CASE SERIES

Early results of a Canadian laparoscopic sleeve gastrectomy experience

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Background: Sleeve gastrectomy (SG) is a relatively new bariatric procedure with a number of advantages compared with Roux-en-Y gastric bypass. However, SG also has a number of disadvantages and associated risks. We sought to examine perioperative complications and outcomes of laparoscopic SG (LSG) in a single major Canadian bariatric surgery centre (Victoria, BC).

Methods: Since June 2008, LSG has been performed at our centre and we reviewed the cases of all patients. We conducted a retrospective chart review in April 2010.

Results: Thirty-four patients had LSG, and none was lost to follow-up. Indications for LSG over other bariatric procedures were patient preference ($n = 28$), severe obesity with a body mass index (BMI) greater than 60 kg/m^2 ($n = 5$) and severe upper abdominal adhesions ($n = 1$). All but 1 of the cohort were women, and the average age was 48 (standard deviation [SD] 11) years. Preoperatively, the average BMI was 50.3 (SD 7.7) kg/m^2. Preoperative obesity-related comorbidity rates were 56% ($n = 19$) for type 2 diabetes mellitus (T2DM), 50% ($n = 17$) for hypertension, 32% ($n = 11$) for dyslipidemia, 62% ($n = 21$) for obstructive sleep apnea (OSA), 62% ($n = 21$) for knee and/or hip pain and 44% ($n = 15$) for depression and/or anxiety. The mean duration of surgery was 74 (SD 21) minutes. There were 2 major perioperative complications: 1 staple line leak and 1 staple line hemorrhage. The median stay in hospital was 1 day. Postoperative upper gastrointestinal imaging studies were conducted in 11 patients; 1 was positive for staple line leak. Histopathology on the excised gastric segments revealed chronic *helicobacter pylori* gastritis in 2 patients and small gastrointestinal stromal tumours in 1 patient. The mean postoperative follow-up interval was 10 months. Weight loss averaged 27.4 (SD 9.0) kg. Overall weight loss was 3.3 (SD 1.8) kg/month. Resolution occurred in 74% of patients with T2DM, 53% with hypertension, 45% with dyslipidemia, 76% with OSA, 38% with joint pain and 20% with depression/anxiety. Overall satisfaction was rated as excellent by 68% of patients, good by 29% and poor by 3% of patients.

Conclusion: Preliminary analysis of our experience with LSG indicates that this is an effective and safe procedure for the treatment of obesity.

Contexte : La gastrectomie en manchon (GM) est une intervention bariatrique relativement nouvelle qui offre de nombreux avantages comparativement au pontage gastrique Roux-en-Y. La GM présente toutefois aussi certains inconvénients et risques connexes. Nous avons cherché à étudier les complications périopératoires et les résultats de la GM par laparoscopie (GML) dans 1 seul centre important de chirurgie bariatrique au Canada (à Victoria, en C.-B.).

Méthodes : Notre centre pratique la GML depuis juin 2008 et nous avons passé en revue les cas de tous les patients. Nous avons procédé à une analyse rétrospective des dossiers en avril 2010.

Résultats : Trente-quatre patients ont subi une GML et aucun n'a été perdu au suivi. La préférence du patient ($n = 28$), l'obésité grave avec indice de masse corporelle (IMC) de plus de 60 kg/m^2 ($n = 5$) et la présence d'adhérences graves au haut de l'abdomen ($n = 1$) constituent les indications en faveur de la GML par rapport aux autres interventions bariatriques. Tous les membres de la cohorte sauf 1 étaient des femmes et les participants avaient en moyenne 48 (écart-type [ET] 11) ans. Avant l'intervention, l'IMC moyen s'établissait à 50,3 (ET 7,7) kg/m^2. Les taux de comorbidité liés à l'obésité avant l'intervention étaient de 56 % ($n = 19$) pour le diabète de type 2 (DT2), de 50 % ($n = 17$) pour l'hypertension, de 32 % ($n = 11$) pour la dyslipidémie, de 62 % ($n = 21$) pour l'apnée du sommeil obstructive (ASO), de 62 % ($n = 21$) pour la douleur

au genou ou à la hanche et de 44 % (*n* = 15) pour la dépression ou l'anxiété. L'intervention chirurgicale a duré en moyenne 74 (ET 21) minutes. Il y a eu 2 complications périopératoires majeures : 1 fuite dans la ligne d'agrafes et 1 hémorragie dans la ligne d'agrafes. Le séjour médian à l'hôpital a été d'une journée. Nous avons soumis 11 patients à des études d'imagerie du tractus gastrointestinal supérieur après l'intervention; il y avait fuite dans la ligne d'agrafes dans 1 cas. L'histopathologie pratiquée sur les segments gastriques excisés a révélé une gastrite chronique à *helicobacter pylori* chez 2 patients et de petites tumeurs du stroma gastro-intestinal chez 1 patient. L'intervalle moyen du suivi postopératoire a été de 10 mois. La perte de poids a atteint en moyenne 27,4 (ET 9,0) kg. Au total, la perte de poids s'est établie à 3,3 (ET 1,8) kg/mois. Il y a eu résolution chez 74 % des patients qui avaient le DT2, 53 % de ceux qui avaient de l'hypertension, 45 % de ceux qui avaient une dyslipidémie, 76 % de ceux qui avaient une ASO, 38 % de ceux qui avaient des douleurs articulaires et 20 % de ceux qui avaient de la dépression ou de l'anxiété. La satisfaction globale a été jugée excellente par 68 % des patients, bonne par 29 % et médiocre par 3 % des patients.

Conclusion : L'analyse préliminaire de notre expérience de la GML indique qu'il s'agit d'une intervention sécuritaire et efficace pour traiter l'obésité.

Sleeve gastrectomy (SG) is a relatively new bariatric procedure involving resection of most of the stomach along the greater curvature to leave only a narrow tube ("sleeve") between the gastresophageal junction and pylorus.[1,2] The remainder of the gastrointestinal tract is not altered. The procedure is typically performed laparoscopically. Weight loss following SG is thought to be due to decreased food intake secondary to reduced stomach volume and distensability[3] and possibly modulation of gastrointestinal hormones.[4] Recent systematic reviews of bariatric procedures found that SG is comparable to Roux-en-Y gastric bypass (RYGP) with respect to weight loss and improvement in the components of the metabolic syndrome.[5,6]

Compared with RYGP, SG has several advantages. The relative simplicity of SG results in a shorter duration of surgery and fewer complications. The pylorus is preserved in SG, so patients are less likely to experience dumping syndrome. In SG, the small bowel and mesentery are not altered; as such, there are fewer nutritional deficiencies, there is no added risk of internal hernia, and the entire upper gastrointestinal tract remains accessible for endoscopy. A further advantage of SG is that there is no permanent large foreign body installed as in adjustable gastric banding (AGB), another popular bariatric procedure.

In addition to the usual risks associated with surgery in general and in obese patients in particular, there are disadvantages and risks associated with SG compared with other bariatric techniques. Unlike AGB, SG is irreversible, and there is a risk of gastric stenosis requiring treatment with dilators. The sleeve may become permanently dilated with overeating. Since the lumen cannot be easily adjusted as in AGB, a second malabsorptive procedure such as RYGP may have to be performed to promote further weight loss. There is a risk of leak in the long gastric staple line in SG, which can be fatal if not detected and repaired early.

The SG procedure was first described in 1993[7] and was performed laparoscopically starting about a decade ago as the first of a 2-stage procedure in high-risk obese patients.[8]

The SG procedure helped these patients lose some weight and reduce their operative risk before undergoing the more complicated biliopancreatic diversion with duodenal switch. More recently, SG has been increasingly performed on lower-risk obese patients and was recently recognized by the American Society for Metabolic and Bariatric Surgery as a primary (single-stage) bariatric procedure.[2] We began performing laparoscopic SG (LSG) at our institution in June 2008, and we present here the early results of what, to our knowledge, is the first published Canadian case series.

METHODS

Starting in June 2008, selected patients were offered LSG as one of the surgical options for treatment of their obesity. Selection was based on patient preference or contraindications for other bariatric procedures. Counselling and monitoring of diet, exercise and behaviour modification was conducted throughout the pre- and postoperative periods. Patients were also encouraged to attend weight-loss support groups both before and after surgery, as there is emerging evidence that such support can increase weight loss in the long-term.[9,10]

Operative technique

All patients received upper gastrointestinal endoscopy before LSG to rule out anatomic anomalies, gastric mucosal pathology and *Helicobacter pylori* infection, as recommended by the Standards of Practice Committee of the American Society for Gastrointestinal Endoscopy.[11] Preoperatively, patients received prophylactic bowel cleansing, antibiotics and subcutaneous heparin and were placed in pneumatic stockings. The surgical technique involved the placement of 5 trochars as follows: left upper quadrant (5- to 10-mm 30° laparoscope), right upper quadrant (5- to 12-mm Versaport [Covidien]), right lateral subcostal

(5-mm liver retractor), left subcostal (5 mm) and the epigastrium (5 mm). A carbon dioxide pneumoperitoneum was created in the left upper quadrant. The liver was retracted superiorly. Beginning 7 cm proximal to the pylorus, the greater curvature of the stomach was freed from the gastrocolic ligament and the short gastric vessels divided with the LigaSure (Covidien) system up to the angle of His. To create the sleeve, the Endo GIA (Covidien) stapler was fired along a line parallel to the lesser curvature beginning 7 cm proximal to the pylorus up to the cardia such that the sleeve was about 36-F. In some cases a bougie (34- to 36-F) placed in the stomach against the lesser curvature was used to guide the stapling. The staple line was oversewn only along areas of bleeding or areas with potential for bleeding. The excised portion of the stomach was removed from the abdominal cavity by minimally enlarging the incision where the Versaport cannula was placed, and was sent for pathologic analysis. Patients early in the series received postoperative upper gastrointestinal imaging with water-soluble contrast to check for staple line leaks. All patients received follow-up care with their family physicians and had at least 1 follow-up visit with their surgeons. The interval for surgeon follow-up was variable to accommodate the travel schedule of the many patients who resided far away from our bariatric surgical centre.

A retrospective chart review was conducted in April 2010 on all patients who underwent the LSG. Data collected and analyzed from the charts included demographics, preoperative and current anthropometrics, preoperative and current obesity-related comorbidities and their severities, operative data and a survey of overall patient satisfaction with the procedure. Weight loss was assessed with percent excess weight loss (%EWL) for comparison to existing literature as well as percent excess body mass index (BMI) loss (%EBL), which has been proposed as a superior metric for comparison of bariatric procedure outcomes[9] but is not yet widely used. The %EWL and %EBL were calculated using the definitions provided by Deitel and colleagues.[12] Assessment of changes in comorbidity status of type 2 diabetes mellitus (T2DM), hypertension and dyslipidemia was defined as follows. Resolution was defined as normalization of the metrics defining each pathology without use of medication. Improvement was defined as either improved control of said metrics while on the same dose of medication or continued adequate control of metrics while on a reduced amount of medication. Resolution of obstructive sleep apnea (OSA) was determined by follow-up assessment by respirologists or internists. Changes in the status of joint pain and mood disorders were assessed subjectively by eliciting the patient's symptoms and perceptions of whether the problem was resolved or improved.

RESULTS

Thirty-four patients underwent LSG performed by 2 bariatric surgeons (B.J.A. and B.Q.T.) between June 2008 and February 2010, and none was lost to follow-up.

All but 1 of the patients were women and the mean age was 48 (SD 11, range 24–71) years. The mean preoperative BMI was 50.3 (SD 7.7, range 33.0–68.0) kg/m^2 (Table 1). Most patients (82%, n = 28) chose LSG over other bariatric procedures, whereas the remaining patients had LSG because of contraindications, including severe obesity with BMI over 60 kg/m^2 (n = 5) and severe upper abdominal adhesions (n = 1), to other procedures. The preoperative obesity-related comorbidity rates were 56% (n = 19) for T2DM, 50% (n = 17) for hypertension, 32% (n = 11) for dyslipidemia, 62% (n = 21) for OSA, 62% (n = 21) for knee and/or hip pain and 44% (n = 15) for depression and/or anxiety (Table 2). Of the patients with diabetes, 4 had type 1 diabetes (12% of all patients).

The mean duration of surgery was 74 (SD 21, range 45–129) minutes. The median number of stapler firings was 6 (range 5–9). The staples and LigaSure system formed the bulk of the surgical materials cost, which was about $1970 (6 firings plus 1 LigaSure). All resected gastric specimens were sent for pathologic examination. Despite negative preoperative endoscopy and biopsy, histopathology of all resected portions of the stomach revealed 2 cases of chronic *H. pylori* gastritis, and 1 patient had 2 small (1.1 cm and 0.3 cm) gastrointestinal stromal tumours (GISTs). The median length of stay in hospital was 1 day (range 1–34 d), with 91% (n = 31) staying 3 days or fewer. One patient had a 5-day stay for extended observation because she was from a remote location and was at high risk for complications due to obesity-associated hypoventilation syndrome. There were no complications with this patient. The patient who stayed 34 days had a staple line leak.

There was no peri- or postoperative mortality. Eleven

Table 1. Pre- and postoperative weight loss metrics of 34 patients who underwent laparoscopic sleeve gastrectomy

Metric	Mean (SD) [range]			
	Preoperative	Postoperative	Overall loss	Monthly loss
Body mass, kg	134.2 (21.9) [92.3–201.8]	106.7 (20.4) [70.0–168.2]	27.4 (9.0) [5.0–47.3]	3.3 (1.8) [0.3–8.6]
BMI, kg/m^2	50.3 (7.7) [33.0–68.0]	39.9 (6.7) [25.0–57.0]	10.4 (3.5) [2.0–17.0]	1.3 (0.7) [0.1–4.0]
%EWL	—	—	38.4 (13.8) [7.1–73.7]	4.5 (2.6) [0.6–12.8]
%EBL	—	—	43.4 (17.1) [8.7–100]	5.1 (3.1) [0.8–16.7]

BMI = body mass index; %EBL = percent excess body mass index loss; %EWL = percent excess weight loss; SD = standard deviation.

patients had postoperative upper gastrointestinal imaging studies with water-soluble contrast when it was clinically indicated to check for staple line leak; 1 study was positive. Two patients had major perioperative complications. One patient had a high gastric staple line leak and underwent reoperation within 12 hours of her initial surgery to over-sew the leak. The leak remained sealed for 7 days, but on the 8th postoperative day, it reopened. The patient was treated with total parenteral nutrition and antibiotics. The leak eventually sealed itself, and she was discharged home on her 34th postoperative day. One patient had a staple line hemorrhage despite oversewing the staple line during the initial surgery. The patient was taken back to the operating room 8 hours after the initial surgery. A 1500 mL hematoma was laparoscopically evacuated from the abdominal cavity, but no active bleeding was found. The patient was given 2 units of packed red blood cells and discharged from hospital 48 hours later on her 3rd postoperative day. In addition to the 2 patients with major complications, 2 additional patients had minor gastric stenoses that were treated the day after surgery with endoscopic dilatation. Both of these patients were discharged home after 24 hours and experienced no further complications.

The mean follow-up time with the bariatric surgeon was 10 (range 2–23) months. Pre- and postoperative weight loss metrics and comorbidity rates are summarized in Tables 1–3. Overall mean weight loss was 27.4 (SD 9.0, range 13.6–34.4) kg and monthly mean weight loss was 3.3 (SD 1.8, range 0.3–8.6) kg/month. Overall mean %EWL was 38.4% (SD 13.8%, range 7.1%–73.7%) and monthly mean %EWL was 4.5% (SD 2.6%, range 0.6%–12.8%) per month. Overall mean %EBL was 43.4% (SD 17.1%, range 8.7%–100.0%) and monthly mean %EBL was 5.1% (SD 3.1%, range 0.8%–16.7%) per month. There was postoperative resolution or improvement in several components of the metabolic syndrome: diabetes resolved in 79% ($n = 15$; 74% of patients with T2DM specifically) and improved in 21% ($n = 4$), hypertension resolved in 53% ($n = 9$) and improved in 47% ($n = 8$), and dyslipidemia resolved in 45% ($n = 5$) and improved in 45% ($n = 5$). Obstructive sleep apnea resolved in 76% ($n = 16$). Resolution or improvement occurred in 90% ($n = 19$; resolution in 38%) of patients with joint pain and 93% ($n = 14$; resolution in 20%) of patients with depression/anxiety. With regards to overall patient satisfaction with LSG, 68% ($n = 23$) rated their experience as excellent, 29% ($n = 10$) rated it as good and 3% ($n = 1$) rated it as poor.

DISCUSSION

We reviewed the cases of all 34 patients who underwent LSG since we began offering this option for bariatric surgery in June 2008. The indication for LSG was patient preference in most cases, which has become the most frequent indication reported in the worldwide literature.[6] Overall patient satisfaction with the procedure has been high, even among our 2 patients who had major perioperative complications. Both of these patients made a full recovery and achieved substantial weight loss as well as resolution of their diabetes. The single patient who rated her experience as poor had no complications but had achieved only a small reduction in weight at 6 months.

Besides the general complications associated with surgery, the most frequent perioperative complications

Table 2. Pre- and postoperative obesity-related comorbidity rates and changes among patients who underwent laparoscopic sleeve gastrectomy

Comorbidity	Preoperative no. (%)	Postoperative; no.		
		Resolved	Improved	Unchanged
Type 2 diabetes mellitus	19 (56)	14	5	0
Insulin dependent	4 (12)	2	2	0
Dyslipidemia	11 (32)	5	5	1
Hypertension	17 (50)	9	8	0
Obstructive sleep apnea	21 (62)	16	4	1
Knee/hip pain	21 (62)	8	11	2
Depression/anxiety	15 (44)	3	11	1

Table 3. Postoperative weight loss metrics and obesity-related comorbidities categorized by follow-up interval among patients who underwent laparoscopic sleeve gastrectomy

Metric	Follow-up interval		
	< 6 mo, $n = 8$	6–12 mo, $n = 19$	12–23 mo, $n = 7$
%EWL, mean (range) %	38.6 (24.5–61.7)	38.5 (7.1–56.3)	37.8 (9.7–73.7)
%EBL, mean (range) %	42.9 (25.0–65.2)	42.6 (8.7–62.5)	45.8 (12.5–100.0)
Resolved or improved comorbidities, no./total no.*			
Diabetes	5/5	12/12	2/2
Dyslipidemia	2/2	8/8	0/1
Hypertension	4/4	11/11	2/2
Obstructive sleep apnea	4/4	14/14	2/3
Knee/hip pain	4/5	10/11	5/5
Mood disorder	4/4	8/8	2/3

%EBL = percent excess body mass index loss; %EWL = percent excess weight loss.
*Total number of patients affected with the given comorbidity in the given follow-up interval.

associated with LSG include staple line leaks (2%), major hemorrhage (1.2%), gastric stenosis (0.6%–0.9%) and death (0.19%).[2,6] In our cohort, 1 patient had a staple line leak, 1 patient had a staple line hemorrhage, 2 patients had minor stenoses and no patients died. Allowing for our limited sample size, our complication rate was consistent with that reported in the literature.

Some measures may be taken to try to reduce the complication rate. Preoperative endoscopy is important in RYGP to rule out mucosal pathology because portions of the gastrointestinal tract will be made inaccessible to endoscopy by the surgery, but this does not apply to SG. Whereas endoscopy is recommended before bariatric surgery,[12] there is no strong evidence for it, and its use is variable.[2] The use of a bougie to guide creation of the sleeve is helpful in avoiding stenosis. However, insertion of a bougie may be difficult, and a staple line disruption may occur if care is not taken. As we were early in our learning curve for LSG, we used bougies early on in the case series, but owing to the extensive experience of our primary bariatric surgeon in RYGP (> 700 procedures) we found that we quickly developed proficiency and could create a good sleeve without use of a bougie and its associated risks. If a surgeon is inexperienced in LSG or RYGP, we recommend use of a bougie for the first 100 procedures. Staple line reinforcement has been shown to reduce hemorrhage, but its effect on staple line leaks is inconsistent.[13,14] The use of buttressing materials is not funded by our institution, as this would increase the cost by $1000–$1500 per procedure. Instead, we reinforce the staple line by oversewing where indicated. Postoperative upper gastrointestinal imaging with water-soluble contrast can be used to check for staple line leaks, although its sensitivity and specificity have been questioned.[2] We performed postoperative upper gastrointestinal imaging in our early patients, but now order such imaging only when clinically indicated.

Weight loss outcomes from SG were reviewed by Brethauer and colleagues,[6] and 23 studies including 1639 patients reported data for mean %EWL at follow-up intervals from 6 to 36 (mean 14) months. The mean of the reported mean %EWL across all studies was 55.1% (range 33%–85%), and the means of the reported mean %EWL at various follow-up intervals were: 48.2% at 6 months (3 studies, 64 patients), 55.8% at 12 months (14 studies, 1042 patients), 59.8% at 18 months (3 studies, 74 patients), 52.4% at 24 months (2 studies, 419 patients) and 66.0% at 36 months (1 study, 40 patients). About one-quarter of our patients were reviewed fewer than 6 months after LSG, and there are no data in the literature with which to compare weight loss outcomes. Nonetheless, after fewer than 6 months, our patients had lost over 38% of their excess weight, and we anticipate that they will continue to do well as we follow them over time. The mean %EWL of our patients reviewed at 6–12 and 12–23 months were consistently around 38%, which is less than the data reported in the

review by Brethauer and colleagues. There was substantial variability in weight loss in our longer follow-up groups. This may be an effect of our small sample size, and we hope that more data will help determine what factors distinguish those who achieve substantial weight loss versus those who do not.

In addition to weight loss, reduction in obesity-related comorbidities is another important outcome in bariatric surgery. A recent review of SG reported a high rate of resolution of several components of the metabolic syndrome at postoperative intervals ranging from 12 to 60 months.[6] The mean and standard deviations of mean resolution rates were 55.7% (SD 27.3%; 754 patients, 10 studies) for T2DM, 49.6% (SD 24.6%; 733 patients, 9 studies) for hypertension and 43.0% (SD 24.0%; 513 patients, 6 studies) for dyslipidemia. There was resolution of T2DM in 74% of our patients (including 2 who had type 1 diabetes), and many of these patients experienced resolution less than 6 months after surgery. Resolution of T2DM occurred among patients with %EWL between 20% and 67%. The changes in T2DM status observed in our patient population demonstrate the independence of T2DM resolution from weight loss as reported in the literature.[15] Hypertension resolved in 53% of our patients, and this only occurred in patients with %EWL over 35% and was not associated with postoperative interval. This is consistent with observations in the literature that components of the metabolic syndrome other than T2DM are dependent on weight loss.[15] Interestingly, observations from our data go against this. We observed early improvement (but not resolution) in hypertension and dyslipidemia among some of our patients with lower %EWL. Whereas these observations may simply be statistical anomalies related to our small sample size, they might also be explained by patients adopting a healthier lifestyle, which is strongly encouraged as an important part of our treatment program. The 76% resolution rate of OSA in our patient population was consistent with results reported in the literature.[6] We also found a high rate of subjective improvement in joint pain and mood, suggesting an improvement in quality of life.

In a 1997 analysis, T2DM and hypertension were identified as the top contributors to the direct costs of obesity in Canada at $656.6 and $423.1 million, respectively. The costs of drugs to manage these conditions in obese Canadians are $96.8 million for T2DM and $338.5 million for hypertension.[16] A survey of Canadians with T2DM estimates that the average out-of-pocket expenses (between 10%–28% of actual drug cost) is $679 per year.[17] Obesity is a costly condition both for affected individuals and our public health system. By contrast, the operative material cost of LSG is around $2000, and data show that we can cure a large proportion of obesity-related conditions with this surgery. Although we will not endeavour a complete cost analysis here, we believe that SG offers a great potential for cost savings to the individual and society.
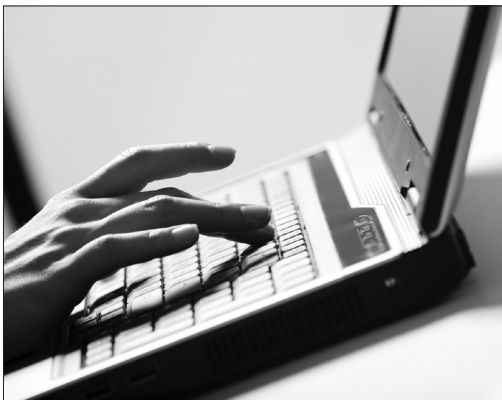
CONCLUSION

Early results of a series of 34 patients who underwent LSG demonstrate low perioperative complication rates, encouraging results with respect to weight loss and obesity-related comorbidity reduction and high patient satisfaction. Our early results and data from SG literature support our expectation for continuing improvement in health and quality of life for our obese patients. Larger studies and longer follow-up intervals are needed to validate short-term results, determine long-term results and analyze health care cost savings. We continue to perform LSG at our institution and expect to publish further data in the future.

Competing interests: None declared.

Contributors: Drs. Tang and Amson designed the study, acquired the data and critically reviewed the article. Dr. Behrens wrote the article. All authors analyzed the data and approved publication of the article.

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