J Gastrointest Surg (2008) 12:662–667
DOI 10.1007/s11605-008-0480-4

Indications for Sleeve Gastrectomy as a Primary Procedure for Weight Loss in the Morbidly Obese

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Received: 23 July 2007 / Accepted: 16 January 2008 / Published online: 9 February 2008

Abstract
Background Single-stage laparoscopic sleeve gastrectomy (LSG) may represent an additional surgical option for morbid obesity.
Methods We performed a retrospective review of a prospectively maintained database of LSG performed from November 2004 to April 2007 as a one-stage primary restrictive procedure.
Results One hundred forty-eight LSGs were performed as primary procedures for weight loss. The mean patient age was 42 years (range, 13–79), mean body mass index of 43.4 kg/m^2 (range, 35–75), mean operative time of 60 min (range, 58–190), and mean blood loss of 60 ml (range, 0–300). One hundred forty-seven procedures (99.3%) were completed laparoscopically, with a mean hospital stay of 2.7 days (range, 2–25). A 2.7% major complication rate was observed with four events in three patients and no deaths. Four patients required readmission; mild dehydration in two, choledocholithiasis in one, and a gastric sleeve stricture in one.
Conclusion Laparoscopic SG is a safe one-stage restrictive technique as a primary procedure for weight loss in the morbidly obese with an acceptable operative time, intraoperative blood loss, and perioperative complication rate.

Keywords Bariatric surgery · Laparoscopy · Morbid obesity · Roux-en-Y-gastric bypass · Sleeve gastrectomy

Abbreviations

BPD-DS	biliopancreatic diversion with duodenal switch
BMI	body mass index
GE	gastroesophageal
LAGB	laparoscopic adjustable gastric banding
LRYGB	laparoscopic Roux-en-Y gastric bypass
LSG	laparoscopic sleeve gastrectomy
POD	postoperative day
SG	sleeve gastrectomy

This work was presented at the SSAT Poster Presentation session on May 21st 2007 at the SSAT Annual Meeting at Digestive Disease Week, Washington. Poster ID M1588.

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Introduction

Worldwide, the incidence of morbid obesity has increased dramatically. Surgery has been proven to be the most effective long-term treatment option for sustained weight loss and improvement in comorbidity in the morbidly obese.[1] Although a number of surgical techniques exist, laparoscopic Roux-en-Y gastric bypass (LRYGB) and laparoscopic adjustable gastric banding (LAGB) are currently the most commonly performed bariatric procedures.[2]

The sleeve gastrectomy (SG) was first described by Hess in 1988 and subsequently by Marceau as a modification of Scopinaro's technique of biliopancreatic diversion (BPD) with distal gastrectomy and gastroileostomy.[3–5] Hess substituted a SG to function as the restrictive component

of the BPD, replacing the need for a distal gastrectomy and thus avoiding the serious complications of stomal ulceration and bleeding. The new BPD–duodenal switch (BPD–DS) procedure combined a vertical SG with a gastric volume of approximately 100 to 150 ml and a duodenal switch with a common channel of 100 cm and an alimentary limb of 150 cm.[3] This approach resulted in comparable weight loss in the long term with reduced morbidity compared to the original Scopinaro BPD procedure.[5–7] As well as reduced rates of ulcerogenicity, the effects of severe malabsorption including hypoproteinemia, hypocalcemia, and the dumping syndrome were attenuated.[6] More importantly, maintenance of greater than 50% excess weight loss (EWL) has been reported by Hess in the majority of patients who underwent BPD–DS with long-term follow-up of more than 10 years.[6]

With the advent of minimally invasive techniques, Gagner performed the first laparoscopic BPD–DS in 1999, and the role of the SG continued to evolve.[8,9] To attempt to reduce morbidity and mortality, and to facilitate the laparoscopic approach, SG was recommended as a staged procedure in the super and super–super morbidly obese or in those patients with high operative risk because of excessive comorbidity.[10–12] A more definitive procedure in the form of a laparoscopic BPD–DS or LRYGB was deferred for approximately 6 months to allow for an initial weight loss.[10–12] This approach was used successfully by several groups as a bridge to a future laparoscopic bariatric surgical procedure with acceptable weight loss and reduction in comorbidity.[10,12] Because of the relative technical ease of performance compared to other bariatric procedures, acceptable operative time, low complication rate, and reports of average EWL of 51–83% at 1 year with improvement in comorbidity, many began to consider laparoscopic SG (LSG) as a primary single-stage restrictive procedure.[11–14]

We and others have adopted the technique as an additional procedure in the surgical management of our morbidly obese patients.[15–19] We wished to examine our series of morbidly obese patients who have undergone LSG as a single-stage primary procedure for weight loss and propose a series of guidelines to assist in the identification of patients who may benefit from this approach.

Methods

A retrospective review of a prospectively maintained database and patient medical record review of all morbidly obese patients presenting to our institution for LSG as a primary restrictive one-stage procedure over a 29-month period from November 2004 to April 2007 was performed. There were no cases where LSG was performed as a bridge to a second bariatric procedure. Laparoscopic SG was offered in the presence of the following criteria: patient preference, contraindications for LRYGB including extensive previous surgery and Crohn's disease, elderly patients with significant comorbidity, adolescents, patients on antocogulant medications, recalcitrant smokers, and patients with low body mass index (BMI) of 35–40 kg/m^2 with comorbidity. All patients had routine laboratory investigations including nutritional parameters, Helicobacter serology, chest X-ray, electrocardiogram, abdominal ultrasound, and additional investigations as deemed necessary determined by their comordid conditions. All patients with positive Helicobacter serology were treated with eradication doses of triple therapy.

All procedures were carried out by two surgeons (S.S. and R.J.R.) in accordance with the National Institute of Health consensus criteria for morbid obesity.[20] Permission for the study was obtained from the Institutional Review Board. All patients had a routine gastrograffin upper gastrointestinal contrast study (GUGI) on postoperative day (POD) 1. If normal, patients were commenced on oral fluids. A preoperatively placed foley catheter was removed on POD 2, and all surgical drains were removed before discharge. Proton pump inhibitors were continued for 3 months. After discharge, patients were reviewed at 1, 3, 6, 12 months and yearly thereafter. All data pertaining to each patient including demographic data, weight, body mass index (BMI), comorbidities, preoperative investigations, previous surgical procedures, perioperative complications, and postoperative outcomes included morbidity, readmission rate, weight loss, and comorbidity status were analyzed from a prospectively maintained bariatric database.

Surgical Technique

Prophylactic heparin and a single dose of a broad spectrum antibiotic were administered at induction. A seven-trocar technique was used as previously described (Fig. 1).[17] After induction of anesthesia and endotracheal intubation, the abdominal cavity was accessed through a 1-cm supraumbilical incision using an Optiview trocar™ (Ethicon EndoSurgery, Cincinnati, OH, USA). The abdominal cavity was insufflated with carbon dioxide to a pressure of 15 mmHg. The operating trocars were inserted under direct vision. The liver was retracted cranially and the gastroesophageal (GE) junction exposed. A point on the greater curvature approximately 6 cm proximal to the pylorus was identified as the distal extent of the resection. The Harmonic scalpel™ (Ethicon EndoSurgery) was used to divide the vessels along the greater curve up to the angle of His. A 44–52 Fr bougie was inserted transorally to the level of the distal stomach and across the pyloric channel. Linear cutting staplers (Endopath®, Ethicon EndoSurgery) were used to vertically transect the stomach, creating a narrow

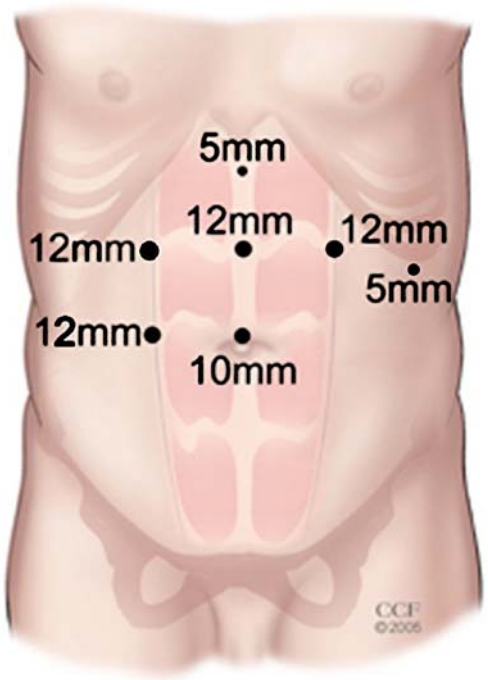

Figure 1 Trocar placement for laparoscopic sleeve gastrectomy.

gastric tube with an estimated capacity of less than 150 ml. The staple line was oversewn with a running 2/0 silk suture (Fig. 2). A large bore drain was placed in the subhepatic space adjacent to the stomach tube. The resected stomach was placed in a specimen bag and extracted through the supraumbilical port site. All trocar sites were closed with a subcuticular suture. Fascial sutures were not inserted routinely.

Results

Over a 29-month period from November 2004 to April 2007, 164 patients underwent LSG as a single-stage restrictive procedure for morbid obesity. Laparoscopic SG was performed as a primary restrictive procedure in 148 patients (90.2%) and as a revisional procedure in 16 patients (9.7%) with prior failed bariatric surgery. Patients who underwent LSG as a revisional procedure were excluded from further analysis.

Of the patients who had LSG as a primary restrictive procedure, the majority were female with a male to female sex ratio of 1:3. The mean age was 42 years (range, 13–79), and mean weight was 270 lbs (range, 168–453), with a mean BMI of 43.4 kg/m^2 (range, 35–75). The procedure was completed laparoscopically in 147 cases (99.3%). One procedure was converted to an open approach after an iatrogenic colotomy in the presence of dense adhesions related to previous surgery. The mean duration of surgery in the 148 patients was 60 min (range, 58–190), with a mean blood loss of 60 ml (range, 0–300). As expected the operative time in the patient who was converted was prolonged at 129 min, with an intraoperative blood loss of 100 ml. The mean operative time was 60 min (range, 58–190) in the laparoscopic group with a mean blood loss of 20 ml (range, 0–300). There were no perioperative deaths. One patient developed a staple-line leak, which was detected on POD 1 on the routine GUGI study and underwent laparoscopic primary repair of the site of leak high on the greater curvature with omental patchplasty. A second patient required laparoscopic exploration for postoperative hemorrhage because of a liver laceration from a retractor-induced injury. A pelvic abscess requiring percutaneous drainage developed in the patient with the iatrogenic colotomy. Three patients (2%) developed umbilical port site infections that responded to oral antibiotics and local wound care. The mean length of hospital stay was 2.7 days (range, 2–25).

In the first 3 months after LSG, four patients required readmission (2.7%). The majority were related to dehydration from inadequate oral intake or vomiting, related to transient gastric dysmotility, choledocholithiasis in one, and a gastric sleeve stricture in one. The patient with the gastric sleeve stricture (0.7%) presented 3 weeks postoperatively with dysphagia and vomiting. A 44-Fr bougie had been used to size the gastric tube at the time of LSG. A single

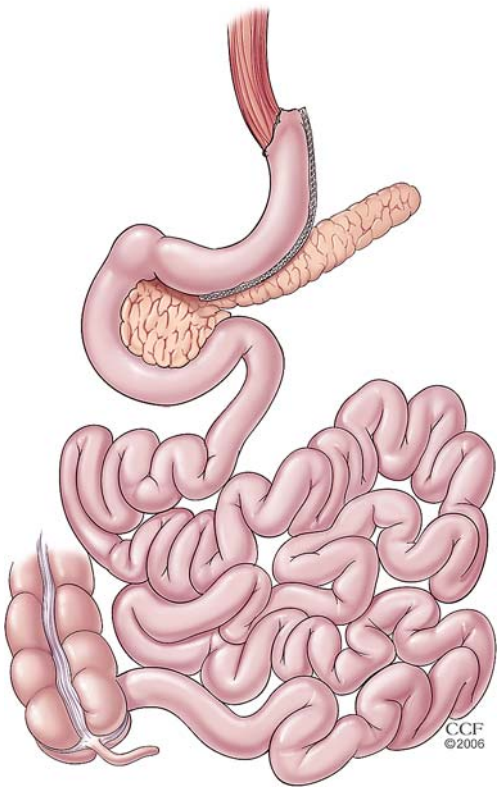

Figure 2 Laparoscopic sleeve gastrectomy.

endoscopic dilation with a through-the-scope endoscopic balloon was sufficient to produce symptomatic relief. An additional two patients developed symptomatic cholelithiasis.

Discussion

Laparoscopic SG results in weight loss not only from the restriction of oral intake but also because of significantly reduced ghrelin levels after resection of the gastric fundus, which is the predominant area of ghrelin production.[21–23] As the first part of the duodenum, pylorus, antrum, lesser curvature, and vagal nerve integrity are maintained, moderate restriction is created while allowing a relatively normal eating behavior. The concept of LSG as a single-stage primary restrictive procedure has not been widely accepted by the bariatric surgical community as published outcome data remains limited. Previous studies of LSG as a single-stage procedure report varying complication rates of 0–23%.[11,18,24,25] Some of the more significant complications after LSG include leaks and hemorrhage, with leak rates of 1.5–2.4%.[10,17,18,25] In a previous report of our early experience with LSG, we observed an acceptable perioperative complication rate with satisfactory short-term weight loss.[17] However, data was presented on only 30 patients who had undergone LSG as a primary or revisional procedure. Our current report evaluates our single center experience of one-stage LSG in 148 patients over a 29-month period and represents the largest series of one-stage LSG performed as a primary procedure for morbid obesity. All patients who underwent LSG as a revisional procedure were excluded. Operative complexity has been evaluated by conversion rates, mean operative time, and mean blood loss. Perioperative morbidity and mortality data are reported with additional data on mean hospital stay, readmission rates, and management of short-term complications. In our experience, LSG had a low conversion rate of 0.7%, with an acceptable intraoperative blood loss and mean operative time. A major complication rate of 2.7% was observed, with four adverse events in three patients. There were no patient deaths. These results compare favorably with other published reports of LSG. In our series, surgical intervention was required for a leak in one patient (0.7%) and bleeding in another (0.7%). All cases were recognized in the early postoperative period with immediate surgical intervention. One patient developed a leak during the early phase of our learning curve. This leak occurred high on the greater curve just distal to the angle of His. This complication emphasizes the importance of meticulous dissection to clearly identify the GE junction and angle of His. We now routinely leave a narrow cuff of tissue at the most superior aspect of the greater curve just below the angle of His, which is imbricated with a running 2/0 silk suture. This suture is continued down to the level of the distal extent of resection. Meticulous attention to oversewing the staple line is the main factor contributing to our extended operative time, but we believe this time is essential to reduce the risk of a staple-line leak and/or hemorrhage. To validate our current findings, similar conversion, perioperative complication, and readmission rates were observed in our initial 28 patients who underwent primary one-stage LSG.[17] Encouragingly, although there was a trend toward a nonstatistically significant increase in mean patient BMI, we observed reduced mean

Table 1 Indications for Primary Laparoscopic Sleeve Gastrectomy in the Morbidly Obese

Procedure	Characteristics
Two-stage procedure	
First step in super–super morbidly obese patient	Followed by RYGB or BPD
First step to a non bariatric second procedure	Low BMI of 35–40
	Followed by hip replacement, recurrent incisional hernia, pull through procedure for ulcerative colitis, renal/liver transplantation
Single-stage procedure	
Final step in ASA IV Morbidly Obese Patient	Low EF, Heart/Liver/Kidney transplant recipient
Final step in poor candidate for LRYGB or BPD-DS	Smoker
	Warfarin
Final step in extremes of age	Adolescents
	Elderly age ≥70 yrs
Final step in a high risk stomach	Chile, Colombia, Japan: high incidence of gastric cancer
Final step in Crohn's disease	
Patient preference	
Low BMI of 35–40 with comorbidity	
BMI 30–35 with the metabolic syndrome	

operative time and mean hospital stay compared to our early experience.

Although our series suggests that LSG may be a safe alternative option for the morbidly obese, it does have several limitations. Late complications of weight regain, gastric sleeve dilatation, and long-term resolution of comorbid conditions were not addressed. In addition, a number of key questions remain unanswered. Will the long-term results be as good as other restrictive procedures such as the LAGB? Will the percentage of excess weight loss at 10 to 15 years be comparable to LRGBP? What is the best bougie size to achieve maximal restriction and therefore optimal weight loss without creating an excessive narrow sleeve causing dysphagia, vomiting, and reflux symptoms? Currently, there is no consensus on the optimal size of the gastric tube. We routinely use a 44- to 52-Fr bougie to size the gastric tube, which has resulted in satisfactory weight loss and a stricture rate of 0.7%, which compares favorably to other published studies.[10,18] Will the gastric tube dilate over time and result in weight gain? Langer et al. demonstrated a single case of an asymptomatic radiologically detected gastric sleeve dilation in 14 patients at 1 year after LSG.[26] A dilated sleeve may be caused by intraoperative use of an excessively large bougie, true gastric tube dilation over time, or inadequate resection of the posterior gastric folds. Will sleeves need to be resleeved, and if so, how often? In a large series of BPD–DS procedures, Gagner et al. reported further weight reduction in one patient with inadequate weight loss after a resleeve.[27] Will the physiological advantage of reduced ghrelin production be lost over time? Will ghrelin levels remain low or will other sites of ghrelin production, such as the duodenum or brain, compensate to *normalize* levels? What percentage of one-stage LSG will eventually be converted to LRYGB or LPBD–DS? And finally, who should undergo LSG?

We believe LSG has a role in the management of the morbidly obese but in highly selected cases. At our institution, LRYGB, LAGB, and LSG are offered to all patients. Laparoscopic SG is performed under an Institutional Review Board-approved protocol while further data is awaited on long-term outcome. We continue to recommend LRYGB as the procedure of choice in patients with a BMI of $\geq$50 kg/m^2 with comorbidity. As our experience increases, we are attempting to define indications for primary LSG in our patient population (Table 1). We currently perform LSG in the presence of contraindications to LRYGB, including extensive previous surgery and Crohn's disease, and in poor candidates for LRYGB or LBPD–DS such as heavy smokers and those taking anticoagulants because of the risk of postoperative anastomotic ulceration and bleeding. We perform LSG in patients at the extremes of age, in high risk elderly patients aged >70 years with significant comorbidity, and in adolescents where a LRYGB and its metabolic consequences may be problematic. Other indications include LSG as a first step to another nonbariatric procedure such as joint replacement, organ transplantation, or incisional hernia repair where an initial weight loss would facilitate the required secondary intervention (Table 1). We also offer LSG to patients with a low BMI of 35–40 kg/m^2 with comorbidity and according to patient preference. Other indications for LSG include as a first step to a staged procedure in the super–super morbidly obese and as a primary procedure in endemic regions at risk of stomach cancer where ongoing endoscopic surveillance is required. More controversially, LSG may have a role in patients with a low BMI of 30–35 kg/m^2 with the metabolic syndrome.

In conclusion, we believe LSG is a safe and effective one-stage restrictive procedure in the short term to achieve weight loss as a primary procedure in the morbidly obese. In our experience, primary LSG is associated with an acceptable operative time, intraoperative blood loss, and perioperative morbidity (0.7% leak rate), with no mortality (0%). Prospective studies are required to evaluate the long-term outcome after LSG, specifically effective weight loss, maintenance of weight loss, resolution of comorbidity, and the potential for gastric tube dilation with weight regain.

Acknowledgment Competing Interests Declared: None

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