



Sleeve gastrectomy technical parameters that may influence gastroesophageal reflux

Rafael C. Katayama^{1^}, Fernando A. M. Herbella¹, Marco G. Patti², Carlos Haruo Arasaki¹, Rafaella O. Oliveira¹, Ana Clara de Grande¹

¹Department of Surgery, Esophagus and Stomach Division, Federal University of São Paulo, São Paulo, Brazil; ²Department of Surgery, University of Virginia, Charlottesville, VA, USA

Contributions: (I) Conception and design: All authors; (II) Administrative support: RC Katayama, FAM Herbella, MG Patti; (III) Provision of study materials or patients: RC Katayama, FAM Herbella, MG Patti, CH Arasaki; (IV) Collection and assembly of data: RC Katayama, RO Oliveira, AC de Grande; (V) Data analysis and interpretation: RC Katayama, FAM Herbella; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Rafael C. Katayama, MD. Department of Surgery, Esophagus and Stomach Division, Federal University of São Paulo, 715, Napoleão de Barros Street, São Paulo 04024-002, Brazil. Email: rafaelcaue@hotmail.com.

Abstract: Gastroesophageal reflux disease (GERD) after sleeve gastrectomy (SG) is the main drawback of this procedure. GERD occur due to a disbalance between natural anti-reflux mechanisms that need to be continent to a transdiaphragmatic pressure gradient that forces gastric contents upwards. Anatomical and physiological changes as consequences of SG should justify the concern for “*de novo*” GERD or worsening of previous GERD symptoms. There are technical points when performing a SG that may help prevent GERD, such as: careful dissection of the angle of His and avoiding stapling too close to the gastroesophageal junction (GEJ), thus preserving the natural valve mechanism as much as possible; tube wider in the antrum and more adjusted in the GEJ, to promote better transit of the food bolus and reduce gastric stasis, in addition to avoiding twisting of the tube during stapling that occurs with stenosis; and calibration of the pouch using a 32–36 F bougie and carry out the complete mobilization of the gastric fundus before the resection. It is relevant to evaluate the presence of a hiatal hernia and suture/close it when it is defective. GERD may be avoidable if these technical points are followed. However, there is a lack of SG standardization in the literature which hinders the performance of the “perfect” SG tube.

Keywords: Sleeve gastrectomy (SG); technical parameters; gastroesophageal reflux; gastric tube; anti-reflux barrier

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Introduction

Obesity is a troublesome and worldwide growing pandemic disease (1). Bariatric surgery proved to be a very effective treatment regarding weight loss and obesity-related comorbidities control (2-4). Sleeve gastrectomy (SG) is one of the most performed procedures with a strong tendency of growth, perhaps because it is technically less

challenging than the gold standard Roux-en-Y gastric bypass (RYGB) (5-7).

Comparing the procedures (SG *vs.* RYGB), good efficiency of both is observed in relation to the percentage and maintenance of long-term weight loss, as well as obesity-related comorbidities control (8-10). However, gastroesophageal reflux disease (GERD) after SG is

[^] ORCID: 0000-0001-9403-8971.

the main drawback of this procedure. Anatomical and physiological changes as consequences of SG should justify the concern for “*de novo*” GERD or worsening of previous GERD symptoms.

The prevalence of GERD in the Western world is high and varies between 10–20% of adults (11), increasing significantly in obese patients (12,13), in whom it may reach 70% (14). The literature is controversial about the incidence of GERD after SG, and surprisingly it can vary from 9% to 60% (9–11).

This review aims to bring an overview of SG technical parameters that may influence GERD and the need for more studies in the field.

GERD pathophysiology

GERD occur due to a disbalance between natural anti-reflux mechanisms that need to be continent to a transdiaphragmatic pressure gradient that forces gastric contents upwards.

Valvular mechanism

- (I) Lower esophageal sphincter (LES): muscular structure that allows the passage of food in a coordinated way from the esophagus towards the stomach, but also prevents food, acid, and bile reflux back to the esophagus. An inefficient LES is found in most GERD patients, although, it is not a “*sine qua non*” condition for the development of reflux since it depends on the other mechanisms involved in the anti-reflux barrier (15,16).
- (II) Diaphragm and phrenoesophageal membrane: the phrenoesophageal membrane is the continuation of the transversalis fascia, consisting in an elastic fiber compassing the esophagus. It transmits positive pressure on the distal part of the esophagus through the esophageal hiatus, composing the LES mechanism as an extrinsic component (15,17).
- (III) Angle of His and Gubaroff valve: the angulation of the stomach close to the gastroesophageal junction (GEJ) prevents the rise of gastric contents towards the esophagus, increasing the distance between the gastric fundus where the alimentary bolus is laid up, and projecting the fundus toward the esophagus during gastric distention. Gubaroff valves works like a cushion mechanism of the mucosa, in the distal esophagus, in its transition to the stomach at the level of GEJ (15,16).

- (IV) Esophageal peristalsis: through synchronized contractions, they propel the food bolus in one direction from the esophagus to the stomach, in addition to acting on the esophageal “clearance” when physiological reflux occurs (16).

Transdiaphragmatic pressure gradient

The thoracic pressure tends to be negative, promoting relative suction of the gastric contents, while the abdominal pressure tends to be positive, pushing the gastric contents towards the thorax. This gradient is normally balanced by natural valvular mechanisms. However, patients with obesity have greater abdominal pressure, in addition to an increase in the number of transient relaxations of the LES, which can generate an imbalance between these mechanisms, leading to GERD (13).

GERD may occur secondary to an inefficient valve at the GEJ and/or a high transdiaphragmatic pressure gradient surpassing the valve mechanism. Surgical procedures that change this balance should favor GERD.

GERD pathophysiology after SG

SG is a restrictive procedure based on the construction of a narrow gastric tube, providing changes in the angle of His that may favor the occurrence of GERD. Moreover, an increase in the intragastric pouch pressure, mostly attributed to different tube shapes such as excessive pouch narrowing or twists, that vary according to surgeon preferences and patients’ characteristics, may, theoretically, worsen GERD symptoms. Finally, possible damage in the sling fibers of the LES during the stapling may favor a decrease in the basal pressure or transient relaxation of the LES. On the other hand, a decrease in the mass of parietal cells and a hasty gastric emptying in consequence to the gastrectomy, should be a defense against GERD (18) (*Figure 1*).

SG technical parameters to prevent GERD

- (I) Saving sling fibers of the LES: some authors believe that stapling close to the GEJ should damage the muscular structure of LES, consequently increasing the number of transient LES relaxation, decreasing the basal pressure of the LES, and been responsible for the severity of GERD symptoms (19–22). Most of authors suggests that the stapling should be at least 1–2 cm far from the GEJ (19).

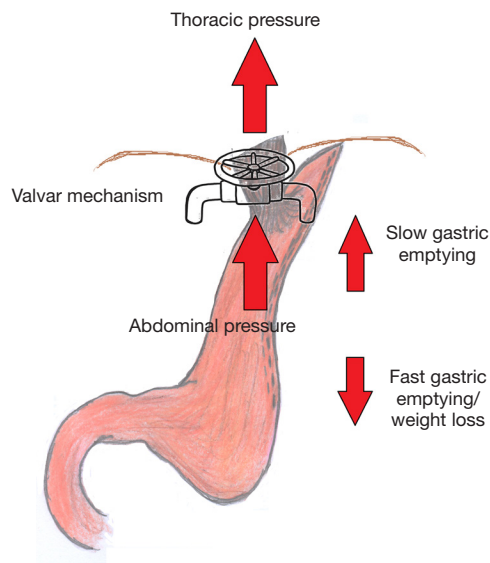


Figure 1 Valvar mechanism and gastroesophageal reflux disease pathophysiology after sleeve gastrectomy. The arrows are demonstrating the direction of the force vector, interacting with the valvar mechanism.

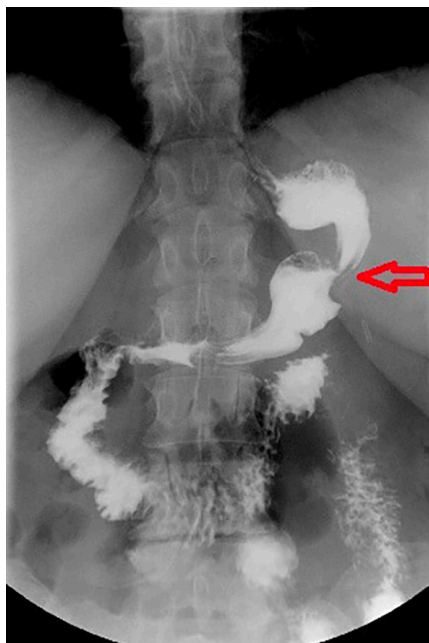


Figure 2 Sleeve gastrectomy with stenosis in the gastric pouch. The arrow is pointing to the antrum stenosis.

(II) Diaphragm and phrenoesophageal membrane dissection should favor the disruption of an important natural anti-reflux barrier, promoting the rising of

- hiatus hernia (HH) (19) that is commonly associated with the imbalance in the anti-reflux barrier. It is essential to carry out an accurate dissection to identify and close the esophageal hiatus when it is enlarged (19).
- (III) Angle of His and Gubaroff valve: Petersen *et al.* demonstrated that the positioning of the stapler line close to the angle of His and without injuring the sling fibers or LES results in higher pressure at the His, consequently, higher LES pressure. On the other hand, a too-narrow stapling at the angle of His, can cause GERD symptoms (23). Moreover, the SG fundus resection causes the angle of His to become obtuse, which is associated with the pathophysiology of GERD (18).
- (IV) Gastric tube: the gastric pouch performed in SG adjusted by a tiny bougie, in addition to the fundus resection could promote a rising in the gastric tube pressure, beyond avoiding the pouch relaxation consequently to the abolishing of the post-feeding vasovagal reflex. Therefore, the decrease in gastric compliance and the rising in gastric pouch pressure should overcome the LES barrier favoring GERD (12,19,21). Moreover, a gastric stenosis or an exceedingly narrow SG could worsen postoperative GERD symptoms (Figure 2). Another concern is related to the tube twisting that can occur during the stapling, which will certainly rise the gastric tube pressure in addition to alimentary stasis (24). For that reason, the SG should be the widest at the antrum (5–6 cm from the pylorus) and the narrowest at the cardia. A retrospective study performed with 120 SG patients has demonstrated that using a 42-Fr bougie has better results on the incidence of GERD after the procedure when compared with a 32-Fr bougie. For the patients with a 42-Fr bougie, almost 80% reported postoperative improvement of GERD symptoms, compared with 60% of patients in the 32-Fr group. Further, GERD symptoms decreased postoperatively in 3% and 10% of the patients, respectively (25). Garay *et al.* had shown that the preservation of the antrum accelerates gastric emptying, reducing GERD by decreasing the intragastric pressure (26). Nevertheless, Hanssen *et al.* concluded that there is a relation between the gastric pouch volume and weight loss, seeming that SG tube ≥ 100 mL at 6 months is associated with poor weight loss (27). That makes controversial to perform the “perfect” SG.
- (V) Weight loss and abdominal pressure: it is estimated

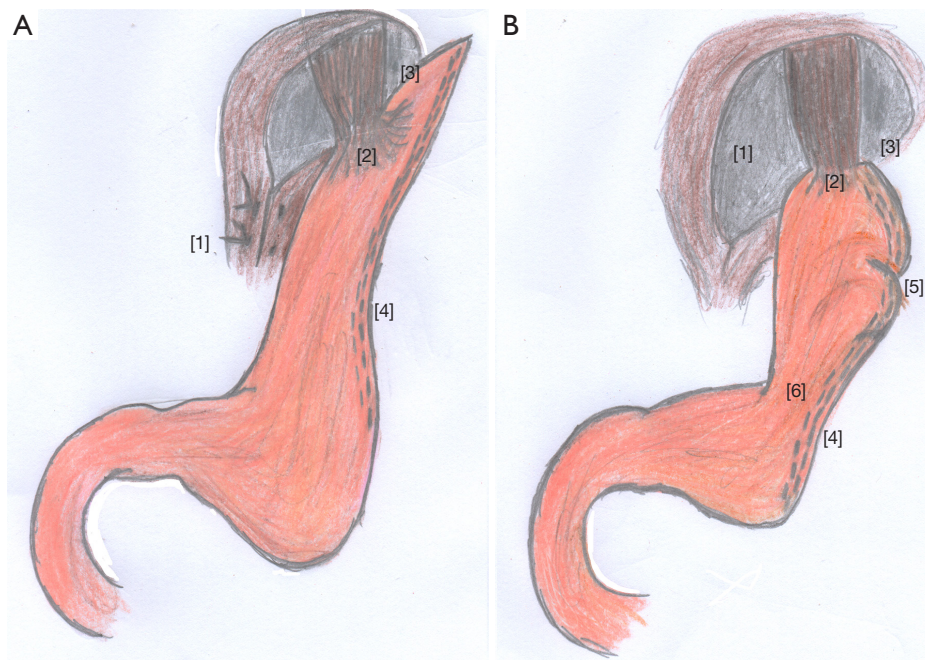


Figure 3 SG technical parameters that can reduce or rise the risk of GERD. (A) SG technical parameters that can reduce the risk of GERD. [1] Suture of the esophageal hiatus; [2] preservation of sling fibers of the LES; [3] stapling 2 cm from the GEJ; [4] stapling 5 cm from the pylorus and gastric pouch without twist. (B) SG technical parameters that can raise the risk of GERD. [1] Enlarged esophagus hiatus; [2] disruption of sling fibers of the LES; [3] disruption of the angle of His; [4] stapling close to the pylorus narrowing the gastric tube; [5] SG tube twists; [6] gastric antrum stenosis. SG, sleeve gastrectomy; GERD, gastroesophageal reflux disease; LES, lower esophageal sphincter; GEJ, gastroesophageal junction.

that 50–60% of excessive weight loss is achieved after 1–2 years of SG (7,8). Weight loss is associated with decreasing in the abdominal pressure which could improve GERD symptoms thus to the reduction in the trans-diaphragmatic pressure (13). Thus, a narrow gastric tube, calibrated by a 32–36 Fr bougie, with a volume no more than 100 mL is essential to provide a satisfactory weight loss (27), and consequently a decrease in the abdominal pressure.

According to these assumptions some authors suggested key points to perform SG. Careful dissection of the angle of His, avoiding stapling too close to the GEJ, thus preserving the natural valve mechanism as much as possible. The tube must be wider in the antrum and more adjusted in the GEJ, to promote better transit of the food bolus and reduce gastric stasis, in addition to avoiding twisting of the tube during stapling that occurs with stenosis; calibrate the pouch by bougie 32–36 Fr and carry out the complete mobilization of the gastric fundus before the resection (28,29). It is important to evaluate the presence of a hiatal hernia and suture/close it when it is defective (6,8).

Braghetto *et al.* could demonstrate a hiatal hernia incidence of 5% after SG in patients without HH previously (19). Although there is insufficient evidence in the literature, and weight loss should be a protect factor to hiatal hernia recurrence, a panel of specialists agreed that it is important to fix the HH when performing SG (28,30) (*Figure 3*).

The literature large variation in the incidence of GERD after SG is intriguing. Chhabra *et al.* have demonstrated an important variation in SG key technical points when surgical SG videos were evaluated by peers, and could find a relation between the technique adopted and early complications (31). Probably the lack of SG standardization combined with technical difficulties inherent to patient's characteristics may justify those findings.

Conclusions

SG can provide anatomical and physiological changes which should ultimately favor GERD. There are technical parameters when performing SG to avoid GERD. However, there is a lack of SG standardization in the literature which

hinders the performance of the “perfect” SG tube. More studies are needed to put some light on the topic.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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