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ORIGINAL ARTICLES

Laparoscopic sleeve gastrectomy and esophageal motility

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Abstract: *Laparoscopic sleeve gastrectomy (LSG) is becoming popular between the bariatric procedures. There are few studies available in the literature about LSG impact on esophageal motility, with debatable results. Technically, it modifies the anatomy of the esophago-gastric junction; it can damage the phreno-esophageal ligament and decrease the lower esophageal sphincter pressure that will predispose to reflux. Gastroesophageal reflux disease (GERD) is already common in obese patients due to frequent hiatal hernia, high intraabdominal pressure, increased transient lower esophageal sphincter relaxations (TLESR), altered esophageal motility and poor esophageal clearance. LSG can worsen gastroesophageal reflux disease, but also the weight loss achieved after it and the decrease of acid production in the small gastric pouch will probably reduce the GERD symptoms. Dysphagia and odynophagia were reported after sleeve gastrectomy, but usually associated with anatomical narrowing of the gastric sleeve, caused by esophageal dismotility or secondary to diabetes mellitus, low tiamine level, the use of opioids and non-steroidal anti-inflammatory drugs, even hypothyroidism. In addition to upper GI tract endoscopy, high-resolution esophageal manometry (HRM) should be required for all patients planning to undergo a LSG, and in the follow-up period according to the contractility pattern.*

Keywords: *obese, sleeve gastrectomy, esophageal motility, esophageal clearance, reflux*

INTRODUCTION

According to World Health Organization (WHO), overweight and obesity are defined as abnormal or excessive fat accumulation that presents a risk to health. If the Body Mass Index (BMI weight in kilograms divided by the height in square meters) is between 25-30 kg/m^2 a person is overweight, and if BMI > 30 kg/m^2 obese [1]. Unfortunately due to behavioral and nutritional changes more than 20% of the worldwide population is overweight and 10% obese, and in the next 20 years the estimation is that 2.16 billion people will be overweight and 1.12 billion obese [2].

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Morbid obesity, defined by BMI greater than 40 kg/m^2 or between 35 and 40 kg/m^2 with any obesity-associated conditions such as diabetes, high blood pressure, cardiovascular disease, stroke, sleep apnea, osteoarthritis, is a serious invalidating health condition that can interfere with basic physical functions such as breathing or walking [3].

The first step to obtain weight loss is through behavioral and lifestyle changes, with low-calorie diet and exercise, but usually previous attempts of weight loss are followed by rapid weight regain. Many obese associate to diet and exercise pharmacological drug therapy, achieving maximum 10% weight loss [5]. Unfortunately, a lot of patients fail to achieve long-term weight loss through these methods, so they are good candidates for surgical treatment.

Bariatric surgery cause weight loss by restricting the amount

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of food in the stomach, or by a combination of gastric restriction and malabsorption[6]. The bariatric surgical procedures can be purely restrictive, such as laparoscopic adjustable gastric band (LAGB) or laparoscopic sleeve gastrectomy (LSG), or malabsorptive-restrictive: Roux-en-Y gastric bypass (RYGB) and biliopancreatic diversion (BPD)[3, 6]. All the bariatric surgical procedures may have local complications (stenosis at anastomotic sites, stomal ulcers, band erosion, fistulae) but they can be managed with proper follow-up and close monitoring.

Table 1: The known risk factors [4] for morbid obesity are:

1. Genetic factors (familyhistory of obesity)
2. Dietaryhabitsandsedentary lifestyle, **q**uittingsmoking, microbiom
3. Stressandanxiety (highlevel of cortisol, high-calorie food)
4. Sleepdisorders
5. Female (post pregnancyweightgain or menopause)
6. Aging (slowingdown metabolism)
7. Somemedications (antidepressants, steroidsand beta-blockers)
8. Cushing'ssyndrome, Prader-Willi syndrome

The laparoscopic adjustable gastric band (LAGB) involves an inflatable band that is placed around the upper portion of the stomach, creating a small gastric pouch and reducing the amount of food. Is a reversible procedure, with shorter hospital stay and low mortality rate, but the band can slip or create erosion into the stomach, requires a foreign device to remain in the body and strict adherence to the postoperative diet and follow-up visits. The weight loss achieved is slower than the other bariatric procedures, with low risk of vitamin/mineral deficiencies, but a high rate of re-operation [6].

The Roux-en-Y gastric bypass was considered the "gold standard" of weight loss surgery, restricting the amount of food consumed and modifying hormonal level of ghrelin, decreasing appetite an enhance satiety. But is technically more complex than LAGB or laparoscopic sleeve gastrectomy (LSG), has longer hospital stay with possible long-term vitamin/mineral deficiencies (vitamin B12, calcium, folate, iron). Nowadays, remains an effective method to alleviate symptoms of GERD and many bariatric procedures are finally converted to Roux-en-Y bypass [6].

Laparoscopic sleeve gastrectomy (LSG) consist of a vertical division on the larger curvature of the stomach, removing a large portion of the body and all of the fundus, the effect being both restrictive and endocrinologic – reducing ghrelin. LSG is very popular among the bariatric procedures, it induces rapid and sustainable weight loss of > 50% for 3-5 years, has relatively short hospital stay (48h), but is a non-reversable procedure with potential long-term vitamin deficiencies [6]. Also, transforming the stomach into a cylindrical structure and altering the anatomy of the esophago-gastric junction will probably influence the lower esophageal sphincter pressure and esophageal motility.

OBESITY AND ESOPHAGEAL HEALTH

Gastroesophageal reflux disease (GERD) is common in obese patients, and they can be even more sensitive to the presence of acid in the esophagus than a normal weight person. Also, hiatal hernia, a risk factor predisposing to GERD is more prevalent among the obese [7]. Obesity may trigger vagal abnormalities and a higher level of bile and pancreatic enzymes, worsening the effect on esophageal mucosa [8].

According to a meta-analysis published by Halmpel H. et al. in 2005 [9], obesity may increase the risk of GERD symptoms by 50%, and also cause a 2-fold increase in esophageal adenocarcinoma [9]. The pathophysiological mechanisms of increased GERD in obese are: high intraabdominal pressure, frequent hiatal hernia, increased transient lower esophageal sphincter relaxations (TLESR), lower esophageal sphincter (LES) pressure, altered esophageal motility with poor esophageal clearance [10, 11].

The esophageal transit time in obese has been in the researchers preoccupation from1985, when Mercer CD et. al [11] measured it by radionuclide scintigraphy using a swallowed technetium sulfur colloid bolus. The data obtained were compared from obese patients with GERD to normal weight with and without GERD. The esophageal transit time was significantly prolonged in the obese group compared with both lean groups (p less than 0.001). Also performing conventional esophageal manometry theyconfirmed that in obese patients gastroesophageal pressure gradient is elevated [12].

Furthermore, in a study published in Obese Surgery in 1999, Jaffin BW et al. revealed a high prevalence of asymptomatic esophageal motility disorders among morbidly obese patients. During a 3-year period, they evaluated manometric and completed a questionnaire of symptoms, medications, demographic data, other medical conditions associated, 111 obese patients for bariatric surgery. Abnormal manometric findings were observed in 61% patients: 14% hypertensive contractions of the esophageal body, 7% diffuse esophageal spasm (DES), 1% achalasia, 25% hypotensive lower esophageal sphincter defined by LES pressure < 10 mm Hg, and 14% were nonspecific esophageal motility disorders [13].

Similar results have been obtained by Koppman's team [14], after performing esophageal manometric evaluation in 116

obese patients selected for laparoscopic gastric banding in 2003. 41% of the patients had abnormal manometric findings: 23% nonspecific esophageal motility disorders, 11% hypertensive contractions, 1% diffuse esophageal spasm, 1% achalasia, 3% isolated hypertensive LES pressure (>35 mmHg), 3% isolated hypotensive LES pressure (<12 mmHg). Only one patient with abnormal esophageal motility reported noncardiac chest pain [14].

LAPAROSCOPIC SLEEVE GASTRECTOMY AND ESOPHAGEAL MOTILITY

In a review of the impact of laparoscopic sleeve gastrectomy on gastrointestinal motility, published in 2018 by Eleni Sioka et al. [15], after a search of the medical literature with two independent reviewers, they selected only 9 eligible studies that focused on esophageal motility [16]. The esophageal motility data were debatable, with differences regarding the follow-up timing (from 6 weeks to median 13 months), the study design, the surgical technique, the bougie size, and the distance from pylorus. To clarify this subject we need more data from future prospective studies on larger cohorts.

Del Genio G et al. [17] studied the impact of LSG on esophageal physiology, performing high-resolution impedance manometry (HRiM) combined 24-h pH and multichannel intraluminal impedance (MII-pH) before and after the procedure, in 25 patiens. After a median follow-up of 13 months, HRiM showed increased ineffective peristalsis and incomplete bolus transit, but normal LES function.

In a retrospective analysis of 53 cases of HRiM performed after LSG, Mion F. et al. [18] found in 77% of patients an increased intragastric pressure (IIGP), even if they were asymptomatic with no specific manometric or impedance changes, and this could be assimilated as a manometric marker of LSG.

An interesting study of Petersen WV et al. [19] published in 2012, proved that LSG increased lower esophageal pressure independent of weight loss achieved after the procedure, thus protecting obese patients from gastroesophageal reflux.

Dysphagia was reported after laparoscopic sleeve gastrectomy, but usually associated with narrowing of the gastric sleeve which means inability to pass a 9.6 mm gastroscope due to stenosis or a sharp angulation [19]. In a study published by A. Nath et al. in september 2016, from 352 patients included, 22.7 % had dysphagia, 9.3% narrow sleeve, 7.1 % sharp angulation, 2.3% stenosis, and they responded well to ballon dilatation (1-3 sessions). Other medical conditions were associated with post-operative dysphagia: esophageal reflux, diabetes, low tiamine level, opioids and non-steroidal anti-inflammatory drugs or hypothyroidism, so dysphagia is not a specific esophageal motility disorder sign [20].

PRACTICAL CONSIDERATIONS

We performed a prospective study in Carol Davila University Central Emergency Military Hospital to determine the manometric pattern of obese patients, the prevalence of esophageal motility disorders prior and after gastric sleeve and the upper GI complications post sleeve.

The aim was to do high-resolution esophageal manometry (HRM) to all obese patients proposed for LSG, before and 6 to 12 months after the procedure, plus upper GI tract endoscopy and GERD questionnaire (GERD-HRLQ). Starting from January 2017, we included in the study 61 morbid obese patients evaluated both endoscopically and manometric. The exclusion criteria were: previous gastric surgery, another bariatric procedure surgical or endoscopically, the use of medications that could affect esophageal contractility or lower esophageal sphincter pressure (prokinetics, calcium-blockers, nitrates). Half of the patients are now in the post-operative evaluation period, because of surgical intervention timing, and the final results will be later published.

Esophageal manometry was performed with a 36-channel High-Resolution Solid State Catheter from Sierra-Given, after 6 h of fasting and previous upper GI tract endoscopy evaluation. The manometric data were obtained through 10 single test swallows of 5 ml of water. The HRM results were then analyzed according to the Chicago Classification v3.0 of esophageal motility disorders, using the ManoView ESO software program (component of the ManoScan system), providing visual images and quantitative physiological parameters.

The principal manometric variables analyzed [21] were summarized in the Table 2.

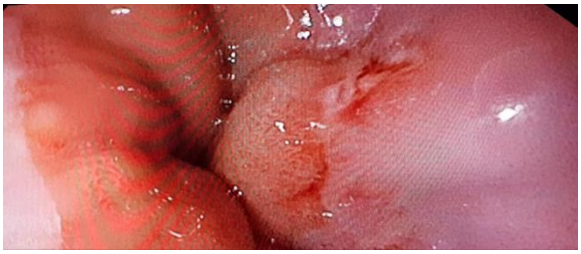
Diffuse esophageal spasm (DES) causes chest pain and sometimes mixed dysphagia for both liquids and solids. The substernal chest pain may waken the patient from sleep or is associated with exercise and often confused with angina pectoris. Hot or cold liquids may aggravate the pain. From the current data available, it is possible that in time this disorder to evolve into achalasia with impaired esophageal peristalsis and lack of lower esophageal sphincter relaxation during swallowing. Usually barium swallow may show poor progression of bolus plus simultaneous contractions [22]. Fragmented peristalsis and ineffective motility are minor esophageal motility disorders according to Chicago Classification v3.0 which can be seen also in normal person.

A particular manometric pattern was found during our study, in a 42-year-old female with morbid obesity BMI = 44.81 kg/m^2 (W= 122 kg, H= 165 cm), obstructive sleep apnea and minor GERD symptoms prior to the surgical intervention. The upper gastrointestinal endoscopy revealed erosive esophagitis grade A, duodenitis with Helicobacter pylori infection both treated preoperative.

Table 2: Principal manometric variables analyzed

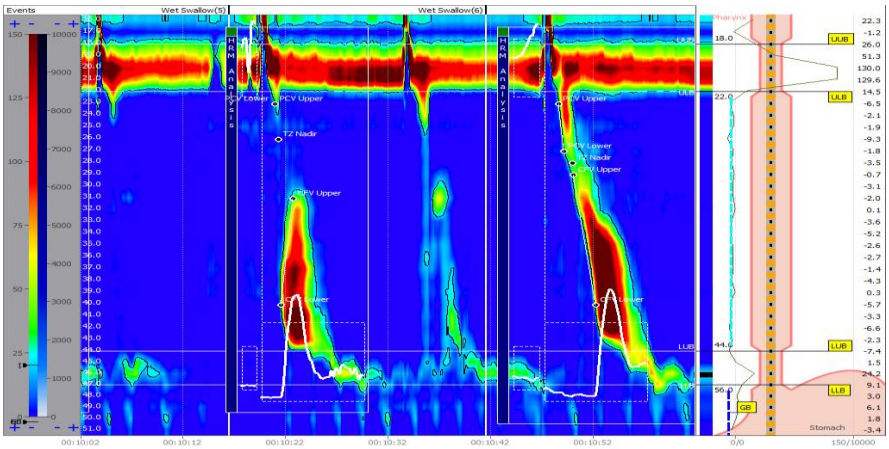
Lower esophageal sphincter(LES) resting pressure	Normal 13-43 mmHg
Deglutitive LES relaxation = Integrated Relaxation Pressure (IRP)	For Sierra-Given solid probe the normal value < 15 mmHg
Esophageal peristalsis = Distal Contractile Integral(DCI)	Normal 500 – 5000 mmHg-cm-sec; > 5000 Hypertensive > 50% contractions weak (DCI < 500) or failed (DCI < 100) = IEM Ineffective motility
Duration of contraction waves in seconds= Distal Latency (DL)	Normal value > 4.5 sec, if 2 contractions are premature < 4.5 sec the diagnose is Diffuse esophageal spasm(DES)
Peristaltic break > 5 cm	More than 50% of swallows = Fragmented peristalsis(FP)

Figure 1: The upper GI tract endoscopy image preoperative – erosive esophagitis grade A Los Angeles Classification



On the preoperative high-resolution esophageal manometry (HRM) she had normal lower esophageal sphincter (LES) basal pressure, LES length = 3 cm, normal deglutitive LES relaxation, with IRP median value of 6.6 mmHg, good esophageal contractility (DCI median= 956.1 mmHg-cm-sec and DCI maximum=1305.7 mmHg-cm-sec) but > 20% premature contraction (distal latency value < 4.5 seconds), aspect of diffuse esophageal spasm according to Chicago Classification v3.0.

Figure 2: Wet 5-ml test swallows recorded with HRM preoperatory – shorten distal latency



Considering the high cardio-vascular risk in a young patient, severe obstructive sleep apnea, the failure of diet and exercise and the need for sustainable weight loss, we didn't contraindicated the laparoscopic sleeve gastrectomy, but we've decided to closely follow the patient.

The laparoscopic surgical intervention went well, with good recovery after the procedure, good tolerance of food intake implementing the diet and exercise protocol. One year after LSG, the patient lost 40 kg, achieved a BMI of 30 kg/m^2 and had 82 kg weight. Clinically, now she had mild dysphagia, early satiety and fullness (that can be related to the low volume of the stomach), and less reflux symptoms compared to baseline.

The result of upper gastrointestinal endoscopy was encouraging: no evidence of erosive esophagitis, a normal gastric scar on the posterior wall of the stomach after LSG, as you can see in Figure 3.

Postoperative data from high-resolution esophageal manometry (HRM) examination revealed normal lower esophageal sphincter basal pressure (mean 20.2 mmHg, min -0.8 mmHg) with normal deglutitive relaxation of LES > 60%, mean IRP value 2.2 mmHg, the same LES length of 3 cm, but more than 50% of the esophageal contractions ineffective, with a DCI < 500 mmHg-cm-sec and normal distal latency,

diagnosis of IEM ineffective motility according to Chicago Classification. Increased intragastric pressure (IIGP) after 5-ml water swallows was observed in 30% of the ten swallows examined.

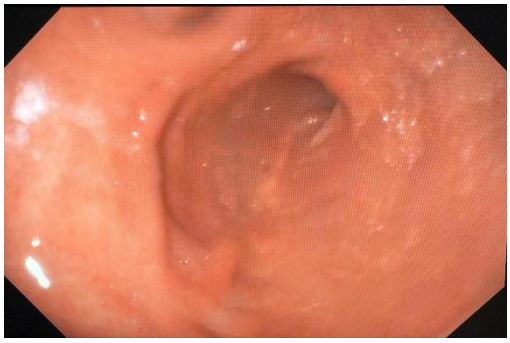


Figure 3: The longitudinal scar on the posterior wall of the stomach after LSG

Figure 4: Wet 5-ml test swallows recorded with HRM postoperatory – ineffective motility

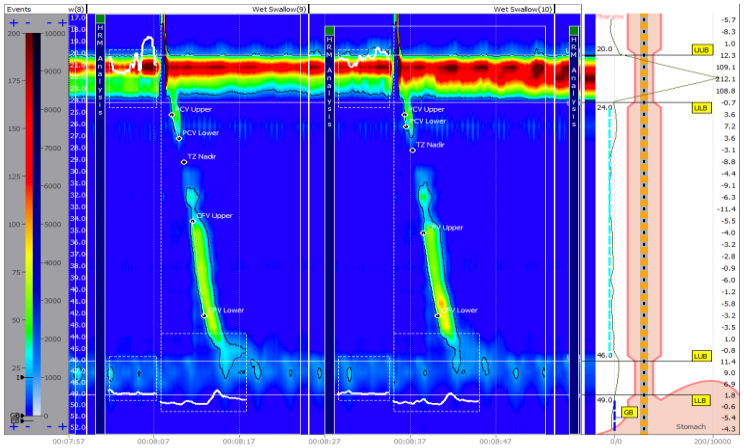


Table 3: The manometric data of LES 1-year after the LSG, no criteria of SED or achalasia as expected

Pressure meas. method	eSleeve	Normal
Basal (respiratory min.)(mmHg)	– 0.8	4.8-32.0
Basal (respiratory mean)(mmHg)	20.2	13-43
Residual IRP (mean)(mmHg)	2.4	<15.0
Residual (highest)(mmHg)	17.9	
Percent relaxation(%)	91	

Table 4: The manometric data of distal esophageal contractility 1-year after LSG (low mean value of DCI = hipocontractility)

High Resolution Parameters		Normal
Distal contractile integral(mean)(mmHg-cm-s)	444.4	500-5000
Distal contractile integral(highest)(mmHg-cm-s)	666.7	
Contractile front velocity(cm/s)	2.9	<9
Intrabolus pressure (@LESR)(mmHg)	– 0.5	<8.4
Intrabolus pressure (avg max)(mmHg)	3.4	<17

Table 5: Detail of all 10 wet test swallows recorded 1-year post LSG (3 failed with DCI < 100 mmHg-cm-sec, 4 weak DCI < 500 mmHg-cm-sec).

	N	Med	1	2	3	4	5	6	7	8	9	10
DCI distal contractil integral (mmHg-cm-sec)	500-5000	444.4	666.7	N/A	422	182.6	N/A	375.7	557	515.2	391.3	N/A

Our patient experienced dysphagia after laparoscopic sleeve gastrectomy, but the GERD symptoms ameliorate. The HRM showed ineffective esophageal motility (IEM) and not achalasia as expected [16]. IEM is considered a minor motility disorder which can be seen also in asymptomatic patients according to Chicago Classification v3.0, but it was also cited by Del Genio G et al. after LSG [17]. We found 30% increased intragastric pressure (IIGP) after water swallows, corresponding to Mion F et al. data [18]. Further manometric follow-up is needed in this patient to see the contractility evolution pattern.

CONCLUSIONS

High resolution manometry (HRM) was already indicated for the preoperative assessment of peristaltic function in patients who needed antireflux surgery, but we consider that it is necessary to extend the HRM recommendation to bariatric surgery for better management of complications.

Studying the manometric changes in obese patients prior to laparoscopic sleeve gastrectomy is important, because it helps to select those patients who could develop postoperative esophageal motor complications and refractory reflux. In addition to upper GI tract endoscopy, high resolution esophageal manometry (HRM) should be required for all patients planning to undergo a LSG.

A proposed alternative to pharmacological treatment to relieve post laparoscopic sleeve gastrectomy GI symptoms is usually the Roux-en-Y gastric bypass, which is considered an effective method to alleviate symptoms of GERD, but it will not resolve the poor esophageal contractility. In conclusion, conversion to gastric bypass is not an universal method for managing GI complications, especially esophageal dysmotility after LSG, so we need to choose wisely the patient eligible for sleeve.

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