Early Experience with Laparoscopic Sleeve Gastrectomy as a Single-Stage Bariatric Procedure

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Laparoscopic sleeve gastrectomy (LSG) as a single-stage restrictive bariatric procedure is becoming increasingly popular, especially in patients who are high risk and/or superobese. Between November 21, 2006, and September 30, 2008, 42 patients underwent LSG at our institution. Average age was 47 ± 11 years, average body mass index was 54 ± 10 kg/m^2, and 62 per cent were female. Preoperative indications for LSG included contraindication to laparoscopic Roux-en-Y gastric bypass (n = 11), severe coronary artery disease and/or congestive heart failure (n = 3), significant liver disease (n = 3), and patient preference (n = 4). Intraoperative indications for LSG included a foreshortened mesentery with inability to create a gastrojejunostomy (n = 13), extensive adhesions (n = 5), and intraoperative findings concerning for cirrhosis (n = 3). Twelve complications occurred in six patients: laparoscopic to open conversion (n = 1), reoperation (n = 3), nosocomial pneumonia (n = 1), wound infection (n = 1), bleeding (n = 1), pulmonary embolus (n = 1), readmission (n = 3), and superior splenic pole infarction. There was one death resulting from pulmonary embolism that occurred 2 weeks postoperatively. Preliminary excess body weight loss at 3, 6, 9, and 12 months was 29, 32 t, 38, and 30 per cent, respectively, and many patients had improvement or resolution of obesity-related comorbidities. Early review of our experience demonstrates that LSG may be an effective single-stage bariatric procedure. Additional follow up will be necessary to better define its long-term safety and efficacy.

THE SLEEVE GASTRECTOMY is a restrictive procedure for the treatment of morbid obesity that is rapidly gaining interest. The operation entails the creation of a long, lesser curve-based gastric conduit through subtotal gastric resection and was first described in 1988 as the initial restrictive component of a duodenal switch.[1] More recently, surgeons began performing laparoscopic sleeve gastrectomy (LSG) as the first step in a two-stage procedure for high-risk or superobese patients with the second step performed 6 months to 1 year later and consisting of either a duodenal switch or gastric bypass.[2, 3] A number of patients were reported to lose significant amounts of weight and have resolution of comorbidities with LSG alone and therefore did not require a second stage. With reports of average excess weight loss (EWL) of 48 to 83 per cent at 1 year and improvement in comorbidities, many have now begun to consider sleeve gastrectomy as a single-stage restrictive procedure.[2, 4–9]

The first laparoscopic sleeve gastrectomy was performed at our institution in November 2006. The purpose of the current communication is to review our early experience with LSG.

Methods

After approval by the Institutional Review Board of the University of California, Los Angeles, a comprehensive prospective patient database for all patients undergoing bariatric procedures at our institution was established and is continually maintained. Data recorded include patient demographics, comorbidities, operative techniques, perioperative events, complications, and follow-up information. The latter was obtained through clinic visits as well as mail, telephone, fax, and web-based surveys. A retrospective review of this database was used to identify the patients in this series. The records for these patients were also reviewed to note indications for LSG and specific outcomes.

Our surgical technique for performing LSG is as follows. Before incision, a prophylactic anticoagulant and antibiotic are administered and a 32-Fr BioEnterics®

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Intragastric Balloon (Allergan Medical, Irvine, CA) is placed into the stomach. Trocars are then inserted using an optical trocar for initial placement. The left gastrophrenic ligament is divided and the gastroesophageal junction is delineated using either hook electrocautery or a Harmonic Scalpel® (Ethicon, Cincinnati, OH). The gastrocolic ligament is opened 6 to 10 cm from the pylorus adjacent to the greater curve of the stomach with either the LigaSure™ (Valleylab, Boulder, CO) or Harmonic Scalpel. A green linear 60-mm stapler (Autosuture™, Mansfield, MA) is used to initiate the gastric resection followed by serial firings of blue linear 60-mm staplers (Autosuture™) using the 32-Fr Intragastric Balloon as a guide. Suture line reinforcement is routinely performed using Seamguard® Bioabsorbable Staple Line Reinforcement (Gore, Flagstaff, AZ). Either the Harmonic Scalpel or LigaSure is then used to divide the short gastric vessels along the greater curvature until free from all attachments. The remnant stomach is then placed into an Endo Catch™ bag (Covidien, Mansfield, MA) and removed. Finally, a leak test is performed by infusing methylene blue through the intragastric tube.

Results

Between November 21, 2006, and September 30, 2008, 42 sleeve gastrectomies were performed at our institution. Average age was 47 ± 11 years (range, 20–68 years), average body mass index (BMI) was 54 ± 10 kg/m^2 (range, 37–86 kg/m^2), and 62 per cent (n = 26) were female. Distribution of obesity-related comorbidities is shown in Figure 1.

Decision for LSG rather than laparoscopic Roux-en-Y gastric bypass (LRYGB) was made preoperatively in 21 patients. The most common preoperative indication for LSG was contraindication to LRYGB as a result of ongoing need for treatment with nonsteroidal anti-inflammatory drugs, corticosteroids, and/or immunosuppressive therapy (n = 11). Of these 11 patients, four had rheumatoid arthritis, two had ulcerative colitis, and one patient each had lupus, pernicious anemia, CREST syndrome, Sjögren's disease, and severe asthma. Three patients underwent LSG because of high risk for complications resulting from significant coronary artery disease and/or congestive heart failure. Another three patients had significant liver disease, including chronic steatohepatitis, hepatitis C cirrhosis, and autoimmune hepatitis. Lastly, there were four patients that preferred LSG over LRYGB.

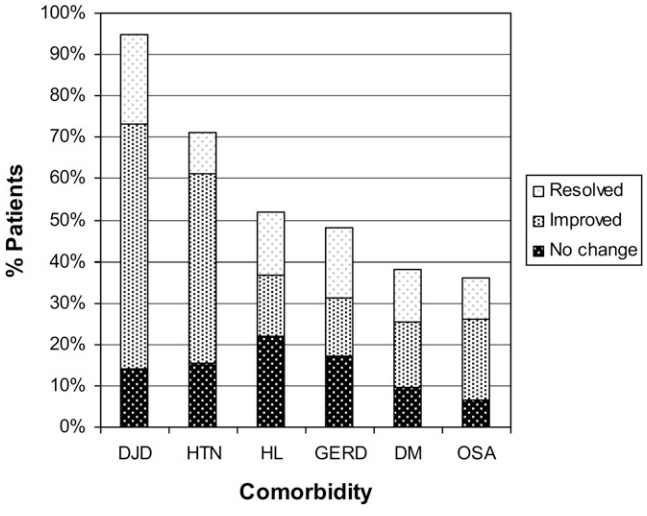

FIG. 1. Comorbidity distribution and resolution of comorbidities in 42 patients undergoing laparoscopic sleeve gastrectomy.

Intraoperative decision for LSG was made in 21 patients. The possibility of LSG instead of LRYGB had been discussed preoperatively with all patients and consent was obtained for either procedure. Inability to perform LRYGB as a result of foreshortened mesentery and inability to create a tension-free gastrojejunostomy occurred in 13 patients with an average BMI of 63 ± 10 kg/m^2 (range, 51–86 kg/m^2). There were five patients with extensive adhesions from previous abdominal surgeries and three patients who were found to have nodular livers concerning for cirrhosis.

Average hospital stay was 3.7 days (range, 3–17 days) with 67 per cent discharged on postoperative Day 2 and 95 per cent discharged by postoperative Day 4. All patients underwent routine upper gastrointestinal study before initiating oral feeding. There were no leaks.

A total of 12 complications occurred in six patients: laparoscopic to open conversion (n = 1), reoperation (n = 3), nosocomial pneumonia (n = 1), wound infection (n = 1), bleeding (n = 1), pulmonary embolus (n = 1), readmission (n = 3), and superior splenic pole infarction. There was one death resulting from a saddle pulmonary embolus that occurred 2 weeks postoperatively. The laparoscopic to open conversion was necessary as a result of narrowing of the gastroesophageal junction during creation of the gastric sleeve, which required mobilization of the distal esophagus, resection of the narrowed segment, creation of a new gastroesophageal anastomosis, and placement of a feeding jejunostomy tube. This patient had a complicated postoperative course and was taken back to the operating room on postoperative Day 4 as a result of concerns of abdominal sepsis after the patient pulled out his jejunostomy tube and subsequently became hypotensive and febrile. The abdomen was washed out and the feeding jejunostomy was revised. The patient also developed nosocomial pneumonia and a wound infection. Total hospital stay was 17 days with the first 12 days in the intensive care unit.

There were three patients who required readmission within the first 30 postoperative days. All presented with abdominal pain, and two had nausea and vomiting. One patient was found on CT to have a port site hernia possibly containing a small amount of omentum. This patient underwent diagnostic laparoscopy and local wound exploration, which revealed no evidence of a hernia. Another patient was diagnosed with a functional stricture at the incisura angularis and required laparoscopic revisional gastroplasty and placement of a feeding jejunostomy tube. The third patient was admitted to an outside hospital and was diagnosed with pyelonephritis.

Infarction of the posterior spleen occurred in one patient who developed significant left upper quadrant pain within the first 24 hours after surgery. A CT scan demonstrated infarction of the superior pole of the spleen, likely resulting from vascular injury while taking down the short gastric vessels. This was managed conservatively with analgesics, and follow-up CT 1 month later demonstrated complete resolution.

Postoperative bleeding occurred in one patient. This was detected by a drop in hematocrit, which declined over the course of 48 hours from 41 to 24 per cent. The patient remained hemodynamically stable and did not experience any symptoms associated with hypovolemia or anemia. The bleeding resolved spontaneously and the patient did not require blood transfusion.

Average follow up was 7.5 ± 6.6 months (range, 1–25 months). Average weight loss and percent excess weight loss (%EWL) at 3, 6, 9, and 12 months is shown in Table 1. Data regarding resolution or improvement of comorbidities were available for 28 patients (67%) with an average follow up of 9 ± 6.8 months (range, 3–25 months) and is shown in Figure 1.

Discussion

Two-stage bariatric surgery has been advocated in superobese (BMI greater than 50 kg/m^2) and/or high-risk patients to decrease morbidity and mortality.[2, 3, 6] Initial LSG was proposed as the first step because it is a relatively fast and easy operation and successfully induces postoperative weight loss.[1–3, 8–10] In fact, LSG has been shown to produce greater than 50 per cent EWL and improve comorbidities and therefore is now being considered by some as a single-stage restrictive procedure.[2, 4–9]

Weight loss after LSG is likely the result of both the restriction of oral intake resulting from the low distensibility of the sleeve[11] as well as significant reduction in ghrelin levels.[12–14] Ghrelin is a hunger-regulating peptide hormone mainly produced in the fundus of the stomach,[15–17] which is resected during LSG. Previous reports have demonstrated that ghrelin stimulates the appetite and that levels increase with diet-induced weight loss.[17] Reports of ghrelin levels after other bariatric procedures have been inconsistent; however, ghrelin appears to immediately decrease after LSG and remain low up to 6 months postoperatively, thereby preventing a compensatory increase in hunger.[14]

The relative safety of LSG over LRYBG or the laparoscopic adjustable band (LAB) is difficult to determine because currently many of the patients undergoing LSG are considered to be too high risk for other bariatric procedures, particularly LRYGB. The reported acute complication rate for LSG ranges from 0 to 29 per cent[6, 8, 10, 18–20] but overall is likely to be approximately 5 per cent.[6] This is compared with acute complications in LAB and LRYGB, which occur in 5 to 10 per cent of patients.[21, 22] Reoperation, anastomotic leak, and bleeding are the three most common and significant complications after LSG.[18, 19] In our series, three patients (7%) required reoperation, one patient (2%) had postoperative bleeding, which resolved spontaneously, and no leaks were detected. A major complication rate of 14 per cent was observed with six adverse events in five patients. There were no surgical mortalities in our series; however, there was one death resulting from a pulmonary embolism, which occurred 2 weeks postoperatively. This is similar to other published reports that have demonstrated a mortality rate of 0 to 3 per cent.[19]

Surgical technique may affect the number of complications that occur after LSG. Most authors advocate oversewing the gastric staple line or using staple line reinforcements to help prevent bleeding and leaks.[23, 24] Another consideration is the order in which the gastric resection is performed. Most published reports describe stapling of the sleeve after full devascularization and mobilization of the gastric

TABLE 1. *Actual Weight Loss and Percent Excess Weight Loss after Laparoscopic Sleeve Gastrectomy in 42 Patients*

	2–4 Months (n = 28)	5–7 Months (n = 12)	8–11 Months (n = 8)	1 Year (n = 9)
Weight loss (lbs)	51 (20–85)	63 (11–122)	93 (49–223)	60 (2–101)
% EWL	29% (12–55)	32% (11–50)	38% (25–58)	30% (2–55)

Figures given as mean (range).
%EWL, percent excess weight loss.

greater curve, whereas we perform stapling first followed by devascularization. We prefer this technique for several reasons. The most demanding step in LSG is the dissection of the angle of His and the final firing of the linear stapler because of risk for esophageal injury or encroachment. Using our technique, the final stapler firing occurs in the same condition as the gastric pouch construction during LRYGB, which therefore makes the maneuver familiar and decreases the learning curve. In addition, because the greater curve has not been resected laterally, the stomach can be sectioned without tension otherwise created by manual lateral retraction. In a study comparing the two techniques, Dapri et al.[5] found no statistically significant difference, although the authors believed it was easier and faster to perform the stapling first and devascularization next.

Short-term and midterm results for weight loss and resolution of comorbidities suggest that LSG is an effective bariatric procedure. Reported %EWL at 1 year ranges from 48 to 83 per cent[4, 5, 9, 24, 25] and in our series was 30 per cent. The lower percentage EWL observed in our patients is partly attributable to two noncompliant patients with %EWL of 2 and 4 per cent as well as the small number of patients (only nine) with 1-year follow up. Of note, the %EWL in our patients with 9 months follow up was 38 per cent, and we expect that as our data mature, %EWL results will be within the reported range of 48 to 83 per cent. Similarly, early results for resolution or improvement of comorbidities demonstrated in our series (Fig. 1) are encouraging. Other published reports[3, 8, 9] have demonstrated that the majority of patients have resolution of their obesity-related comorbidities at 1 year with up to 100 per cent resolution of diabetes and sleep apnea, 93 per cent resolution of hypertension, 85 per cent resolution of degenerative joint disease, 73 per cent resolution of hyperlipidemia, and 70 per cent resolution of gastroesophageal reflux disease. If patients who experienced improvement without full resolution of their comorbidities are also included, rates are close to 100 per cent for all comorbidities except for hyperlipidemia. Assuming that many patients with early improvement of comorbidities in our series will eventually have resolution, our results are expected to be comparable at 1 year.

The American Society for Metabolic and Bariatric Surgery (ASMBS) has not yet endorsed LSG as a single-stage bariatric procedure because long-term (greater than 5-year) weight loss and comorbidity resolution data are not yet available.[26] The ASMBS currently recommends that sleeve gastrectomy be performed only in carefully selected patients, particularly those who are high risk or supersuperobese. In our practice, and in agreement with Lee et al.[25] and Tucker et al.,[18] LSG may be considered in the following cases: 1) high-risk patients with medical problems that prevent them from having bariatric surgery (e.g., anemia, Crohn's disease, severe asthma requiring frequent steroids); 2) patients who have undergone extensive prior abdominal surgery or who require a bariatric procedure as a first step toward a nonbariatric procedure such as incisional hernia repair or organ transplantation; 3) patients who require anti-inflammatory medications, because LSG does not carry the same risk of ulcer formation as LRYGB; 4) patients on critical medications such as transplant or cardiac medications, because delivery and absorption are more predictable; 5) young patients for whom potential long-term metabolic consequences and protein/vitamin deficiency associated with LRYGB may be more problematic; 6) supersuperobese patients (BMI greater than 60 kg/m^2), particularly men, in whom other bariatric procedures are technically challenging or not possible; and 7) patients who desire LSG over other bariatric procedures.

In conclusion, our early experience with LSG is comparable to other published reports, which suggest that LSG may be a safe and effective single-stage bariatric procedure, particularly in high-risk or superobese patients. Future analysis will be needed as our data matures, and long-term (greater than 5-year) outcomes will be necessary before any final conclusions can be made.

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