeve gastrectomy

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## Introduction

In the currently available literature, there is plenty of evidence that obesity is associated with a statistically significant increase in the risk of GERD symptoms, erosive esophagitis, and esophageal carcinoma [1–6]. According to the data reported by Csendes et al., 79% of patients presented heartburn, 66% regurgitation, 24% of them presented reflux symptoms without macroscopic esophagitis, however, 49% of patients presented macroscopic esophagitis, short segment Barrett´s esophagus at the moment of preoperative evaluation is presented in 18%, and 9% of patients presented long segment Barrett´s esophagus [7]. In patients with severe esophagitis submitted to gastric bypass the incidence of GERD is as high as 50% to 100% [8].

On the other hand, bariatric procedures present successful results in terms of reduction of body weight and body mass index. However, regarding reflux control, the results are quite different among them. Vertical banding gastroplasty presents successful results for weight loss but not for control of GERD unless an antireflux procedure is also performed [9]. In patients operated on with adjustable gastric banding, the results are controversial because some authors report very good control of obesity and reflux esophagitis but others reported a worsening of GERD symptoms [10–12]. There is consensus that Roux-en-Y-

gastric bypass presents successful results both for reduction of BMI, GERD, and for Barrett´s esophagus [8, 13–16].

Laparoscopic sleeve gastrectomy has been accepted as an option for surgical treatment for obesity. This procedure modifies the anatomy of the esophagogastric junction (EGJ) converting it in a straight tubular segment and cutting partially the sling fibers may affect the lower esophageal sphincter mechanism. Consequently, some patients present reflux symptoms associated with endoscopic esophagitis, therefore proton pump inhibitor's (PPI's) treatment must be indicated. Few data regarding reflux symptoms after SG, and no data concerning the manometric characteristic of the lower esophageal sphincter (LES) is available at this time. The purpose of the present paper was to evaluate the manometric characteristic of the LES before and after sleeve a gastrectomy.

## Material and Method

### Patients

This prospective study included 20 obese patients, three males and 17 females with a mean age of 37.6±12.6 (23–55) and a mean BMI of 38.3±3.47 Kg/m$^2$ (range 34 to 44 kg/cm$^2$). All patients who were candidates for a sleeve gastrectomy were submitted to a preoperative evaluation with a biochemical test, abdominal ultrasound, upper GI endoscopy, and manometry. Patients with GERD symptoms, endoscopic esophagitis, or abnormal manometry were excluded.

Manometry was performed preoperatively and 6 months after the operation.

All patients gave us their informed consent for this study.

### Manometry

Patients were submitted to a manometric evaluation of the characteristics of the lower esophageal sphincter. According to the methodology and equipment previously described [17] We studied the resting pressure and total and abdominal length. For "normal" LESP is considered a range pressure of 12.1 to 25.0 mmHg, total length more than 4 cm and abdominal length more than 1 cm.

The presence of incompetent sphincter was defined if one of these parameters was present: lower sphincter pressure less or equal to 6 mmHg, total length less than 20 mm, or abdominal length less than 10 mm [17].

### Surgery

Sleeve gastrectomy was performed by division of the greater curvature vessels using a Ligasure device (Covidien, USA) starting at 2 cm from the pylorus until His angle, cutting the short gastric and posterior fundic vessels. Once this maneuver is completed, a 32-Fr bougie is introduced by the anesthesiologist to the stomach and the surgeon pushes it along the lesser curvature into the pyloric channel and duodenal bulb. Then an EndoGIA device (Covidien, USA) 4.8-mm staplers (green charge) is introduced by the 15-mm port located at the right quadrant in order to start the division of the antrum 2–3 cm from the pylorus, which is completed with an another green charge to the angular incisure. The gastric tubulization is performed by division of the gastric corpus straight to the His angle applying three to four charges of 3.8 mm stapler EndoGIA (blue charge), parallel to the lesser curvature. Reinforcement with absorbable stitches over the mechanical suture is performed, leaving a small gastric tubular pouch of 60–80 ml capacity controlled by the instillation of methylene blue through a nasogastric tube placed after the pulling off of the bougie, with the purpose to exclude leaks of the suture line and evaluation of the gastric capacity.

Statistical variations on the LESP were validated according to Student's "*t*" test.

## Results

Seventeen female and three male patients were included, with a mean age of 37.6±12.6 years. All patients reduced their body weight, from an initial BMI of 38.3 kg/m$^2$ to 28.2 kg/m$^2$ 6 months after surgery. No postoperative complications were observed in these patients. Before surgery all patients had normal LES and the preoperative mean LESP was 14.2±5.8 mmHg, (range 12.3 to 23.9 mmHg). After the operation, LESP decreased significantly to a mean value of 10.5±6.06 mmHg ($p$=0.01; Fig. 1). Despite the decrease in the mean LESP of only four points, in the analysis of the values after the operation, only three patients (15%) presented normal LESP (23.1± 3.7 mmHg). On the other hand, 17 patients (85%) presented a hypotensive lower esophageal sphincter with a mean LESP of 8.3±2.6 mmHg, 11 patients (55%) presented a LESP higher than 6.1 mmHg (9.9+1.7 mmHg), and six of them (30%) presented a LESP less than 6.0 mmHg (5.45± 0.5 mmHg; Fig. 2).

All the patients had a normal total and abdominal length before the operation. After the sleeve gastrectomy the abdominal length and total length of the high pressure zone at the EGJ were also affected. Six patients had normal total and abdominal LES length (total length >3.5 and abdominal length >1 cm). With regards to the other 14 patients, five patients had total length=3.5 cm but an abdominal length <1 cm and nine patients had a total <3.5 cm and an abdominal length=0.5 cm (Table 1).

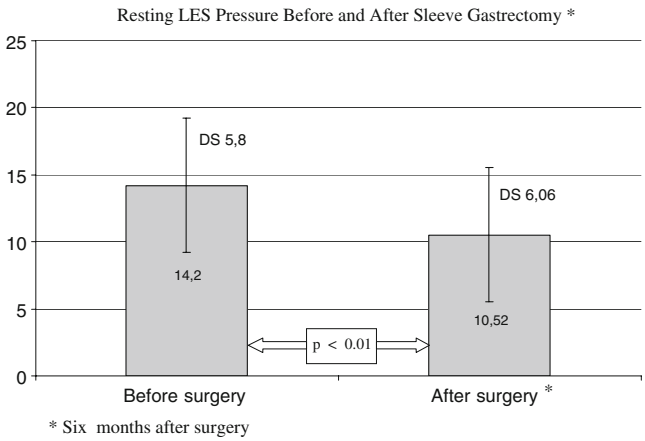


**Fig. 1** Resting LES pressure before and after sleeve gastrectomy. *Asterisk* 6 months after surgery

We have performed a close postoperative follow-up in all of our patients submitted to sleeve gastrectomy including clinical questionnaire in order to evaluate the evolution of postoperative weight, BMI, comorbidities, reflux symptoms, and endoscopic esophagitis, but is not the aim of the present study.

## Discussion

After sleeve gastrectomy LES incompetence was present in 85% of patients and thus could promote reflux esophagitis. However, others have suggested that reflux esophagitis improves after a sleeve gastrectomy. This is a very controversial point because some patients presented heartburn after surgery and PPI's treatment must be indicated. [18] Han [19] reported a decrease in the incidence of reflux symptoms and esophagistis after SG in 70% of cases. The explanation for improvement of reflux after SG is related to accelerated gastric emptying observed in patients submitted to SG and a decrease of intraabdominal pressure after the operation when a reduction in body weight was obtained [20, 21]. The increase in intragastric pressure after a sleeve gastrectomy and the increase in intraabdominal pressure in obese patients could worsen the scenario and promote reflux [21–24]. Afterwards, enlargement of the gastric tube has been observed [25], and therefore a decrease in intragastric pressure may occur reducing the risk of reflux. In fact, after a sleeve gastrectomy, Himpens published the appearance of

**Table 1** Lower esophageal sphincter length before and after sleeve gastrectomy

| | Before | After |
|---|---|---|
| Normal length | 20 | 6 |
| Total >3.5 cm | | |
| Abdominal length >1 cm | | |
| Incompetent | 0 | 14 |
| Total length >3.5 | | |
| Abdominal length <1 cm | | 5 |
| Total length <3.5 | | |
| Abdominal length <1 cm | | 9 |

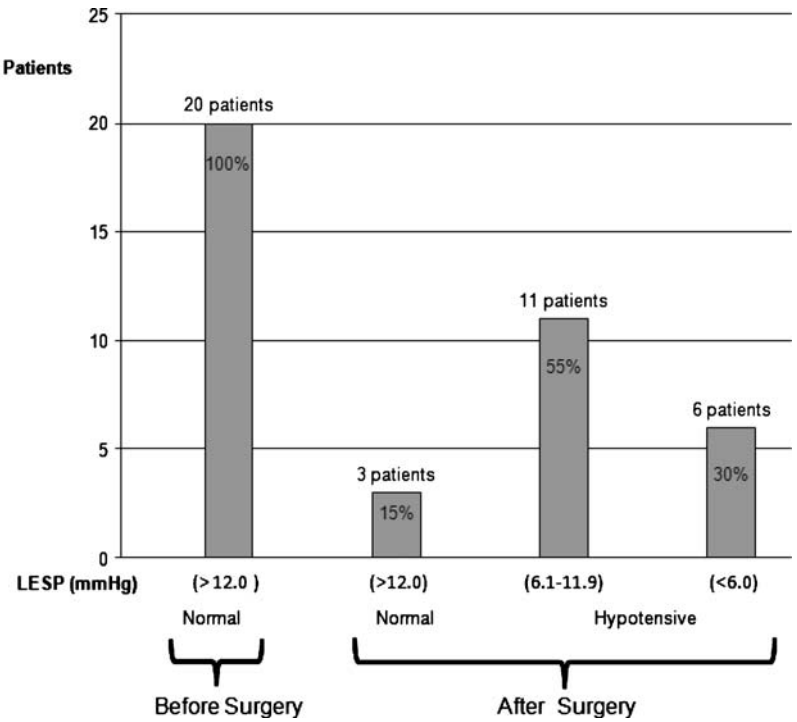


**Fig. 2** Number of patients with normal or hypotensive resting LES pressure before and after a sleeve gastrectomy

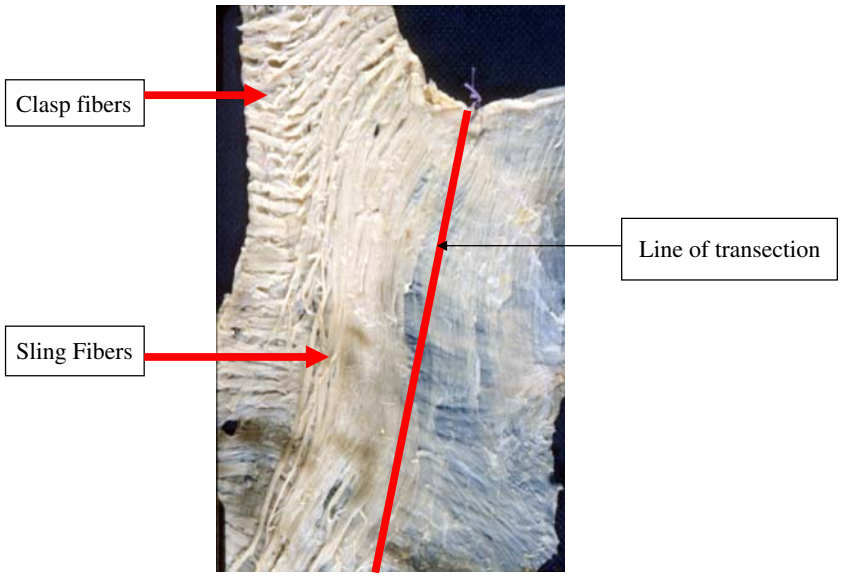


**Fig. 3** Muscle fibers component of LES Claps fibers and sling fiber

GERD once again in 21.8% of patients after 1 year. However, 3 years later only 3.1% of patients presented GERD. [18] More information and new studies are needed in order to clear up this controversial point, because when performing a transection near His´ angle during a sleeve gastrectomy at least a partial section of the sling fibers can occur. Stein and Korn, described the anatomical configuration of the muscle fibers involved in the LES and correlated it with the competency of the sphincter demonstrating that the section of the fibers was associated with the hypotensive sphincter (Fig. 3) [26, 27]. In Fig. 4 we show the current concept of the LES anatomy and the fibers which can be divided during the operation. Klauss [28] agreed with our results because the angle of His is resected and therefore the LES is affected and the resting pressure is reduced. It is also possible to expect that patients who have preoperative reflux symptoms or esophagitis will have a worsening of GERD. Currently, according to our own experience, in more than 250 patients submitted to a sleeve gastrectomy nearly 15% have shown reflux symptoms and endoscopic esophagitis with positive acid reflux after a 24 h. pH monitoring (unpublished date). Preoperative esophageal manometry has been suggested as a valid instrument in order to determine the risk of reflux after surgery, at least in patients with symptoms or esophagitis which could be helpful in order to choose the best bariatric procedure.[28] We believe, if a patient presents reflux symptoms and manometry confirms an incompetent LES, sleeve gastrectomy is not the best option and RYGBP is probably the operation of choice according to the reported data based on the available literature [8, 13–16] Other bariatric operations can induce or prevent GERD through various described mechanisms. Vertical banding gastroplasty appears to be ineffective in controlling GERD and the addition of fundoplication is needed to prevent reflux [9]. Moreover, some papers demonstrated high rates or GERD and most of the patients had to be converted to Roux-en-Y gastric bypass [29]. Laparoscopic adjustable gastric banding presents conflicting results because reflux can be improved in 90% of cases when banding is adequately located but others have reported a worsening of reflux symptoms after the operation.

Regarding reflux after sleeve gastrectomy, according to the data in the available literature, the rate is variable

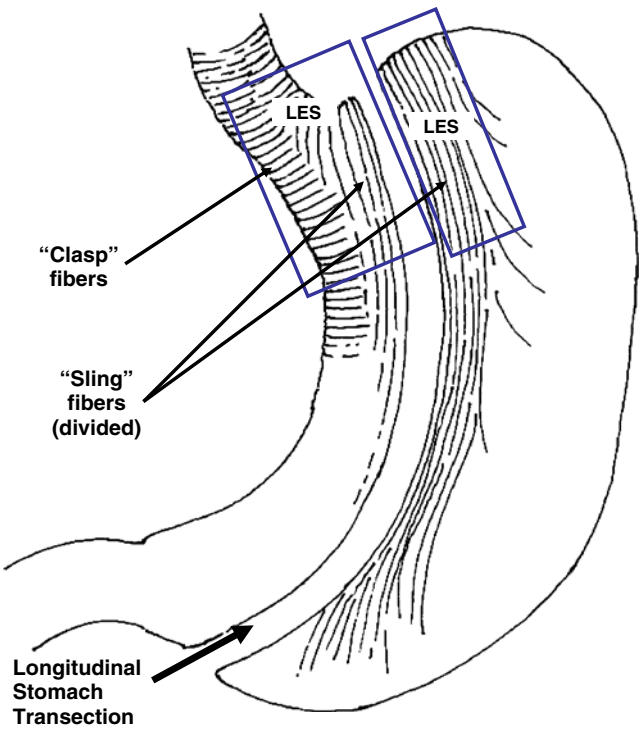


**Fig. 4** Line of transection of gastric wall during sleeve gastrectomy and division of sling fibers of LES

ranging from 2.8% to 13% [30–35]. Almogy and Crookes [30, 31] suggested that sleeve gastrectomy does not reliably reduce symptoms or complications of GERD and may actually induce or exacerbate GERD. They reported only 3% of symptom resolution. On the other hand, GERD was induced in 13% of patients after sleeve gastrectomy requiring PPI. Nocca [32, 33] reported 11.8% of GERD after SG and Dietel [34], reporting the experiences of the First International Consensus Summit for SG (ICSSG) published postoperative GERD in 4.7+8.9% after SG. Others have reported that 30% of patients had some early postoperative vomiting [35, 36]. Fedenko in order to avoid reflux after sleeve gastrectomy described the combination of sleeve gastrectomy and Magenstrasse-Mill operation with a Nissen fundoplication [37]. As we can see, until now, long discussions exist regarding whether sleeve gastrectomy treats reflux or induces reflux. Santoro [38] postulates that sleeve gastrectomy could treat reflux by reducing acid production since removes the fundus that is the source of relaxation waves into the inferior esophageal sphincter and it reduces the tension on the gastric wall below the cardia by Laplace´s law. Nevertheless, there are patients who present intense gastroesophageal reflux and would need an antireflux fundoplication, which is difficult to perform or could compromise the right tubulization of the stomach including the fundus, causing a dilatation of this gastric pouch later on after surgery.

In our opinion, if patients have reflux symptoms or esophagitis, they must be thoroughly evaluated with functional esophageal tests and the most appropriate bariatic operation must be indicated for them.

In conclusion, sleeve gastrectomy produces an important decrease in LES pressure, which can promote the appearance of reflux symptoms and esophagitis after the operation due to the partial resection of the sling fibers during the gastrectomy. GERD symptoms and esophagitis observed in these patients can be explained due to this mechanism.

These findings should be considered in order to choose the best surgical option in obese patients with GERD or hiatal hernias.

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