Laparoscopic sleeve gastrectomy versus laparoscopic gastric greater curvature plication: a prospective randomized comparative study

Mohamed M. Abouzeid[a], Osama Taha[b]

[a]Department of General Surgery, Ain Shams University, Cairo, [b]Department of Plastic Surgery, Assiut University, Assiut, Egypt

Correspondence to Mohamed M. Abouzeid, MD, MRCS, 64 Nakla El Motaee St, Heliopolis, Cairo, 11736, Egypt
Tel: +20 100 662 9170/+20 111 228 8844;
e-mail: abouzeid2000@hotmail.com

Received 26 September 2014
Accepted 08 October 2014

The Egyptian Journal of Surgery
2015, 34:41–47

Background
Laparoscopic sleeve gastrectomy (LSG) involves resection of a significant portion of the stomach. Laparoscopic greater curvature plication (LGCP) is a relatively new alternative procedure similar to LSG, but without the need for gastric resection.

Patients and methods
Fifty patients fulfilled the National Institutes of Health criteria and were assigned randomly to receive either LGCP ($n = 25$) [16 women and nine men; mean age 32.1 years (19–49 years) and mean BMI 47.8 kg/m^2 (42–57 kg/m^2)] or LSG ($n = 25$) [18 women and seven men; mean age 34.8 years (18–58 years) and mean BMI 46.8 kg/m^2 (41–55 kg/m^2)] by a block randomization method. Patients were studied in terms of postoperative weight loss, changes in hypertension, HbA1c, and postoperative complications.

Results
All procedures were completed laparoscopically. Follow-up was 24 months. The mean hospital stay was 36 h (range 24–144 h) for both groups. No intraoperative complications occurred. Postoperatively, one case of minor leak was detected after LSG and two cases of stenosis following LGCP. All patients experienced postoperative excess weight loss and improvement in HbA1c. The improvement was significantly better in the LSG group in terms of the change in BMI (mean 14.45 compared with 10.35 in LGCP) and change in HbA1c (mean 1.2 compared with 0.5 in LGCP); the change in hypertension was not statistically significant.

Conclusion
LGCP is feasible, safe, and effective, but has an inferior weight-loss effect and is less effective in diabetes compared to LSG for morbidly obese patients with BMI above 40 kg/m^2.

Keywords:
greater curvature placation, laparoscopic bariatric surgery, laparoscopic sleeve gastrectomy, morbid obesity, restrictive procedure

Egyptian J Surgery 34:41–47

1110-1121

Introduction

Obesity is a major health problem affecting over 1.7 billion individuals worldwide, and although it was considered a disease of the western world, it seems to have expanded to the developing world, especially in urban settings [1]. Since 1997, the WHO has recognized it as a global epidemic, and in 2005, over 400 million obese adults were recorded. Conservative measures, such as dieting and physical exercise, have proven inadequate, as has treatment with medications [2]. There is considerable evidence in the literature on the long-term positive impact of bariatric surgery as a primary therapy for the treatment of obesity and its comorbidities. Significant debate remains as to which patients are optimal candidates for which procedures [3]. Traditionally, the primary mechanisms through which bariatric surgery achieves its outcomes are believed to be the mechanical restriction of food intake, reduction in the absorption of ingested foods, or a combination of both [4]. Adjustable gastric banding and vertical sleeve gastrectomy (VSG) are restrictive approaches used commonly in bariatric practice. Although these procedures have proven to be good therapeutic options for some patients, they are not without significant complications, such as erosion or slippage of the gastric band or gastric leaks in VSG. Leaks in VSG pose a particularly difficult challenge when they occur near the angle of His, potentially generating severe clinical conditions that require reoperation, and may even cause death [5,6]. Laparoscopic sleeve (VSG) gastrectomy was first described in 1999 as part of the biliopancreatic diversion duodenal switch procedure [7]. Subsequently, laparoscopic sleeve gastrectomy (LSG) has been performed as a stand-alone procedure [8].

Laparoscopic greater curvature plication (LGCP) is a new restrictive technique that was first reported by Wilkinson in 1981 [9]. It reduces the gastric volume successfully by plication of the greater curvature and has the advantage of a reversible restrictive procedure without the use of foreign materials or gastrectomy.

 DOI: 10.4103/1110-1121.153370

The aim of the present study was to investigate LGCP, which is a new restrictive bariatric surgical technique in comparison with the more performed LSG in terms of postoperative weight loss, changes in hypertension and HbA1c, and postoperative complications.

Patients and methods

The study was carried out in Ain Shams University hospitals and Assiut University hospitals under the supervision of the authors following the same protocol in the period from August 2011 to January 2014. All patients provided signed informed consent and the study was approved by the hospital's ethics committee.

Fifty patients fulfilled the National Institutes of Health criteria [10] and were assigned randomly to receive either LGCP ($n = 25$) or LSG ($n = 25$) by a block randomization method. Patients with BMI more than 60 kg/m^2 were not encouraged to participate in the study. This study was carried out on 25 patients who underwent LSG [18 women and seven men, mean age 34.8 years (18–58 years) and mean BMI 46.8 kg/m^2 (41 kg/m^{2}55)], and 25 patients who underwent LGCP [16 women and nine men, mean age 32.1 years (19–49 years) and mean BMI 47.8 kg/m^2 (42–57 kg/m^2)]. The two groups were studied in terms of postoperative weight loss, changes in hypertension and HbA1c, and postoperative complications. Follow-up was 24 months (Table 1).

All patients underwent a multidisciplinary evaluation (endocrinologist, cardiologist, psychologist, and nutritionist). Blood tests, abdominal ultrasonography, and upper endoscopy were performed preoperatively to establish a baseline.

All surgical procedures were performed under general anesthesia with the patient in a supine position. Prophylactic intravenous antibiotics and subcutaneous heparin were administered before induction of anesthesia. Closed pneumoperitoneum was achieved using a five-trocar port technique similar to that used in laparoscopic Nissen fundoplication.

Operative technique of laparoscopic sleeve gastrectomy

Trocar placement was as follows: one 12-mm optical trocar above and slightly to the left of the umbilicus for the 30° laparoscope; one 12 mm on the upper right quadrant for the surgeon's left hand and one 15 mm trocars for the surgeon's right hand were placed 5 cm subcostally; one 5- or 10-mm trocar on the upper left quadrant (ULQ) anterior axillary line 3–4 cm subcostally for the surgeon's assistant; and one 10-mm wound below the xiphoid appendices for liver retraction (Fig. 1).

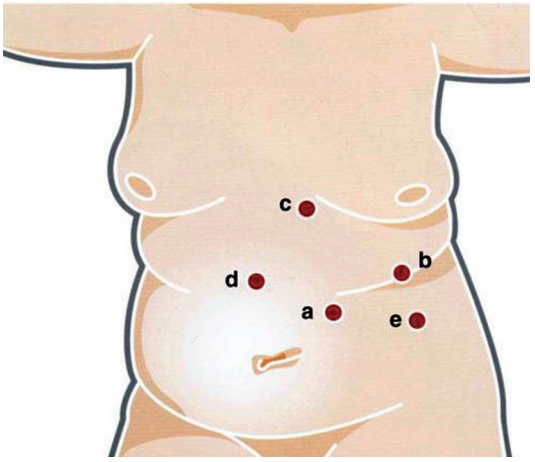
The procedure began with the dissection of the angle of His, followed by careful dissection of the gastric greater curvature using the Harmonic scalpel (Ethicon Endo-Surgery Inc., Cincinnati, Ohio, USA) or the LigaSure Vessel Ligation System (Covidien, USA). Starting from the antrum 7 cm from the pylorus toward the left crus of the diaphragm and the angle of His, the omentum and the gastroepiploic vessels were dissected away from the greater curvature, followed by the short gastric vessels, the posterior gastric vein, and the posterior gastric attachments. The left side of the crus was prepared carefully, preserving the fat pad (Fig. 2).

Then, a 36 Fr bougie was passed into the stomach with its tip positioned in the pylorus. The bougie was used to calibrate the size of the sleeve. The stomach was first transected tangentially from the greater curve toward the lesser curve using a Endo GIA™ stapler 7 cm proximal to the pylorus. Once the bougie was reached, all subsequent stapler firings were cephalad, parallel to the bougie (Fig. 3), until the angle of His was identified and transected. The specimen was then

Table 1 Comparison between two the study groups in personal data

Personal data	LPSG [*N* (%)]	LGP [*N* (%)]	*P*	Significance
Sex				
Male	7 (28.0)	9 (36.0)	0.544	NS
Female	18 (72.0)	16 (64.0)		
Age				
Mean ± SD	34.8 ± 11.3	32.1 ± 8.8	0.348	NS
Range	18–58	19–49		

Figure 1



Trocar position. a, 12 mm above the umbilicus slightly to the left; b, 15 mm in upper left quadrant (ULQ); c, 10 mm wound below xiphoid; d, 12 mm in the upper right quadrant (URQ); e, 5 or 10 mm on the ULQ at the anterior axillary line.

extracted through the 15-mm port site. Finally, we leak tested the entire staple line using methylene blue. Intra-abdominal drain was inserted and removed 24 h postoperatively; patients were discharged as soon as they could consume a liquid diet and could tolerate pain, provided they were vitally stable, and received a prescription of a daily proton-pump inhibitor for 90 days. During the first 6 postoperative months, all patients were treated with multivitamins.

The postoperative diet was prescribed as follows: a customized liquid diet for 10 days, followed by a progressive return to solid foods in a stepwise manner, with the dietary restrictions removed at 4–6 weeks, depending on patient acceptance. Follow-up visits for the assessment of safety and weight loss were scheduled for 1 week and at 1, 3, 6, 12, 18, and 24 months in the postoperative period, with assessment of hemoglobin, liver enzymes, serum creatinine, iron, vitamin B_{12}, and calcium blood levels. Upper endoscopy was performed optionally.

Plication surgical procedure

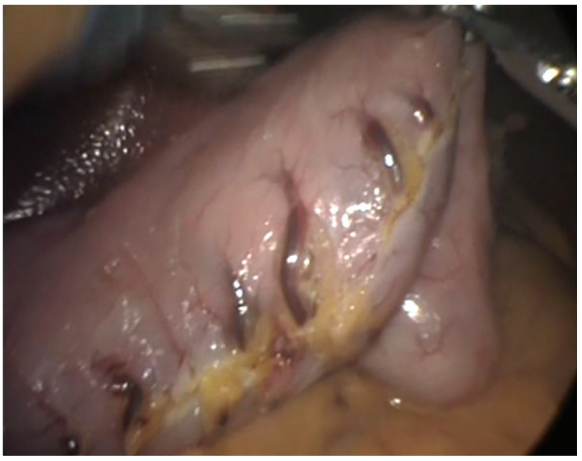
Trocar placement was as follows: one 12-mm optical trocar above and slightly to the left of the umbilicus for the 30° laparoscope; one 12-mm trocar in the ULQ for passing the needle, for suturing, and for the surgeon's right hand; one 5-mm trocar also in the ULQ at the anterior axillary line for the surgeon's assistant; one 10-mm wound below the xiphoid appendices for liver retraction; and one 5-mm trocar in the URQ for the surgeon's left hand (Fig. 4).

We followed the same steps for dissection of the greater curve as in sleeve gastrectomy, also beginning 7 cm proximal to the pylorus till the angle of His. Posterior gastric adhesions were also dissected to allow optimal freedom to create and size the invagination properly.

The next step was to initiate gastric plication by invaginating the greater curvature over a 36 Fr bougie and applying a first row of extramucosal continuous stitches of nonabsorbable sutures 2-0 Ethibond (Ethicon Inc., Somerville, New Jersey, USA) or 2-0 Prolene (Ethicon Inc.). This row guided a subsequent row created with extramucosal running suture lines. The reduction resulted in a stomach shaped like a large sleeve gastrectomy (Figs. 5–8).

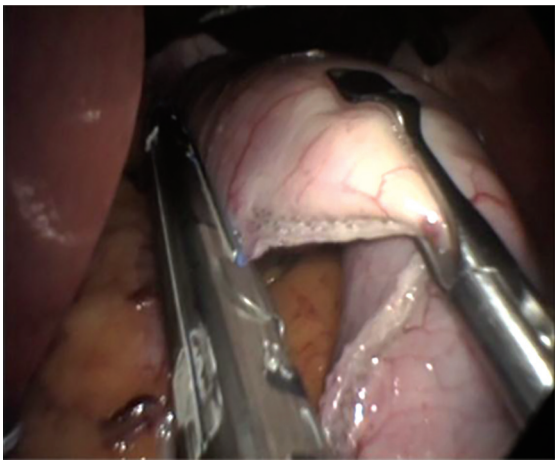
Leak tests were performed with methylene blue in all cases, which was injected under pressure to ensure that there was no out-pouching in the plicated stomach. No drains were placed. On the first postoperative day, nausea, vomiting, and sialorreia were reported by all patients; these symptoms resolved on treatment with ondasetron and the anti spasmodic hyoscine. The rest

Figure 2



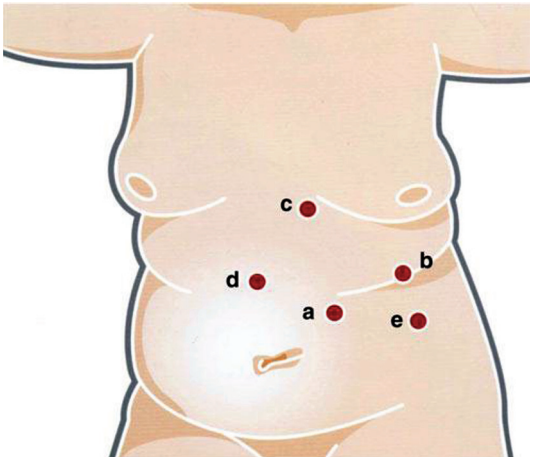
Dissected greater curve and bougie introduction.

Figure 3



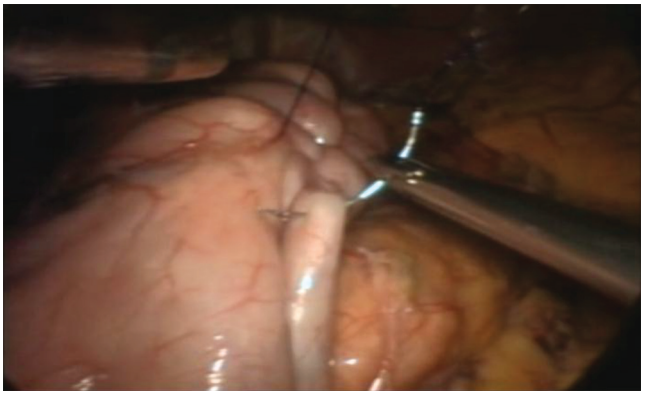
Dividing the stomach parallel to the bougie.

Figure 4



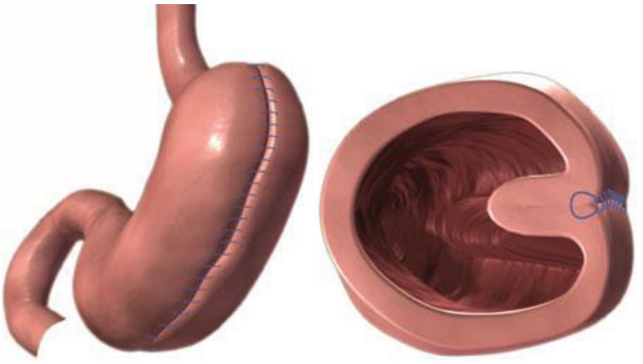
Trocar position. a, 12 mm above the umbilicus slightly to the left; b, 12 mm in upper left quadrant (ULQ); c, 10 mm below xiphoid; d, 5 mm in the URQ; e, 5 mm on the ULQ at the axillary line.

Figure 5



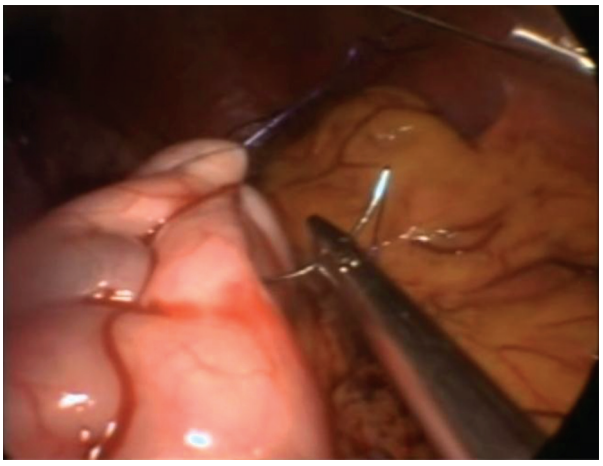
First row of extramucosal continuous stitches of nonabsorbable sutures.

Figure 6



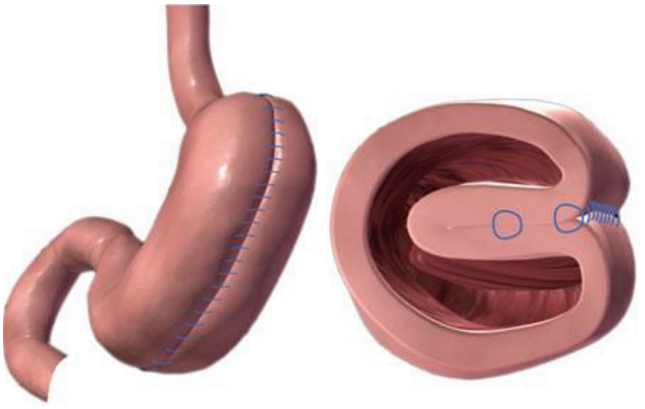
Computerized drawing of the initial fold generated by first initial suture line.

Figure 7



Intraoperative pictures of the final suture line with running nonabsorbable suture.

Figure 8



Computerized drawing of the final aspect of laparoscopic greater curvature plication procedure.

of the postoperative follow-up protocol was the same as for sleeve gastrectomy.

Results

All procedures were completed laparoscopically. Follow-up was 24 months. There was no statistically significant difference in hospital stay for LSG and for LGCP and the mean length was 36 h (range 24–144 h) for both groups. The mean operative time was 44 min (32–70 min) for LSG and 48 min (36–68 min) for LGCP, with no statistically significant difference between both. Postoperatively, one patient developed a minor leak after sleeve gastrectomy treated by endoscopic stenting and two patients developed stenosis following gastric placation; the first patient was treated by a second look after 3 days and removal of the second row of stitches at the stenotic area and the second patient presented after 2 months from the surgery and was treated by endoscopic dilatation (Fig. 9 and Table 2).

Table 2 Comparison between two the study groups in terms of postoperative leak and stenosis

Complication	LSG [*N* (%)]	LGCP [*N* (%)]	*P*	Significance
Leak				
Yes	1 (4.0)	0 (0.0)	1.00*	NS
No	24 (96.0)	25 (100.0)		
Stenosis				
Yes	0 (0.0)	2 (8.0)	0.490*	NS
No	25 (100.0)	23 (92.0)		

LGCP, laparoscopic greater curvature plication; LSG, laparoscopic sleeve gastrectomy; *X2 test.

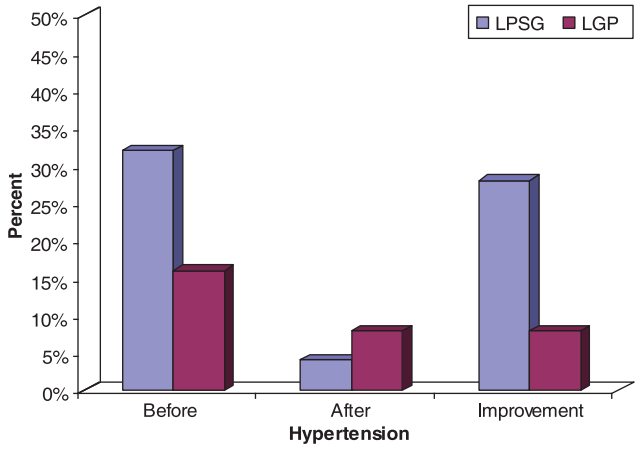
In terms of hypertension, there were no statistically significant changes in both groups, attributable to the small number of hypertensive patients in each group, but in the hypertensive group, seven out of eight patients (87.5%) improved after LSG whereas two out of four (50%) patients improved after LGCP (Fig. 10 and Table 3).

All patients experienced postoperative excess weight loss and improvement in HbA1c, but the improvement was significantly better for sleeve gastrectomy in terms of the change in BMI (mean 14.45 compared with 10.35 in gastric plication) and change in HbA1c (mean 1.2 compared with 0.5 in gastric placation). No weight regain in any patient was recorded until the end of the study (Figs. 11–13 and Tables 4–8).

Discussion

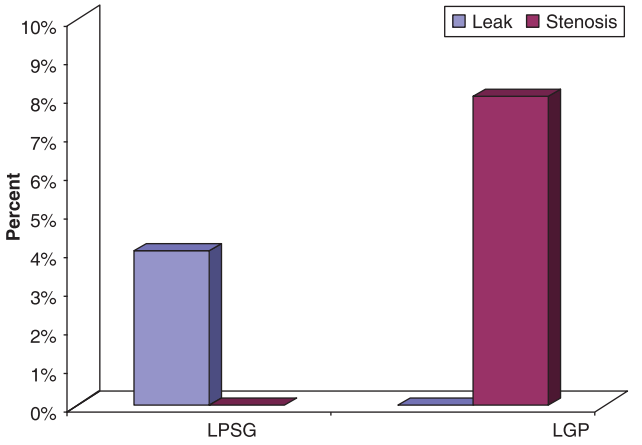
LSG is a procedure used initially as the first stage of a definitive bariatric treatment known as the duodenal switch [11]. Vertical gastrectomy of the greater curvature is performed, resulting in a tubular stomach with the purpose of restricting food intake. As a primary bariatric procedure, medium-term results have been shown to be adequate (>60% exsess weight loss (EWL)), with improvements in comorbidities such as type 2 diabetes mellitus, hypertension, and obstructive sleep apnea in more than 65% of cases [12]. These promising results are associated with some complications, however, such as esophagitis, stenosis, fistulas, and gastric leaks near the angle of His. These leaks and fistulas are reported in nearly 1% of cases [6,13]. LGCP is notably similar to a LSG in that it generates a gastric tube by means of eliminating the greater curvature, but does so without gastric resection. It is likely that LGCP considerably reduces the possibility for gastric leaks. Talebpour and Amoli [14] reported one case of a gastric leak associated with a more aggressive version of LGCP, which the authors attributed to excessive vomiting in the early postoperative period. In two separate

Figure 9



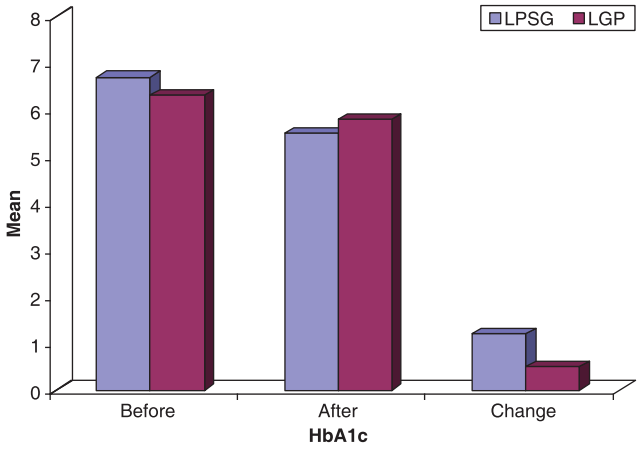
Comparison between two study groups in terms of postoperative leak and stenosis. LGCP, laparoscopic greater curvature plication; LSG, laparoscopic sleeve gastrectomy.

Figure 10



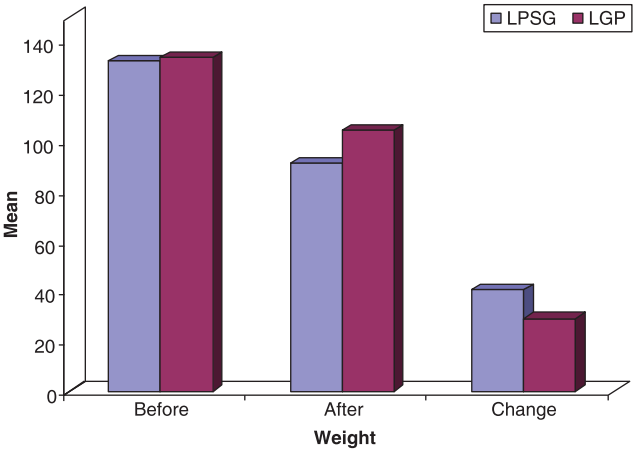
Comparison between two study groups in terms of hypertension before, after and its change after operation. LGCP, laparoscopic greater curvature plication; LSG, laparoscopic sleeve gastrectomy.

Figure 11



Comparison between two study groups in terms of HbA1c before, after and its change after operation. LGCP, laparoscopic greater curvature plication; LSG, laparoscopic sleeve gastrectomy.

Figure 12

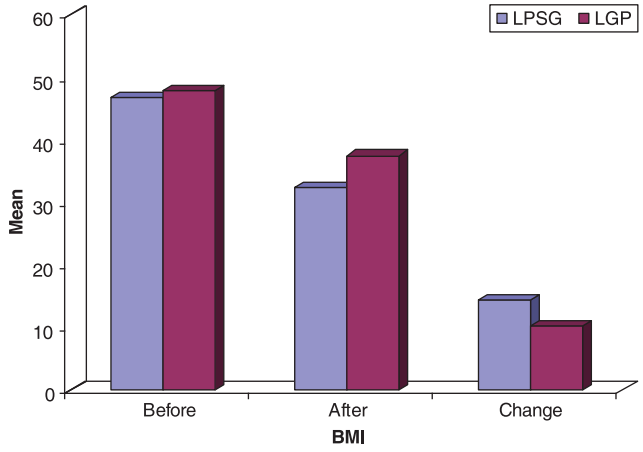


Comparison between two study groups in terms of weight before, after and its change after operation. LGCP, laparoscopic greater curvature plication; LSG, laparoscopic sleeve gastrectomy.

papers, Fusco *et al.* [15,16] reported efficacy in gastric plication procedures, as measured by changes in the weight progression of rats. In one paper, Fusco and colleagues reported an increased effect from placation of the greater curvature compared with plication of the anterior surface. These results are in agreement with initial clinical reports by Brethauer *et al.* [17], who reported increased weight loss in patients receiving LGCP compared with plication of the anterior surface.

In the present study, we also aimed to explore the efficacy of the new LGCP procedure, which has

Figure 13



Comparison between two study groups in terms of BMI before, after and its change after operation. LGCP, laparoscopic greater curvature plication; LSG, laparoscopic sleeve gastrectomy.

Table 3 Comparison between two the study groups in terms of hypertension before and after, and change after the operation

HTN	LSG [*N* (%)]	LGCP [*N* (%)]	*P*	Significance
HTN before				
Yes	8 (32.0)	4 (16.0)	0.158[a]	NS
No	17 (68.0)	21 (84.0)		
HTN after				
Yes	1 (4.0)	2 (8.0)	1.00[b]	NS
No	24 (96.0)	23 (92.0)		
HTN change				
Improvement	7 (28.0)	2 (8.0)	0.138[b]	NS
No change	18 (72.0)	23 (92.0)		

HTN, hypertension; LGCP, laparoscopic greater curvature plication; LSG, laparoscopic sleeve gastrectomy, [a]χ^2-Test, [b]Fisher's exact test.

Table 4 Comparison between HbA1c, weight, and BMI before and after a laparoscopic sleeve gastrectomy operation

	Before LSG (mean ± SD)	After LSG (mean ± SD)	*P*	Significance
HbA1c	6.7 ± 1.5	5.5 ± 0.8	0.0001	HS
Weight	132.3 ± 13.4	91.4 ± 9.6	0.0001	HS
BMI	46.8 ± 3.7	32.3 ± 2.9	0.0001	HS

HS, highly significant; LSG, laparoscopic sleeve gastrectomy, Paired *t*-test.

Table 5 Comparison between HbA1c, weight, and BMI before and after a laparoscopic greater curvature plication operation

	Before LGCP (mean ± SD)	After LGCP (mean ± SD)	*P*	Significance
HbA1c	6.3 ± 1.6	5.8 ± 1.2	0.0001	HS
Weight	133.9 ± 13.0	104.7 ± 8.9	0.0001	HS
BMI	47.8 ± 3.8	37.5 ± 3.7	0.001	HS

LGCP, laparoscopic greater curvature plication; HS, highly significant, Paired *t*-test.

Table 6 Comparison between two the study groups in terms of HbA1c before and after, and change after the operation

HbA1c	LSG			LGCP			*P*	Significance
	Mean ± SD	Minimum	Maximum	Mean ± SD	Minimum	Maximum		
HbA1c before	6.7 ± 1.5	4.0	9.2	6.3 ± 1.6	4.0	9.0	0.348	NS
HbA1c after	5.5 ± 0.8	4.0	7.0	5.8 ± 1.2	4.0	8.2	0.417	NS
HbA1c change	1.2 ± 0.9	0.0	3.2	0.5 ± 0.7	0.0	2.1	0.006	HS

HS, highly significant; LGCP, laparoscopic greater curvature plication; LSG, laparoscopic sleeve gastrectomy, Student's *t*-test.

Table 7 Comparison between the two study groups in terms of weight before and after, and change after the operation

Weight (kg)	LSG			LGCP			*P*[a]	Significance
	Mean ± SD	Minimum	Maximum	Mean ± SD	Minimum	Maximum		
Weight before	132.32 ± 13.35	165.00	105.00	133.92 ± 12.95	165.00	110.00	0.669	NS
Weight after	91.40 ± 9.57	110.00	70.00	104.68 ± 8.94	122.00	87.00	0.0001	HS
Weight change	40.92 ± 9.41	70.00	29.00	29.24 ± 8.42	49.00	9.00	0.0001	HS

HS, highly significant; LGCP, laparoscopic greater curvature plication; LSG, laparoscopic sleeve gastrectomy, [a]Student's *t*-test.

Table 8 Comparison between the two study groups in terms of BMI before and after, and change after the operation

BMI	LSG			LGCP			*P*[a]	Significance
	Mean ± SD	Minimum	Maximum	Mean ± SD	Minimum	Maximum		
BMI before	46.76 ± 3.66	40.60	55.25	47.80 ± 3.77	42.13	57.50	0.328	NS
BMI after	32.31 ± 2.86	26.23	37.72	37.45 ± 3.67	30.46	46.00	0.0001	HS
BMI change	14.45 ± 2.97	8.80	23.12	10.35 ± 2.60	3.50	15.20	0.0001	HS

HS, highly significant; LGCP, laparoscopic greater curvature plication; LSG, laparoscopic sleeve gastrectomy, [a]Student's *t*-test.

gained more popularity during the last 3 years; the change in BMI after LGCP was 10.35 kg/m^2 (45.4% EWL) compared with LSG, which was 14.45 kg/m^2 (66.4% EWL) after 1 year; thus, the result was significantly better with sleeve gastrectomy. There has been no record of weight regain in any patient until the end of the study. Both groups showed improvement in hypertension and HbA1c, but the improvement in HbA1c was significantly better with sleeve gastrectomy (the mean change was 1.2 compared with 0.5 in gastric placation). The effect of LGCP was inferior and may not be sustained compared with LSG. Silecchia *et al*. [12] have described type 2 diabetes mellitus resolution in 69.2% and an improvement in 15.4% at 12 months and 76.9 and 15.4% at 18 months in morbidly obese patients after LSG.

Conclusion

The present trial shows that LGCP may be a feasible and safe procedure in the short term when used in morbidly obese patients; it has a positive effect in improving hypertension and diabetes mellitus in morbidly obese patients, but is inferior to other restrictive procedures such as LSG and adjustable gastric banding. Longer follow-up and prospective comparative trials are needed to clarify whether it can be used as a stand-alone effective procedure for weight loss and resolution of comorbidities, especially in developing countries.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

References

1 Tsigosa C, Hainer V, Basdevant A, Finer N, Fried M, Mathus-Vliegen E *et al.* Management of obesity in adults: European clinical practice guidelines. Obes Facts 2008; 2:106–116.

2 Wing R, Phelan S. Science-based solutions to obesity: what are the roles of academia, government, industry, and health care? Proceedings of a Symposium, Boston, Massachusetts, USA, 10–11 March 2004 and Anaheim, California, USA, 2 October 2004.

3 Buchwald H, Avidor Y, Braunwald E, Jensen MD, Pories W, Fahrbach K, Schoelles K. Bariatric surgery: a systematic review and meta-analysis. JAMA 2004; 292:1724–1737.

4 DeMaria EJ. Bariatric surgery for morbid obesity. N Engl J Med 2007; 356:2176–2183.

5 Nocca D, Frering V, Gallix B, de Seguin des Hons C, Noël P, Foulonge MA, *et al.* Migration of adjustable gastric banding from a cohort study of 4236 patients. Surg Endosc 2005; 19:947–950.

6 Baltasar A, Bou R, Bengochea M, Serra C, Cipagauta L. Use of a Roux limb to correct esophagogastric junction fistulas after sleeve gastrectomy. Obes Surg 2007; 17:1408–1410.

7 Gumbs AA, Gagner M, Dakin G, Pomp A. Sleeve gastrectomy for morbid obesity. Obes Surg 2007; 17:962–969.

8 Deitel M, Crosby RD, Gagner M. The First International Consensus Summit for Sleeve Gastrectomy (SG), New York City, October 25–27, 2007. Obes Surg 2008; 18:487–496.

9 Wilkinson LH, Peloso OA. Gastric (reservoir) reduction for morbid obesity. Arch Surg 1981; 116:602–605.

10 [No authors listed] Gastrointestinal surgery for severe obesity. National Institutes of Health Consensus Development Conference Statement. Am J Clin Nutr 1992; 55(Suppl):615S–619S.

11 Gumbs AA, Gagner M, Dakin G, Pomp A. Sleeve gastrectomy for morbid obesity. Obes Surg 2007; 17:962–969.

12 Silecchia G, Boru C, Pecchia A, Rizzello M, Casella G, Leonetti F, Basso N. Effectiveness of laparoscopic sleeve gastrectomy (first stage of biliopancreatic diversion with duodenal switch) on co-morbidities in super-obese high-risk patients. Obes Surg 2006; 16:1138–1144.

13 Campos JM, Siqueira LT, Meira MR, Ferraz AA, Ferraz EM, Guimarães MJ. Gastrobronchial fistula as a rare complication of gastroplasty for obesity: a report of two cases. J Bras Pneumol 2007; 33:475–479.

14 Talebpour M, Amoli BS. Laparoscopic total gastric vertical plication in morbid obesity. J Laparoendosc Adv Surg Tech A 2007; 17:793–798.

15 Fusco PE, Poggetti RS, Younes RN, Fontes B, Birolini D. Evaluation of gastric greater curvature invagination for weight loss in rats. Obes Surg 2006; 16:172–177.

16 Fusco PE, Poggetti RS, Younes RN, Fontes B, Birolini D. Comparison of anterior gastric wall and greater gastric curvature invaginations for weight loss in rats. Obes Surg 2007; 17:1340–1345.

17 Brethauer SA, Harris JL, Chand B, Kroh M, Rogula T, Schauer PR. *Initial results of vertical gastric plication for severe obesity*. Phoenix, Arizona: Society of American Gastrointestinal and Endoscopic Surgeons; 2009.