

# Outcome Analysis of Early Laparoscopic Sleeve Gastrectomy Experience

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## ABSTRACT

**Background and Objectives:** Laparoscopic vertical sleeve gastrectomy (LSG) was initially performed as the first stage of biliopancreatic diversion with duodenal switch in the super-obese population. In the past few years, however, LSG has been performed as a definitive procedure because of its promising early and midterm results. In this study we describe our initial experience and outcomes with LSG as a potential independent bariatric operation.

**Methods:** A prospectively maintained database including all patients between 2008 and 2011 was reviewed.

**Results:** A total of 100 initial consecutive patients (69 women and 31 men) were included, with a mean age of 50 years (range, 19–79 years) and body mass index of 49 kg/m<sup>2</sup> (range, 36.6–70.3 kg/m<sup>2</sup>). The mean operative time was 106 minutes (range, 58–212 minutes) with a 2% conversion rate. Thirty-day perioperative complications included port-site hemorrhage (1.0%) and the inability to tolerate oral intake resulting in dehydration (3%). The reoperation rate was 2%, and the mean length of stay was 3.1 days (range, 2–12 days). In one patient with a prolonged hospital stay, an acute cholecystitis developed, and prosthetic heart valve complications developed in another patient. The mean excess body weight loss was 18%, 31.7%, 45%, 52%, 58.4%, and 64% at 1, 3, 6, 9, 12, and 18 months postoperatively, respectively. No deaths occurred in this series.

**Conclusions:** Satisfactory outcomes and low complication rates were observed after LSG. Our findings suggest that LSG is safe and effective to serve as a definitive bariatric procedure.

**Key Words:** Laparoscopic sleeve gastrectomy, Outcomes, Complications.

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DOI: 10.4293/108680813X13693422520963

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## INTRODUCTION

Laparoscopic sleeve gastrectomy (LSG) was initially proposed as a staged approach to biliopancreatic diversion (BPD) with duodenal switch (DS) in high-risk, high-body mass index (BMI) (>50 kg/m<sup>2</sup>) obese patients.<sup>1</sup> LSG involves removing a large portion of the stomach, by creating a 150-mL gastric tube, which in turn limits the capacity for food intake. In the past several years, LSG has been increasingly considered a definitive surgical procedure for obesity because of its promising midterm data.<sup>2</sup> This study was aimed to evaluate our experience and outcomes with LSG as an independent bariatric operation.

## METHODS

A prospectively maintained database of the initial consecutive 100 patients who underwent LSG between February 2008 and December 2011 in a large independent teaching hospital was reviewed. Patient characteristics, intraoperative details, 30-day perioperative complications (specifically anastomotic leak, hemorrhage, intra-abdominal abscess, thromboembolic events, and soft-tissue infection), and weight loss outcomes were analyzed. This study was approved the institutional review board committee.

### Patient Selection

Standard inclusion criteria in this study were based on the National Institutes of Health 1991 bariatric surgery guidelines. Patients with a BMI >40 kg/m<sup>2</sup> without comorbidities or with a BMI >35 kg/m<sup>2</sup> with at least one obesity-related comorbidity qualify for bariatric surgery, which includes LSG. All patients underwent a comprehensive preoperative medical evaluation, a detailed psychological assessment, relevant laboratory/radiologic testing, and esophagogastroduodenoscopy. Sleep apnea testing was performed in most patients based on clinical suspicion of obstructive sleep apnea.

### Surgical Technique

Pneumoperitoneum was established with a Veress needle in the left upper quadrant. A Nathanson liver retractor was used to elevate the left lobe of the liver. The standard 5-trocar technique was used. Mobilization of the greater

curvature of the stomach was performed with an ultrasonic dissector, which was started 4 cm from the pylorus to the angle of His. The sleeve was fashioned with a 36-F bougie. A green load 60-mm Echelon linear stapler (Ethicon Endo-Surgery, Cincinnati, Ohio, USA) was applied from the dissection point toward the incisura angularis, followed by sequential applications of blue load 60-mm staplers superiorly alongside the lesser curvature. Staple line reinforcement, that is, oversewing or Seamguard (Gore, Flagstaff, Arizona, USA) buttressing, was used under the individual surgeon's discretion. A leak test was performed by use of an intranasogastric injection of 60 mL of methylene blue. The resected stomach was removed with an Endocatch bag (Covidien, Mansfield, Massachusetts, USA).

**RESULTS**

A total of 100 consecutive patients comprised the study. The study population had a mean age of 45 years, had a mean BMI of 48.2 kg/m<sup>2</sup>, and was predominantly female. Patient demographic characteristics are shown in **Table 1**. The mean operative time was <2 hours, which improved to <1.5 hours in the last 15 cases. Extensive intra-abdominal adhesions from previous laparotomies, most frequently open cholecystectomy and open hernia repair, are the reasons for the 2% conversion rate. A return to the operating room was needed in two patients: one for surgical control of port-site bleeding and another for clinical signs of staple line leak (tachycardia, epigastric abdominal pain, and oliguria). In the latter patient, an intact gastric sleeve was found, with absence of intra-abdominal spillage or fluid collections to suggest staple line leak or inadvertent bowel injury. The symptoms resolved after the laparoscopic exploration, which suggested that they were most likely related to inadequate pain control and/or mild dehydration postoperatively. In the beginning of our se-

ries, intolerance to oral intake developed in 3 patients in the immediate postoperative days, which was likely related to gastric sleeve edema. They required intravenous fluid administration for 24 to 48 hours, and the symptoms gradually resolved without further intervention. Potential major complications, specifically staple line leak, bleeding, intra-abdominal space infection, and gastric sleeve stricture, were not seen in our study (**Table 2**). The mean length of hospital stay was 3 days. One patient stayed for 9 days because of an episode of acute cholecystitis, and another patient stayed for 12 days because of prosthetic heart valve complications.

Among the common obesity-related comorbidities, hypertension was found in 55% of patients, followed by diabetes mellitus (33%) and hyperlipidemia (36%). At 1 year after the vertical sleeve gastrectomy, the highest resolution was seen with diabetes mellitus (72%), followed by hypertension (55.5%) and hyperlipidemia (50%). All diabetic patients had improved control of their hyperglycemia (either complete resolution or less severe disease—as reflected by fewer oral antidiabetic agents and/or insulin requirements) at 18 months postoperatively. Significant improvements in hypertension and hyperlipidemia were seen in 36.1% and 19.6% of patients, respectively.

The mean excess body weight loss was 18.03%, 32.3%, 44.06%, 50.94%, 57.9%, and 62.8% at 1, 3, 6, 9, 12, and 18 months postoperatively, respectively (**Figure 1**). Follow-up data were available in 65% of patients at 6 months, 51% of patients at 1 year, and 35% of patients at 1.5 years. No deaths occurred in this series.

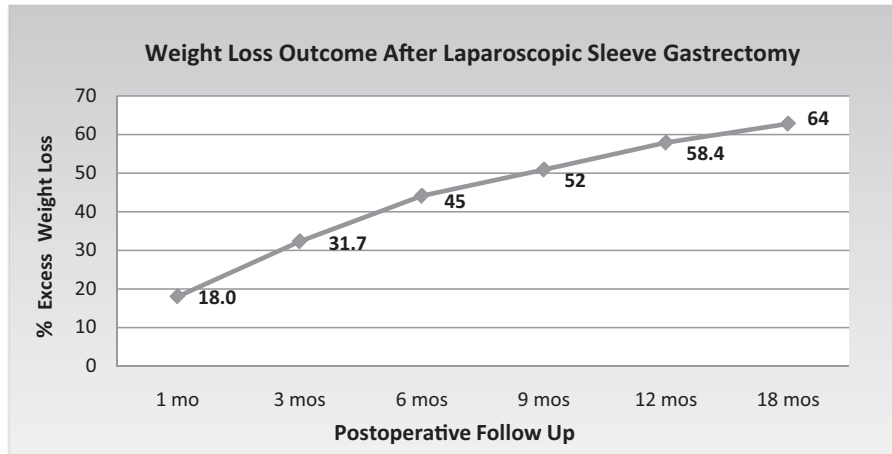
**Table 1.**  
Patient Demographic Characteristics (N = 100)

	Data
Gender (female/male)	69/31
Mean age (y)	50 (19–79)
Preoperative BMI (kg/m <sup>2</sup> )	49 (36.6–70.3)
Excess body weight (lb)	164 (91–306)
Preoperative diabetes mellitus (%)	33
Preoperative hypertension (%)	55
Preoperative hyperlipidemia (%)	36

**Table 2.**  
Thirty-Day Outcomes and Complications

	Data
Operative time (min)	106 (58–212)
Conversion to open (n)	2 (2%)
Complications (n)	
Staple line leak	0
Hemorrhage	1 (1%) <sup>a</sup>
Infection/abscess	0
Dehydration	3 (3%)
Gastric sleeve stricture	0
Return to operating room <sup>a</sup> (n)	2 (2%)
Length of stay (d)	3.1 (2–12)

<sup>a</sup>Port-site bleeding.



**Figure 1.** Weight loss outcome after LSG.

## DISCUSSION

LSG-associated weight loss is believed to be due to restriction of food intake by the small gastric reservoir. However, the mechanism behind LSG and the resolution of type 2 diabetes mellitus has not been clearly defined. Karamanakos et al<sup>3</sup> and Arias et al<sup>4</sup> found a marked reduction of fasting ghrelin levels after LSG surgery. Ghrelin is a 28-amino acid peptide produced primarily by the gastric fundus cells with basal hyperchromatic nuclei, which are resected in the LSG. Clinically, ghrelin produces the hunger sensation when the stomach is empty, and it also inhibits insulin secretion and blocks hepatic insulin signaling.<sup>5</sup> Abbatini et al<sup>6</sup> stated that by reducing the ghrelin level and its insulinostatic effect, the islet cells will be able to secrete additional insulin by increasing the maximal capacity of glucose-induced insulin release.

In contrast to other bariatric operations, ghrelin is increased after laparoscopic adjustable gastric banding and after the classical Scopinaro BPD, decreased after Roux-en-Y gastric bypass, and nearly absent after LSG and BPD/DS. These findings support the benefit of stomach downsizing operations such as LSG and BPD/DS.<sup>7,8</sup> In addition, when compared with Roux-en-Y gastric bypass or Scopinaro BPD, the absence of dumping syndrome after LSG represents an important advantage for the patient's quality of life.

Hindgut theory of the vertical sleeve gastrectomy mechanism of action postulates that rapid delivery of nutrients to the distal bowel upregulates the production of L-cell derivatives, such as glucagon-like peptide 1 (GLP-1) and peptide YY. These changes, in turn, result in better postprandial glucose control and improved severity of diabetes

mellitus in almost all patients.<sup>9,10</sup> This theory was confirmed by Melissas et al,<sup>11</sup> who found that despite preservation of the pylorus, gastric emptying is accelerated after LSG.

Many authors have reported that sleeve gastrectomy produces an estimated weight loss of 50% and 63% on average by 6 and 12 months postoperatively, respectively.<sup>12–16</sup> In our study we found a 58.4% excess weight loss outcome at 1 year and 64% at 18 months. Rosenthal and colleagues<sup>4</sup> reported 68% excess weight loss at 2 years and stated that the results with LSG appear to be as good as any bariatric operation.

In addition to its technical simplicity, reduced operative time, and less steep learning curve, LSG does not require postoperative adjustments such as those after gastric banding. Because of its technical simplicity, LSG may have wider applicability to practicing general surgeons. Buchwald et al,<sup>17</sup> in their meta-analysis containing 705 morbidly obese patients, reported favorable outcomes after vertical sleeve gastrectomy. The risks of surgery, such as malabsorption and postoperative complications, are minimal. From 16 studies, the estimated mortality rate for LSG was 0.35% (4 deaths in 1117 patients). Postoperative complications, such as bleeding (1.79%) and staple line leak (1.97%), compared favorably with the rates reported accompanying gastric bypass and BPD/DS.<sup>18</sup> Internal hernias, which are the most life-threatening complications of Roux-en-Y gastric bypass and BPD/DS, are not seen with LSG. Dumping syndrome is also not an issue after LSG.

In recent years there has been a concern regarding the increased rate of late-onset gastroesophageal reflux af-

ter LSG, especially in patients with a preoperative esophageal motility disorder. In the DS operation, reflux is not a major concern because the sleeve size is >200 mL, the phrenoesophageal ligament and the sling fibers are preserved, and there is a larger antrum. In the LSG, however, the sleeve has a volume of approximately 100 to 150 mL, a disrupted phrenoesophageal ligament, and a smaller antrum. These differences predispose LSG patients to a higher rate of postoperative reflux symptoms.

To objectively study the effects of creating a gastric sleeve on the esophagogastric physiology, Del Genio et al<sup>19</sup> performed a 24-hour pH study and manometry of the lower esophageal sphincter, both preoperatively and postoperatively. At 1 year postoperatively, they found that the lower esophageal sphincter pressure had not changed, but there were increased ineffective secondary waves without clinical symptoms of reflux. The optimum size of bougie used during LSG is often still a matter of debate among many bariatric surgeons. Parikh et al<sup>20</sup> compared the use of 40-F and 60-F bougies in LSG. A significant weight loss difference was not found between the two groups; however, an increase in gastroesophageal reflux events was observed in the group with a smaller bougie size. A correctly fashioned sleeve provides adequate food restriction without inducing gastroesophageal reflux symptoms. A later study by Keidar et al<sup>21</sup> found that a dilated upper sleeve can be associated with severe postoperative gastroesophageal reflux and dysmotility. In this situation, if significant reflux persists postoperatively, the LSG can be converted to a Roux-en-Y gastric bypass.<sup>22</sup> The future possibility of conversion to other bariatric operations, such as Roux-en-Y or BPD/DS, for inadequate weight loss or poor resolution of obesity-related comorbidities is an additional advantage of LSG.

## CONCLUSIONS

Satisfactory weight loss outcomes and low complication rates were observed after LSG. In our experience LSG is technically simple, safe, and effective to serve as a definitive procedure for morbid obesity.

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