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Outcomes of primary sleeve gastrectomy versus conversion sleeve gastrectomy in morbidly obese patients

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Purpose: Our aim for this study was to evaluate early and late complications and outcomes of primary sleeve gastrectomy (PSG) versus conversion sleeve gastrectomy (CSG).
Methods: From February 2013 to December 2016, a total of 180 patients underwent sleeve gastrectomy (150 PSG and 30 CSG). All patients received a metal clipping at the end of the stapling line and a continuous seromuscular suture at the resection margin, for reinforcement.
Results: There were no differences in the percentages among males and females or age between the 2 groups, but the body mass index (BMI) of the PSG group was higher at 36.8 ± 4.7 than that of the CSG group (32.4 ± 5.7, $P < 0.001$). Three early postoperative complications were noted in the PSG group; 1 patient underwent repeat laparoscopic exploration due to pancreatic injury, and 2 other patients developed pulmonary atelectasis. On the contrary, 2 early minor complications were noted in the CSG group. Thirty-eight patients (25.3%) in the PSG group developed 43 late, minor complications, while 9 patients (30.0%) developed 11 late minor and 1 major complication in the CSG group. However, there was no difference in complication rate between PSG and CSG. Percentage excess BMI loss at 3, 6, and 12 months after surgery was comparable between the groups.
Conclusion: PSG and CSG were comparable in terms of postoperative complications and loss of weight. Therefore, CSG could be used for failed primary restrictive bariatric surgery. However, the durability of these outcomes remains unknown.
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Key Words: Bariatric surgery, Reoperation

INTRODUCTION

Adjustable gastric banding (AGB) is simple to perform, reversible, and safe [1]. However, AGB can cause numerous complications related to the band itself, including slippage, erosion, migration, and esophageal dilatation, due to gastric outlet obstruction or stenosis [2,3]. According to a nationwide study, the removal rate of AGB at 5, 6, and 7 years was 28%, 34%, and 40%, respectively, and the conversion rate at 7 years was 71% [4]. Sleeve gastrectomy (SG) is superior to AGB in terms of weight loss and impact on obesity related comorbidities [5,6]. As a result, there has been a significant decrease in the number of AGBs performed worldwide, in favor of Roux-en-Y gastric bypass and SG [5-7]. However, even in patients with SG, inadequate weight loss, regaining weight, or complications such as severe gastroesophageal reflux disease, often require revisional bariatric strategies [8]. Revisional or conversion procedures for failed primary bariatric surgery have increased from nearly 0%

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in 2008 to about 5% in 2014 as per a premier database in the United States [7].

SG is one of the options for revisional bariatric surgery. The risk of postoperative complications in patients undergoing revision surgery is higher than that in patients undergoing primary sleeve gastrectomy (PSG) [9,10]. On the other hand, several reports have concluded that SG as a revision procedure is feasible and safe. Moreover, additional weight loss and further resolution of comorbidity appear achievable [5,11]. However, there is still debate about whether SG as a revisional or conversion surgery is safe and effective.

This study aimed to compare the early and late complications, and outcomes of PSG with those of conversion laparoscopic sleeve gastrectomy (CSG).

METHODS

From February 2013 to December 2016, 180 patients who underwent PSG or CSG were enrolled in this study; 150 patients underwent PSG and 30 patients underwent CSG at a minimally invasive obesity surgery center. The indications for CSG included failure to lose weight, gastric band complications (stenosis, erosion, slippage, and infection), and the patient's voluntary choice after previous primary bariatric surgery.

This study was a retrospective analysis of our prospectively collected database. The following demographic data were collected and analyzed: age, sex, body mass index (BMI), comorbidities, the type of primary bariatric surgery, reason for conversion, interval between primary and repeat surgery in CSG, duration of follow-up, duration of surgery, estimated blood loss, simultaneous operation, mean duration of hospital stay, short-term and long-term postoperative complications, and change in the percentage of excess BMI loss (%EBMIL). Percentage of excess BMI loss is derived by dividing the change in BMI from excess BMI at baseline, which was obtained by subtracting the ideal BMI (23 kg/m^2) from the actual BMI. Since the normal range of BMI in adult Asians is 18.5–22.9 kg/m^2, the ideal BMI cutoff is 23 kg/m^2 [12]. Weight loss failure was defined as percentage of excess weight loss (%EWL) $< 50\%$ during the first 1 year after bariatric surgery, and weight regain was diagnosed if %EWL reached $< 50\%$ postoperatively from nadir. Surgical complications were defined as early and late complications, with the cutoff being 30 days after surgery. This study was approved by the Gangnam CHA Medical Center Institutional Review Board (approval number: GCI-16-20).

The surgical procedures for PSG and CSG are not very different. Two 12-mm ports, including one port for the camera, and two 5-mm ports were used, and the Endo-GIA staplers (Ethicon Endo-Surgery, Cincinnati, OH, USA) were applied for SG, following which a continuous seromuscular reinforcement suture at the resection margin was applied. A 36F bougie was used for resection. A point on the greater curvature of the stomach approximately 4 cm proximal to the pylorus was used as the distal resection point [12,13]. One-stage surgery, performed with band-removal and sleeve gastrectomy simultaneously, was planned for patients who did not suffer from complications of the gastric band, such as erosion, stenosis, slippage, or infection. For the patients who underwent CSG due to complications of the gastric band, a 2-stage surgery was planned. The first step was band removal, followed by SG in the second step. The purpose of our study was explained to the patients, and informed consent was obtained.

All patients underwent a routine gastrografin upper gastrointestinal study on postoperative day 1. If the outcome was normal, patients received a clear liquid diet and progressed to a full liquid diet for 1 week. Subsequently, a soft diet was followed for 2 weeks and then advanced to a regular diet in the fourth week. Follow-up visits were scheduled every 3 months in the first postoperative year. Later, follow-up visits were scheduled every 6 months. Telephonic interviews were conducted to obtain information on sought postoperative weight loss and general health status, in patients who were lost to follow-up [12].

Data were analyzed by descriptive statistical methods with the SPSS ver. 18.0 (SPSS Inc., Chicago, IL, USA). They were then presented either as means ± standard deviations or as percentages. The significance of differences between the groups was evaluated using a chi-square test, Fisher exact test, Student t-test or Mann-Whitney test, as appropriate. A P-value ≤ 0.05 was considered statistically significant.

RESULTS

There were no differences in sex and age at baseline, between the 2 groups. However, the BMI of the PSG group was higher at 36.8 ± 4.7 versus 32.4 ± 5.7 of the CSG group ($P < 0.001$). Significant comorbidities in the PSG group compared to the CSG group included fatty liver (50.0% *vs.* 26.7%, $P = 0.019$), dyslipidemia (50.7% *vs.* 16.7%, $P = 0.001$), and hypertension (48.0% *vs.* 16.7%, $P = 0.002$). The incidence of gallbladder stone was higher in the CSG group than in the PSG group (4.0% *vs.* 20.0%, $P = 0.006$).

Twenty-six patients (86.7%) underwent primary AGB, 3 patients (10.0%) underwent PSG, and 1 patient (3.3%) underwent greater curvature gastric placation after AGB, prior to CSG (Table 1). Among the 26 patients (86.7%) who underwent CSG after AGB, 9 and 17 patients underwent 1-step CSG and 2-step CSG with gastric band removal, respectively. The indications for conversion were failure to lose weight in 19 patients (63.3%), and complications of gastric banding in 9 patients (30.0%), which included 4 band erosions (13.3%), 1 stenosis (3.3%), 3 slippages (10.0%), and 1 infection (3.3%). The interval of repeat surgery

Table 1. Patients' general characteristics

Characteristic	PSG (n = 150)	CSG (n = 30)	P-value
Age (yr)	33.3 ± 8.0	35.6 ± 6.5	0.139
Sex			
Female	127 (84.7)	28 (93.3)	0.210
Male	23 (15.3)	2 (6.7)	
Weight (kg)	99.6 ± 17.1	87.1 ± 21.2	0.001
Height (cm)	164.3 ± 0.1	163.2 ± 0.1	0.497
Body mass index (kg/m^2)	36.8 ± 4.7	32.4 ± 5.7	<0.001
Comorbidities[a)]			
Fatty liver	75 (50.0)	8 (26.7)	0.019
Dyslipidemia	76 (50.7)	5 (16.7)	0.001
Hypertension	72 (48.0)	5 (16.7)	0.002
Hiatal hernia	61 (40.7)	9 (30.0)	0.274
Insulin resistance	41 (27.3)	5 (16.7)	0.221
Obstructive sleep apnea	33 (22.0)	2 (6.7)	0.053
Type II diabetes mellitus	33 (22.0)	3 (10.0)	0.134
Arthritis & back pain	26 (17.3)	1 (3.3)	0.052
Dys- or amenorrhea	27 (18.0)	2 (6.7)	0.174
Reflux esophagitis	23 (15.3)	4 (13.3)	>0.999
Gout	13 (8.7)	2 (6.7)	>0.999
Gallbladder stone	6 (4.0)	6 (20.0)	0.006
Depressive disorder	7 (4.7)	1 (3.3)	>0.999
Asthma	8 (5.3)	0 (0)	0.356
Previous bariatric surgery			
Gastric banding	-	26 (86.7)	
One-step conversion surgery		9 (34.6)	
Two-step conversion surgery		17 (65.4)	
Sleeve gastrectomy	-	3 (10.0)	
Banding → gastric plication	-	1 (3.3)	
Reason of conversion operation			
Failure of weight loss	-	19 (63.3)	
Complications of gastric band		9 (29.9)	
Erosion	-	4 (13.3)	
Stenosis	-	1 (3.3)	
Slippage	-	3 (10.0)	
Infection	-	1 (3.3)	
Wanted	-	2 (6.7)	
Interval of reoperation (mo)	-	47.3 ± 31.4	
Period of follow-up (mo)	14.2 ± 10.8	61.0 ± 31.7	<0.001

Values are presented as mean ± standard deviation or number (%).
PSG, primary sleeve gastrectomy; CSG, conversion sleeve gastrectomy.
[a)]Included in duplication.

in CSG was 47.3 ± 31.4 months. The mean period of follow-up was longer in the CSG group than in the PSG group (14.2 ± 10.8 months *vs.* 61.0 ± 31.7 months, P < 0.001) (Table 1).

All 180 patients underwent laparoscopic surgery. The mean duration of surgery was 136.0 ± 31.8 minutes in the PSG group versus 217.6 ± 44.1 minutes in the CSG group (P < 0.001) (Table 2). Estimated blood loss was lower in the PSG group than in the CSG group (60.5 ± 135.3 mL *vs.* 135.9 ± 210.8 mL, P = 0.083). In 1 patient with previous band erosion, a foreign body, which was a part of the gastric band material, was found incidentally during CSG. Mean hospital stay was lower in the PSG group than in the CSG group (3.6 ± 1.0 *vs.* 4.8 ± 1.8, respectively, P = 0.002) (Table 2).

Three early postoperative complications were noted in the PSG group, 2 patients developed pulmonary atelectasis, and Clavien-Dindo surgical complication classification (C–D grade) was grade I [14]. Another patient underwent repeat laparoscopic exploration on postoperative day 2, due to pancreatic injury from the laparoscopic energy device. Two complications occurred in the CSG group. One patient developed pleural

effusion (C–D grade I), and another patient developed a gastric stricture (C–D grade II) [14]. The patient with the gastric stricture was readmitted thrice after CSG. Each admission lasted 3–4 days, during which she received conservative management. A gastrografin upper gastrointestinal series did not demonstrate any disturbance in the flow of the dye; however, a small phytobezoar was found in the remnant stomach during gastroscopy. The patient remained symptom-free at her 3-year follow-up visit. No patients developed leakage after CSG, and the mortality rate was zero. Thirty-eight patients (25.3%) in the PSG group developed 43 minor late complications, while 9 patients (30.0%) in the CSG group developed 11 minor and 1 major late complication. There were no differences in late complications between the groups (P = 0.219). One patient in the CSG group underwent adhesiolysis surgery 40 days after the CSG procedure (Table 3).

The results of %EBMIL at postoperative 3 months (79.9 ± 34.8) versus 6 months (107.8 ± 47.0), and 6 months versus 12 months (124.9 ± 56.0) in the PSG group significantly increased (P < 0.001 and P < 0.001, respectively). The results in the CSG group were also significantly different (87.1 ± 46.8 at 3 months, 109.8 ± 54.6 at 6 months, and 136.6 ± 55.5 at 12 months; 3 months *vs.* 6 months P < 0.001, and 6 months *vs.* 12 months P < 0.001, respectively). The %EBMIL at postoperative 3, 6, and 12 months after surgery was not significantly different between the 2 groups (Table 4).

Table 2. Intraoperative and postoperative features

Characteristic	PSG (n = 150)	CSG (n = 30)	P-value
Operative time (min)	136.0 ± 31.8	217.6 ± 44.1	<0.001
Estimated blood loss (mL)	60.5 ± 135.3	135.9 ± 210.8	0.083
Simultaneous operation			
None	78 (52.0)	6 (20.0)	0.001
Hiatal hernia repair	59 (39.3)	9 (30.0)	0.336
Hiatal hernia & cholecystectomy	1 (0.7)	0 (0)	>0.999
Hiatal hernia & liver biopsy	1 (0.7)	0 (0)	>0.999
Liver biopsy	7 (4.7)	0 (0)	0.603
Cholecystectomy	4 (2.6)	5 (16.8)	0.007
Band removal only	-	4 (13.3)	
Band removal & hiatal hernia repair	-	4 (13.3)	
Band removal & cholecystectomy	-	1 (3.3)	
Foreign body removal[a]	-	1 (3.3)	
Mean hospital stay (day)	3.6 ± 1.0	4.8 ± 1.8	0.002

Values are presented as mean ± standard deviation or number (%).
PSG, primary sleeve gastrectomy; CSG, conversion sleeve gastrectomy.
[a]Foreign body (part of band material) removal.

Table 3. Postoperative complications

Complication	PSG (n = 150)	CSG (n = 30)	P-value
Early postoperative complications[a] (≤30 days)	3 (2.0)	2 (6.6)	0.194
Atelectasis (I)	2 (1.3)	0 (0)	>0.999
Pancreatic injury (IIIb)	1 (0.7)	0 (0)	>0.999
Pleural effusion (I)	0 (0)	1 (3.3)	0.167
Gastric stricture (II)	0 (0)	1 (3.3)	0.167
Late postoperative complications (>30 days)	43 (28.7)	12 (40.0)	0.219
GERD (II)	30 (20.0)	6 (20.0)	>0.999
Anemia (II)	4 (2.7)	2 (6.7)	0.262
Gallbladder stone (II)	5 (3.3)	2 (6.7)	0.330
Ureter stone (II)	4 (2.7)	1 (3.3)	>0.999
Trocar site hernia (IIIb)	0 (0)	1 (3.3)	0.167

Values are presented as number (%).
PSG, primary sleeve gastrectomy; CSG, conversion sleeve gastrectomy; GERD, gastroesophageal reflux disease.
[a]According to Clavien-Dindo surgical complication classification.

Table 4. Changes in percentage of excess body mass index loss

	PSG (n = 150)	CSG (n = 30)	P-value
3 Months	79.9 ± 34.8	87.1 ± 46.8	0.490
6 Months	107.8 ± 47.0	109.8 ± 54.6	0.862
12 Months	124.9 ± 56.0	136.6 ± 55.5	0.401

Values are presented as mean ± standard deviation or number (%).
PSG, primary sleeve gastrectomy; CSG, conversion sleeve gastrectomy.

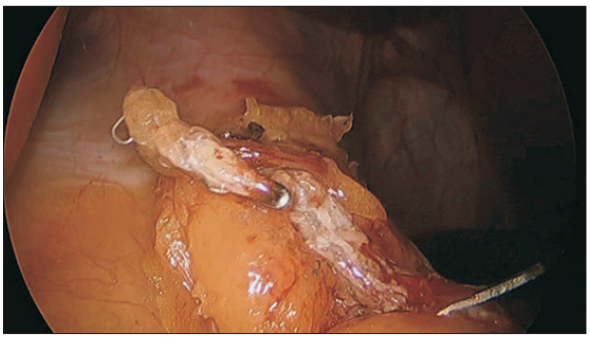

Fig. 1. Metal clipping at each end of stapling line.

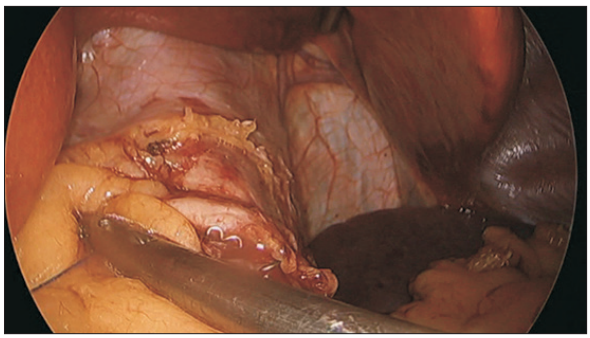

Fig. 2. Continuous seromuscular reinforcement suture at resection margin.

DISCUSSION

Our results indicate that there were no differences in postoperative early and late complications, and weight loss after PSG and CSG. Duration of surgery, estimated blood loss, and hospital stay were higher or longer in the CSG group than in the PSG group, owing to other simultaneous procedures in some cases. In PSG, 39.3% of the surgeries included hiatal hernia repair simultaneously with the primary surgery, while nine patients in the conversion surgery underwent a 1-step surgery, which included removal of AGB and CSG simultaneously. Therefore, a head-to-head comparison of the duration of surgery between the 2 groups does not lead to a definite conclusion. Although the duration of surgery, estimated blood loss, and hospital stay were higher or longer in the conversion patients, these are acceptable since these were not associated with significant complications.

The risk of postoperative complications is higher in patients who undergo revision surgery, and is even higher after multiple revisions [9]. The leak rate was reportedly higher after revision of AGB into SG – this procedure involves stapling over the scarred tissue, a longer stapler line, and dissection at the left crus, which can jeopardize the blood supply at the gastroesophageal junction [9,15-17]. However, the surgeon's experience with a number of revisional bariatric procedures decreases risk and complications to an acceptable rate [18-20]. In our institution, appropriate staplers were chosen according to the thickness of each individual patient's stomach, and the time of holding tissue with a stapler before firing should be sufficient for preventing leakage. Accurate angle of the stapler and sufficient mobilization of the stomach from adjacent structures are necessary to prevent creating dog ears at the overlap between the staplings. If staple debris is found at the end of the stapling line before the next stapler firing, it should be removed to prevent another misfired staple. We applied a 5-mm clip to prevent bleeding or leakage at the beginning and end of the stapling line (Fig. 1). Subsequently, a continuous seromuscular suture at the resection margin was applied (Fig. 2). These meticulous steps prevent leakage or bleeding. No leakage or bleeding was noted in either PSG or CSG group in our study.

Several studies reported that 2-step conversion of failed AGB to SG, results in a significantly reduced rate of postoperative staple line leaks, gastric tube stricture, and respiratory complications, and 1-step conversion of gastric band to SG is associated with increased postoperative complications [21,22]. On the contrary, one systematic review and meta-analysis suggests that immediate or delayed revisional bariatric surgeries are both safe options for AGB revisions. There were statistically similar rates of complications, abscess formation ($P = 0.54$), postoperative bleeding ($P = 0.77$), leak and fistula ($P = 0.26$), and morbidity ($P = 0.56$), between 1-step and 2-step surgeries. No mortality events were recorded [23]. Nine patients who underwent 1-step conversion in our study did not develop any early surgical complication. Two early complications, such as pleural effusion and gastric stricture, were noted in the patients who underwent 2-step CSG from AGB. A drawback of the 2-step surgery is that weight could be regained in the interval between band removal and conversion surgery [24]. Therefore, if the tissue at the resection line is healthy, a 1-step conversion surgery should be considered.

Revisional or conversion surgery is expected to increase significantly, considering the annual rate of bariatric surgery in Korea; the rate of revisional surgery in bariatric surgery has increased since 2008 [7,25]. The reasons for conversion sur-

gery from primary AGB include complications of the gastric band, and regaining of weight. In the early days of bariatric surgery, AGB was performed in over 50% of the cases [7,25]. According to the national data, the band survival rate after AGB was 72% at 5 years, and about half of the patients underwent revisional surgery. Among several revisional surgeries, SG was the most common revisional procedure (44.3%) [4]. Thus, the complications of gastric band and weight regain after AGB are likely to increase with time, leading to an increase in conversion surgery.

The results of %EBMIL at 3 months, 6 months, and 12 months postoperatively were comparable, and good in both groups. These results are in line with those of previous studies [18,26-28]. Some studies showed that the rate of weight loss during the early period until 1 year after PSG was better than that after CSG; however, weight loss was similar in both groups at 1 or 2 years after surgery [26,27]. The most plausible explanation is the fact that the LAGB to LSG group includes patients that evolve more rapidly toward failure as they have already undergone the experience of surgery-induced restriction and have developed eating habits to overcome the effects of surgery [26]. Our result was different from those of these studies. The patterns of weight loss at postoperative months 3, 6, and 12 in our study were similar between the groups, confirming that PSG and CSG have similar outcomes [28].

Limitations of this study include clinicopathologic differences between the 2 groups, the patients included from a single-institution with a small sample size, and retrospective nature of the study. The patients in the PSG group had a higher BMI ($P < 0.001$) and higher rate of comorbidities like fatty liver ($P = 0.019$), dyslipidemia ($P = 0.001$), and hypertension ($P = 0.002$). However, as it is related with the results of primary bariatric surgery, it can be a difference in terms in relation thereto.

PSG and CSG are comparable in terms of complications and weight loss. Therefore, CSG could be a strategy for conversion operations after failed primary restrictive bariatric surgery. However, the durability of these outcomes remains unknown.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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