Laparoscopic sleeve gastrectomy: a novel procedure for weight loss

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ABSTRACT

Introduction: Morbid obesity is associated with increased morbidity and mortality. Bariatric surgery offers morbidly obese individuals substantial and sustainable weight loss and reduction in obesity-related comorbidities. Laparoscopic sleeve gastrectomy (LSG) is a new restrictive procedure in bariatric surgery. We aimed to evaluate our experience with LSG with regard to its safety and feasibility and early weight loss.

Methods: The surgical outcome, complications and early clinical results of all patients who underwent LSG at Singapore General Hospital were studied.

Results: 30 patients underwent LSG between December 2008 and October 2010. The mean preoperative weight of the patients was 113.4 (range 91.0–170.0) kg, while the mean body mass index (BMI) was 42.6 (range 33.0–60.0) kg/m^2. Diabetes mellitus was present in 39 percent of the patients, hypertension in 43 percent, hyperlipidaemia in 35 percent, obstructive sleep apnoea in 30 percent and osteoarthritis in 22 percent. The majority of patients had two or more obesity-related comorbidities (52 percent). Mean operative time was 142 (range 80–220) minutes and median duration of postoperative stay was three days. At two weeks, one, three and six months post operation, the mean BMI was 38.6 kg/m^2, 37.8 kg/m^2, 34.5 kg/m^2 and 30.8 kg/m^2, the mean percentage of excess weight loss was 17.7 percent, 23.3 percent, 40.9 percent and 56.7 percent, and absolute weight loss was 8.00 kg, 11.52 kg, 18.77 kg and 26.85 kg, respectively.

Conclusion: LSG is a promising procedure for surgical treatment of obesity, with good early weight loss and low morbidity.

Keywords: bariatric surgery, laparoscopic sleeve gastrectomy, morbid obesity, weight loss

Singapore Med J 2011; 52(11): 794-800

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INTRODUCTION

Obesity has reached epidemic proportions worldwide. There are more than one billion overweight adults, of which at least 400 million are clinically obese.[1] According to the World Health Organization (WHO), Southeast Asian countries, together with India and China, are leading this epidemic.[2] In the most recent National Health Survey in Singapore, the obesity rate was found to have increased from 6.9% in 2004 to 10.8% in 2010.[3]

Morbid obesity is associated with increased morbidity and mortality. Bariatric surgery offers morbidly obese individuals substantial and sustainable weight loss and reduction in obesity-related comorbidities when other conservative treatments have failed. Many types of operative procedures for morbid obesity have been popularised over the past three decades, and they are continuously evolving. These procedures are classified into three main categories according to their main mechanism of action: restrictive (e.g. laparoscopic adjustable gastric banding [LAGB], vertical banded gastroplasty); malabsorptive (e.g. biliopancreatic diversion and duodenal switch [BPD-DS]); and a combination of both (e.g. laparoscopic Roux-en-Y gastric bypass [LRYGBP]).

Laparoscopic sleeve gastrectomy (LSG) is a relatively new option in bariatric surgery for the treatment of morbid obesity. It involves the subtotal gastric resection of the fundus and the body to create a long, tubular gastric conduit along the lesser curve of the stomach (Fig. 1). This procedure was originally described by Marceau et al in 1993 as the restrictive part of a duodenal switch malabsorptive operation, in an attempt to improve the results of biliopancreatic diversion without performing a distal gastrectomy.[4] LSG has been proposed as the

first step in the treatment of super-obese patients or in patients with a high operative risk, before performing more complicated procedures such as laparoscopic BPD-DS or LRYGBP.[5-11] Recently, it has also been proposed that LSG may be a potential 'stand-alone' procedure for morbid obesity due to its promising early results.[12] The mechanisms of weight loss and improvement in co-morbidities seen after LSG are postulated to be related to gastric restriction, increased gastric emptying and neurohumoral changes related to gastric resection, e.g. decreased ghrelin production.[13,14]

A systematic review of the current data of LSG in adults was published in 2009.[15] The major complication rates reported in this review were relatively low, with the reported leak, bleeding and stricture rates at 2.2%, 1.2% and 0.63%, respectively. The postoperative 30-day mortality rate in the published data was 0.19%, while the mean excess weight loss was 55% (range 33%–85%). In Singapore, LSG is a relatively new option for treatment of morbid obesity within the armamentarium of the bariatric procedures available. We present the first and largest series of LSG cases in Singapore to date, and aimed to evaluate the technical aspects as well as review our early experience and weight loss results.

METHODS

Between December 2008 and October 2010, all patients who underwent LSG for morbid obesity at the Singapore General Hospital (SGH) were reviewed and followed up for their weight loss and resolution of obesity-related co-morbidities. The patients' clinical data, including age, gender, initial body mass index (BMI) and comorbidities, were obtained from a prospectively maintained computerised clinical database, Sunrise Clinical Manager version 5.8 (Allscripts Healthcare Solutions Inc, Chicago, IL, USA) (Table I).

Surgical information, such as the American Society of Anaesthesiologists status and duration of surgery, was obtained from another prospectively maintained computerised operative database (OTM version 10, SGH, Singapore). Morbidity analyses were conducted by reviewing the patient charts and clinical records. Mortality was confirmed from hospital medical records or from the records of the Registry of Births and Deaths, Singapore (for all patients who were residents of Singapore). Operative morbidity and mortality was defined as any significant complication or death within 30 days following surgery. Significant complications included wound infection, reactionary haemorrhage necessitating repeat surgery, postoperative pneumonia, culture-proven septicaemia, radiological identification of an intra-abdominal abscess, staple line leak or confirmed deep vein thrombosis and/or pulmonary embolism. The study was approved by the Centralised Institutional Review Board of the hospital. BMI was calculated by dividing weight in kilograms by height in metres squared. Obesity was defined according to WHO definition and is summarised in Table II.[16] Excess weight was defined as the total preoperative weight minus ideal weight

Table I. Patient characteristics and summary of the results.

Characteristic	Result
Gender (No.)	
Male	11
Female	19
Mean age; range (yrs)	39; 23–64
Mean pre-op weight; range (kg)	113.4; 78.0–170.0
Mean pre-op BMI ± SD (kg/m^2); range	42.6 ± 7.02; 33.0–60.0
Comorbidity (%)	
Diabetes mellitus	39
Hypertension	43
Hyperlipidaemia	35
Obstructive sleep apnoea	30
Osteoarthritis	22
≥ 2 comorbidities	59
Mean operative time; range (min)	142; 80-220
Mortality	Nil
Morbidity (%) – staple line bleeding	3
Median post-op stay; range (days)	3; 1–9
Mean BMI post surgery ± SD (kg/m^2)	
2 weeks	38.6 ± 6.53
1 month	37.8 ± 5.14
3 months	34.5 ± 6.61
6 months	30.8 ± 4.18
Excess weight loss ± SD (%EWL)	
Two weeks	17.7 ± 9.18
One month	23.3 ± 10.27
Three months	40.9 ± 19.56
Six months	56.7 ± 18.45
Absolute weight loss ± SD (kg)	
Two weeks	8.0 ± 3.41
One month	11.52 ± 5.41
Three months	18.77 ± 9.01
Six months	26.85 ± 9.88

BMI: body mass index; SD: standard deviation

Table II. WHO definition of obesity and criteria for bariatric surgery in the Asia-Pacific region.

Definition/criteria[16]	BMI (kg/m^2)
Indication for bariatric surgery in the Asia-Pacific region	≥ 37.5 or ≥ 32.5 in the presence of significant obesity-related comorbidities
Obese class type	
III	≥ 37.5
II	32.5–37.4
I	27.5–32.4
Overweight	23.0–27.4

WHO: World Health Organization; BMI: body mass index

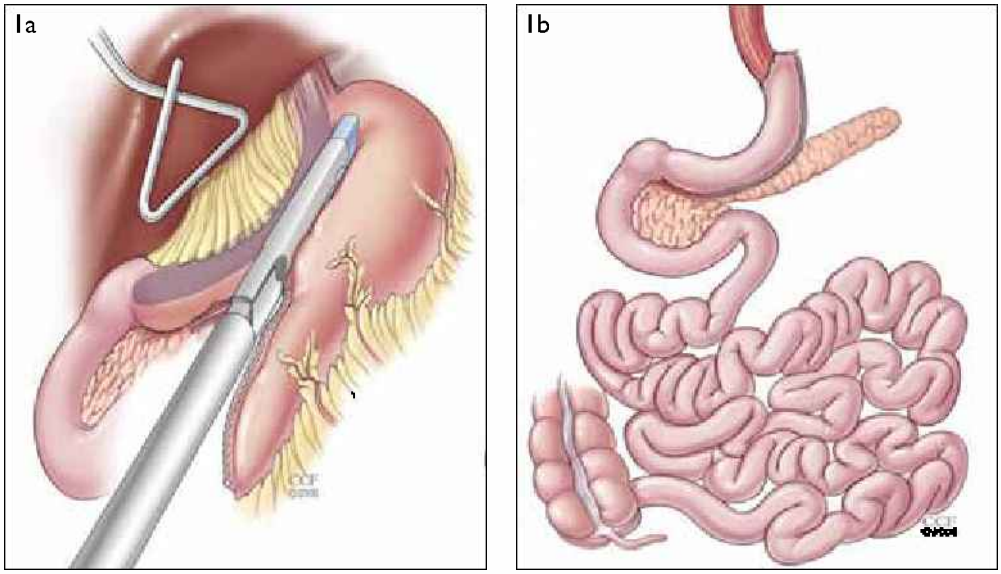

Fig. 1 Diagrammatic representation of sleeve gastrectomy shows (a) a stapler fired along the length of an intragastric bougie; and (b) a completed sleeve gastrectomy demonstrating a tubularised stomach [reprinted with permission, Cleveland Clinic Center for Medical Art & Photography ©2006-2011. All Rights Reserved].

(ideal weight was calculated using BMI of 23 kg/m^2). Percentage of excess weight loss (%EWL), as defined in standard bariatric surgery nomenclature, is weight loss at a point of time as a percentage of excess weight (weight loss/excess weight × 100).[17] The minimum BMI qualification for bariatric surgery in our centre was 37.5 kg/m^2 or 32.5 kg/m^2 in the presence of significant obesity-related comorbidities, in accordance with the Asia Pacific Metabolic and Bariatric Surgery Society consensus statement.[18]

All patients were evaluated by a multidisciplinary team with a standardised workflow. LSG was selected amid an array of laparoscopic weight loss operations offered at our department (LSG, LAGB, LRYGBP, BPD). Briefly, the characteristics, pros and cons of each procedure were discussed with the patient, and a joint decision was made with the patient after all the factors were considered. Patients who preferred a restrictive procedure were offered a choice between LAGB and LSG. After satisfying the criteria for bariatric surgery, pre-surgery workup, including standard blood investigations, chest radiography and electrocardiogram, was conducted. Oesophagogastroduodenoscopy was routinely performed in order to exclude any gastric pathologies (e.g. peptic ulcers, significant gastroesophageal reflux disease or cancers) and to define anatomy. Patients were admitted one day prior to surgery.

Surgery was performed under general anaesthesia, with the patients positioned on an operating table (Eschmann T20, Eschmann Holdings Pte Ltd, West Sussex, UK) designed to withstand a maximum weight of 450 kg. The patients were placed in supine position with the table in reverse Trendelenburg position (the feet were supported by cushioned foot plates to prevent the patients from sliding caudally down the operating table). Intermittent pneumatic calf compressors were applied, with prophylactic intravenous cephalosporin administered prior to incision and insertion of a Foley catheter post-induction. The operation theatre set-up is illustrated in Fig. 2, with the surgeon on the right of the patient. All the procedures in this series were performed by a single surgeon (SP).

Post induction, ultrasonography-guided transversus abdominis plane (TAP) block was administered by the anaesthetist to minimise postoperative pain and opioid usage. Transumbilical incision was made for the optical trocar (a 30° high-definition laparoscope); a 12-mm port was placed at the level of the left mid-clavicular line (MCL) for the surgeons's right hand instrument, a right MCL port for the surgeon's left hand instrument and bilateral anterior axillary line (AAL) for the assistant's instruments and/or liver retractor (Fig. 2). Carbon dioxide (CO_2) was insufflated up to and maintained at 12–16 mmHg. The greater omentum was divided close to the stomach wall and medial to the gastroepiploic arcade using either the Ligasure device (Tyco, New Haven, CT, USA) or a Harmonic scalpel (Ethicon Endo-Surgery Inc, Cincinnati, OH, USA). The dissection extended from 4 cm proximal to the pylorus to the angle of His of the stomach at the base of the left diaphragmatic pillar, which was entirely freed from its posterior aspect. Sleeve gastrectomy was then performed with endoscopic staplers (Echelon Flex, Ethicon EndoSurgery, Cincinnati, OH, USA and ENDO GIA™, Covidien, Mansfield, MA,

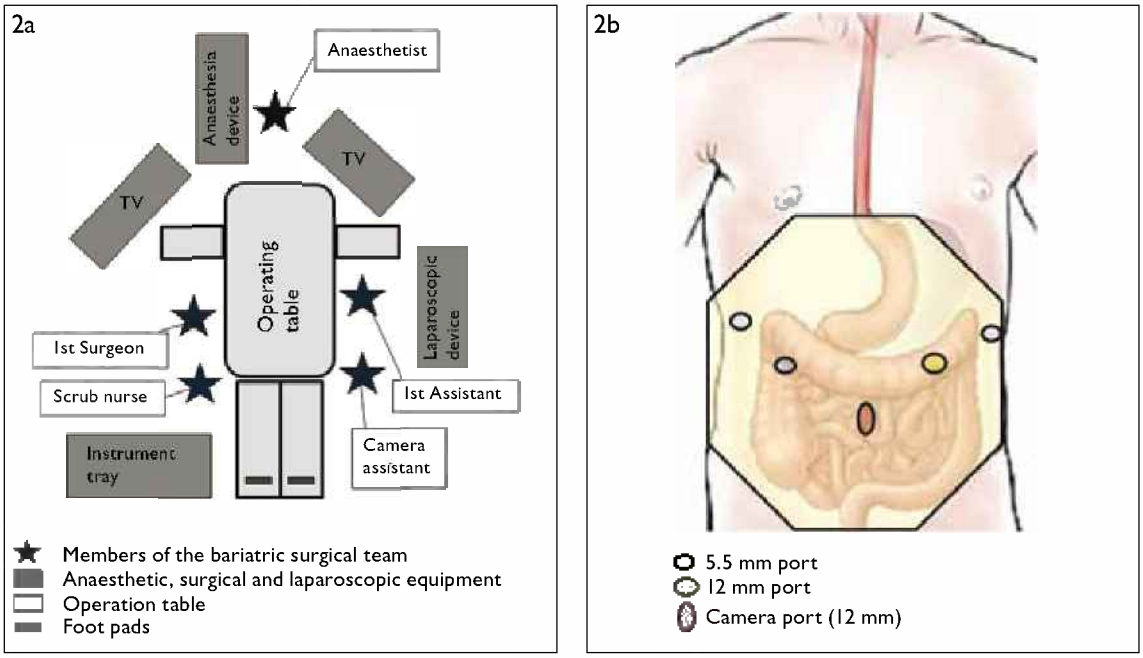

Fig. 2 Illustrations show (a) the operative room setup; and (b) the laparoscopic port positions.

USA). Prior to stapling, the anaesthetist passed down a 38 French size gastric calibration tube to guide the gastric division. The first firing of a linear stapler divided the greater curvature in the direction of the crow's foot about 4 cm proximal to the pylorus. Care was taken not to create a stricture at the level of the incisura angularis. Additional firings of the endoscopic stapler divided the greater curve longitudinally from the antrum to the angle of His, and usually required 4–6 staple cartridges. Haemostatic clips and sutures were used to reinforce the staple line, where necessary. A leak test with methylene blue dye was performed to demonstrate the integrity of the newly created gastric tube prior to completion of the procedure.

Patients were observed in the high-dependency unit for the first night after the procedure. On the second postoperative day, water soluble contrast study was performed before the patients were discharged (Fig. 3). They were encouraged to sit out of bed, and chest physiotherapy was commenced on the evening after surgery in order to minimise postoperative atelectasis. They were followed up in the outpatient clinic at two weeks, one month, three months and six months post discharge, and subsequently at six-monthly intervals.

Fig. 3 Radiograph with water-soluble contrast on postoperative Day 2 shows the remnant sleeve gastrectomy conduit in one of the patients.

RESULTS

A total of 30 patients (19 females, 11 males) underwent LSG between December 2008 and October 2010. The mean age of the patients was 38 (range 23–64) years. The mean preoperative weight was 113.4 (range 91–170) kg and the mean BMI was 42.6 (range 33.0–60.0) kg/m^2. Diabetes mellitus was present in 39% of the patients, hypertension in 43%, hyperlipidaemia in 35%, obstructive sleep apnoea in 30% and osteoarthritis in 22%. The majority of patients had two or more obesity-related comorbidities (52%). The mean operative time was 142 (range 80–220) minutes, and there was no conversion to open surgery. One patient required re-laparoscopy on the first postoperative day for bleeding from the gastric staple line. She subsequently recovered well but developed a superficial wound infection from one of the laparoscopic port sites. The wound infection was treated

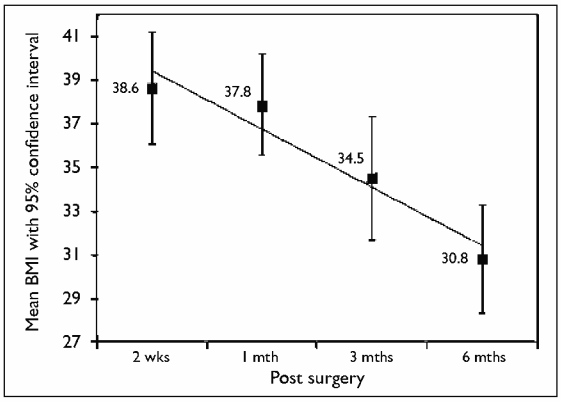

Fig. 4 Graph shows a decrease in the mean body mass index of patients after surgery.

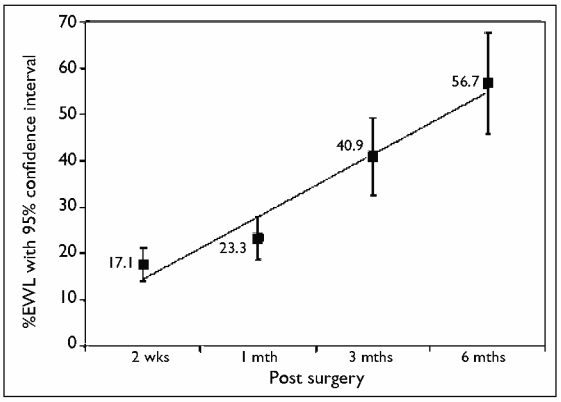

Fig. 5 Graph shows the mean percentage of excess weight loss in patients after surgery.

with antibiotics and daily dressings. There were no other morbidities. The median duration of postoperative stay was three (range 1–9) days. At two weeks, one month, three months and six months post operation, the patients' mean BMI was 38.6 kg/m^2, 37.8 kg/m^2, 34.5 kg/m^2 and 30.8 kg/m^2 (Fig. 4), the mean %EWL was 17.7%, 23.3%, 40.9% and 56.7% (Fig. 5), and absolute weight loss was 8.00 kg, 11.52 kg, 18.77 kg and 26.85 kg, respectively (Fig. 6).

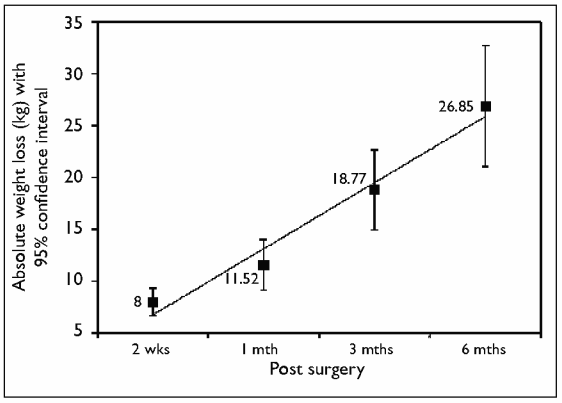

Fig. 6 Graph shows the absolute weight loss in patients after surgery.

DISCUSSION

The rising prevalence of obesity is associated with an increase in the prevalence of obesity-related comorbidities (e.g. diabetes mellitus, hyperlipidaemia, hypertension, obstructive sleep apnoea, heart disease, stroke, asthma, back and lower extremity osteoarthritis, several cancers and depression).[19-21] These comorbidities are responsible for more than 2.5 million deaths per year worldwide.[22] The negative effect of obesity on life expectancy is profound in comparison with a normal-weight individual; for example, a 20-year-old morbidly obese man has a 22% reduction in his expected remaining lifespan, which estimates to a loss of 13 years of life.[23] Unfortunately, diet therapy, medical treatment and exercise regimes are relatively ineffective in treating morbid obesity in the long term.[24] In 1991, the National Institutes of Health established guidelines for the surgical therapy of morbid obesity (BMI > 40 or > 35 in the presence of significant comorbidities), which is now referred to as bariatric surgery.[25] These guidelines have since been adopted by most national organisations worldwide. In Singapore, the Ministry of Health guidelines were published in 2004.[26]

LSG has gradually attracted considerable interest in the bariatric community since its introduction, as it does not require an anastomosis or intestinal bypass and is considered technically less challenging than LRYGBP. It also avoids the implantation of an artificial device around the stomach unlike in the case of LAGB. The mechanisms of action of LSG are via mechanical restriction and hormonal modulation. First, it serves to work as a restrictive operation that reduces the size of the gastric reservoir to 60–100 ml and restricts distension, thus permitting the intake of only small amounts of food, resulting in a feeling of early satiety during a meal. Second, evidence has suggested that attenuation of endogenous ghrelin levels may also contribute to the success of LSG.[27] Ghrelin, a hunger-regulating peptide hormone, is produced by P/D1 cells that are found mainly in the fundus of the stomach. By resecting the fundus in LSG, the majority of ghrelin-producing cells are removed, thus reducing plasma ghrelin levels and subsequently, the sensation of hunger. However, the disadvantages of the procedure are its permanence and irreversibility. Although the procedure is relatively safe, the complications, when they do occur, can be serious (e.g. bleeding and gastric leak from the staple line). Some patients also complain of worsening gastroesophageal reflux symptoms.

Information regarding the long-term results of LSG as a relatively novel restrictive bariatric procedure is still

lacking. In 2009, a review of the current status of bariatric surgery estimated the total number of LSGs performed worldwide in the last five years to be 18,098,[28] which corresponds to the 5.3% of total number of bariatric operations for this period of time. To date, most studies in the literature reported only short- and medium-term results of up to three years of follow-up. The expected EWL at one year is 62% and 72% at two years.[29-32] Only one study has reported the long-term results of LSG. Himpens et al followed up on 53 patients for a period of six years and found a three-year EWL of 77.5% and a six-year EWL of 53.3%. 20% of their patients required additional malabsorptive procedures (duodenal switch) due to weight regain.[12]

Two randomised trials comparing LSG and other bariatric procedures have recently been published. One prospective randomised trial compared LSG and LAGB (n = 16 in each group) and reported an EWL of 66% vs. 48% ($p < 0.025$) after LSG at three years.[32] Another prospective randomised trial compared LSG and LRYGBP, and reported better weight loss with LSG at one year (EWL of 70% vs. 61%, respectively, $p < 0.05$).[27] In 2009, the American Society for Metabolic and Bariatric Surgery issued an updated statement on sleeve gastrectomy, accepting LSG as an approved bariatric surgical procedure primarily due to its potential value as a first-stage operation for high-risk patients, with the full realisation that successful long-term weight reduction in an individual patient after LSG would obviate the need for a second-stage procedure.[33]

Laparoscopic techniques in bariatric surgery are challenging, notably contributed by the body habitus of these patients: the thick abdominal wall is much less compliant to CO_2 distension, and manipulation of the long, narrow laparoscopic instruments is difficult and tiring for the surgeon. Furthermore, the enlarged left lateral liver lobe hampers the view of the gastroesophageal junction and the angle of His, making dissection in this area challenging. There is no consensus on the best technique; for example, the optimal diameter of the indwelling bougie typically used to calibrate the sleeve segment during surgery varies from 32 French to 60 French. However, the published literature shows a general trend toward smaller diameters, as evidence suggests that the volume of the resected stomach correlates with long-term weight loss and that dilation of the gastric sleeve may be a cause of weight regain.[14] It is noteworthy that there are concerns regarding stricture formation when smaller diameter bougies are used to calibrate the sleeve segment. Strictures can contribute to gastric leak and fistula after LSG. Nevertheless, strictures are usually responsive to endoscopic management. We opted for 38 French for the gastric bougie size as a suitable compromise.

Although LSG does not involve anastomoses, the long staple line renders the patient susceptible to a potential risk of bleeding or leakage. Some authors have described oversewing the entire staple line, whereas others have tried buttressed material (e.g. GORE® SEAMGUARD® Bioabsorbable Staple Line Reinforcement) or fibrin glue as a sealant. The potential benefits of an absorbable polyglyconate polymer staple line buttress were also demonstrated in a small randomised study involving patients undergoing LSG.[34] In our series, one patient had reactionary haemorrhage on the first postoperative day, necessitating re-laparoscopy. The bleeding was from the staple line at the mid portion of the neo-greater curve of the sleeve gastrectomy. This bleeding point was oversewn, haemostasis secured, the haemoperitoneum aspirated and a drain inserted. In this patient, we did not oversew the staple line during the initial sleeve gastrectomy. There was no further episode of bleeding, and the patient recovered well and was discharged.

Our early experience has taught us several valuable learning points. Obese patients pose a unique medical and surgical challenge in their pre-, peri- and postoperative management. The involvement of a multidisciplinary team of health professionals who is interested in the treatment of obesity and its related problems is crucial to the success of a weight loss programme. The bariatric surgical procedure only forms part of the many factors contributing to a patient's successful and sustainable weight loss. Preoperative counselling to select the most suitable procedure, psychiatric assessment, risk optimisation and diet modification (commenced preoperatively) are essential. Perioperative considerations include logistical issues such as a dedicated operating table rated to withstand the weight of such patients and advanced laparoscopic instrumentation appropriate for bariatric surgery (i.e. longer instruments).

Due to the inherent coagulopathic risk of these patients and the fact that pulmonary embolism is an important cause of mortality in bariatric patients, prophylactic measures such as subcutaneous enoxaparin (40–80 mg, commenced the night before surgery), intermittent pneumatic calf compressors (intra- and postoperative) and thromboembolic deterrent stockings (applied preoperatively) are standard in our practice.[35,36] With these measures, there were no complications of deep vein thrombosis and pulmonary embolism in our series. We also routinely performed TAP block for all our patients (post-induction and pre-incision) to optimise their pain control and decrease the dependence on opioid

analgesia postoperatively. As obese patients are generally more prone to postoperative atelectasis, we believe that the decrease in opioid usage can minimise opioid-related respiratory depression and allow patients to perform effective postoperative breathing exercises without pain.

This study has its limitations. The small sample size is limited by the fact that bariatric surgery and LSG is a relatively new field and procedure, and public knowledge regarding this procedure is sparse. Furthermore, as this study is our early experience, we do not have mid- or long-term results currently, but our multidisciplinary working group has already established a prospective database for all our patients. In conclusion, our experience shows that this novel procedure is safe and promising in terms of weight loss and patient acceptance.

REFERENCES

1. World Health Organization. WHO fact sheets (Fact sheet N°311) [online]. Available at: www.who.int/mediacentre/factsheets/fs311/en/. Accessed January 5, 2011.
2. Hossain P, Kawar B, El Nahas M. Obesity and diabetes in the developing world--a growing challenge. N Engl J Med 2007; 356:213-5.
3. Khamid HMA. Singaporeans getting fatter. Channel News Asia [online]. Available at: www.channelnewsasia.com/stories/singaporelocalnews/view/1091906/1/.html. Accessed January 5, 2011.
4. Marceau P, Biron S, Bourque RA, et al. Biliopancreatic diversion with a new type of gastrectomy. Obes Surg 1993; 3:29-35.
5. Hess DS, Hess DW. Biliopancreatic diversion with a duodenal switch. Obes Surg 1998; 8:267-82.
6. Hess DS, Hess DW, Oakley RS. The biliopancreatic diversion with the duodenal switch: results beyond 10 years. Obes Surg 2005; 15:408-16.
7. Nguyen NT, Longoria M, Gelfand DV, Sabio A, Wilson SE. Staged laparoscopic Roux-en-Y: a novel two-stage bariatric operation as an alternative in the super-obese with massively enlarged liver. Obes Surg 2005; 15:1077-81.
8. Ren CJ, Patterson E, Gagner M. Early results of laparoscopic biliopancreatic diversion with duodenal switch: a case series of 40 consecutive patients. Obes Surg 2000; 10:514-23.
9. Regan JP, Inabnet WB, Gagner M, Pomp A. Early experience with two-stage laparoscopic Roux-en-Y gastric bypass as an alternative in the super-super obese patient. Obes Surg 2003; 13:861-4.
10. Almogy G, Crookes PF, Anthone GJ. Longitudinal gastrectomy as a treatment for the high-risk super-obese patient. Obes Surg 2004; 14:492-7.
11. Langer FB, Bohdjalian A, Felberbauer FX, et al. Does gastric dilatation limit the success of sleeve gastrectomy as a sole operation for morbid obesity? Obes Surg 2006; 16:166-171.
12. Himpens J, Dobbeleir J, Peeters G. Long-term results of laparoscopic sleeve gastrectomy for obesity. Ann Surg 2010; 252:319-24.
13. Karmali S, Schauer P, Birch D, Sharma AM, Sherman V. Laparoscopic sleeve gastrectomy: an innovative new tool in the battle against the obesity epidemic in Canada. Can J Surg 2010; 53:126-32.
14. Weiner RA, Weiner S, Pomhoff I, et al. Laparoscopic sleeve gastrectomy--influence of sleeve size and resected gastric volume. Obes Surg 2007; 17:1297-305.
15. Brethauer SA, Hammel JP, Schauer PR. Systematic review of sleeve gastrectomy as staging and primary bariatric procedure. Surg Obes Relat Dis 2009; 5:469-75.
16. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004; 363:157-63.
17. Deitel M, Greenstein RJ. Recommendations for reporting weight loss. Obes Surg 2003; 13:159-60.
18. Lakdawala M, Bhasker A. Report: Asian Consensus Meeting on Metabolic Surgery. Recommendations for the use of Bariatric and Gastrointestinal Metabolic Surgery for Treatment of Obesity and Type II Diabetes Mellitus in the Asian Population. Obes Surg 2010; 20:929-36.
19. World Health Organization. World Health Report 2002 . Available at: www.who.int/whr/2002/en/whr02_en.pdf. Accessed January 13, 2004.
20. Must A, Spadano J, Coakley EH, et al. The disease burden associated with overweight and obesity. JAMA 1999; 282:1523-9.
21. Overweight, obesity, and health risk. National Task Force on the Prevention and Treatment of Obesity. Arch Intern Med 2000; 160:898-904.
22. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. JAMA 2004; 292:1724-37.
23. Fontaine KR, Redden DT, Wang C, Westfall AO, Allison DB. Years of life lost due to obesity. JAMA 2003; 289:187-93.
24. Klein S, Sheard NF, Pi-Sunyer X, et al. Weight management through lifestyle modification for the prevention and management of type 2 diabetes: rationale and strategies. A statement of the American Diabetes Association, the North American Association for the Study of Obesity, and the American Society for Clinical Nutrition. Am J Clin Nutr 2004; 80:257-63.
25. NIH conference. Gastrointestinal surgery for severe obesity. Consensus Development Conference Panel. Ann Intern Med 1991; 115:956-61.
26. Ministry of Health Singapore. MOH Clinical Practice Guidelines on Obesity. Singapore: MOH, 2004.
27. Karamanakos SN, Vagenas K, Kalfarentzos F, Alexandrides TK. Weight loss, appetite suppression, and changes in fasting and postprandial ghrelin and peptide-YY levels after Roux-en-Y gastric bypass and sleeve gastrectomy: a prospective, double blind study. Ann Surg 2008; 247:401-7.
28. Buchwald H, Oien DM. Metabolic/bariatric surgery Worldwide 2008. Obes Surg 2009; 19:1605-11.
29. Arias E, Martínez PR, Ka Ming Li V, Szomstein S, Rosenthal RJ. Mid-term followup after sleeve gastrectomy as a final approach for morbid obesity. Obes Surg 2009; 19:544-8.
30. Menenakos E, Stamou KM, Albanopoulos K, et al. Laparoscopic sleeve gastrectomy performed with intent to treat morbid obesity: a prospective single-center study of 261 patients with a median follow-up of 1 year. Obes Surg 2010; 20:276-82.
31. Gumbs AA, Gagner M, Dakin G, Pomp A. Sleeve gastrectomy for morbid obesity. Obes Surg 2007; 17:962-9.
32. Himpens J, Dapri G, Cadière GB. A prospective randomized study between laparoscopic gastric banding and laparoscopic isolated sleeve gastrectomy: results after 1 and 3 years. Obes Surg 2006; 16:1450-6.
33. Clinical Issues Committee of the American Society for Metabolic and Bariatric Surgery. Updated position statement on sleeve gastrectomy as a bariatric procedure. Surg Obes Relat Dis 2010; 6:1-5.
34. Consten EC, Gagner M, Pomp A, Inabnet WB. Decreased bleeding after laparoscopic sleeve gastrectomy with or without duodenal switch for morbid obesity using a stapled buttressed absorbable polymer membrane. Obes Surg 2004; 14:1360-6.
35. Sapala JA, Wood MH, Schuhknecht MP, Sapala MA. Fatal pulmonary embolism after bariatric operations for morbid obesity: a 24-year retrospective analysis. Obes Surg 2003; 13:819-25.
36. Hamad GG, Choban PS. Enoxaparin for thromboprophylaxis in morbidly obese patients undergoing bariatric surgery: findings of the prophylaxis against VTE outcomes in bariatric surgery patients receiving enoxaparin (PROBE) study. Obes Surg 2005; 15:1368-74.