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ORIGINAL ARTICLE

Does Contouring of the Sleeve Help Prevent *de novo* GERD after Laparoscopic Sleeve Gastrectomy? A Nonrandomized Study

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Purpose: The authors undertook this study to compare their modified version of sleeve gastrectomy with conventional sleeve gastrectomy in terms of the severity and incidence of gastroesophageal reflux. **Materials and Methods:** This study was conducted for the patients that underwent primary laparoscopic sleeve gastrectomy in a single center from 2011 to 2015. Patients that underwent conventional LSG were allocated to Group A (n=46), and sleeve contouring gastrectomy to Group B (n=45). Postoperatively %EBMIL, PPI use, and endoscopy findings, and receipt of conversion surgery were compared. **Results:** Age, gender (F:M), and baseline BMI in groups A and B were 34.2±10.5 years vs. 30.9±8.9 years (P=0.142), 28:18 vs. 30:15 (P=0.565), and 36.8±8.9 kg/m^2 vs. 35.5±5.8 kg/m^2 (P=0.046), respectively. %EBMIL values at 1 year postoperatively were not different (P=0.946), mean durations of PPI use were 141.2±240.3 (30-1160) days vs. 71.9±24.3 (60-128) days, respectively (P=0.058). Endoscopic findings at 1 year were LA-M in 22/32 (68.8%) vs 19/24 (79.2%), LA-A in 7/32 (21.9%) vs. 5/24 (20.8%), LA-B in 1/32 (3.1%) vs. 0/24 (0.0%), and LA-C in 2/32 (6.3%) vs. 0/24 (0.0%) (P=0.483). Numbers of patients used PPIs over 1 year were 4/46 (8.77%) vs. 0/45 (0.0%) (P=0.043), and conversions to RYGP were 1/46 (2.21%) vs. 0/45 (0.0%), respectively (P=0.320). **Conclusion:** Contouring of the sleeve in LSG in this study might reduce the incidence of *de novo* GERD without compromising weight loss.

Key Words: Laparoscopic sleeve gastrectomy, GERD, Hiatal hernia, Complication

INTRODUCTION

Laparoscopic sleeve gastrectomy (LSG) has gained popularity as a primary bariatric procedure for the morbidly obese due to its simplicity, excellent weight loss, and relatively freedom from major complications as compared with Roux-en-Y gastric bypass. In a recent study by the American College of Surgeons' National Surgical Quality Improvement Program (NSQIP), Roux-en-Y gastric bypass (RYGB), adjustable gastric band, and SG comprised 58.4, 28.8, and 9.3% of the procedures in 2010, which changed to 37.6, 3.1, and 58.2% in 2014, respectively [1]. However, a small number of patients suffer from gastroesophageal reflux disease (GERD) after LSG, that is, *de novo* GERD or GERD aggravation in those with GERD preoperatively. Many studies have been performed on conversion LSG to gastric bypass due to intolerable GERD after LSG [2-5], and many suggestions have been made regarding the cause of GERD [6]. High intraluminal pressure from narrow tube-like stomach with an intact pylorus sphincter play a major role in the development of GERD or a low esophageal sphincter complex (e.g. sling muscle fiber of cardia) could be

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damaged intraoperatively and cause GE reflux. However, our clinical experience it that the majority of LSG patients experience GERD when they overeat or eat food incompatible with the sleeve. Furthermore, these phenomenon are more prominent after technical modifications when making a tube-like stomach to avoid kinking or narrowing. We hypothesized that the technical modification adopted in this study could ameliorate *de novo* GERD after LSG.

MATERIALS AND METHODS

This single center, retrospective study was conducted by reviewing the prospectively collected data of patients that underwent LSG at the Gil Medical Center (Gachon University, Incheon, South Korea) from 2011 to 2015. These dates were selected in order to recruit patients within 1 year of surgery, that is, with a follow-up of at least 1 year. The guidelines issued by the Asian Consensus Meeting on Metabolic Surgery (ACMOM 2008, Trivandrum, India) for BMI restriction using bariatric surgery (http://www.acmoms.com/acmom_2008.html) were followed throughout. All procedures were approved beforehand by the ethical standards committee at our institution. Endoscopic procedures were performed in an endoscopy unit using GIF-Q260 or GIF-H260 endoscopes (Olympus Medical Systems Corp., Tokyo). Those who suffered from GER and those with a diagnosis or hiatal hernia (HH) preoperatively were excluded from the study. Revision LSG for failed bariatric procedures was also excluded. After encountering patients that suffered from severe postoperative reflux, we modified our surgical technique from the beginning of 2014. Those that underwent surgery before technical modification were allocated to Group A, and those that underwent surgery after technical modification to Group B. The technical modifications included; 1) the use of a new calibration system to guide resection, 2) fixation of a sleeved stomach to retroperitoneal fat, and 3) plication of redundant antrum. Surgical techniques were as follows. In group A, after gastrolysis of the greater omentum, starting 6 cm proximal to the pylorus to the angle of His, a Bougie (32-40 Fr) was inserted along the lesser curvature to lodge into the pylorus. Gastric resection was started at 6 cm from the pylorus, and spared EG junction about 1 cm using sequential five to seven 60 mm staples in parallel direction with Bougie. A seroserosal reinforcement suture was placed using 2-0 Vicryl®. In Group B, we have only used a 36 Fr Bougie. After gastrolysis of the greater omentum starting 6 cm proximal to the pylorus going all the way up to the angle of His, a Bougie (36 Fr) was inserted along the lesser curvature to lodge at the greater curvature 6 cm from the pylorus. Gastric resection was started at 6 cm from the pylorus, and spared EG junction about 1cm using sequential five to seven 60 mm staples in parallel direction with Bougie. In group B, gastric stapling around the gastric angle was performed to maintain more distance from the bougie (as long as 36 Fr=72 Fr from the incisura angularis). A seroserosal reinforcement suture was placed using 2-0 Vicryl®. Using same suture row, in the stomach body, a sleeved stomach was fixed to retroperitoneal fat (peri-pancreatic or mesocolic), and finally, using same suture row, the antral part of the sleeved stomach was plicated (Table 1, Figs. 1, 2). In both groups, HH was aggressively searched. If evidence of weakness was present, an anterior hiatal dissection and suture repair was performed with a nonabsorbable interrupted suture. Fibrin glue and a JP drain were routinely used. After surgery, nil per os was maintained until nausea subsided. Semifowler's position was recommended on the day of surgery. Generous hydration was maintained along with intravenous esomeprazole (Nexium®; AstraZeneca, London, United Kingdom)

Table 1. Surgical techniques adopted for sleeve gastrectomy in this study

Common Surgical Techniques	
Gastric stapling starting 6 cm from pylorus and about 1 cm away from the GE junction at last firing Buttressing staple line with absorbable sutures Aggressive search and repair of hiatal defects	
Group A	**Group B**
Use of 32-40 Fr Bougie	Use 36 Fr Bougie only
Bougie was inserted along the lesser curvature to lodge through the antrum into the duodenum	Bougie was inserted along the lesser curvature to lodge at the greater curvature 6 cm proximal to the pylorus
Gastric stapling parallel the Bougie	Wider distance stapling around the angle
	Sleeve-pexy to retroperitoneal fat
	Plication of redundant antrum

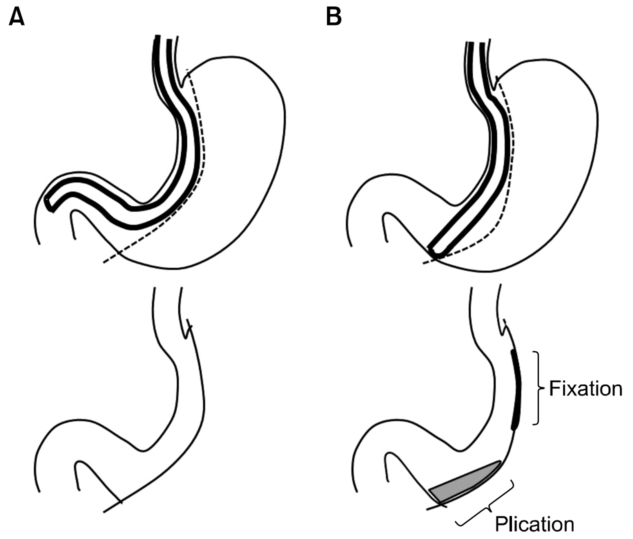

Fig. 1. Schematic drawings of the surgical techniques adopted. (A) Group A. (B) Group B. In group B, wide distance stapling was performed around the angle and Sleeve-pexy to retroperitoneal fat with plication of redundant antrum.

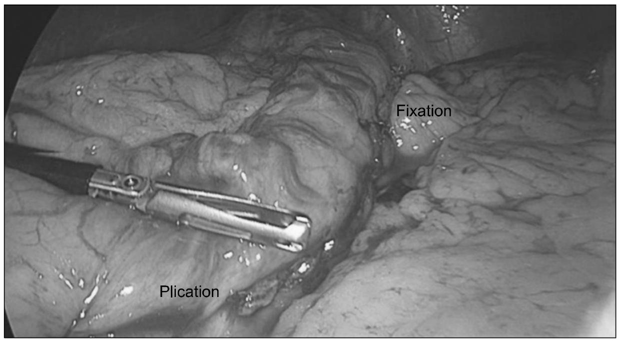

Fig. 2. Sleeve contouring (new calibration + sleeve pexy + antral plication).

(40 mg/day), metoclopramide (Macperan®; Donghwa Pharmaceutical Co., Ltd., Seoul, Republic of Korea) (30 mg/day). Discharge was considered when a patient tolerated sips of water, and on discharge patients were advised to progress to a soft diet in 15 days and to solid food in 30 days.

Oral omeprazole (Losec; AstraZeneca) (40 mg a day or 20 mg twice a day) was prescribed regularly for 2 months in both groups, and the prescription was repeated based on patient symptom during follow-up. Patients in both groups were asked to visit at 1, 3, 6, 12, 18, and 24 months postoperatively and annually thereafter. Ideal body weight was defined as weight corresponding to a BMI of 23 kg/m^2 (the upper limit of normal BMI for Asian populations). %EBMIL (% excess BMI loss) was defined as following formula; % EBMIL=(pre-op BMI − current BMI/pre-op BMI−23)×100. We recommend RYGBP to those who cannot stop taking PPI after postoperative 1 year. Groups' ages, genders, preoperative BMIs, operative findings, and complications were compared. Postoperatively, the two groups were compared with respect to duration of PPI used, and investigated the incidence of long PPI users, and conversion surgery. Information on patient perioperative BMIs, percent excess BMI loss (%EBMILs) were collected during follow-up outpatient visits or by e-mail or telephone. Postop 1 year endoscopic findings of GER were classified using the modified Los Angeles classification system [7]. Data were analyzed using SPSS version 18 (SPSS Chicago). Continuous data are presented as means ± SDs and categorical data as numbers (percentages). The Student's t test and the chi-square test were used to analyze continuous and categorical variables, respectively. Statistical significance was accepted for P values < 0.05.

RESULTS

Ninety-one patients were eligible for this study, and 46 were allocated to group A and 45 to group B. Mean ages, genders (F:M), and baseline BMIs of patients in groups A and B were 34.2 ± 10.5 years vs. 30.9 ± 8.9 years (P=0.142), 28:18 vs. 30:15 (P=0.565), and 36.8 ± 8.9 kg/m^2 vs. 35.5 ± 5.8 kg/m^2 (P=0.046), respectively. Rates of hiatal defect repair were similar (5/46 (10.9%) vs. 7/45 (15.6%), P=0.509). Contouring of sleeve in group B did not take more time because fixation or plication were performed during buttressing staple line with a same row of suture. There were no mortalities or major morbidities such as bleeding, leak, and obstructive symptoms. %EBMIL values at 1 year were 75.5 ± 12.2 % vs. 75.1 ± 12.1 %, respectively (P=0.946). Mean durations (range) of PPI use were 141.2 ± 240.3 (30-1160) days vs. 71.9 ± 24.3 (60-128) days, respectively (P=0.058). One patient in group A did not take PPI regularly (only 30 days) because of discomfort in taking the medication. Endoscopic findings at 1 year (n, %) in groups A and B were as follows; LA-M in 22/32 (68.8%) vs 19/24 (79.2%), LA-A in 7/32 (21.9%) vs. 5/24 (20.8%), LA-B in 1/32 (3.1%) vs. 0/24 (0.0%), and LA-C in 2/32 (6.3%) vs. 0/24 (0.0%) (P=0.483). Rates of PPI use over the 1st postop year were 4/46 (8.77%) vs. 0/45 (0.0%), respectively (P=0.043). The duration of PPI use of those four patients were 414, 806, 1037, 1160 days, respectively and one of those (PPI for 806 days) underwent conversion surgery. Others refused conversion and opted to continue PPI medication. Taken it total, the rates of conversion to RYGP during follow-up were 1/46 (2.21%) vs. 0/45 (0.0%), respectively (P=0.320) (Table 2).

DISCUSSION

"Contouring" can be considered as a novel term in the field of surgery. We have used the term because we focused morphologic changes of sleeved stomach after technical modification. It is a more comprehensive term than individual component (plication, fixation, new calibration) in our techniques. Main finding of this study is that contouring of the sleeve reduced the incidence of *de novo* GERD after LSG regardless of hiatal repair in patients without preoperative GERD. HH has been regarded as the main cause of GERD after LSG, and to be due to anatomic change after LSG: partial opening of the hiatal orifice, which depends on the extent to which dissection is pushed into the hiatal orifice once the lateral border of the left pillar has been identified. In both groups, we aggressively searched HH. If evidence of weakness was present, an anterior hiatal dissection and suture repair was performed with a nonabsorbable interrupted suture, thereby excluding the possibility that the HH affected *de novo* GERD in both groups.

Soricelli et al. [8] reported that "*de novo*" GERD symptoms developed in 22.9% of the patients undergoing SG alone as compared with 0% of patients undergoing SG plus hiatal hernia repair (HHR), and concluded SG with HHR provides good management of GERD. In addition, they also recommended careful examination of the crura be performed intraoperatively during LSG. Daes et al. [9] concluded that careful attention to surgical technique dealing with hiatus can significantly reduce GERD symptoms for up to 12 months after surgery.

Repair of hiatal hernia during LSG has been the standard practice, but it has not been substantiated. International Sleeve Gastrectomy Expert Panel Consensus Statement best practice guidelines based on experience of 12,000 cases [10], indicate aggressive identification of HH intraoperatively is appropriate (83% of experts agree). Furthermore, the panel concluded surgeons should always dissect the phreno-esophageal membrane and inspect the greater curvature side of the stomach for the presence of HH, and that if identified, dissection should be conducted posteriorly to achieve appropriate closure of the crus. If a hernia is found, it should be repaired (82% of experts

Table 2. Demographic and preoperative data of eligible patients. Follow-up data was at least 1 year after sleeve gastrectomy

	Group A (n=46)	Group B (n=45)	P
Preop data			
Age	34.2±10.5	30.9±8.9	0.142
Gender (F:M)	28:18	30:15	0.565
Preoperative BMI	36.8±8.9	35.5±5.8	0.046*
Periop and postop data			
Repair of hiatal defect (%)	5/46 (10.9%)	7/45 (15.6%)	0.509
Postop complication	-	-	
Duration of PPI use (d) (range)	141.2±240.3 (30-1160)	71.9±24.3 (60-128)	0.058
%EBMIL at 1 year	75.5±12.2	75.1±12.1	0.946
Endoscopy at 1 year (n, %)			0.483
LA-M	22/32 (68.8%)	19/24 (79.2%)	
LA-A	7/32 (21.9%)	5/24 (20.8%)	
LA-B	1/32 (3.1%)	0/24 (0.0%)	
LA-C	2/32 (6.3%)	0/24 (0.0%)	
Use PPI >1 year	4/46 (8.77%)	0/45 (0.0%)	0.043*
Conversion to RYGP	1/46 (2.21%)	0/45 (0.0%)	0.320

agree). The diaphragmatic defect should be closed after the sleeve procedure has been completed (71% of experts agree). More recently in the Fifth International Consensus it was agreed the presence of a HH should investigated using identification maneuvers and the left crus and should be repaired (84% of experts agree) [11].

However, Santonicola et al. [12] compared 78 patients with HH that underwent LSG with concomitant HHR and 102 patients without HHR that underwent only LSG. LSG+HHR patients had significantly higher heartburn frequency-intensity scores than LSG patients, which confirmed LSG beneficially relieved GERD symptoms. However, HHR did not produce any improvement in GERD symptoms. Dakour Aridi et al. [13] also assessed the effect of concomitant HHR on postoperative GERD symptoms. GERD remission was observed in 21.3% of patients that underwent concomitant HHR and in 29.7% of those that did not, whereas new-onset GERD symptoms were reported in 41.4% and 46.2% that underwent LSG with HHR or LSG without HHR, respectively. They concluded routine HHR at the time of LSG does not improve GERD symptoms.

Our data also shows, *de novo* GERD occurred in 4/91 patients clinically, despite aggressive searching for and repairing hiatal defects in patients without signs or symptoms of GERD before surgery. Follow-up endoscopy at 1 year postoperatively showed moderate mucosal change due to esophagitis (LA>M) in ~30 % (15/56) of patients. Therefore, although we are not against HHR during LSG, we suggest focus be directed to contouring of the sleeved stomach to prevent *de novo* GERD after LSG, because it is our point of view that the primary mechanism of *de novo* GERD after LSG is a lack of gastric compliance and increased intraluminal pressure caused by gastric fundus removal. Stenard and colleagues suggested that final shape of the sleeve affects the incidence of *de novo* GERD (e.g., narrowing, twisting, and dilatation of the sleeve stomach) [6]. In this regards, our focus in performing LSG was on three anatomical points: 1) fixation of the sleeved stomach in retroperitoneal or mesocolic fat; 2) a wider distance stapling to avoided narrowing the gastric angle; and 3) antral plication (rather than resection) for minimize delayed gastric emptying. Under normal anatomic conditions, the stomach is fixed in place by four "ligaments", that is, the gastrohepatic, gastrosplenic, gastrocolic, and gastrophrenic ligaments, and laxity of these, the absence of omentum, paraesophageal hernia, or diaphragmatic eventrations increase the mobility and ability of the stomach to rotate organo-axially or mesentero-axially [14]. It has recently been reported that loss of abdominal ligament fixation along the greater curvature of the stomach may result in improper gastric pouch positioning and cause food intolerance and persistent reflux [15,16]. Sleeve gastrectomy leaves the stomach with no fixations along the entire greater curvature, which may predispose volvulus [14]. Fixing the sleeved stomach into retroperitoneal or mesocolic fat will prevent this phenomenon, and possibly prevent axial distortion due to postoperative adhesion after withdrawal of the calibrated orogastric tube. Although not applicable to all cases, we recommend fix the staple line to the retroperitoneum especially when the gastric tube tends to coil or is floppy at the end of the procedure. We also focused on the prevention of narrowing of the incisura angularis of the sleeved stomach because sleeve stenosis is serious complication after LSG that presents with food intolerance and *de novo* GERD. Small bougies tend to cause stricture, and conversely large bougies theoretically will produce sleeve dilatation and weight regain [17]. Group A was operated with various size of bougie while group B was operated only with 36 Fr. Initially we routinely used 32 Fr bougie, then we used 36 or 40 Fr bougie according to BMI (40> or 40<). In the four patients in group A taking PPI more than 1 year, the bougie size used was 32 (n=1), 36 (n=2), and 40 (n=1), respectively, thus the relationship of the size of bougie and long usage of PPI was not significant in our study. After technical modification, we used a 36 Fr bougie only, and gastric stapling around the gastric angle was performed to maintain a greater distance from the bougie (as long as 36 Fr=72 Fr from the incisura angularis). Finally, although the role of the gastric antrum has not been fully clarified, it is thought that extensive resection of the antrum may impair gastric emptying and favor GERD [6]. It is important to keep in mind that, LSG should preserve natural functional activity around the pyloric antrum. Therefore, after stapling starts 6 cm from pylorus we plicated the antrum, rather than opting for wide resection (e.g. 2-4 cm from pylorus), to prevent both delayed gastric emptying and possible weight loss failure secondary to antral dilatation.

Our study has several limitations. Most obviously the study design was retrospective and the number of patients includes was relatively small. There were some loss of EGD follow-up at 1 year. The rate for performing EGD is only 32/46 (70%) in group A and 24/53 (53%) in group B, while the follow up population in the PPI usage at >1 year is 46 (100%) and 45 (100%). Even if they were aware of the need for follow-up, they have canceled or did not show up at one 1 year EGD. We analyzed PPI dose mainly based on prescription records, telephone, and e-mail. Since the patient enrollment was differed in time, the proficiency of the surgeon might have influenced the results (learning curve effect). We also excluded patients with GERD or HH preoperatively, who are in question whether these group of patients will benefit from our surgical techniques in terms of GERD progression after LSG. Furthermore, we did not used more sophisticated tools, such as PH manometry. Assessments were largely based on patient reports of reflux symptoms and PPI intake and no detailed, standardized tool was used. Components of contouring (new calibration, fixing, and antral plication) were not individually compared between the two study groups.

Though the clinical efficacy of our contouring technique for preventing postoperative GERD symptoms remains to be proven, no additional cases of severe GERD have occurred among the patients included in the present study treated after making the described technical modifications. Longer follow-up is required to confirm our findings.

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