Laparoscopic Sleeve Gastrectomy: Our First 100 Patients

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ABSTRACT

Background: Laparoscopic sleeve gastrectomy is becoming a popular procedure for the morbidly obese patient. Its utilization as a standalone procedure has good results with weight loss in short- and midterm reports. The aim of this study was to assess our technique and whether it warranted any modifications in the early postoperative period.

Methods: Our first 100 consecutive patients undergoing laparoscopic sleeve gastrectomy were retrospectively reviewed. Data analysis was conducted at 3 and 6 months to assess the percentage of excess body weight loss and comorbidity status change.

Results: The percentage of excess body weight loss at the 3- and 6-month marks was 34.2% and 49.1%, respectively. Comorbidities were also improved at the 3- and 6-month marks. Hypertension resolved in 38%, hyperlipidemia resolved in 19%, and diabetes in 46%. Complication rate during the first 6 months was 10%. Major complications included 2 patients with postoperative bleeding, 2 patients with acute renal failure from dehydration, and 1 postoperative bleeding patient who developed a gastric fistula. No surgical reintervention was required for any complication.

Conclusion: Our technique is a safe method that is easily reproducible and does not require any modification. Laparoscopic sleeve gastrectomy is an excellent surgical option with a low complication rate.

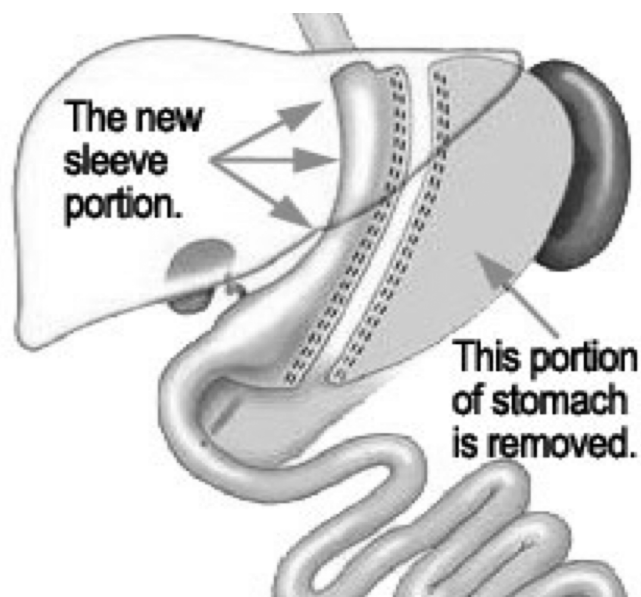**Key Words:** Gastric bypass, obesity, gastrectomy, comorbidity.

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INTRODUCTION

Laparoscopic sleeve gastrectomy (LSG) is a lesser curvature based, subtotal gastric resection used in the surgical treatment of morbid obesity. LSG is a restrictive bariatric procedure in which approximately 80% of the stomach is removed, creating a cylindrical "sleeve" like conduit **(Figure 1)**. The vagus nerves and pylorus are preserved, limiting the problems associated with functional gastric outlet obstruction and dumping syndrome.[1,2]

Historically, sleeve gastrectomy was used as the first part of a 2-staged bariatric procedure to reduce the morbidity and mortality for high-risk patients including the super-super obese (BMI>60kg/m^2). LSG is also the gastric component of the malabsorptive bariatric procedure, biliopancreatic diversion with duodenal switch (BPD/DS).

Although not reversible, LSG can be converted to a Roux-en Y gastric bypass or BPD/DS.[3] Recent studies have shown promising results with LSG as a single-step procedure in the surgical treatment for morbid obesity. Its reproducibility and low complication rate make it a viable option for morbid obesity surgery.

The authors present their standardized surgical technique and early postoperative results at 3 and 6 months of their first 100 consecutive patients who underwent LSG from November 2006 to July 2008. We wished to evaluate whether this method proved to be efficacious and with few complications. In this manner, the technical success of the procedure could be assessed.

MATERIALS AND METHODS

Patient Selection

The data for 100 consecutive patients undergoing LSG between November 2006 and July 2008 were analyzed prospectively. All patients were evaluated at the office of the Surgeons Group of Baton Rouge. Each LSG was performed by 1 of 2 surgeons in private practice with assistance from a fellow. Both surgeons previously had been performing laparoscopic gastric bypass (LGB) and laparoscopic adjustable gastric band (LAGB).

Figure 1. Schematic illustration of Sleeve Gastrectomy.

Any patient with a BMI>40kg/m² or >35kg/m² with severe comorbidity was offered LSG, LGB, or LAGB as a surgical option for morbid obesity. Each patient underwent a standardized workup including medical clearance, psychiatric and nutritional evaluation, preoperative imaging, and standard laboratory examinations. Patients were also evaluated for previous attempts at weight loss using other modalities.

Patients had scheduled postoperative office visits at 1 week and 3 weeks, then at 3 months and 6 months with the intent to follow-up at 9, 12, 18, and 24 months. Data collected included patient demographics, past medical history, comorbidities, preoperative weight and BMI, operative data (operating time, complications, and conversion), and morbidity/mortality rates. Postoperative data analysis included percentage of excess weight loss and change in comorbidity status.

Surgical Technique

All patients received preoperative intravenous antibiotics and DVT prophylaxis with unfractionated heparin and sequential compression devices. Patients were placed in a supine position with arms out at roughly 90 degrees and in a steep reverse Trendelenburg. Local anesthesia was used before all skin incisions. An initial 5-mm trocar was placed in the midline approximately 15cm below the xiphoid process. Access to the peritoneal cavity was gained under direct vision.
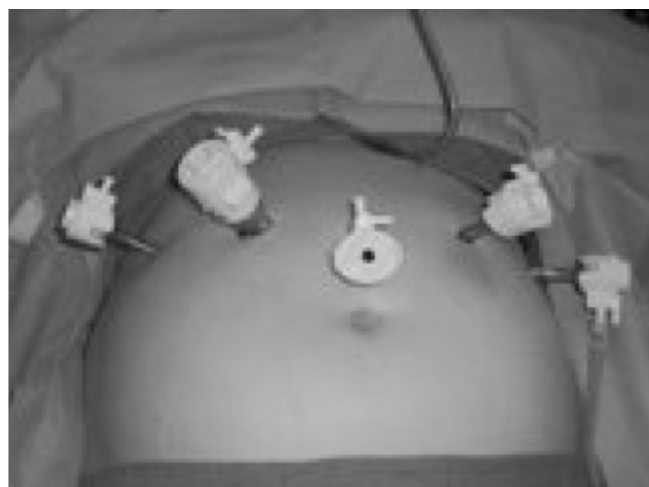
Figure 2. Typical trocar placement.

Pneumoperitoneum was achieved, and then a 30-degree laparoscope was used to assist with the placement of the other trocars. Five trocars **(Figure 2)** were placed in the upper abdomen: 2 left upper quadrant trocars both 5mm, and 2 right upper quadrant trocars, a 5mm (lateral) and a 15mm (medial) for use of the stapler and an extraction site for the resected stomach. The liver was retracted antero-superiorly using a Nathanson Liver retractor (Cook Medical, Bloomington, Indiana).

First, the attachments at the Angle of His were divided by using electrocautery. Next, dissection of the omentum off the greater curvature of the stomach was initiated 5cm to 6cm proximal to the pylorus and continued to the Angle of His. Care was taken to preserve the gastroepiploic vessels. A 34-French (F) bougie was passed down the esophagus, along the lesser curvature and through the pylorus if feasible. The sleeve gastrectomy was created using a 60-mm Echelon (Ethicon, Cincinnati, Ohio) stapling device beginning from the point 5cm to 6cm proximal to the pylorus and continuing to the Angle of His, tightly abutting the bougie. Graduated staple height loads (based on tissue thickness) with Seamguard (WL Gore and Associates, Flagstaff, Arizona) reinforcements were used.

The antrum distal to the staple line or jejunum near the ligament of Treitz was then clamped, and a saline submersion test was performed to assess for potential leaks. The resected stomach was delivered through the 15-mm trocar site, and the fascial defect was closed. Pneumoperitoneum was relieved, and all trocars were removed.

At the end of the procedure, patients were transferred to the postanesthesia care unit and then the surgical unit. A

Phase 1 bariatric diet of sugar-free, clear liquids was started immediately. On the morning of postoperative day 1, patients received a water-soluble upper gastrointestinal radiological examination **(Figure 3)** to evaluate for extravasation or obstruction of contrast. The majority of patients were then discharged to home that same day.

RESULTS

Preoperative Findings

Included in the study were 100 consecutive patients who underwent sleeve gastrectomy from November 2006 to July 2008. Data were collected prospectively. Patient demographics are depicted in **Table 1**.

Operative Findings

All 100 cases were completed laparoscopically with an average operative time of 83.3 minutes (range, 42–210). No iatrogenic injuries occurred in this series of patients. No surgical bleeding occurred within the peritoneal cav-

Figure 3. Postoperative upper intestinal series showing sleeve conduit.

ity. No clinical leaks were identified intraoperatively using the saline submersion test.

Postoperative Findings

Weight Loss
The average excess weight loss percentage were 34.2% (range, 21 to 63) and 49.1% (range, 28 to 95) at 3 and 6 months, respectively. Average BMI at 3 and 6 months was 38.0 (range, 26.9 to 64.6) and 34.2 (range, 23.2 to 58.7). This corresponded to an average change in BMI of $8.4kg/m^2$ and $12.2kg/m^2$ respectively at 3 and 6 months.

Comorbidities
Comorbidity status was assessed at each follow-up visit. Improvements in comorbidities had occurred if either a lower dosage of medication was required or patients needed fewer medications to manage the comorbidity. Resolution of the comorbidity was defined as no longer requiring medical therapy. At the 6-month period, hypertension resolved in 17 (38%) and improved in 11 (24%) patients, hyperlipidemia resolved in 5 (19%) and improved in 3 (11%), and diabetes resolved in 19 (46%) and improved in 2 (5%).

Complications
Complications were stratified into minor and major based on hospital admission **(Table 2)**. Minor complications did not warrant hospital admission and were solely managed in an outpatient setting. The overall complication rate was 10% with no mortalities in our first 100 patients.

Minor complications included nausea with intermittent vomiting that occurred in 3 patients. All 3 patients had a negative upper gastrointestinal (UGI) series and a normal upper endoscopy. Two patients were later diagnosed with cholelithiasis by ultrasonography, to which their symptoms were attributed. The third patient had a preoperative

Table 1.
Preoperative Patient Demographics

	Male (n=12)	Female (n=88)	Total
Avg. Age-years (range)	44.3y (18-58)	44.7 (23-64)	44.7 (18-64)
Avg. Weight-lb (range)	330.7 (271.5-407)	268.7 (197-478.5)	276.1 (197-478)
BMI-kg/m^2 (range)	47.5 (39.3-60.9)	46.3 (34.4-79.6)	46.4 (34.4-79.6)
HTN-n (%)	6 (50)	39 (44)	45 (45)
Hyperlipidemia-n (%)	3 (25)	24 (27)	27 (27)
Type II Diabetes-n (%)	4 (33.3)	37 (42)	41 (41)

Table 2.
Postoperative Complications

Complications	Number of Patients
Symptomatic Cholelithiasis	5
Nausea/Vomiting	3
Incisional Hernia	2
Bleeding requiring transfusion	2
Acute Renal Failure	2
Wound infection	1
Nephrolithiasis	1
Intraabdominal abscess/Gastric fistula	1

history of gastroesophageal reflux and was placed on a proton pump inhibitor, which alleviated the patient's nausea. Five patients developed symptomatic cholelithiasis, including the above 2 who presented with nausea. All 5 patients underwent successful laparoscopic cholecystectomy leading to resolution of symptoms. One patient developed superficial wound infection at the extraction port site. This patient was treated with a course of oral antibiotics for cellulitis and displayed no evidence of infection at the 3-week follow-up. One patient developed recurrence of a ventral hernia that was initially repaired primarily at the time of LSG. This patient was asymptomatic and underwent a laparoscopic ventral hernia repair with mesh near the 6-month follow-up without any complications.

Major complications occurred in 4 patients. Postoperative bleeding occurred in 2 patients, both of whom required a blood transfusion. These patients were monitored with serial hemoglobin levels and did not require any further medical or surgical intervention during their initial admission. Both patients were discharged home on postoperative day 4 in satisfactory condition. Two patients developed severe dehydration with acute renal failure due to intractable nausea and vomiting. Renal failure appropriately responded to intravenous fluids in both patients. Both patients underwent a UGI, endoscopy, and CT scans, which could not identify any source of obstruction. One patient's dehydration was accounted for by a long-standing history of severe arthritis, requiring disease modifying antirheumatic drugs including methotrexate. Incidentally, renal cell carcinoma was found on a CT scan during the workup for persistent nausea and anorexia in this patient. This patient underwent a nephrectomy and a feeding jejunostomy for nutritional support. The second patient's dehydration was caused by vomiting and diarrhea that

occurred within the first month of surgery; however, no specific cause could be identified. Both patients were discharged home, tolerating the standard bariatric diet.

One patient developed a gastric fistula and a left upper quadrant abscess. An initial UGI series on postoperative day one had no evidence of contrast extravasation. At 7 weeks postsurgery, the workup for the patient's nausea and vomiting with oral intake included a UGI and endoscopy. The UGI did not visualize any extravasation, and the EGD showed minimal antritis. The patient was continued on a bariatric diet and advised to eat smaller portions. Three weeks later, the patient presented with fever and anorexia. At this time, a CT scan showed a fluid collection in the left upper quadrant. This was percutaneously drained, and the patient was placed on parenteral nutrition and intravenous antibiotics. The patient was allowed to continue her treatment at home once the fevers subsided. A follow-up UGI approximately one month after drainage visualized extravasation of contrast at the superior aspect of the staple line. With the aid of the gastroenterologist, a covered stent was placed. With decrease in fistula output, the drain and endoscopic stent were subsequently removed. Total parenteral nutrition was continued for about 6 weeks. This patient required no further surgical treatment and is currently on a standard bariatric diet approximately 1 year from LSG.

DISCUSSION

Results from this series of patients indicate laparoscopic sleeve gastrectomy to be safe, easily reproducible, and efficacious as a standalone bariatric procedure. Early data in our series show excellent weight loss achieved at the 3- and 6-month mark. In our series, resolution of morbid obesity (BMI<35kg/m^2) occurred in 46% of patients by 6 months. Presently, there are only a few series with ≥100 patients reporting short- and midterm data up to 2 years. In a recent series of 135 patients, Fuks et al[4] showed percentage excess body weight loss of 38.6% and 49.4% at 6 months and 1 year, while Nocca et al[5] in 163 patients found the percentage lost in excessive body weight was 48.9% at 6 months, 59.4% at 1 year (120 patients), and 61.5% at 2 years (98 patients), similar to our results. In comparing our patients with patients in these studies, we found no significant difference in preoperative demographics between the 3 patient populations.

Currently, no recommendations exist on the optimal bougie size for the lesser curve conduit. In our series, a 34F bougie was chosen to create the gastric sleeve. The cre-

ation of a smaller gastric sleeve enhances the restrictive properties of the procedure. There is a concern of postoperative strictures with the use of smaller bougies and the need for dilation. This was not seen in any patient in our series. Many different size bougies (32F to 60F) have been described for constructing the gastric sleeve, and some studies have shown no significant difference in weight loss in the early period.[6] This was not the case with Weiner et al[7] who showed that the more restrictive LSG (bougie sizes of 32F and 44F versus an uncalibrated sleeve), resulted in maintaining excess weight loss after the 2-year mark. The study also found that a resected gastric weight volume <500cc was a predictor in treatment failure or early weight regain.

In comparing LSG to LGB, early data appear to suggest that LSG is comparable in achieving weight loss in the morbidly obese patient.[8] To our knowledge, only a single prospective randomized trial has compared LSG with LGB with data up to 3 years. In this trial, the median EWL was 41.4% after LGB and 57.7% after LSG at 1 year (P=0.0004). EWL at the 3-year mark were 48% after LGB and 66% after LSG (P=0.0025).[9] In addition, patients after LSG have significantly lower plasma ghrelin (hormone involved in appetite suppression) levels compared with those who had other restrictive procedures due to resection of the gastric fundus. The fundus of the stomach contains the greatest number of ghrelin producing cells. This was evident in a prospective, double-blinded study by Karamankos et al[10] comparing LSG with LGB.

There are multiple factors besides weight loss and low morbidity and mortality rates that make LSG an enticing procedure for morbid obesity. In addition, LSG appears to be a technically easier procedure compared with LGB. The procedure can be completed laparoscopically in virtually all patients, even those with a large left lobe of the liver, the extremely obese patient, and those who have undergone multiple abdominal surgeries.[11] LSG has no enteric anastomosis, and there are no mesenteric defects, thereby eliminating the risk for internal herniation. LSG is not associated with dumping syndrome, because of preservation of the vagus nerves and the pylorus. Furthermore, there are no foreign bodies or the need for percutaneous access, as with LAGB. Vitamin, mineral, nutrient, and drug metabolism may remain unchanged, and the gastrointestinal tract is easily suitable for endoscopic surveillance and therapeutic procedures.

The complication rates for laparoscopic sleeve gastrectomy range from 0% to 24% with an overall mortality rate of 0.39%.[12–14] A surgical quandary is the patient with a ventral hernia known preoperatively. Patients who require a mesh placement may be considered a relative contraindication based on the clean contamination aspect of the procedure. Although the risk for recurrence is high, a primary repair should be performed at the time of LSG to prevent the risk and complications of incarceration. In our patient, we elected to wait until the 6-month period to perform a laparoscopic ventral hernia repair with mesh, which occurred without complications.

The 2 major complications during bariatric surgery include bleeding and anastomotic or staple line leaks.[15] Recent data suggest that buttressing the staple line with a bioabsorbable polymer like Seamguard (WL Gore and Associates, Flagstaff, Arizona) may decrease the incidence of bleeding and gastric fistulas. Bleeding occurred in 2% of patients in our study (both intraluminal), while 7.3% in the study by Silechhia et al.[16] In our series, all patients had buttressing with a bioabsorbable copolymer along the entire length of the staple line. Meanwhile patients in the Silechhia series only received a selective area of buttressing, this may have accounted for the difference in bleeding. In 2 separate prospective studies, application of Seamguard (WL Gore and Associates, Flagstaff, Arizona) in gastric resections as part of bariatric surgery showed a significant reduction in blood loss and no evidence of intraoperative or postoperative leaks.[17,18]

The complication of gastric fistula is a serious concern. While it occurred in only a single patient (1%) in our series, it has been reported as high as 5.1%.[4] We did not identify a specific cause for gastric fistula formation in our patient. The patient's preoperative BMI was 44kg/m^2, and comorbidities included hypertension and diabetes mellitus. The patient had a negative saline submersion test intraoperatively and a negative workup at 7 weeks. This patient presented with clinical signs of an abscess approximately 10 weeks after surgery.

Could changes in intestinal physiology and local milieu in the morbidly obese patient have a role in staple-line failure? Body habitus would suggest that the morbidly obese patient is well nourished. However, these patients are in fact malnourished as evident by micronutrient deficiency reported in multiple studies.[19,20] Perhaps ulceration plays a factor and would account for the late leak.

The ability to determine patients at high risk for staple-line failure is a difficult task. Although the major risk factor for gastric fistula remains preoperative BMI >60kg/m^2,[4] multiple studies have shown fistulas to occur in patients with lower BMIs. Currently, there appears to be no consensus on how to manage the exposed staple line to prevent

leaks and fistulas. Different methods have been utilized including over-sewing of the staple line. In one study, over-sewing of LSGs, the leak rate was zero.[21] Meanwhile, Kasalicky et al[22] in 61 patients without over-sewing of the staple line also had a zero leak rate, but the last 24 cases were buttressed with Surgicel (Johnson and Johnson, Langhorne, PA) strips. Still other techniques are being utilized; we and others buttress with absorbable polymers and in our first 100 cases only had one gastric fistula occurrence.

Management of gastric fistula remains a dilemma. Surgical reintervention remains at the forefront and should be used for any patient with abdominal sepsis. It should be at the surgeon's discretion and based on intraoperative findings whether simple drainage is appropriate or a more definitive procedure can be attempted. Multiple factors should play a role in the decision-making process. These include nutritional status, hemodynamic stability, local inflammatory changes, and the ability of a patient to tolerate a prolonged surgical procedure. We elected to proceed with percutaneous drainage due to the easy accessibility of the abscess and no radiological evidence of a leak.

With interval development of a gastric fistula, we attempted nonoperative management with parenteral nutrition and antibiotics. However, our patient continued to have high fistula output likely due to the patient's non-compliance with diet restrictions. We elected to place a covered stent, a method utilized by others.[23] Although our patient did not require any further surgical intervention, other methods such as over-sewing the gastric leak site, injecting fibrin glue, simple drainage, and total gastrectomy have been described.[15,24] Although gastric fistula is a significant complication of LSG, its low occurrence rate is an acceptable risk for this excellent procedure.

CONCLUSION

The basis of this article was to assess our surgical technique and the need for any changes in the early postoperative period. We found no significant problems and consider our method to be a safe technique for LSG without need of modification. Based on early and mid-term reports, we believe that LSG is an excellent stand-alone bariatric procedure and should be considered as an option for the morbidly obese patient seeking surgical intervention.

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