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The Sleeve Gastrectomy: Evidences and Controversies

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Abstract

Surgery of obesity has constantly grown over the past twenty years. Several surgical approaches are proposed, including the Sleeve Gastrectomy. It is technically simple, does not involve anastomoses and it is becoming popular. However, it is still subject to controversy. We intend, through a review of the litterature, to study the technical particularities and the results of the Sleeve Gastrectomy to clarify its role and its place in bariatric surgery.

Keywords: Sleeve gastrectomy; Laparoscopy; Weight loss; Complications.

Introduction

Obesity now represents a public global health problem. The World Health Organization estimates the number of obese people in the World (Body Mass Index (BMI) over 30 kg/m^2), to be over 500 million people [1]. For twenty years, various surgical techniques have been proposed to lose excess weight and reduce the impact of comorbidities associated with obesity. Recently, a new procedure has become popular - the Longitudinal Gastrectomy, also know as "Sleeve" Gastrectomy **(SG)**. This attractive and promising technique has continued to develop for ten years, but is still subject to several controversies. We propose to make an update and review of the literature concerning the results of the SG and locate its place in the surgical treatment of morbid obesity.

History of Sleeve Gastrectomy

It was initially described by Hess and Hess [2] Marceau et al. [3], in 1988, as the first restrictive part of a surgical malabsorptive procedure called "duodenal switch". The isolated form of the SG was described for the first time in 1993, by Johnson et al. [4].

The first Indications concerned "super" obese patients (BMI>60 kg/m^2) and those with a high anesthetic risk related to several comorbidities. At the time, bariatric surgery was performed in 2 separated operating times. The purpose of this first surgical step (SG) was to reach a consistent initial weight loss able to reduce the technical difficulties, and thus the perioperative morbidity [5,6]. The second step (malabsorptive step) was performed within six months. Because of the encouraging initial results, the SG, considered technically easier and relatively faster than other malabsorptive bariatric procedures, was then used as an independant technique, showing a low rate of complications, a comparable excess weigh loss, and a significant decrease of comorbidities [6,7].

Principles

The SG involves removing a large part of the stomach to form a tube and reduce the reservoir function of the stomach. Compared to other bariatric surgical techniques, the SG appears to be an attractive technique as it theoretically offers several benefits: it is easy to perform; it preserves the pylorus, entails no anastomoses, does not imply adding any foreign body, shows no risk of internal hernia, and does not prevent the exploration of the digestive tract.

Gastric tubulisation is made under calibration probes, along the lesser curvature of stomach. A small calibrator (32-42 French) is generally preferred instead to 60 French probes [8-10]. Stapling - section of the stomach is often a retaining part of the antrum starting 5-6 cm proximal to the pylorus, the line section is then parallel to the lesser curvature, ending 1 cm left of esophagus.

Procedures to enhance the seal of the staple line have not yet been unanimously approved [11,12]. Similarly, there is no consensus on the type of staples applied at tubulisation stage. In a small experimental series, Fournier et al. [13] showed that the height of the staples used is a key factor in the development of a fistula on a SG. Indeed, staples low rise are more resistant. Strengthening the line of stapling Biosyn (transparent film, thin and resorbable) further increases the resistance. Removing a portion of the stomach under 500 mL seems to be a failure and weight regain factor [14].

"Sleeve" and Weight Loss

Weight loss after SG is partly based on a gastric restrictive mechanism tubulisation which reduces the size of the new stomach. The SG has also a hormonal effect. By removing the gastric fundus, the secretion of ghrelin, a hormone that stimulates appetite secreted by fundic parietal cells, is almost stopped, causing loss of appetite. Similarly, some studies have shown the existence of high levels of the peptide hormone-YY (hormone that decreases appetite) and glucagon-like peptide-1 (pancreatic hormone that increases insulin secretion) after "Sleeve", leading to prolonged satiety, a decrease in gluconeogenesis and an increase in insulin secretion [15,16]. A recent large series of about 1000 SG reported an excess weight loss of 86.6% at 1 year, 84.2% at 2 years and 84.5% at 3 years from the intervention [8]. In a systematic review, Brethauer et al. [17] showed an excess weight loss **(EWL)** of 55.4% (1,662 cases) and a mean BMI decrease from 51.2 to 37.1 kg/m^2 after SG (n = 1,940), with a maximum decrease at 5 years (3 months to 60 months). The most recent studies show a drop in excess weight loss at rates of 50-59% after 5 years postoperatively [9,18-22]. Based on 15 RCTs, comprising a total of 1,191 patients, out of which 795 had undergone LSG, Trastulli et al. [23] reported the EWL ranged from 49% to 81% in the SG group, from 62.1% to 94.4% in the Laparoscopic Gastric By-pass **(LGB)** group, and from 28.7% to 48% in the Laparoscopic Adjustable Gastric Banding **(LAGB)** group, with a follow-up ranging from 6 months to 3 years. However, reviewing the main studies comparing the SG to the LGB, we found almost similar results regarding to the weight excess loss (Table 1).

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Author	Year	Patients	% WEL after SG	% WEL after LGB	Follow up (year)	Significant difference (p)
Kehagias [24]	2011	30 SG / 30 LGB	68%	62%	3	>0.05
Lyeba [25]	2011	42 SG / 75 LGB	78.8%	86%	3	>0.05
Woelnerhanssen [26]	2011 **(RCT)**	11 SG / 12 LGB	27,9%	34,5%	1	>0.05
Lee [27]	2011 **(RCT)**	30 SG / 30 LGB	76,3%	94,4%	1	>0.05
Boza [28]	2012	811 SG / 786 LGB	86,8%	93,1%	3	>0.05
Vidal [29]	2013	114 SG / 135 LGB	65%	66%	4	>0.05
Abdeladi [30]	2013	34 SG / 36 LGB	57,1%	77,6%	1,5	**0.003**

Table 1: Studies comparing percentage of excess weight loss after Sleeve gastrectomy laparoscopic Gastric By-pass.

	Moon Han [39]	Silecchia [40]	Cottam [5]	Catheline [19]	Zachariah [41]
Year	2005	2006	2006	2013	2013
Patients	60	41	126	65	228
Follow-up (months)	12	18	12	60	60
Type II Diabète	100%	79,6%	81%	61,5%	66%
High blood pressure	93%	62,5%	78%	55%	100%
Hyperlipidemia	45%	-	73%	58,3%	50%
Sleep apnea	100%	56,2	80%	75%	-
Degenerative joint disease	76%	-	85%	-	-

Table 2: Improvement of comorbidities after Sleeve Gastrectomy.

Article	Year	Patients (n)	Percentage of leaks
Moon Han [39]	2005	130	0.7
Hamoui N [7]	2006	118	0.8
Moy [49]	2008	135	1.4
Serra [50]	2007	993	0.6
Lalor [51]	2008	148	0.7
Felberbauer [52]	2008	126	3
Casella [53]	2009	200	3
Burgos [54]	2009	214	3.2
Stroh [55]	2009	144	7
Ser [56]	2010	118	3.4
Armstrong [57]	2010	185	0
Bellanger [58]	2011	529	0

Table 3: Incidence of gastric leak after Sleeve Gastrectomy.

"Sleeve" and Comorbidities

One of the major challenges of bariatric surgery is the control of diabetes. It is now well established that the SG has a remission rate greater than the non-surgical treatment [31,32]. The disappearance of type II diabetes occurs in 60-96 % of patients operated by SG [33]. In a systematic review, Gill et al. [34] showed a complete remission of diabetes in 66.2% of cases, improvements in 29.9% of cases and stabilization in 13.1% of cases within average 13.1 months. These results are similar to those obtained by the LGB at short term in comparative studies [24, 25, 35, 36], but seems to be inferior after 5 years in non comparative studies [37,38].

Other co-morbidities, such as hypertension, dyslipidemia, arthritis and sleep apnea, are clearly improved after SG, which giveswith satisfactory results (Table 2).

It was also demonstrated that the SG significantly reduced the risk of developing coronary heart disease from the first 6 months postoperatively, and allows a significant risk reduction by up to 80% within 12 months after intervention [42]. Pimenta et al. [43] concluded that quality of life has improved with 92.5 % of patients after an average 19.1 months.

After a 1 year follow-up, Zhang et al. [44], found similar comorbidity remission rates between SG and LGB for sleep apnea (91.2 vs. 82.8%; P = 0.338), hyperlipidemia (63 vs. 55.8%; P = 0.633), hypertension (38.8 vs. 52.9%; P = 0.062), diabetes (58.6 vs. 65.5%; P = 0.638) and musculoskeletal disease (66.7 vs. 79.4%; P = 0.472).

Complications of "Sleeve"

The mortality rate reported in the literature varies between 0 and 3.3% with a majority of publications reporting a rate close to 0% [18,45,46].

The complication rate after SG varies in the literature, ranging from 0 to 29% [18]. Most of these are minor complications, such as wound infections or non-major bleeding. Major complications were significantly less for sleeve gastrectomy patients (4.6%) compared with patients who had laparoscopic gastric bypass (10.6%) or duodenal switch (39.3%) by the same surgeons [10]. The overall morbidity seems to be comparable to the bypass, ranging between 4.6 and 20.5% in the literature [18,47,48]. Two RCTs [10,24] reported a significantly higher incidence of complications in LGB the group than in the LSG group, but there was no major difference in reoperation between the 2 groups. The most feared complication after SG is leakage on the staple line, occurring in 0 to 7% of cases (Table 3).

It is a serious complication requiring complex and non-consensual

management. The international Sleeve Gastrectomy Expert Panel Consensus Statement in 2011 reported a gastric leakage rate of 1.06% based on the study of 12,799 cases [59]. In a systematic review, the rate of leaks found was 2.4% (115 out of 4,888 SG). The leakage location is usually proximal to the oesogastric junction (89% of cases). Half of them are diagnosed after the 10th post-operative day [60]. The causes of these fistulas are not yet elucidated. Several theories have been advanced, including one that impugned increased intragastric pressure following pyloric dysfunction or loss of gastric compliance [46,61]. According to Baker et al. [62] the cause of the fistula can be either mechanical with fistulas declared at the 2nd or 3rd postoperative day or ischemic responsible in fistula at 5th or 6th postoperative day.

How to avoid fistula?

The surgical technique used is of vital importance to reduce the risk of postoperative complications, among which are leaks. Using a larger bougie size may give greater clearance at the dreaded esophagogastric junction thereby reducing the risk of leak. According to Aurora et al. [60], the risk of these fistulas is increased in patients with a BMI>50 kg/m² when using probe calibration <40 French. Surgeons who used a bougie size of 40-Fr or greater had a 0.6% leak rate (5/897 cases) however, the leak rate was 2.8% (110/3,991) in groups who used a bougie size <40-Fr (P<0.05). This difference was statistically significant, thus favoring the use of a bougie of 40-Fr to avoid leak, but it was independent of BMI.

Does staple-line re-enforcement prevent fistula?

Baltasar et al. [46] protect the staple line with a continuous sero-serous suture (from the angle of Hiss to the half-way point, and a second continuous suture from this point to the end) that inverts the staples, controls bleeding, and reduces the number of leaks, without increasing the cost of the procedure. No evidence based results are confirming this technic. Aurora et al [60] report that 675 SG performed using staple-line reenforcement had a leak rate of 3%. On the contrary surgeons that did not reenforce the stapleline by any means had 16 leaks out of 688 patients (or 2.3%).

Recently, fibrin glue was used to cover the staple-line to prevent fistula and hemorrhage. Bellanger et al. [58] published their study of 529 cases using fibrin glue without a leak. Other studies have reported that these materials reduce the number of leaks [63,64], but the evidence for the use of fibrin glue is currently limited and will require larger controlled studies.

Other authors used to begin tissue compression carefully, when using endostaples, and sustain this position for enough time to allow the tissue fluids to exit, as well as to carefully place the staples [62]. Some authors advise waiting for around 10 s before beginning stapling [57].

Some other principles are reiterated throughout much of the literature to prevent fistula after SG such as: avoid creating a stricture by not stapling too close to the incisura, avoid stapling too close to the GE junction [58], optimal use of endostaplers, prevention of distal stenosis, and good hemostasis without damaging tissues [54].

How to manage the fistula?

The treatment of fistulas that appear after SG is very problematic and controversial. What remains difficult is to stop the leak. Management mainly depends on the state of the patient.

Patients presenting hemodynamic instability, complicated fistulas or signs of sepsis require surgical reintervention [65]. In case of early fistula (<3 days after surgery), some authors support primary repair, when possible, despite a high percentage of recurrences [54]. If it is not technically possible or in the case of late fistulas, washing out the cavity and placing a drain seems to be the best option. Some authors have used endoscopically placed fibrin glue with variable success [53].

On the other hand, stable patients without a sepsis, or those who develop fistulas after a long postoperative period, should be managed conservatively by placing a drain under radiologic or endoscopic control, parenteral or better an early enteral nutrition [50,53], high-dose proton pump inhibitors, and the use of broad spectrum antibiotics.

When the fistula persists for more than 4 weeks or the size of collection does not clearly decrease, most authors have supported the use of gastric flexible coated stents as a second step [50,53,66–69] placed under endoscopy or fluoroscopic guidance, combined with percutaneous drainage and a short duration of parenteral nutrition usually provide a good result. It is recommended a period of 6 to 8 weeks as the optimal time to withdraw the stent [66]. Patients who do not respond to any of these procedures and those with persistent fistula are candidates for three types of reintervention: conversion to gastric bypass, Roux en-Y, or total gastrectomy [70,71].

The second most frequently reported complication of the SG is gastroesophageal reflux disease (GERD). This is a complication that can occur in 12.1% of cases (± 8.9 %) [59]. However, the rates reported in literature are highly variable and sometimes contradictory. Carter et al. [72] in a retrospective study, found an increase in GERD during the first postoperative month of 12.6 % and a late increase of GERD by 14% with a mean follow-up of 32 weeks. Prospective multicenter study done by Nocca et al. [73] on 163 patients showed an increased incidence of GERD by 5.7%. Tai et al. [74] in his prospective study conducted by a single surgeon operator showed an increase in GERD by 34.9 %, the highest rate reported in the literature.

Several theories have been advanced to explain the role of the SG in the genesis and exacerbation of GERD, but proved unfounded. The only evidence is the existence of a hypotonic lower esophageal sphincter after a SG [75] and the existence of hypotonia of the digestive tract after a fall in ghrelin rate in animals [76]. It thus seems logical to avoid this procedure in patients with GERD because of the risk of worsening postoperatively [77]. Most experts recommend making a 24 hours ph monitoring test for sreening of GERD before making a SG. If there is a hiatal hernia, it is recommended to repare it by closing the diaphragm pillars intraoperatively before performing SG [59,78,79]. Patients with persistent GERD after SG can be treated by a conversion to Roux-en-Y Gastric Bypass [80].

In contrast, other studies report that SG can improve symptoms and reduce the rate of GERD by up to 20% [14,81,82]. No evidence-based theory can explain these results. However it should be noted, that all results reported in the literature on GERD after SG, lack uniformity and accuracy as the criteria for the definition and diagnosis of GERD.

Conclusion

The Sleeve Gastrectomy is a new, simple bariatric procedure which entails no anastomoses. It has many technical variations and it is subject to much controversy. It seems preferable to use calibration probes around 40 French. No consensus has developed on the types of stapling used or the methods of strengthening the staple line. The main complication is severe gastric fistula. No study has succeeded in

demonstrating risk factors of this complication. Fistula management is difficult and should combine different procedures. SG may aggravate and be responsible for GERD, so it seems reasonable to avoid SG in patients with GERD. The results of the SG in terms of weight loss and control of comorbidities are encouraging at medium term but seems to fade over time, however without dropping any lower after 5 to 6 years. Comparing to gastric by-pass, SG can be proposed as a surgical technique at first intension in patients not having GERD.

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