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ORIGINAL CONTRIBUTIONS

Analysis of the Five-Year Outcomes of Sleeve Gastrectomy and Mini Gastric Bypass: A Report from the Indian Sub-Continent

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Abstract
Background Few reports have compared laparoscopic sleeve gastrectomy (LSG) to laparoscopic Roux-en-Y procedure (LRNY). This study aims at comparing the 5-year follow-up results of mini gastric bypass (MGB or omega gastric bypass (OGB)) and LSG in terms of weight loss, weight regain, complications, and resolution of co-morbidities.
Methods A retrospective analysis of the prospectively collected database was done from the start of our bariatric practice from February 2007 to August 2008 (minimum 5-year follow-up). During this period, 118 patients underwent LSG. These patients were matched in age, gender, preoperative weight, and BMI to 104 patients who underwent MGB in the same time period. The results were compared.
Results Follow-up was achieved in 72 MGB vs 76 LSG patients up to 5 years. The mean BMI for the MGB and LSG group was 44±3.1 and 42±5.2 kg/m^2, respectively ($P<0.001$). The average percentage of excess weight loss (%EWL) for MGB vs LSG was 63 vs 69 % at 1 year and 68 vs 51.2 % at 5 years ($P=0.166$), respectively. Post-op gastro-esophageal reflux disease (GERD) was seen in 2.8 % MGB patients and marginal ulcer was diagnosed in 1 MGB patient (1.4 %). GERD was seen in 21 % post-LSG patients.
Conclusions Both MGB and LSG are safe, short, and simple operations. Weight loss is similar in MGB and LSG in the first years, but lesser %EWL with LSG at 5 years (68 % in MGB vs 51 % in LSG). Post-op GERD is more common after LSG.

Keywords Laparoscopic · Mini gastric bypass (MGB) · Omega gastric bypass (OGB) · Sleeve gastrectomy (LGB)

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Introduction

Both the laparoscopic sleeve gastrectomy (LSG) and mini gastric bypass (MGB) (omega gastric bypass (OGB)/OAB) are newer bariatric procedures [1]. The LSG is becoming more popular and is being used as a primary procedure for morbid obesity [1].

MGB has been reported to be a very safe, simple, and effective bariatric procedure [2]. All the reports published to date have been very encouraging [2]. Various studies of the MGB [2, 4–6] and the LSG [6] have reported excellent results with the additional benefits of both procedures being relatively simple to perform and associated with low complication rates.

LSG was initially described as vertical gastrectomy as a part of a biliopancreatic diversion with duodenal switch by Marceau et al. [7] in 1993. From the last 16 years, LSG was being used as a stage I procedure to bring down super obese high-risk patients. Once the patient loses some weight and co-morbidities improve, then the stage II definitive procedure, such as biliopancreatic diversion with duodenal switch or laparoscopic Roux-en-Y gastric bypass (LRYGB) is done [8]. In the last few years, several encouraging reports have been published considering LSG as a primary or stand-alone procedure [9], with better results than laparoscopic adjustable gastric banding or an intragastric balloon [6, 10, 11]. Reports with short-term follow-up have shown results similar to laparoscopic Roux-en-Y (LRNY). There are few reports comparing LSG and LRNY [12] but, fewer reports were found on

comparison of LSG and MGB (OGB)[13–15]. The purpose of this study was to compare the midterm results of MGB (OGB) and LSG in terms of excess weight loss (EWL), weight regain, resolution of co-morbidities, and complications.

Materials and Methods

From the start of our bariatric program in February 2007 up to August 2013, a total of 1,746 patients (1,354 LMGB, 248 LSG, and 144 LRYGB) have undergone bariatric surgery at our institute. A retrospective analysis of the prospectively collected database was done from August 2008 to Feb 2007. During this period, 118 patients underwent LSG. These patients were matched in age, gender, preoperative weight, and BMI to 104 patients who underwent MGB (OGB), in the same time period. Mostly, the patients with a history of diabetes or gastro-esophageal reflux disease (GERD) were encouraged to undergo MGB. Exclusion criteria were age less than 18 or older than 72, being pregnant, major psychiatric illness, and a medically unfit patient.

All the patients were assessed for their medical fitness, nutritional status, and psychological well-being by a team of bariatric surgeons, anesthesiologist, physician, nutritionist, psychologist, and nurses. A fully informed written consent was taken from every patient. The patient information including anthropometric data, weight loss, percentage EWL, resolution of co-morbidities, weight regain, complications, and all follow-up information was recorded in our prospective data base. Success was defined as an EWL of >50 % at the follow-up after the maximum weight loss. A minimum follow-up of 5 years was completed for all patients. GERD was defined as the presence of reflux symptoms with epigastric pain/discomfort. Dyspepsia was defined as painful, difficult, or disturbed digestion, which may be accompanied by symptoms such as nausea and vomiting, heartburn, bloating, and stomach discomfort.

Surgical Technique

For LSG, a 37 French standard bougie was used for all patients. The stapling was started at around 5 cm from the pylorus at the greater curve and continued along the bougie up to the left crus at the angle of His. Fundus was completely dissected but a small cuff of around 1 cm was left behind at the angle of His. Gold, green, and blue cartridges were used on the antrum and body depending upon the thickness of the tissue. No staple line reinforcement was done. The stomach was removed through the left sub-costal port.

For MGB, the dissection started at the crow's foot along the lesser curvature and was continued down toward the antrum for up to 5 cm from the pylorus, thus making a wide window into the lesser sac. The first staple 45-mm blue or green was fired at this point and the gastric tube was fashioned over the 37 French bougie, along the lesser curve up to the angle of His. A cuff of around 1 cm was left at the angle of His. The gastric tube thus formed was anastomosed at about 200 cm from the ligament of Treitz. The gastrojejunostomy (GJ) was done with a 45-mm blue cartridge and the anterior defect was closed with 2-0 vicryl with hand in two layers.

No proton pump inhibitor (PPI) was given after surgery unless indicated for symptoms. Most of the patients were ambulated 2–4 h after surgery. Patients were generally discharged after 48–72 h.

The LSG patients received a clear fluid diet starting on day 1 post-operative for up to 3 weeks. The MGB patients would receive liquid diet on day 1 post-operative and then semisolid diet starting from day 2 up to day 7 and thereafter, full diet was encouraged with special instructions to chew well and eat slow.

In both groups, the first post-operative follow-up was done on day 7, when the sutures were removed and a barium meal was done in all to assess and document the size of the pouch or the sleeve. The next follow-ups were encouraged at 1, 3, and 6 months and then yearly. Those who could not follow up physically were asked to see their local physicians and the data was collected by phone or email. All the patient information like the duration of surgery, length of stay, early complications (<30 days), weight loss, resolution of the co-morbidities, weight regain, revision, and late complications (>30 days) was recorded. Patients' blood work in the form of Hb, glycosylated Hb, RBS, renal function tests (RFT), liver function test (LFT), lipid profile, Sr calcium, Sr iron, Sr vitamin D3, and Sr vitamin B12 was also performed on all visits and recorded. The remission of diabetes was defined as normal blood glucose and glycosylated Hb of <6 % without any drugs and improvement in diabetic control as normal values with lesser dosage of drugs required than pre-op. For hyperlipidemia, remission was defined as normal lipid values without drugs and improvement as normal values with lesser dosage than pre-op. For sleep apnea, the cure was defined as a minimum 95 % SpO2 during night without using a supportive device. Hypertension remission was defined as normotensive patient without drugs. GERD remission was defined as asymptomatic patient without drugs.

Data Analysis

Univariate analysis was performed using chi-square tests for the categorical data and *T* tests for the continuous data. A *P* value of <0.05 was considered significant. The data are expressed as the mean with standard deviation for continuous variables and as numbers with the percentages in parentheses for nominal variables (Table 1).

Table 1 Resolution of co-morbidities conditions

Co-morbidity	MGB (omega gastric bypass)		LSG	
	Pre-op. co-morbidity (%)	Remission (%)	Pre-op. co-morbidity (%)	Remission (%)
Type 2 diabetes	63 (60.4 %)	92	61 (2.4 %)	81
Hypertension	60 (58.3 %)	76	56 (47.3 %)	74
Hyperlipidemia	65 (62.2 %)	90	64 (54.3 %)	72
Sleep apnea	28 (26.8 %)	97	26 (22.2 %)	86
GERD	5 (4.9 %)	72	6 (5.5 %)	33

MGB mini gastric bypass, *LSG* laparoscopic sleeve gastrectomy, *GERD* gastro-esophageal reflux disease

Results

Follow-Up

Follow-up was achieved in 72 MGB vs 76 LSG patients up to 5 years.

Perioperative Characteristics

The mean operating time was 52±20.2 min (range 25–110) in the MGB and 76.6±28.3 min (range 35–215) in the LSG (*P* value <0.001). Conversion to open surgery was not required in any patients. No mortality occurred in this series up to 5-years follow-up; the other perioperative characteristics are listed in (Table 2).

Table 2 Perioperative parameters, early, and late complications

Variables	MGB	LSG	*P* value
Operative time	52±20.2 min	76.6± 28.3 min	<0.001
Hospital stay	2.5±1.3 days	3.4±2.4 days	<0.001
Early complications	5 (4.8 %) (*n*=104)	14 (11.8 %) (*n*=118)	<0.001
Intra-abdominal abscess	0 (0 %)	1 (0.8 %)	
Intra-abdominal bleed	1 (0.96 %)	4 (3.3 %)	
Early reoperation	0 (0 %)	1 (0.8 %)	
Dyspepsia	4 (3.8 %)	8 (7.0 %)	
Late complications	14 (20.8 %) (*n*= 72)	26 (34.2 %) (*n*=76)	<0.001
Marginal ulcers	1 (1.4 %)	0 (0 %)	
GERD	2 (2.8 %)	16 (21 %)	
Anemia	5 (6.9 %)	2 (2.6 %)	
Cholelithiasis	6 (8.3 %)	8 (10.5 %)	
Malnutrition	1 (1.4 %)	0 (0 %)	
30-Day mortality	0 (0 %)	0 (0 %)	

Data presented as mean±standard deviation or numbers, with percentages in parentheses

MGB mini gastric bypass, *LSG* laparoscopic sleeve gastrectomy, *NS* non-significant

Resolution of Co-Morbidities

Both the LSG and MGB are good at resolving co-morbidities (Table 1). But the MGB performs better than the LSG. For example, in the LSG group, the remission of diabetes is 81 % but the MGB results in remission in 92 % of cases and this is significant ($P<0.05$). Other co-morbidities resolution is listed in Table 1.

Weight Loss

The weight loss progression is presented in Figs. 1 and 2. The %EWL at 1, 2, 3, 4, and 5 years was 63±21.2, 71.6±24.3, 70 ±22.6, 69±20.4, and 68±24.0 % for the MGB patients and 69 ±22.5, 66.2±23.4, 61±26.4, 56±25.0, and 51.2±23.0 % for the LSG group, respectively ($P<0.001$ and $P=0.081$, respectively).

Revisions

Out of 118 LSG patients, 16 had to be revised, 13 for weight regain, and 3 for severe GERD/intractable acid reflux. Out of these 16 patients, 10 were converted to MGB and 6 into RNY. These revisions were done between 2–5 years post-operatively. One MGB patient had malnutrition and excess weight loss and was reversed after 18 months post-operatively (Table 3).

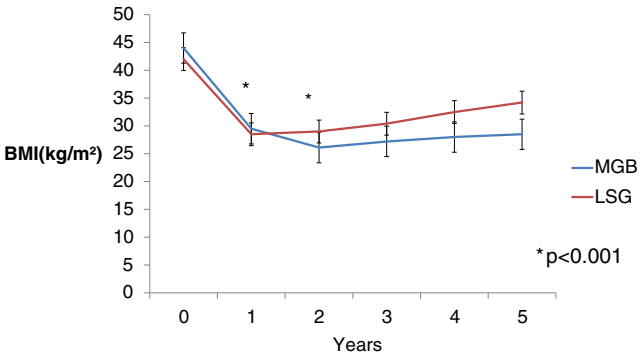

Fig. 1 BMI evolution after MGB and LSG

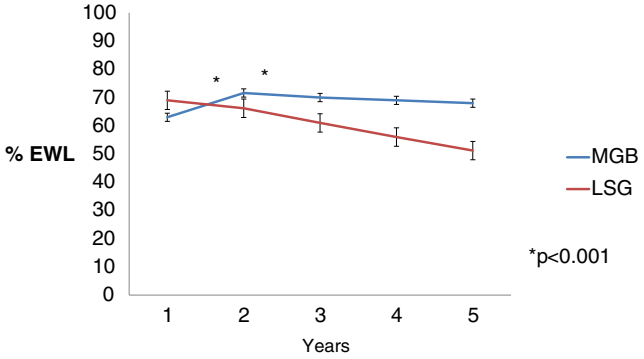

Fig. 2 5 years %EWL after MGB and LSG

Complications The LSG group had a greater percentage of early and late complications (11.8 and 34.2 %, respectively) than the MGB group (4.8 and 20.8 %, respectively); $P<0.001$ (Table 2). GERD was seen in 21 % post-LSG patients out of which 12 (16 %) were new onset . The new onset GERD started mostly after 3 years of LSG. In MGB, 2.8 % post-op GERD was seen. All these patients underwent UGI endoscopy and marginal ulcer was detected in one case. These patients were managed with proton pump inhibitors (PPIs) .

Discussion

Interestingly, LSG and MGB (omega gastric bypass) have emerged as new and effective weight loss procedures [13, 14, 16–19]. LSG is a common bariatric procedure at present. It has shown very good results in the short term, compared to the LRNY [12]. More and more data is being published on omega gastric Bypass/MGB and it has been reported to be a safe and effective procedure giving results equivalent to LRNY in the long term [3]. There are few studies comparing MGB to LSG [13, 15].

There has always been a fear of bile reflux and marginal ulcers associated with the omega gastric bypass/MGB. But in the published series of omega gastric bypass/MGB, the incidence of bile reflux and marginal ulcers has been reported to be very low and equivalent to RNY [2]. For example, in the series by Noun et al. of 1,000 patients in 6 years, only 4 (0.4 %) patients required revision of the omega gastric bypass/MGB because of bile reflux and were cured by laparoscopic latero-lateral (Braun) jejuno-jejunostomy [4].

In the present study, weight loss has been better after LSG in first year 69 vs 63 % with MGB. But this initial weight loss showed a subsequent slowing down in the LSG, at 2 years it was 71.6 % in MGB vs 66.2 % in the LSG, at 5 years it was 68 % in MGB vs 51.2 % in LSG.

As far as the co-morbidity resolution is concerned, the present study has shown better metabolic strength in the omega gastric bypass/MGB group. Type 2 diabetes resolution of 92 % was observed in the MGB group and 81 % in the LSG group and a hyperlipidemia remission of 90 % in MGB and 72 % in LSG group.

Recently, Lee et al. [13] published the first comparative study between sleeve gastrectomy and mini gastric bypass to determine the efficacy of these treatments on diabetic control. It always shows double efficacy of MGB in control of diabetes as compared to LSG. Their results strongly support the hypothesis that duodenal exclusion may play a role in diabetes mellitus resolution following bariatric surgery in overweight patients.

There has been another significant observation in the present study showing GERD remission of 72 % in the MGB and 33 % in the LSG group, although there has been 21 % persistent GERD after LSG at 5 years. New onset GERD in LSG was seen mostly after 3 years and could be attributable to the dilation of stomach after 3 years.

Himpens et al. reported 21 % new onset acid reflux after 3 years of LSG [20].

Another 5-year study of LSG by Rawlins et al. [21] is showing 11 % new onset acid reflux, although it shows much better weight loss of 86 % EWL at 5 years but their patients were all super obese with an average BMI of 65 kg/m^2; this could explain the better weight loss.

In another short study of 1 year by Milone et al. [15] there has been 66.7 % remission of diabetes with LSG at 1 year, 87.5 % remission with MGB at 1 year, but showing equivalent weight loss in the first year. Laparoscopic mini gastric bypass in

Table 3 Revisions after MGB and LSG

Reason for revision surgery	Primary procedures		Type of revision	*P* value ($P<0.001$)
	LSG ($n=118$)	MGB ($n=104$)		
Weight regain	13 (12.5 %)	Nil	10 MGB, 3 RNY	0.322
Intractable reflux	3 (2.8 %)	Nil	3 RNY	0.123
Malnutrition	Nil	1 (0.8 %)	Reversal	0.163
Overall	16 (15.3 %)	1 (0.8 %)		0.285

morbidly obese patients with type-2 DM has been shown to be highly effective in prospective randomized controlled trials [22].

Early complications have been low in both groups in the present study. No leaks were observed in LSG or omega gastric bypass/MGB. Incidence of dyspepsia was more in LSG group in the early post operative period (4.8 % in MGB vs 11.8 % in LSG). There has been more incidence of postoperative bleeding in the LSG group as compared to the MGB group (3.3 vs 1 %). Other available studies also show similar low incidence of complications with MGB and LSG [3, 6].

Anemia was seen in 6.9 % of MGB patients at 5 years, this is attributable to the bypassed duodenum. Similar incidence of anemia was seen in Lee et al.'s, Rutledge and Walsh's, and Rutledge's study [3, 5, 23]. Incidence of marginal ulcers has been remarkably low in our series (one patient only) as compared to 2–3 % in other series. This could be attributable to the majority of non-smoking population in the state of Punjab owing to religious causes and also higher use of fresh cooked vegetables in food as compared to preserved foods in some developed nations.

Conclusion

Both MGB and LSG are safe, short, and simple operations. Weight loss is similar in MGB and LSG in thr first 2 years, after which the LSG shows lesser %EWL as compared to MGB. New onset GERD is more common after LSG and is mostly seen after 3 years.

Conflict of Interest All the contributing authors declare that they have no disclosures and no conflict of interest.

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