Laparoscopic Sleeve Gastrectomy versus Laparoscopic Mini-Gastric Bypass for the Treatment of Morbid Obesity

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Abstract

Background: Obesity is one of the greatest twenty first century public health challenges. Laparoscopic sleeve gastrectomy (LSG) and laparoscopic mini-gastric bypass (LMGBP) have gained popularity for morbid obesity treatment. **Objective**: The aim of the present study was to compare the safety and effectiveness of LSG versus LMGBP in the morbid obesity treatment. **Patients and methods:** This is a prospective study included 60 patients, who divided into 30 patients, underwent a LSG (group I); and 30 patients underwent LMGBP (group II). All patients were followed up postoperatively for 6 months. **Results:** There was a highly statistically significant difference between groups I & II in the mean operative time (minutes). There was no statistically significant difference between groups I & II according to postoperative complications. There was a statistically significant difference between 2 groups as regard percentage of excess body weight loss and comorbidities improvement. **Conclusion:** Both LSG and LMGB are safe, short, simple and effective bariatric operations. LMGB was longer in operative time and length of hospitalization but higher in its metabolic effect. LSG was more effective in weight loss in the first 6 months.

Keywords: Morbid Obesity; Sleevew Gastrectomy; Mini-Gastric Bypass

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INTRODUCTION

Obesity is responsible for approximately 5 % of all deaths a year worldwide. Its global economic impact amounts to roughly trillion annually, which equates to 2.8 % of global gross domestic product **(1)**. Currently, more than 2.1 billion people, approximately 30 % of the global population, are overweight or obese. More worryingly if the prevalence of obesity continues on its current trajectory, almost half of the world's adult population will be overweight or obese by 2030 **(2)**.

Obesity is classified according to WHO through the body mass index (BMI). This index is obtained by dividing the weight in kg by the square of the height in meters, and a BMI over 40 kg/m2 or over 35k/m2 with coexisting comorbidities is pronounced as morbid obesity **(3)**. Excess of weight is associated with the raise of morbidity and mortality, and this risk rises progressively according to the weight gain. Obese individuals die more from diseases related to the cardiovascular system, especially stroke and acute myocardial infarction, when compared to individuals with normal weight **(4)**. Diabetes and arterial hypertension occur 2.9 times more frequently in obese individuals **(5)**.

The negative impact of obesity is related not only to morbidity and mortality, also to quality of life, which is defined by the WHO as "a broad-ranging concept incorporating in a complex way the person's physical health, psychological state, level of independence, social relationships, and their relationship with the salient features of their environment" **(6)**.

The medical management of obesity is difficult because both weight loss and maintenance of the achieved weight are not possible for most of the extreme obese patients. Approximately 30% to 35% of the weight loss is regained after 1 year of the initiation of the treatment in up to 50% of the patients **(7).**

Laparoscopic sleeve gastrectomy (LSG) has gained popularity as a primary operation for the treatment of morbid obesity **(8)**. LSG is a restrictive bariatric procedure which involves subtotal gastric resection of the fundus and body to create a long, tubular gastric conduit constructed along the lesser curve of the stomach **(9)**.

Mini gastric bypass (MGB) involves making of along narrow tube of the stomach along its right border, the lesser curvature. A loop of small gut is brought up and hooked to this tube at about 180-200 cms from the start of the intestine (ligament of treitz). MGB has been suggested as an alternative to roux en-y procedure due to simplicity of its construction, which reduces the challenges of bariatric surgery. It is becoming more and more popular because of low risk of complications and good sustained weight loss. It has been estimated that 15.4% of weight loss surgery in Asia is now performed via the MGBN technique **(10)**.

Therefore, this study aimed to compare the safety and effectiveness of laparoscopic sleeve gastrectomy (LSG) and laparoscopic mini-gastric bypass (LMGBP) in the treatment of morbid obesity for 6 months.

PATIENTS AND METHODS

This is a prospective study included 60 patients. 30 patients underwent a LSG and the other 30 patients underwent LMGBP in Cairo university hospitals and military armed forces hospitals during 2016 and 2017.

Inclusion criteria:

The subjects were considered appropriate candidates for our present study if they were willing to give consent and comply with the evaluation and treatment schedule. Patients who had BMIs between 35 to 40 kg/m^2 or more, with other significant disease that could be improved if they lost weight (Diabetes, Hypertension, dyslipidemia). All appropriate non-surgical measures failed to achieve or maintain adequate, clinically beneficial weight loss for at least six months before the surgical intervention. Patients were fit for anesthesia and surgery. Patients committed the need for 6 months follow up. Patients need to demonstrate the absence of significant psychopathology that could limit their ability to understand the procedure and comply with the medical, surgical, and/or behavioral recommendations.

Exclusion criteria:

The exclusion criteria included pregnancy or lactation at screening or surgery. A documented history of drug and/or or supplements within 30 days of the screening visit or during study participation.Alcohol abuse within 2 years of the screening visit. Previous malabsorptive or restrictive procedures performed for the treatment of obesity. Any condition that would preclude compliance with the study. Such conditions including inflammatory diseases, congenital or acquired anomalies of the gastrointestinal tract, severe cardiopulmonary disease or other serious disease. Additional exclusion criteria included chronic or acute upper gastrointestinal bleeding conditions, cirrhosis, congenital or acquired intestinal telangiectasia, esophageal dysmotility, or Barrett's esophagus, hiatal hernia, previous surgery of the foregut, pancreatitis, an immunocompromised status or autoimmune connective tissue disease . Patients with GERD were excluded from undergoing LSG.

Ethical Consideration:

An approval of the study was obtained from Cairo University Academic and Ethical Committee. Written informed consent of all the participants was obtained. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Preoperative assessment

Determination that subject meets all the screening inclusion criteria and presents none of the preoperative exclusion criteria. Demographic information review was taken, subject physical examination including vital signs, height and weight were obtained. Blood tests including Ur, Cr, fasting glucose, ALT,AST, Lipid Profile, CBC, Prothrombin Time,and INR were measured. Abdominal ultrasound, endoscopic evaluation of stomach, chest X-ray, and pulmonary function tests were performed. Other potential imaging or cardiac other referral and evaluation as needed for pre-operative evaluation (e.g:Echocardiography if needed).

Surgical procedure:

All procedures were done under general anaesthesia with the patient in supine position and the surgeon positioned between the legs of the patient (French position) after applying compression stockings on the patient lower legs. The patients were firmly secured to the operating table to allow for placement in the anti-Trendelenburg position as required.

Carbon dioxide insufflation was used to create pneumoperitoneum, using the veress needle in the left hypochondrium for all cases maintaining a 15 mmHg intra-abdominal pressure and flow rate between 2-2.5 litres/minute.

I. Laparoscopic sleeve gastrectomy:

5 ports are typically inserted for LSG in our patients. The 1st port 10-12 mm. is inserted in the upper abdomen about 15 cm below the xiphisternum for the camera. Another 10-12 mm subxphoid trocar for liver retraction. The working port for the operating surgeon include 12mm port in left anterior axillary line and 15 mm port in right mid-clavicular line. A 5mm port is inserted in left mid-clavicular line for the assisting surgeon.

The vascular supply of the greater gastric curvature was divided starting 3 cm from the pylorus and proceeding to the angle of His. The gastroepiploic vessels along the greater curvature of the stomach and the short gastric vessels were divided using the LigaSure device or the harmonic shears (Cincinnati, OH, USA). Dissection of adhesions between the back of the stomach wall and the pancreas is performed. A 36-Fr calibrating bougie was introduced by the anaesthesiologist into the stomach and advanced along the lesser curvature into the pyloric channel and duodenal bulb. The stomach was divided 3-4 cm from pyloric ring. The first was green reload and the rest were blue reloads. An approximately 5-10mm cuff of stomach were left at the level of the angle of His to avoid including the esophagus with the staple line. Thereafter, a leak test with methylene blue was used to check the integrity of the stapler line. At the end of the procedure,we put adrain and the calibrating bougie was removed

II. Laparoscopic Mini-Gastric Bypass:

The technique used for LMGBP was a 5-port technique. A long gastric tube was created using an EndoGIA stapler (Medtronic, United States Surgical Corporation) approximately 1.5 cm to the left of the lesser curvature from the antrum to the angle of His. A loop gastroenterostomy was created with the small bowel about 200 cm distal to the ligament

of Trietz with an Endo-GIA stapler. The gastroenterostomy was then closed with continuous suture. A drain was left in the lesser sac before closure of the wound.

Post-operative Care & Follow up:

Number of days after surgery patient condition permitted home discharge (2 weeks fluids, 3 weeks puree, 3 weeks soft diet). Nausea, vomiting, siallorrhea, as well as any other postoperative complication were detected. Number of spoons causing satiety, and concomitant medications were recorded. The follow up were as the following:

(a) Visit 1-Month 1(30 days +/- 5 days).
(b) Visit 2-Month 3 (90 days +/- 14).
(c) Visit 3 – Month 6 (180 days +/- 14).

All follow up visits including subject weight, number of spoons causing satiety, changes in preoperative co-morbidities if present (Diabetes medications, hypertension, cardiovascular disease, sleep apnea, arthiritis, back pain, gastroesophageal reflux disease).Concomitant medications and complications follow up.

Study endpoints

The occurrence of adverse events were monitored throughout the entire study period and recorded as applicable on the day of surgery, 1 week after surgery, and at 1, 3, and 6 months postoperatively.

Statistical analysis:

Data were analyzed using Statistical Program for Social Science (SPSS) version 20.0. Quantitative data were expressed as mean±standard deviation (SD). Qualitative data were expressed as frequency and percentage. Independent-samples t-test and Chi-square (X2) test were used. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following P-value <0.05 was considered significant; P-value <0.001 was considered as highly significant; and P-value >0.05 was considered insignificant.

RESULTS

The present study showed statistically significant difference between group I and group II according to demographic data and anthropometric measurements **(Table 1).**

There was a highly statistically significant difference between group I and group II according to operative time (minutes) **(Figure 1)**. However, there was no statistically significant difference between group I and group II according to length of hospitalization **(Figure 2)**.

There was no statistically significant difference between group I and group II according to pre-operative problems **(Table 2).** No statistically significant difference between group I and group II according to intra-operative problems **(Table 3).** There was no statistically significant difference between group I and group II according to post-operative complications **(Table 4).**

There was a highly statistically significant difference between groups I & II according to body weight loss after 3 months weight **(Figure 3)**.

There was a statistically significant difference between groups I & II according to current weight **(Figure 4)**.

There was a statistically significant difference between group I and group II according to % of excess body weight loss **(Figure 5)**.

There was a statistically significant difference between group I and group II according to comorbidities improvement **(Table 5).** Additionally, 75 % of MGB patients have GERD improvement **(Figure 6)**.

Table (1): Demographic and Clinical data between LSG and LMGB groups

Demographic Data	Group I: LSG (N=30)	Group II: LMGB (N=30)	t/x2#	p-value
Age (years) Mean±SD Range	**30.11±6.75** **20-40**	**33.23±6.19** **24-46**	**1.524** **0.136**	
Sex Male Female	**2 (6.7%)** **28 (93.3%)**	**8 (26.7%)** **22 (73.3%)**	**3.000#** **0.083**	
Weight (kg) Mean±SD Range	**135.40±16.86** **96-185**	**140.93±20.93** **101-193**	**2.019** **0.125**	
Height (cm) Mean±SD Range	**161.73±7.61** **149-190**	**163.77±6.32** **155-183**	**1.267** **0.265**	
BMI [wt/(ht)^2] Mean±SD	**47.01±5.55**	**51.56±7.57**	**1.048**	

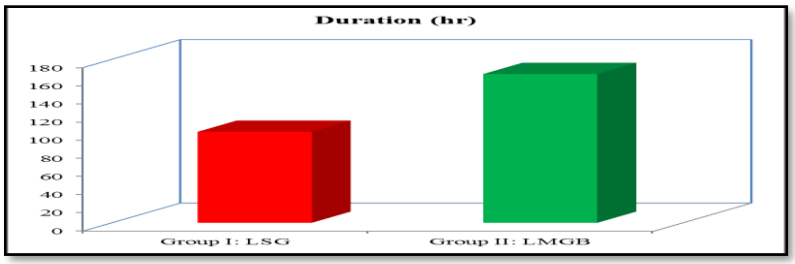

Fig. (1): Bar chart between group I and group II according to operative time.

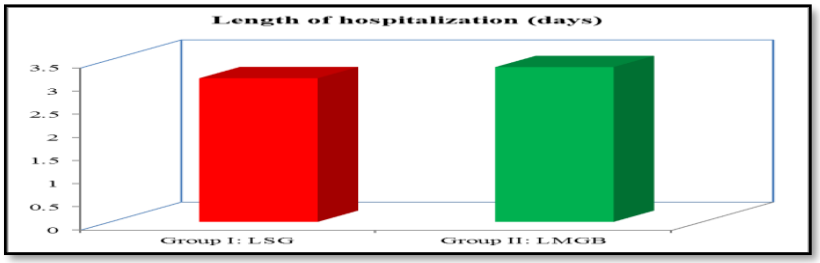

Fig.(2):Comparison between LSG and LMGB groups in length of hospitalization.

Table (2): Comparison between groups I & II according to preoperative problems

Complications	Group I: LSG (N=30)		Group II: LMGB (N=30)		Chi-square test	
	No.	%	No.	%	x2	p-value
Bleeding (controlled)	**1**	**3.3%**	**1**	**3.3%**	**4.681**	**0.471**
Liver injury	**1**	**3.3%**	**1**	**3.3%**		
Leakage	**0**	**0%**	**0**	**0%**		
Post operation ICU	**0**	**0%**	**1**	**3.3%**		

PE	**0**	**0%**	**1**	**3.3%**		
D.V.T	**1**	**3.3%**	**2**	**6.7%**		
Wound infection	**1**	**3.3%**	**1**	**3.3%**		
Bile reflux	**0**	**0%**	**2**	**6.7%**		
Iron deficiency	**0**	**0%**	**2**	**6.7%**		
New onset GERD	**1**	**3.3%**	**0**	**0%**		

Table (3): Comparison between groups I & II according to intra-operative problems

Intra operative Problems	Group I: LSG (N=30)		Group II: LMGB (N=30)		Chi-square test	
	No.	%	No.	%	x2	p-value
Bleeding (controlled)	**1**	**3.3%**	**1**	**3.3%**	**4.196**	**0.406**
Liver injury	**1**	**3.3%**	**1**	**3.3%**		
Leakage	**0**	**0%**	**0**	**0%**		

Table (4): Comparison between groups I & II according to post-operative complications

Post-operative Problems	Group I: LSG (N=30)		Group II: LMGB (N=30)		Chi-square test	
	No.	%	No.	%	x2	p-value
Post operation ICU	**0**	**0%**	**1**	**3.3%**	**3.115**	**0.689**
P.E	**0**	**0%**	**1**	**3.3%**		
D.V.T	**1**	**3.3%**	**2**	**6.7%**		
Wound infection	**1**	**3.3%**	**1**	**3.3%**		
Bile reflux	**0**	**0%**	**2**	**6.7%**		
Iron deficiency	**0**	**0%**	**2**	**6.7%**		
New onset GERD	**1**	**3.3%**	**0**	**0%**		

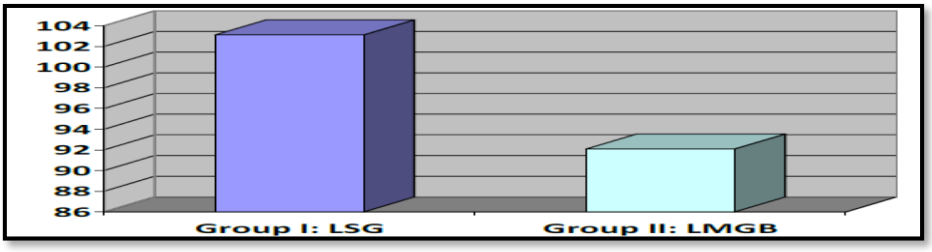

Fig. (1): Bar chart between groups I &II according to body weight loss after 3rd months.

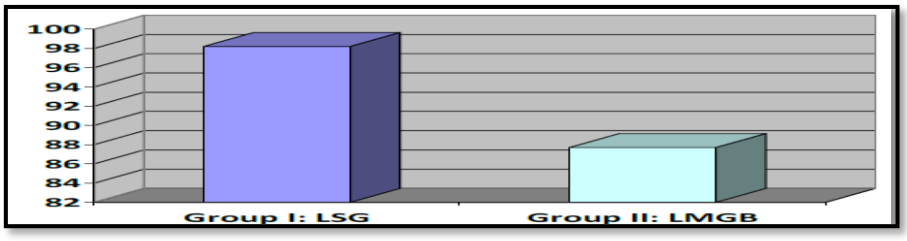

Fig. (4): Bar chart between groups I &II according to body weight loss after 6th months.

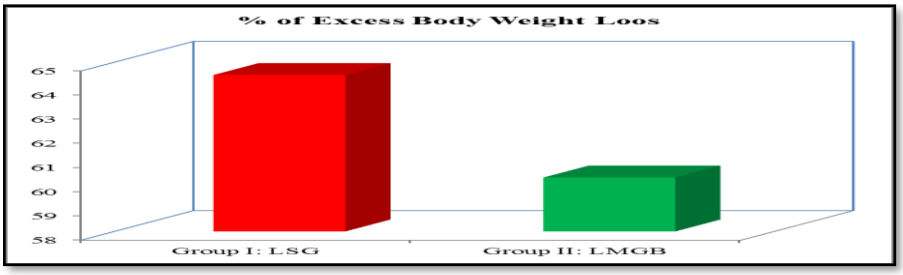

Fig. (5): Bar chart between groups I &II according to % of excess body weight loss.

Table (2): Comparison between group I and group II according to comorbidities improvement.

Improved	Group I: LSG (N=24)		Group II: LMGB (N=23)		Chi-square test	
	No.	%	No.	%	x2	p-value
Improved	18	75%	19	82.6%	0.079	0.779
Not Improved	6	25%	4	17.4%		

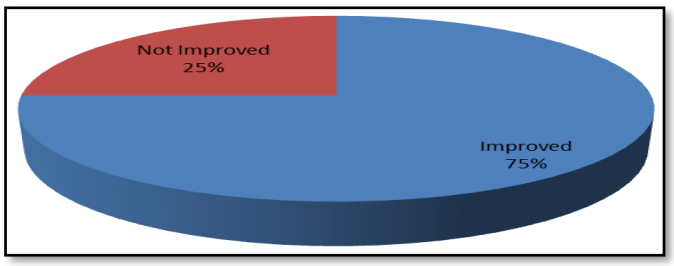

Fig. (6): Pie chart GERD improvement with MGB

DISCUSSION:

Severe and complex obesity is associated with multiple medical problems. The lines of causality are often complex with (a) medical problems causing obesity and obesity causing medical problems as well as (b) 'third' factors (such as sedentary lifestyle or poor diet) causing both the medical problem and obesity **(11)**.

There is optimism that with continued advances in our understanding of the biology of energy regulation, in particular the mechanisms by which bariatric surgery mediates its beneficial weight loss and metabolic effects that non-surgical therapies, resembling the health benefits of surgery are on the horizon **(12)**.

The aim of the present study to to compare the safety and effectiveness of LSG versus LMGBP in the morbid obesity treatment for 6 months.

Several studies have provided strong evidence that bariatric surgery is currently the best answer to the management of morbidly obese patients, despite the need for elucidating the mechanisms involved in the weight loss **(13-15)**. In fact, prospective controlled trials such as the Swedish Obesity Study (SOS) are still confirming the good outcomes in the surgically treated patients when compared with the matched population treated with conventional therapies **(13)**. The SOS study designed to offer a controlled prospective long term instrument to investigate the effects of bariatric surgery and weight loss on mortality and on cardiovascular complications of obesity, Type 2 diabetes improvement/resolution, quality of life and the cost-effectiveness of bariatric surgery compared with the medical management of

obesity and its complications. The results in term of weight loss were not only better for the surgical group but it was sustained during the long period of follow up. It is to be noted that the drop out at follow-up ranged from 24.6 to 40 % at 10 years follow up. Despite the high numbers, a specific survey on the patients who did not attend their follow up appointments at 10 years did achieve similar results in term of weight loss and remission of co-morbidities in the surgical arm **(13)**.

The evidence collected from the sub-studies of the SOS were the basis for validating the efficacy of weight loss surgeries and of the weight loss itself in reducing mortality while improving the quality of life in the morbidly obese population. Evidence based studies also witnessed the cost effectiveness of bariatric surgeries, which could represent cost saving procedures in the management of morbid obesity in most countries **(14,16)**.

Laparoscopic sleeve gastrectomy was developed as the first stage of a two stage duodenal switch with the intention to reduce the risks of this complex technique. It was established as a stand-alone procedure after it demonstrated to be so effective in terms of weight loss that most patients did not require a second stage procedure. Short term follow up demonstrated better results in term of weight loss when compared with other purely restrictive procedures such as gastric banding or VBG. The weight loss in some studies is comparable with the gastric bypass, with a %EWL of 65-70 % achieved at 2 year follow-up **(17).**

The discovery of ghrelin as a trigger of appetite, produced mainly in the portion of the stomach (fundus) which was resected as part of sleeve gastrectomy, suggested the presence of other metabolic mechanisms that lead to weight loss. This was confirmed by long term studies that showed the presence of low levels of ghrelin even after 2 years whilst patients treated with gastric bypass were experiencing an increase in ghrelin levels. Further evidence that ghrelin has the potential to increase insulin resistance was achieved following the observation that sleeve gastrectomy had the same potential to induce a decrease in blood glucose levels before significant weight loss **(18)**.

Hence, sleeve gastrectomy is a metabolic-restrictive procedure similar to gastric bypass. Moreover, recent studies about gastric sleeve emptying show an accelerated transit through the antrum and duodenum, so that some authors consider the procedure as a "functional duodenal bypass"**(17)**.

It is still unclear why some patients experience weight re-gain following the first 2 postoperative years. The dilation of the sleeve could be responsible for an increased capacity and greater calorie intake. The procedure is still not standardized; it is unclear what should be the ideal distance from the pylorus to start making the gastric sleeve and there is still no consensus about the precise size of bougie that should be used to size the sleeve. This variation could lead to different results mainly in the long term follow up as patients experience possible increases in the sleeve volume. Greater steps have been taken in the reduction of early complications such as sleeve leak since the risk of leak has progressively reduced from 10-15 % in 2002 to 2 % in 2012. The incidence of leak was shown to be between 0.6-2.38 % when using a bougie size greater than 40 Fr in diameter **(19,20)**.

Gagner et al. (21) analyzed the leak rate associated with the use of buttressed sutures. Whilst the overall incidence of leak was 2.1 %, it increased to 3.3 % when buttressing the staple lines with bovine pericardium and was significantly lower when absorbable polymer membrane (e.g. Seamguard) was used with an incidence of 1.09 %.

An incidence of sleeve staple line leak of 3.6 % was recently reported in one series from a high volume bariatric center in Belgium **(22)**.

The main reason for the reduction in leaks is possibly due to the efforts done to identify their causes. At present, stapling too close to the esophago-gastric junction (with possible

ischemia of the upper suture line) and narrowing at the mid-portion of the sleeve at the incisura (increasing the endo-luminal pressure) are well recognized risk factors for an increased incidence of leaks. Since the formation of the sleeve must exclude the fundus, careful dissection of the left crus must be done and often a concomitant hiatal hemia repair is necessary. In fact it has been proposed that disruption of the lower esophageal sphincter mechanism may explain the propensity of sleeve patients to develop acid reflux or even a sliding hernia with most of the sleeve herni-ating into the chest **(23,24).** The risk of leak and unknown outcomes in the long term limits the widespread practice of this technique compared to the gold standard procedure, gastric bypass.

Mini-gastric bypass (MGB) was developed by **Rutledge (25)** and is consistent with an omega, single anastomosis technique. In this procedure the gastric pouch must be longer than in traditional RYGB and narrower, and the anastomosis with the afferent limb is measured at 200 cm from the Ligament of Treitz which means there is a long bilio-pancreatic component of the bypass **(26)**. Several concerns limited the initial uptake of this technique. Most surgeons felt bile reflux, reportedly experienced in up to 70 % of patients who underwent the first Mason's horizontal bypasses with omega-loop, would be a significant problem. Quality of Life (QOL) surveys completed postoperatively showed that the creation of a long, narrow lesser curvature based gastric pouch with the gastro-jejunal anastomosis at its bottom-end reduces the risk of bile reflux and alkaline esophagitis. Currently there is a lack of evidence about the long term results following this procedure though it seems there is a lesser pro-pensity for weight re-gain after the second postoperative year compared to laparoscopic Roux-en-Y gastric bypass (LRYGB). The presence of just one anastomosis and the shorter operation time makes the MGB appear attractive. In addition to the good results reported in term of weight loss, which are similar or slightly better than that obtained with the established LRYGB. Some concerns about possible long term anastomotic complications still need to be clarified, in particular, whether the presence of a greater acid pocket related with the longer shape of the pouch could increase the incidence of marginal ulcers and whether bfle reflux could have a carcinogenic effect on the gastric/ esophageal mucosa.

MGB has been reported to be a safe, simple, and effective bariatric procedure in several studies **(27-29).** All the reports published to date have been very encouraging. Various studies of the MGB and the LSG have reported excellent results with the additional benefits of both procedures being relatively simple to perform and associated with low complication rates. There are few studies comparing MGB to LSG **(29,30).**

In our study, the mean operating time and hospital stay were longer in LMGB. Conversion to open surgery was not required in any patients no mortality occurred in these 6 months. Weight loss has been better after LSG (64%) VS (60%) with LMGB As far as Comorbidities resolution is concerned the present study show both LSG and LMGB are good at resolving co-morbidities with a better metabolic strength in LMGB group.

Lee et al. (31) 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 **(32).**

In another study by **Milone et al., (29)** there has been 66.7% remission of diabetes with LSG, 87.5%remission with MGB. Laparoscopic mini gastric bypass in morbidly obese patients with type 2 DM has been shown to be highly effective in prospective randomized controlled trials **(26).**

Early complication have been low in both groups in the present study no leaks were observed in LSG or LMGB ,with the same incidence of bleeding 3.3% and one case of ICU

admission due to PE with LMGB. This finding are agreed with a priovous studies that showed low incidence of complications with LMGB and LSG **(10,21).**

Our study showing GERD remission of 75% in LMGB with one case of new onset GERD was seen in LSG. **Himpens et al. (33)** reported 21 % new onset acid reflux. Another study of LSG by **Rawlins, et al. (4)** showed 11% new onset acid reflux.

CONCLUSION:

Both LSG and LMGB are safe, short, simple and effective bariatric operations. LMGB was longer in operative time and length of hospitalization but higher in its metabolic effect. LSG was more effective in weight loss in the first 6 months.

Further comparative studies with larger numbers of patients a longer follows up are needed.

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Author contribution: Authors contributed equally in the study.

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