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Impact of preoperative body mass index on the final outcome after laparoscopic sleeve gastrectomy for morbid obesity

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ABSTRACT

Objective: Laparoscopic sleeve gastrectomy (LSG) is a popular bariatric surgery due to its excellent results and limited morbidity. Our study aims to assess the efficacy of LSG in terms of loss of weight and co-morbidity improvement and to evaluate the impact of preoperative body mass index (BMI) on the final outcome.

Material and Methods: The data of 173 patients who underwent LSG were analyzed. Laparoscopic sleeve gastrectomy was indicated only for patients with BMI >40. Mean postoperative BMI, co-morbidity improvement, operative data and complications, length of hospital stay and excess weight loss were evaluated and recorded.

Results: This study included 151 females and 22 males with a mean age of 37.6 years. Patients were divided into two groups according to their BMI (group I <50, group II >50). Mean preoperative BMI was 53.8 kg/m^2. Mean operative time was 120 minutes. Mean duration of hospital stay was 3.2 days. Mean postoperative BMI decreased to 47.3 kg/m^2 at 1 year. Excess weight loss was 43.1% at 6 months, 71.1% at 1 year, and 87.5% at 5 years. Group I showed a significantly shorter length of hospital stay, more improvement of laboratory parameters and more reduction in BMI as compared to group II. There was one mortality and six cases had gastric staple line leakage.

Conclusion: Laparoscopic sleeve gastrectomy is an efficient treatment to achieve significant weight loss that is maintained up to 5 years of follow up, also it improves some of the obesity related co-morbidities. This beneficial impact of LSG appears to be significantly higher in patients with BMI <50.

Keywords: Bariatric, morbid obesity, sleeve gastrectomy

INTRODUCTION

Morbid obesity is one of the most serious health issues worldwide. The prevalence of morbid obesity has increased over the past two decades at a significant rate in such a way that it can be considered a pandemic. According to World Health Organization (WHO) 2.3 billion adults will be overweight by 2015. The prevalence of overweight and obese people among the Egyptian population is increasing. Although no single study has reported the incidence of obesity in Egypt, it is estimated to be around 24%. Co-morbidities associated with morbid obesity include type 2 diabetes (T2DM), ischemic heart diseases, musculo-skeletal disorders, sleep apnea and a higher mortality rate (1-3).

The medical treatment of obesity did not achieve sufficient success to balance the increase in the prevalence of obesity, which in turn led to the emergence of bariatric surgery. Bariatric surgery proved to be the most successful treatment as it achieves long-term weight loss and correction of metabolic abnormalities in patients suffering from morbid obesity (4, 5).

Laparoscopic sleeve gastrectomy (LSG) developed as the first stage of a two - stage duodenal switch procedure. Laparoscopic sleeve gastrectomy involves partial gastrectomy along the lesser curvature leaving a thin tube of gastric tissue connecting the esophagus to the pylorus. The volume of the sleeve is approximately 100 mL over a 32–36 French sized bougie (6). Laparoscopic sleeve gastrectomy gained the attraction of many surgeons as a bariatric operation, being technically easier than gastric bypass, with less malabsorption, less risk of renal calculi and no risk of internal hernia or anastomotic ulcer formation. Operative complication rates and weight loss outcomes in LSG surgery are similar to those of Roux-en-Y gastric bypass (RYGB) (7).

Laparoscopic sleeve gastrectomy has increasingly gained acceptance among bariatric surgeons during the past years. Even high-risk patients underwent a staged procedure with LSG serving as a primary stage before RYGB or biliopancreatic diversion/duodenal switch. Data have shown that LSG is a highly efficient, technically easy and safe bariatric operation that can be used as a stand-alone procedure (8). Although morbidly obese patients are high risk surgical patients, rates of postoperative leaks, bleeding and other complications are low and acceptable (9). Recently LSG is considered the best bariatric surgery in morbidly obese patients (10).

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The objective of our study is to evaluate the efficacy of LSG as a mode of surgical management of morbidly obese patients and to investigate the impact of preoperative body mass index (BMI) on the final outcome to determine whether patients with BMI higher than 50 can achieve the same results after LSG as patients with BMI lower than 50 or not.

MATERIAL AND METHODS

In the period from March 2010 to January 2015, 173 morbidly obese patients [22 (12.7%) male patients and 151 (87.3%) females] underwent LSG in the general surgery department at Mansoura University Principal Hospital as well as private hospitals in Mansoura city. The mean age of patients was 37.6±12.4 years. All patients have tried every non-surgical method of weight loss and none of them has undergone any previous bariatric surgery. Patients excluded from this study include those with an extremely high operative risk, major psychologic or endocrinologic conditions, and patients with significant hiatus hernia or Barrett's esophagus.

Preoperative Evaluation

Age, sex and BMI of the patients were recorded. Thorough clinical evaluation including blood pressure, pulmonary and cardiac examinations was done. Laboratory investigations in the form of complete blood count, plasma glucose levels, triglyceride (TG), serum total cholesterol (Tc), and low density lipoprotein (LDL) concentrations were determined as baseline levels. Upper gastrointestinal (GI) endoscopy was routinely performed in all patients in order to exclude significant hiatus hernia and Barrett's esophagus. Informed consent was obtained from all patients included in this study. Patients then were divided according to their preoperative BMI into two groups, group I with BMI <50 and group II with BMI >50.

Surgical Procedure

After induction of general anesthesia, the patient was placed in the supine position. Five port technique was used. The laparoscope was introduced through a supra-umbilical port, two 12 mm ports were placed one on the right and one on the left, 10 cm caudal from the costal margin at midclavicular line, one 5 mm port in the right subcostal margin for the retraction of the liver and 10 mm port in the left subcostal margin. We began de-vascularization of the greater curvature of the stomach with harmonic scalpel (ultrasonic dissector) at about 2 cm proximal to the pylorus and then we proceeded upwards till the angle of His. A linear stapler (Endo GIA) was used with two sequential 4.8/60 mm green load firings from the antrum, followed by two or three sequential 3.5/60 mm blue loads for the remaining gastric body and fundus. After inserting a 36 French calibrating bougie into the stomach, the stapler was applied alongside the bougie. The resected stomach was grasped by a laparoscopic grasper at the tip of the antrum and then retrieved through one of the 12 mm port sites. Any bleeding site was clipped. No supportive materials were added to reinforce the suture line except in case of bleeding suture line, in which overlying sutures were used for hemostatic purpose. An abdominal drain was routinely placed.

Postoperative Course and Follow Up

The nasogastric tube was removed on the first postoperative day. The abdominal drain was removed on the second or the third postoperative day except in cases of gastric leakage, where the drain was kept in place for a longer period as part of conservative management. Patients were discharged on the third postoperative day.

All patients were instructed to take postoperative oral multivitamin supplementation for life and histamine 2 receptor blockers for 6 months. The mean operative time, duration of hospital stay and early postoperative complications were recorded.

Follow up was scheduled at the third, sixth, ninth and twelfth postoperative months in the outpatient clinic in the first year and followed with a visit every year for the next four years. Follow up parameters measured at each visit included body weight, BMI, blood pressure, blood glucose level, hemoglobin A1c (HBA1c), serum TG level, Tc level and LDL.

Statistical Analysis

Data were analyzed using excel and Statistical Package for Social Science (SPSS Inc.; Chicago, IL, USA) programs version 16 under Microsoft Window. Data were summarized using mean and standard deviation (SD). Relative percentage change was calculated to get the actual change in each time measure. Relative percentage change = [(Post measure – Pre measure)] x100. Comparison between groups were done using unpaired Student's t-test for quantitative variables.

RESULTS

One hundred seventy-three patients were included in this study and underwent LSG. Patients were divided according to their preoperative BMI into two subgroups, group I (BMI less than 50) comprised 64 (37%) patients and group II (BMI more than 50) comprised 109 (63%) patients. The preoperative characteristics of the patients are listed in Table 1.

The mean operative time was 120±25.3 minutes (range, 90-180) while the mean postoperative hospital stay was 3.2±1.5 days (range, 3-11days). No intra-operative mortality was reported.

In terms of postoperative complications, leakage from the site of anastomosis with intra-abdominal collection was noted in six patients, two patients were treated with ultrasound guided drainage, the other two patients were managed conservatively and the last two patients underwent exploratory laparotomy. On the other hand, we did not report other complications such as bleeding or wound- related complications, i.e. infection or herniation.

Gastric dilatation was reported in four patients, two of them were still losing weight and dilatation was not exceeding double the size of remnant, while the other two patients stopped losing weight and even regained weight and eventually re-sleeve was done with good results.

Other complications include postoperative nausea and vomiting in 23 (13.2%) patients who were treated conservatively. Gastro-esophageal reflux disease (GERD) symptoms developed in 17 (9.8%) patients who were treated conservatively. Six (3.4%) patients developed asymptomatic gallbladder stones and were managed conservatively. Two patients developed pulmonary embolism and they were also managed conservatively. There was only one postoperative mortality which occurred at the 8th postoperative day, in a male patient

Table 1. Demographic data of the population included in the study

Number of patients	173
Mean age in years±SD (range)	37.6±7.7 (23-58)
Sex (female/male)	151/22
Mean BMI in kg/m^2±SD (range)	53.8±8 (40-75 kg/m^2)
BMI <50 kg/m^2 (%)	64 cases (37%)
BMI >50 kg/m^2 (%)	109 cases (63%)
Mean operative time minutes±SD (range)	120.1±25.3 (90-180)
Mean hospital stay days±SD (range)	3.18±1.5 (3-11)

SD: standard deviation; BMI: Body Mass Index

Table 2. Change in BMI at the first postoperative year

Preoperative	First Postoperative Year	p
53.8±8	47.34±4.4	<0.0001

BMI: Body Mass Index

Table 3. Improvement of co-morbidities after laparoscopic sleeve gastrectomy

Co-morbidities	Improvement assessed at 1 year	Improvement assessed at 3 years	Improvement assessed at 5 years	p
Diabetes (cases)	77% (57 out of 74)	91.8% (68 out of 74)	91.8% (68 out of 74)	0.0217
Hypertension (cases)	78.8% (41 out of 52)	88.5% (46 out of 52)	88.5% (46 out of 52)	0.2888
Dyslipidemia (cases)	86.7% (72 out of 83)	91.5% (76 out of 83)	95.1% (79 out of 83)	0.1017
Musculoskeletal problems (cases)	72.6% (45 out of 62)	87.1% (54 out of 62)	96.8% (60 out of 62)	0.0003
Symptoms of GERD (cases)	39.3% (11 out of 28)	57.1% (16 out of 28)	67.8% (19 out of 28)	0.0598
Sleep apnea (cases)	68.8% (22 out of 32)	84.4% (27 out of 32)	96.9% (31 out of 32)	0.0059
Infertility in females only	44.4% (4 out of 9)	44.4% (4 out of 9)	55.5% (5 out of 9)	1
Urinary incontinence in females only	58.3% (7 out of 12)	75% (9 out of 12)	75% (9 out of 12)	0.6668

GERD: gastroesophageal reflux disease

with BMI >50. This mortality was due to massive pulmonary embolism.

Mean preoperative BMI for all patients was 53.8±8 (range, 40-75 kg/m^2) which dropped one year after surgery to 47.34±4.4 (range, 37-56.7 kg/m^2) with a p value less than 0.0001 (Table 2). Mean preoperative HbA1C for all patients was 8.75±1.32 (range, 7.9-11.8%), which declined postoperatively to 6.92±1.7 (range, 6.5-9.4%) (p<0.05). Resolution of diabetes was maintained up to five years follow up in 68 (91.8%) patients. Improvement of the obesity associated co-morbidities over the study period is illustrated in Table 3.

Both group I and group II had co-morbidities related to obesity such as diabetes, hypertension, hyperlipidemia, infertility and urinary stress incontinence in females. There was no significant difference between the two groups in terms of operative time(Table 4), yet group I showed significant reduction of BMI at five years postoperatively, significantly shorter hospital stay and significant improvement of laboratory parameters as serum Tc, LDL, TG level and blood glucose level (p<0.05).

Table 5 illustrates the overall changes in the laboratory parameters, body weight and BMI in the immediate postoperative period and over 5 years of follow-up. As demonstrated, BMI showed a remarkable drop from 53.8 preoperative to 33.1 five years after surgery. Also, TG, blood glucose, HBA1c, and LDL have declined over five years postoperatively, reflecting an improvement in terms of diabetes and dyslipidemia.

DISCUSSION

Laparoscopic sleeve gastrectomy exerts its weight-losing effect by reducing the capacity of the stomach to less than 100 mL, which induces early satiety sensation during eating. Another mechanism for weight loss is the decrease in serum levels of ghrelin and leptin. Since intestinal bypass is not performed in LSG; anemia, vitamin deficiencies, protein malnutrition or osteoporosis are not encountered. The absence of dumping syndrome is another advantage of LSG.

Laparoscopic sleeve gastrectomy is categorized as a restrictive bariatric procedure; however, LSG is also a metabolic procedure due to the changes in gut hormones induced by the operation in addition to the caloric restriction effect thus leading to an important role in the field of bariatric surgery (11, 12).

Previous studies have shown that bariatric surgery causes significant weight loss and is more effective than non-surgical interventions. Not only does LSG achieve the greatest weight loss in the first few months after the operation, but also this weight loss is sustained for a long time reaching up to 20 years, with far less mortality rate than that obtained with diet regimen, exercise programs, and medications (4).

A systematic review of 36 studies recently evaluated overall weight loss after sleeve gastrectomy and assessed reduction of weight for both staged and primary patient groups (7). The mean preoperative BMI for all patients included in the systematic review was 51.2 kg/m^2 which decreased to 37.1 kg/m^2 during three years of follow-up. This is comparable to our results, as in our study the mean preoperative BMI for all patients was 53.8±8 (range 40-75 kg/m^2) and decreased to 47.34 ±4.4 range (37-56.7 kg/m^2) at one year after surgery and progressively declined to 33.1±2.8 at 5 years postoperatively. The overall mean excess weight loss (EWL) after sleeve gastrectomy as reported in 24 studies was 55.4% (range, 33%-85%) that was comparable to our findings of EWL of 55.6% (7).

Laparoscopic sleeve gastrectomy is associated with a significant improvement of T2DM and other obesity-associated co-morbidities such as hypertension and hyperlipidemia (13, 14). Postoperative improvement of diabetes starts even before significant weight loss has occurred. The mechanism for this rapid metabolic improvement is not fully understood and it may be independent of weight loss. This implies that bariatric

Table 4. Comparing the two groups regarding BMI and comorbidity improvement

Parameter	Group I BMI <50 (n=64)	Group II BMI >50 (n=109)	p
Mean age	36.98±5.2	37.98±5.4	0.23
Sex			
Male (%)	9 (14%)	13 (11.9%)	
Female (%)	55 (86%)	96 (88.1%)	0.42
Operative time (Minutes)	124.29±35.2	117.66±34.4	0.22
Mean hospital stay (Days)	2.79±1.35	3.41±1.43	0.005
Mean preoperative cholesterol	305.87±40.1	309.22±43.2	0.61
Mean postoperative cholesterol at 5years	217.5±22	210.3±26	0.06
Mean preoperative triglyceride	242.04±98.7	228.32±99.3	0.38
Mean postoperative triglyceride at 5 years	172.73±3.1	171.42±4.8	0.05
Mean preoperative LDL	214.82±62.8	222.44±65.9	0.46
Mean postoperative LDL at 5 years	151.67±34.2	139.94±32.1	0.02
Mean preoperative RBG	198.67±75.8	192.08±71.8	0.57
Mean postoperative RBG at 5 years	108.42±37.9	105.77±36.4	0.64
Mean preoperative body weight	143.48±44.8	167.85±51.6	0.002
Mean postoperative body weight at 5 years	82.15±2.1	81.82±2.5	0.07
Mean preoperative BMI	46.8±8.2	60.8±8.8	<0.0001
Mean postoperative BMI at 5 years	29.7±4.3	36.5±5.1	<0.0001

BMI: Body Mass Index; LDL: low density lipoprotein; RBG: random blood glucose

Table 5. Overall changes in the laboratory parameters, body weight and BMI over the study period

	Preoperative	6 months Postoperative	1 year Postoperative	5 years Postoperative
BMI	53.8±8	43.1±4.9	47.3±4.4	33.1±2.7
Total cholesterol	308±41.8	280.9±37.6	264.3±32.5	213±24.4
Triglyceride	233.4±99.1	203.9±60.3	192.7±22.4	171.9±4.2
LDL	219.6±63.7	150.6±44.2	151.6±44.7	144.2±33.8
Blood glucose (mg %)	194.5±73.7	170.7±54.8	163.3±47.2	106.7±37.3
HBA1c	8.75±3.2	6.92±2.7	6.85±2.5	5.75±1.8
Body weight (kg)	158.8±48.4	120.2±22.6	117.6±18.2	82±2.3

BMI: Body Mass Index; HBA1c: hemoglobin A1c; kg: kilogram; mg: milligram; LDL: low density lipoprotein

surgery is also a metabolic procedure that improves metabolic conditions even in non-obese patients (15). Varying degrees of diabetes remission has been reported after each current bariatric procedure.

A recent review by Gill et al. (16) evaluated the rate of improvement in diabetes after sleeve gastrectomy, and identified 28 studies that met their inclusion criteria. This systematic review included 673 patients with a mean preoperative BMI of 47.4 kg/m^2, which is less than the mean preoperative BMI in our study (53 kg/m^2). In their review, LSG resulted in diabetes remission in 66.2% of patients. In eleven studies that included HbA1c as a measure of glucose control, the mean HbA1c decreased from 7.9% to 6.2%. In our study, a significant resolution of diabetes mellitus was detected in 77% of patients at one year and reached up to 91% at 5 years postoperatively while HbA1c decreased from 8.75% to 5.75%. The effect is caused by a decrease in insulin resistance due to weight loss and caloric restriction rather than an increased insulin secretion (17).

A decline in the serum levels of Tc, TG and LDL is noted after surgery while high-density lipids increase. However, the improvement in dyslipidemia in our study was not statistically significant. Resolution of dyslipidemia, T2DM and blood pressure would definitely improve the Framingham risk score for cardiac events (18).

Review of the literature revealed improvement of dyslipidemia in 70%, hypertension in 62%, arthralgia in 77%, ischemic heart diseases in 56%, and sleep apnea in 86% of patients. Excellent improvement of infertility and of urinary incontinence in females have also been reported in the literature, which contradicts our results as the improvement of both infertility and incontinence in females was not significant, possibly due to the small number of patients with both conditions (19, 20).

The overall mortality rate through 30 days in the published literature is 0.19% (13). There was only one mortality in our study due to massive pulmonary embolism that occurred on the 8th postoperative day. Nevertheless, our mortality rate was 0.57%, which is apparently high due to the limited number of cases in the study group.

Sleeve gastrectomy is associated with acceptable perioperative morbidity and it offers a rapid and effective treatment for morbid obese patients (21). The main concern with LSG mentioned by various authors is the possibility of dilatation of the gastric sleeve that occurred in 4 patients (2.3%) in our study with the consequence of weight regain in two of them (1.15%). However, gastric dilatation was not proved to be an etiology for inappropriate weight loss (22), and even if it occurred laparoscopic re-sleeve gastrectomy can be performed easily and safely in the setting of gastric tube dilation or inadequate original gastric volume reduction.

Gastric leak is one of the most serious and dreaded complications of LSG. It occurs in up to 5% of patients following LSG (23). In our study leakage from staple line with intra-abdominal collection was seen in six patients (3.4%), which is within the acceptable range.

Gastro-esophageal reflux disease remains a concern after sleeve gastrectomy and the onset of severe refractory GERD after LSG maybe an indication to revise the procedure to gastric bypass. Often early improvement of GERD symptoms oc-

curs after LSG (24) but late onset of GERD symptoms has also been reported. In the report by Himpens et al. (25), the overall incidence of new-onset GERD (defined as symptoms requiring proton pump inhibitor use) was 26%, which is higher than our incidence rate of 9.8%. A neo-fundus (dilated pouch of fundus at the proximal sleeve) is probably the cause of the new-onset GERD symptoms and it occasionally requires re-operation. GERD symptoms improved in patients who had their dilated fundus resected. Additionally, in the study by Bohdjalian et al. (26), 31% of patients were on chronic therapy for acid suppression for GERD symptom after 5 years of follow-up.

Classifying patients into two groups according to their preoperative BMI, those lower or higher than 50, revealed that while the operative time held no significant difference, the mean hospital stay was significantly shorter in the first group and also the improvement of laboratory parameters, body weight reduction and decline in BMI at 5 years postoperatively were in favor of the first group. This might imply that the lower the preoperative BMI, the better are the results obtained by bariatric surgery and LSG in particular. This finding is concordant with the study by Ochner et al. (27) reporting that the effect of preoperative BMI was apparent, heavier individuals showed lower percentages of initial and excess weight loss, and that this effect was particularly apparent after the initial rapid weight loss phase during the first year, when patients with BMI <50 continued losing weight, while patients with BMI ≥50 regained significant weight. Another cohort study reported significant weight loss and improvement of T2DM, hypertension and dyslipidemia after LSG in 78 patients whose BMI was less than 50 (28).

CONCLUSION

Laparoscopic sleeve gastrectomy provides satisfactory weight loss and reduction of BMI with simultaneous improvement of obesity related co-morbidities. The therapeutic effect of LSG is more significantly observed in patients with BMI less than 50. This observation implies that the preoperative BMI has a strong impact on the final outcome of the procedure, patients with BMI more than 50 may not achieve the same good results as patients with a lower BMI, and thus other alternatives such as mini gastric bypass can be their ultimate solution.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Mansoura University School of Medicine.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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