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RESEARCH ARTICLE

Laparoscopic Sleeve Gastrectomy with Minimal Morbidity Early Results in 120 Morbidly Obese Patients

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Abstract
Background In recent years, laparoscopic sleeve gastrectomy (LSG) as a single-stage procedure for the treatment of morbid obesity is becoming increasingly popular. Of continuing concern are the rate of postoperative complications and the lack of consensus as to surgical technique.
Methods A prospective study assessment was made of 120 consecutive morbidly obese patients with body mass index (BMI) of 43±5 (30 to 63), who underwent LSG using the following technique: (1) division of the vascular supply of the greater gastric curvature and application of the linear stapler-cutter device beginning at 6–7 cm from the pylorus so that part of the antrum remains; (2) inversion of the staple line by placement of a seroserosal continuous suture close to the staple line; (3) use of a 48 Fr bougie so as to avoid possible stricture; (4) firing of the stapler parallel to the bougie to make the sleeve as narrow as possible and prevent segmental dilatation.
Results Intraoperative difficulties were encountered in four patients. There were no postoperative complications—no hemorrhage from the staple line, no anastomotic leakage or stricture, and no mortality. In 20 patients prior to the sleeve procedure, a gastric band was removed. During a median follow-up of 11.7 months (range 2–31 months), percent of excess BMI lost reached 53±24% and the BMI decreased from 43±5 to 34±5 kg/m^2. Patient satisfaction scoring (1–4) at least 1 year after surgery was 3.6±0.8.
Conclusions The good early results obtained with the above-outlined surgical technique in 120 consecutive patients undergoing LSG indicate that it is a safe and effective procedure for morbid obesity. However, long-term results are still pending.

Keywords Bariatric surgery · Sleeve gastrectomy · Laparoscopy · Morbid obesity

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Introduction

Sleeve gastrectomy, a new procedure for weight loss, was initially devised to constitute the first stage of bariatric surgery, to achieve significant weight loss prior to performance of a more extensive mixed restrictive and malabsorptive operation and thereby decrease risk in patients with super-superobesity [1–3]. Recently, some surgeons have

begun to perform laparoscopic sleeve gastrectomy (LSG) as a sole procedure not only for superobese patients but also for those with a body mass index (BMI) of less than 50 [4–6]. Of persisting concern, however, are the rate of postoperative complications associated with the procedure and the lack of consensus as to surgical technique [7]. Gumbs et al. [8], in their 2007 review of the relevant literature, found that among the 646 patients having undergone LSG the mortality rate was 0.6%, with a variety of complications, including reoperation (in 4.5%), leak (in 0.9%), stricture (in 0.7%), bleeding (in 0.3%), pulmonary embolism (in 0.3%), delayed gastric emptying (in 0.3%), intra-abdominal abscess (in 0.1%), wound infection (in 0.1%), splenic injury (in 0.1%), and trocar site hernia (in 0.1%). Lalor et al. [9] of the Cleveland Clinic, FL, USA, in 2008 reported an incidence of 0.7% for staple-line leak, bleeding, stricture, and abscess among 164 patients who underwent LSG. Of further note is the variety of surgical techniques employed by the different authors in their performance of LSG. Lee et al. [10] reinforced the staple line with Seamguard® (Gore, Newark, DE, USA) but without suturing and reported a leak rate of 0.8%. Baltasar et al. [11], using a 32-Fr tube and starting the dissection close to the pylorus, reported leakage at the staple line in 2% as well as one case of gastric atony treated by total gastrectomy. Weiner et al. [12] documented a 5.2% leak rate when performing an LSG for gastric band migration.

In view of the above, we undertook a prospective study of the patients undergoing LSG, aiming to evaluate most particularly the postoperative morbidity associated with the procedure as performed in our service, as well as the effect of LSG on body weight and patient satisfaction.

Patients and Methods

A prospective noncontrolled study was initiated in January 2006 and terminated in May 2008, when 120 consecutive obese patients had undergone LSG. These comprised 98 females and 22 males, with a mean age of 38±12 years, a mean weight of 120±20 kg, and a mean BMI of 43±5 kg/m^2 (Table 1). The preoperative workup included: blood tests, chest radiography, electrocardiogram, abdominal ultrasound, and endocrinological, nutritional evaluation. All patients were kept on a low-carbohydrate diet for 4 weeks prior to surgery in order to decrease the steatosis [13]. All patients received a one-dose prophylactic intravenous antibiotic immediately before surgery. One superobese patient (BMI>60 kg/m^2) had been treated with an intragastric balloon (BIB^R, BioEnterics, Allergan, USA) and this was removed after 6 months of treatment 4 weeks prior to surgery. Twenty patients had previously undergone laparoscopic adjustable gastric banding (LAGB): in 17, the indication for LSG was a weight regain; in two, there was band slippage and, in one, port disconnection.

Table 1 Patients' demographic characteristics, postoperative weight, and BMI alterations (values expressed as mean±SD)

	Patients (n=120)	Median follow-up of 11.7 months
Age (years)	38.1±11.8	
Male/female	22/98	
Weight (kg)	120.2±20.3	95.1±18.4
BMI (kg/m^2)	42.7±5.3	33.9±5.5
%EBMIL		53.1±23.9

BMI Body mass index, *%EBMIL* percent of excess body mass index loss

The data collected comprised of demographics, BMI, and operative parameters (intraoperative complications, hospital stay, postoperative complications).

All the patients underwent LSG by the same surgeon. The surgical technique of the LSG, as reported previously [7], is as follows. The vascular supply of the greater gastric curvature is divided starting at 6–7 cm from the pylorus and proceeding to the angle of His. The gastroepiploic vessels along the greater curvature of the stomach are divided using the Harmonic Scalpel™ (Ethicon Endo-Surgery, Cincinnati, OH, USA). Once the lesser sac has been entered, the dissection is continued in a cephalad direction, the lower pole of the spleen being quickly reached. At the level of the spleen, the short gastric vessels are carefully coagulated separately. The dissection reaches the root of the left pillar of the hiatus.

The LSG is performed using a linear stapler-cutter device (EndoGIA®, US Surgical, Norwalk, CT, USA) with one 4.1-mm green load firings for the antrum, followed by five to seven sequential 3.5-mm blue loads for the remaining gastric corpus and fundus. The stapler is applied alongside a 48-Fr calibrating bougie strictly positioned against the lesser curve so as to avoid stenosis and to obtain a narrow gastric tube. The greater curvature, including the complete fundus together with the major part of the corpus and antrum, is resected from the antrum, beginning opposite the nerve of Latarjet and up to the angle of His. To strengthen the staple line and to prevent bleeding and leakage, it is oversewn using a seroserosal continuous absorbable suture from the angle of His. These sutures result in an additional narrowing of the sleeve. At the end of the procedure, the bougie is withdrawn and the fundic area is reexamined to locate any excess fundic tissue possibly remaining, which should be resected.

In the case of redo surgery after LAGB, the prosthesis is removed at the beginning of the operation. On the first postoperative day, an upper gastrointestinal contrast study is performed. A liquid diet is given for the first week, followed by a soft diet for another 3 weeks, in accordance with nutritional counseling. Subsequently, a long-term hypo-

caloric, protein-enriched solid diet is maintained. Long-term oral supplements of vitamins are given to all patients.

Statistical Analysis

The study protocol was approved by the local Ethical Committee. Results are expressed as mean±standard deviation. Statistical evaluations were performed by *t* test. Statistical significance was set at P value<0.001.

Results

The mean operative time was 100 min (range 70–120 min). Intraoperative difficulties were encountered in four patients: in one—opening of the mechanical suture line due to a defective cartridge was immediately sutured manually; in two—bleeding of short gastric vessels at the upper pole of the spleen was successfully treated with the Harmonic Scalpel™ device; in one—the temperature sensor probe became embedded in the staple line of the linear stapler-cutter device; the site was opened, the probe withdrawn, and the site then sutured. There were no conversions to open procedures. There were no postoperative complications: no hemorrhage from the staple line or anastomotic leakage, no stenosis, and no mortality. Histology of the resected stomach was normal in 85 patients: there was chronic gastritis in 35 patients; one patient had mucosal-associated lymphoid tissue lymphoma of the stomach.

The hospital stay was a mean 3.1±1.4 days. All patients have remained under regular follow-up. During the median follow-up period of 11.7 months (range 2 to 31 months), the BMI significantly (p<0.001) decreased from 43±5 to 34±5 kg/m^2, and the percent of excess BMI lost reached 53±24% (Table 1). With a satisfaction scale from 1 to a maximum of 4, the patient satisfaction scoring for the 63 patients who had completed at least 1 year of follow-up after surgery was 3.6±0.8. In three of the 20 patients who first underwent band surgery and then LSG, there was a weight regain due to proximal pouch dilatation.

Clinically, all these patients have done extremely well. There were no complaints of vomiting in the follow-up period and early satiety has usually been their only symptom. Among the 120 patients, only five have expressed any degree of dissatisfaction with the results (three with previous band surgery).

Discussion

LSG is gaining popularity whether as a primary, staged, or revisional operation [14]. In fact, in the past 3 years, there have appeared in the literature an increasing number of reports on its use as a single-stage operation for morbid obesity [5–7]. As noted above, however, the incidence of complications is a continuing concern [15]. In view of the good early results obtained in our series of 120 obese patients undergoing LSG, without any mortality or immediate postoperative morbidity, it was felt that an assessment of the various elements involved in the surgical procedure would be warranted.

Following are the four elements felt to be of most importance in lessening the complications and postoperative morbidity when performing LSG:

1. Division of the vascular supply of the greater gastric curvature and application of the linear stapler-cutter device beginning at 6–7 cm from the pylorus so that part of the antrum (the pump mechanism) remains. This is done to avoid delayed gastric emptying or gastric atony that could necessitate total gastrectomy, as occurred in the case described by Baltasar et al. [11] who reportedly started the division of the antrum only 2 cm proximal to the pylorus. The important role of the antrum in the mechanism of gastric emptying is in agreement with the report of Weiner et al. [12].
2. Inversion of the entire staple line by placing a seroserosal continuous suture close to the staple line. This aims to prevent leakage or bleeding. To protect the gastric suture line from such bleeding and leaks, other surgeons have used various materials, e.g., Peristrips® (Synovis Surgical Innovation, St. Paul. MN, USA) [16, 17] and Seamguard® [10] with mixed results.
3. Utilization of a 48-Fr bougie to calibrate the size of the sleeve. Continuous suturing close to the staple line over a 48-Fr bougie will not lead to postoperative stricture despite the decrease in sleeve volume, whereas use of a 32-Fr bougie is likely to do so.
4. Firing of the stapler parallel to the bougie in order to prevent segmental dilatation of the sleeve and to make the sleeve as narrow as possible, ensuring the complete removal of the fundus, which has the greatest potential for later dilatation.

LSG involves removing 80–90% of the stomach, leaving behind only a sleeve of the stomach, thus restricting the amount of food that can be ingested and elevating the intragastric pressure [18]. Complete resection of the fundus is particularly important to avoid the creation of a new reservoir by possible dilatation of this relatively thin gastric area. The diameter of the gastric sleeve is also important in preventing or delaying subsequent dilation: a wide sleeve will dilate earlier than a tighter one.

The finding that some of the patients who previously had undergone LAGB showed a weight gain after the sleeve operation stresses the importance of achieving a constant

width along the sleeve: the distortion of the fundus in the band operation makes accurate resection very difficult.

The main mechanism of weight loss following the sleeve gastrectomy procedure is the restriction of food intake resulting from the low distensibility of the sleeve and the consequent immediate high intraluminal pressure [18]. Other factors to be taken into consideration are the hormonal changes following the operation [19, 20] and its possible effect on gastric motility [21]. The behavior modification of the individual patient taking place before and after the operation may also be of importance in achieving a long-term successful outcome [22].

The early results documented for this series of 120 obese patients who underwent LSG without any serious complications, neither bleeding nor leakage and no mortality but with a notable weight loss and a high rating for patient satisfaction, have certainly been encouraging. It now remains to be seen whether these will be confirmed in larger series of patients and on a long-term basis.

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