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ORIGINAL CONTRIBUTIONS

Survey on laparoscopic sleeve gastrectomy (LSG) at the Fourth International Consensus Summit on Sleeve Gastrectomy

Michel Gagner · Mervyn Deitel · Ann L. Erickson · Ross D. Crosby

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Abstract
Background LSG has been increasingly performed. Long-term follow-up is necessary.
Methods During the *Fourth International Consensus Summit on LSG* in New York Dec. 2012, an online questionnaire (SurveyMonkey®) was filled out by 130 surgeons experienced in LSG. The survey was submitted directly to the statisticians.
Results The 130 surgeons performed 354.9±SD 453 LSGs/surgeon (median 175), for a total of 46,133 LSGs. The LSGs had been performed over 4.9±2.7 year (range 1–10). Of the 46,133 LSGs, 0.2±1.0 % (median 0, range 0–10 %) were converted to an open operation. LSG was intended as the sole operation in 93.1±14.8 %; in 3.0±6.3 %, a second stage became necessary. Of the 130 surgeons, 40 (32 %) use a 36F bougie, which was most common (range 32–50F). Staple-line is reinforced by 79 %; of these, 57 % use a buttress and 43 % over-sew. Mean %EWL at year 1 was 59.3 %; year 2, 59.0 %; year 3, 54.7 %; year 4, 52.3 %; year 5, 52.4 %; and year 6, 50.6 %. If a second-stage operation becomes necessary, preference was: RYGB 46 %, duodenal switch 24 %, re-sleeve 20 %, single-anastomosis duodenoileal bypass 3 %, sleeve plication 3 %, minigastric bypass 3 %, non-adjustable band 2 %, and side-to-side jejunoileal anastomosis 1 %. Complications were: high leak 1.1 %, hemorrhage 1.8 %, and stenosis at lower sleeve 0.9 %. Postoperative gastroesophageal reflux occurred in 7.9±8.2 % but was variable (0–30 %). Mortality was 0.33±1.6 %, which translates to ~152 deaths. Eighty-nine percent order multivitamins (including vitamin D, calcium, and iron) and 72 % order B_{12}. A PPI is ordered by 29 % for 1 month, 29 % for 3 months, and others for 1–12 months depending on the case.
Conclusions LSG was relatively safe. Further long-term surveillance is necessary.

Keywords Sleeve gastrectomy · Laparoscopy · Survey · Complications · Bariatric surgery

M. Gagner
Clinical Professor of Surgery, Herbert Wertheim College of Medicine, Florida International University, Miami, FL, USA
e-mail: gagner.michel@gmail.com

M. Gagner
Bariatric and Metabolic Surgery, HGH, Doha, Qatar

M. Gagner
Hopital du Sacre Coeur, Montreal, QC, Canada

M. Deitel (✉)
Editor-in-Chief Emeritus and Founding Editor, Obesity Surgery, 39 Bassano Road, Toronto, ON M2N 2J9, Canada
e-mail: book@obesitysurgery.com

A. L. Erickson
Statistics Department, Neuropsychiatric Research Institute, Fargo, ND, USA

R. D. Crosby
Department of Biomedical Statistics, Neuropsychiatric Research Institute, Fargo, ND, USA

Introduction

Parietal cell gastrectomy evolved into sleeve gastrectomy (SG) for morbid obesity in the early 2000s, the sleeve being the first part of the duodenal switch (DS) operation [1–3]. In high-risk and super-super-obese patients, the gastric sleeve portion of the DS operation was often performed alone as a first-stage [4–8]. It was soon found that the laparoscopic SG (LSG) with a narrower sleeve could be performed in many cases as a stand-alone bariatric operation [9–11].

As a means of surveillance, a comprehensive International SG Summit Conference has been held every 2 years since 2007 under the direction of Michel Gagner [12]. With increased usage of the SG operation, further worldwide interaction was achieved by a Fourth International Consensus Summit on SG (4ICSSG) in New York City in December 2012.

The 4ICSSG provided the opportunity for an online questionnaire to be filled out by experienced attendees.

Methods

The online questionnaire using web-based SurveyMonkey® was organized in collaboration with biostatisticians Ann Erickson and Ross Crosby of the Neuropsychiatric Research Institute, Fargo, ND, USA, who compiled the data and performed the analyses. Those experienced attendees with >1-year performance of the LSG were asked to report their data in the online survey, which they submitted directly to the department of biomedical statistics. Data are reported as mean±standard deviation (SD), median and range, or frequency and percentage of valid responses.

Results

Of the 700 attendees, there were 130 surgeons who had actively performed the LSG for >1 year. Their responses to the online questionnaire provided a total of 46,133 LSGs (mean per surgeon 354.9±SD 453.2, median 175.0). The LSGs were performed over a mean of 4.9±2.7 years (median 5.0, range 1–10). On average 93.1±14.8 % of LSGs (median 100, range 20–100) were intended as the sole bariatric operation; however, in 3.0±6.3 % (median 0.3, range 0–50), a second-stage operation became necessary. In the 46,133 LSG operations, 0.2±1.0 % (median 0, range 0–10 %) were converted to an open operation.

For the respondents who had the data, the percent excess weight loss (%EWL) to 6 years is shown in Fig. 1. Vertical bars show SD, with number of surgeons reporting at each time-point given at the bottom of each bar. The way the questions are asked on the web-based SurveyMonkey® led a few surgeons to report a zero for %EWL for some years where they actually had no data and should have left a blank. Thus, the %EWL data may be underestimated. As it could not be determined whether these responses were real (i.e., zero %EWL) or were intended to represent no information (i.e., missing), these zeroes were included in calculating the mean %EWL. Thus, these numbers should be interpreted with some caution.

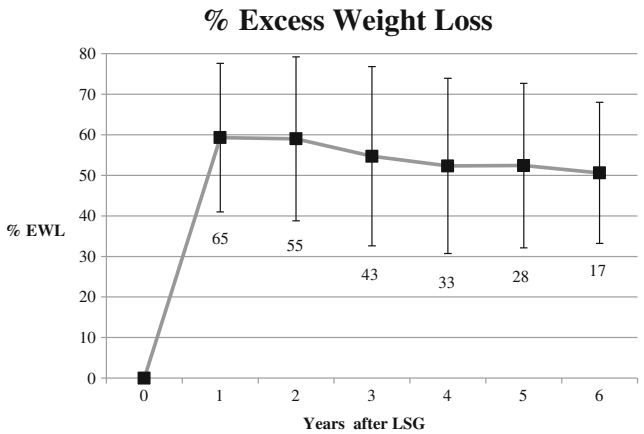

Fig. 1 Graph showing the reported percent excess weight loss (%EWL) after LSG. *Vertical bars* show the SD

Of the 130 surgeons, 69 % specifically look for a hiatal hernia (HH); the remaining 31 % only look for a HH if shown on preoperative studies or if there is a history of gastro-esophageal reflux disease (GERD). If a HH is identified, 89 % (114 surgeons) do a repair, while 11 % do not. For the 114 who repair, 65 % use Ethibond™, 11 % use Prolene®, and 16 % use silk; mesh is added to the repair by 13 surgeons (nine bioabsorbable, two Prolene®, and two PTFE®).

Of the respondents, 97 % mobilize the greater curvature first, and then perform the stapling transection; only 3 % do the stapling-transection first and then mobilize the greater curvature.

Of the 130 surgeons, 40 (32 %) use a 36F bougie, which was the most common size selected—with a wide range of 32–50F. Of the bougies, 68 % use a blunt-tipped, 21 % a tapered, 8 % the MID-Sleeve™ tube (Medical Innovation Developpement), and 3 % use a gastroscope.

Resection in the antrum typically began 4–5 cm (in 32.2 %), followed by 3–4 cm (in 27.3 %), and 5–6 cm (in 22.7 %) proximal to the pylorus. A total of 96 of the surgeons (75 %) reported that they reinforce the staple-line of the gastric sleeve; of those who reinforce, 57 % use a buttress on the staple-line and 43 % over-sew the staple-line (6 % applying an omental patch). Of those who utilize a buttress, 49 % used Bioabsorbable Seamguard®, 31 % used Peristrips®, and 14 % used Duet™ tissue buttress.

The estimated fundus resected was 88 %±15 % (median 90 %); many cautioned to avoid involving the esophagus. At the primary LSG, two of the surgeons apply a silicone Autolock™ ring (Bariatech) around the upper third of the sleeve [13].

A drain is left in by 39 % of the surgeons—usually closed-suction (Blake/Jackson-Pratt); 61 % do not insert a drain.

The percentage of complications in these LSGs is listed in Table 1. Although leaks were rare, they presented a major challenge for the surgeon and patient. The most common methods for treatment of leaks included percutaneous CT-guided drainage, repeat laparoscopy, re-operation (with over-sewing if early), nothing by mouth, total parenteral nutrition, naso-gastro-jejunal tube or feeding jejunostomy, antibiotics, fibrin glue, endoscopic clip, and endoscopic pneumatic dilatation of distal narrowing. For persisting leaks or chronic fistulas, most now recommended covered or partially covered self-expanding single or double stents used earlier, pigtail drains, or a Roux-loop to the leak if needed. Three surgeons

Table 1 Percent of patients with complications after LSG

Complication	Percent of patients	
	Mean±SD (%)	Range (%)
High leak (GE junction)	1.1±2.2	0–18
Lower leak	0.2±0.7	0–5
Hemorrhage	1.8±3.1	0–21
Splenic injury	0.2±0.7	0–5
Liver injury	0.2±1.0	0–10
Stenosis	0.9±1.6	0–8
Postoperative GER	7.9±8.2	0–30
Postoperative HH	9.7±15.6	0–60
Portal vein thrombosis	0.2±0.8	0–5
Venous thromboembolism (DVT, PE)	0.3±0.7	0–4
Other	0.2±0.5	0–2
Mortality[a]	0.33±1.6	0–3

Reported by 130 surgeons, based on 46,133 LSGs

[a] 152 deaths

have had to perform a total gastrectomy. The incidence of leaks was greater in revision operations.

Mortality was 0.33±1.6 % out of 46,133 LSGs, which translates to ~152 deaths, which is a very low mortality considering that a number of these patients were poor risk. Postoperative gastroesophageal reflux (GER) was variable, but a problem for a number of patients.

Postoperatively, 89 % of the surgeons order supplements (multivitamins, including vitamin D, calcium, and iron) and 72 % order vitamin B_{12}. A proton pump inhibitor (PPI) was routinely prescribed for 1 month by 30 (29 %) of the surgeons and for 3 months by 30 (29 %) of the surgeons; many noted that they prescribe the PPI for 1–12 months, depending on the case.

A total of 45 % of the surgeons order a water-soluble upper GI series on the first postoperative day. Follow-up upper GI series is ordered by 57 % and/or endoscopy by 20 % at 1 year routinely; 21 % only perform these studies if there are problems—GER, weight regain, or dysphagia. Regarding indications, LSG is being performed in adolescents by 63 %, high-risk patients by 94 %, the elderly by 86 %, diabetes by 87 %, at lower BMI by 76 %, and for revision of gastric banding by 79 %.

Many respondents denied observing significant weight regain; however, when this occurred, the patient was assessed by the team, including dietary, exercise, and psychologic consultation. As seen in Fig. 1, weight loss maintenance has been good in the majority of patients. If a second operation becomes necessary for regain, currently 20 % consider re-sleeve, 46 % conversion to Roux-en-Y gastric bypass, 24 % conversion to a duodenal switch [14, 15], 3 % add a single-anastomosis duodenoileal bypass [16], 3 % plication of the sleeve [17], 3 % a minigastric bypass [18, 19], 2 % would apply a band [13], and 1 % a side-to-side jejunoileal anastomosis [20].

Discussion

LSG is increasingly being done as a potentially stand-alone bariatric operation, performed with some ease laparoscopically. After bariatric operations, there has been variable weight regain reported in the long-term [21–23], the least regain apparently following the duodenal switch [24, 25]. As shown in Fig. 1 after 2 years following LSG, there has been slight progressive weight regain, which will require longer follow-up.

The occurrence of GERD has been reported [26] but remains a controversial issue after the LSG. Himpens' group found early true reflux and late regurgitation due to over-eating in some patients postoperatively [12, 27]. However, Chiu and co-workers [28] in a review reported that most studies found no increase in GERD after LSG. Tai et al. [29] found postoperative GERD and erosive gastritis to be related to the presence of a HH. An increase in lower esophageal sphincter pressure accompanied by a decrease in GER has been reported when narrow lesser curvature gastric tubes are constructed [30, 31]; the lesser curvature open inner transverse C-shaped muscle (sling) fibers are approximated, increasing intraluminal tension (Laplace's law). Abnormal esophageal motility has been found in morbidly obese individuals, but without GER [32]. The observed fact that the stomach appears to empty rapidly after sleeve gastrectomy [33] should tend to decrease GERD. The issue is still in dispute, but most surgeons repair a HH (when present) at LSG, and if there is a high degree of GERD and/or a large HH, most would perform a Roux-en-Y gastric bypass [15, 27, 34, 35]. Both Soricelli et al. [35] and Daes et al. [36] found that searching for and repairing a HH at the LSG operation decreases GER significantly.

The average bougie size used for LSG has remained 36 F over the years [12]. However, using a ≥40F bougie has not decreased %EWL thus far up to 36 months [37]. Furthermore, narrower bougies have been found to result in a higher incidence of gastric leaks [37, 38].

The majority of surgeons reinforced the staple-line with a buttress or over-sewing, which appears to decrease bleeding [15, 39, 40], but there are surgeons who have not encountered problems without reinforcement [41].

Leak at the cardia, where the blood supply may be deficient, has been a rare but dreaded complication. Furthermore, if a leak at the angle of His retracts into the mediastinum, there is potential for a leak to the pleural cavity, which is a serious problem [42]. The surgeons in this survey were fairly uniform in their treatment for leak and fistula [43, 44], but there was a

change from previous surveys [12, 45] to earlier and more frequent use of endoscopic stents. For strictures in the lower sleeve, endoscopic dilatation, seromyotomy [46], stricturoplasty, or gastric bypass may be necessary. Although the complications of LSG in the current report from experienced surgeons were found to be minimal, the reader should be cautioned by a recent report of devastating complications after LSG [47].

LSG is followed by less nutritional deficiencies over the long term than gastric bypass or malabsorptive operations. Nevertheless, multivitamin, mineral, and adequate protein supplements are necessary [48–50], as is follow-up by the multidisciplinary team and surgeon [51]. Serum vitamin D_3 has been a particular deficiency in these patients during winter [52]. Moreover, in LSG, the intrinsic-factor portion of the stomach is resected, but with the stores in the liver, vitamin B_{12} deficiency may not become evident until 5 years postoperatively.

This study has the limitation that it is a survey; it is not a prospective collection of data or a randomized controlled trial. The reports of %EWL were highly variable, and the number of surgeons with experience >5 years is small. Thus, these data from experienced bariatric surgeons should be interpreted with some caution. The survey also shows a wide variation in techniques practiced.

The indications for LSG have broadened, and the results have been found to be equivalent to those reported for gastric bypass [53, 54]. Controversial issues remain, and longer surveillance is necessary. Because the co-morbidities of severe obesity recur if there is weight regain, the secondary operations after LSG indicated by the respondents may be entertained.

Conflict of Interest Mervyn Deitel, Ann L. Erickson and Ross D. Crosby have nothing to disclose. Michel Gagner is a consultant for Ethicon EndoSurgery, Covidien, Gore, MID, and Transenterix.

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