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## Hiatal Hernia, GERD, and Sleeve Gastrectomy: a Complex Interplay

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Laparoscopic sleeve gastrectomy (LSG) is considered by most the ideal bariatric procedure because of its simple and straight-forward surgical technique that does not include any digestive anastomosis or intestinal bypass. LSG is also considered as a physiologic procedure because the continuity of the digestive tract is respected. For these reasons, SG is currently the most performed bariatric procedure in many countries [1].

Hiatal hernia (HH) is a frequent condition in the obese patient. Type I HH, defined as the migration of the esophagogastric junction (EGJ) into the chest, is the most common form of HH in obese. Type II is characterized from a localized defect in the phrenoesophageal membrane, while the EGJ remains fixed to the preaortic fascia and the median arcuate ligament. Types III and IV refer to the migration of part of the stomach or other viscera, respectively, into the chest through an enlarged hiatal orifice. The main issue of HH in patients undergoing SG is the association between gastroesophageal reflux disease (GERD) and HH. Indeed, although most bariatric surgeons consider the occurrence of leak at the upper part of the staple line the Achilles'

heel of this procedure, the endeavors of the bariatric community have identified some key factors including the size of the endoluminal bougie, the technique of stapling besides the learning curve that have all contributed to the dramatic reduction in the rate of leak [2, 3]. However, the occurrence of “de novo GERD” in previously asymptomatic patients as well as the aggravation after LSG of preexisting reflux symptoms has now emerged as a main concern linked to this procedure. The relationship between GERD and LSG is complex and multifactorial. The LSG implies the dismantling of some anatomic antireflux mechanisms such as the sling fibers, the His angle, and the partial opening of the hiatal orifice depending on how much the dissection is pushed into the hiatal orifice once the lateral border of the left pillar has been identified. Other factors may be responsible for the occurrence of de novo GERD and/or its aggravation including a stricture of the gastric tube either anatomical or functional, the persistence of part of the gastric fundus, and the caliber of the tube that may determine an increased intraluminal pressure in the gastric tube [4].

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There are significant data indicating that the spatial separation between the EGJ component attributable to the lower esophageal sphincter (LES) and that contributed by the crural diaphragm increased significantly in overweight and obese patients compared with patients with a normal BMI. There is a significant correlation between the separation of EGJ pressure components and anthropometric measurements, especially BMI [5]. Consequently, the rate of erosive esophagitis increases with increasing BMI [6]. Furthermore, the incidence of cardia adenocarcinoma is significantly higher in obese subjects [6] although there is evidence that obesity is an independent risk factor for this cancer [7]. All these data suggest that GERD complicating LSG may become an alarming concern in the next years given the very high number of LSG procedures performed in the world.

However, the literature remains contradictory concerning the effects of LSG on GERD [8] and the role of HH in the occurrence of de novo GERD or its aggravation [9]. First, the definition of GERD in studies reporting the evolution of the latter after the LSG is rather confusing and mainly based on clinical and subjective appreciation of symptoms by the surgeon in the absence of any standardized questionnaires. The definition of HH is based on upper gastrointestinal (GI) endoscopy and/or upper GI series but even more on the subjective appreciation of the surgeon during surgery that is considered the gold standard. Furthermore, differences in the surgical technique with different sizes of the intraluminal bougies and variable dissection of the gastric fundus are other potential confounders accounting for the variable results reported in the literature [4]. One of the largest study comparing the evolution of GERD symptoms after LSG and laparoscopic Roux-en-Y gastric bypass (LRYGBP) showed that after LSG, 84.1 % of patients continued to have GERD symptoms postoperatively and only 15.9 % demonstrated GERD resolution. Of LSG patients who did not present preoperative GERD, 8.6 % developed de novo GERD postoperatively. On the other hand, the LRYGBP was associated with complete resolution of GERD symptoms in 62.8 % of cases while symptoms remained unchanged in 17.6 % and worsened in 2.2 % [10]. These data are particularly interesting in that they are issued from a registry reflecting the results of many bariatric centers that contrast with the results reported in single center series. Furthermore, the most important information is that patients with preexisting GERD keep their GERD symptoms unchanged and the latter worsen only in a minority of patients. These data are in line with the fact that very few patients undergo secondary conversion of LSG to LRYGBP for severe GERD [11]. Indeed, in a recent study, Rosenthal et al. showed that only four patients out of 919 (0.4 %) needed conversion to LRYGBP for severe GERD after LSG [12].

Concerning the effect of the concomitant LSG and HH repair, the literature is even more confusing. Although the concept of concomitant HH repair has been shown to be

associated with initial satisfactory results [13], other more recent studies have questioned the efficacy of the HH repair to reduce the symptoms of GERD and the occurrence of de novo GERD symptoms [14, 15]. To further complicate the problem, some studies report the use of mesh to repair the crura when the pillars are hypotrophic or the defect too large [16]. Different prosthetic materials have been used including non-absorbable, biological, and synthetic absorbable meshes. Although the concept of reinforcing the hiatal orifice is seducing, there is no data indicating its efficacy in the mid-term. Furthermore, its use should be limited to absorbable meshes as the risk of erosion although limited in the case of antireflux surgery [17] not only is theoretically higher due to the concomitant gastrectomy but it may render life-threatening any further surgery of the hiatal region, namely the conversion to LRYGBP in case of persistence of severe GERD symptoms. On the other hand, the efficacy of simple repair as well as the use of absorbable meshes has still to be proved in the long term. Others have used old concepts of antireflux surgery such as the Hill's procedure [18], the use of a fundus wrap [19], or the ligamentum teres procedure [20]. Although all these techniques are interesting, long-term results are still awaited and their systematic use may change the most appealing feature of the LSG, namely its technical simplicity. Another potential problem is the occurrence of de novo GERD in asymptomatic patients in whom a HH is discovered either before or worse during surgery and fixed in order to prevent the occurrence of symptoms. Although this has been reported to be a rare event in the short term [16], it should be taken into account in the balance of benefice/risk when the decision to dissect the hiatal region is taken intraoperatively to fix an asymptomatic HH.

Patients with GERD symptoms should be carefully identified before surgery through the systematic use of dedicated questionnaires. The systematic use of the combination of upper GI endoscopy and series and even better the esophageal high-resolution manometry (HRM) that showed higher sensitivity and specificity compared to the previous two techniques [21] should be used in patients with symptoms as this improves the preoperative diagnosis of a HH [22]. The decision to perform a HH repair should be taken before surgery in most if not all the cases and the potential benefits and risks discussed with the patient. The patient with GERD symptoms should be informed on the fact that symptoms will remain unchanged in most of the cases and he or she will remain on PPI treatment as before surgery. The patient should also be offered the possibility to undergo a LRYGBP that results in a high rate of resolution of GERD symptoms. The LRYGBP remains the operation of choice as it is an effective antireflux procedure when GERD symptoms are severe and associated with endoscopic lesions such as erosive esophagitis and Barrett's esophagus [23]. In case of a HH, care should be taken to dissect the herniated stomach at time of LRYGBP especially in men to avoid to perform a too large pouch. If this implies



the dissection of the crura, the latter should be approximated to avoid the secondary migration of the pouch in the chest through the hiatal orifice.

Finally, when a patient with a LSG complains of invalidating GERD-related symptoms that do not respond to PPIs, thorough investigations should be done including esophageal HRM and/or 24-pH impedance. Not only the GERD has to be proved before taking the decision to proceed with a LRYGBP but also a HH should be ruled out before surgery as any other potential anomalies such as a gastric twist. If a HH is identified, it should be fixed at time of conversion to LRYGBP in order to avoid to miss part of the stomach in the hiatal orifice and to fashion a small, “non-acid producing,” lesser curve-based gastric pouch.

### Compliance with Ethical Standards

**Conflict of Interest** The authors declare that they have no conflict of interest.

**Ethical Statement** This article does not contain any studies with human participants or animals performed by any authors.

**Consent Statement** For this type of study, formal consent is not required.

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