A study on weight loss outcomes after laparoscopic sleeve gastrectomy

Samy M. Osman[a], Ahmed M. Ali[a], Mahmoud S. Marzouk[b]

[a]Department of General Surgery, Faculty of Medicine, [b]Department of General Surgery, Assiut University Hospitals, Faculty of Medicine, Assiut Governorate, Egypt

Correspondence to Mahmoud S. Marzouk, MBBCh,
Faculty of Medicine, Assiut University, Assiut, Egypt
Postal Code: 71111;
Tel: +20 100 314 2839;
e-mail: mahmoudshihsta666@gmail.com

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Background
Obesity increases the likelihood of various diseases and conditions, particularly cardiovascular diseases, type 2 diabetes, obstructive sleep apnea, osteoarthritis, and depression. The most effective treatment for obesity and its associated comorbidities is bariatric surgery in its various forms.

Patients and methods
A prospective and a retrospective study is carried out on 54 patients with BMI more than or equal to 40 kg/m^2 or BMI more than or equal to 35 kg/m^2 with comorbid conditions who underwent laparoscopic sleeve gastrectomy (LSG).

Results
Weight loss follow up was done at 1, 3, 6, and 12 months. The weight loss was measured in terms of absolute weight loss (kg), change in BMI and percentage of excess weight loss (%EWL) which was as follows. Body weight: after LSG, the mean body weight significantly declined to 36.9% of initial weight at 1 year. BMI: postoperative BMI declined from 46.51 ± 7.02 to 29.5 ± 5 kg/m^2 after 1 year. %EWL: the %EWL was about 70.6 ± 14.8 at 1 year. The proportion of patients having successful weight loss (%EWL < 50%) were 92.6%.

Conclusion
LSG is a low-risk procedure that can significantly reduce the BMI, with near 70% EWL with success rate about 92% after 1 year.

Keywords:
bariatric surgery, obesity, sleeve gastrectomy, weight loss

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Introduction

WHO describes obesity as most visible but neglected health issue affecting both developed and developing countries. The most effective treatment for obesity and its associated comorbidities is bariatric surgery in its various forms. Bariatric surgery has become a safe, effective, and proven therapy [1].

Sleeve gastrectomy (SG) was performed for the first time in 1988 by Hess and Hess. In 2009, the American Society for Metabolic and Bariatric Surgery (ASMBS) issued a position statement recommending laparoscopic sleeve gastrectomy (LSG) as an approved primary bariatric procedure [2]. This study was done to assess weight loss outcomes 1 year after LSG as a type of bariatric surgery.

Patients and methods

After ethics committee approval from Assiut University Hospital and obtaining written informed consent, involving 54 male and female patients with age 18 up to 60 years old scheduled to undergo LSG. This study was done from November 2015 to April 2017.

A prospective study plus a retrospective analysis of our prospectively maintained database is carried out to identify all patients with BMI more than or equal to 40 kg/m^2 or BMI more than or equal to 35 kg/m^2 with comorbid conditions who underwent LSG. Data regarding weight loss during first 12 months is assessed.

Inclusion criteria

(1) Age between 18 and 60 years
(2) Both sexes
(3) BMI more than or equal to 40 kg/m^2 or more than or equal to 35 kg/m^2 with comorbid conditions
(4) Obesity lasting more than 5 years
(5) Patients who failed to lose weight or to maintain long-term weight loss despite appropriate nonsurgical medical care
(6) Patient willingness to participate in a postoperative multidisciplinary treatment program.

Exclusion criteria

(1) Age more than 60 or less than 18
(2) BMI less than 35 kg/m^2
(3) Patient suffering from endocrine or psychological disorder.

All relevant preoperative data were reported including age, sex, BMI, presenting symptoms like osteoarthritis, sleep apnea, type 2 diabetes mellitus, hypertension, GERD, heart disease, liver disease, gallbladder disease, asthma, menstrual disturbance, fertility, venous disease, lower limb swelling, and psychiatric complains such as depression.

Investigations

(1) Complete blood count
(2) Liver function tests
(3) Renal function tests
(4) Fasting blood sugar
(5) Total proteins and serum albumin
(6) ECG
(7) Chest radiography
(8) Abdominal ultrasonography.

All diabetic patients or patients with chest troubles were well controlled before the operation. Other patients with organomegaly, ascites, severe cardiac conditions, or severe obstructive air way disorders were excluded from the study.

Abdominal examination focused on; abdominal contour, presence of hernias, visible swelling, divarication of recti, Murphy's sign, and McBurney's sign.

Intraoperative assessment

Intraoperative assessment focused on intraoperative bleeding and its cause (splenic injury, liver injury, and bleeding from stable line), stable line leak, intraoperative lumen narrowing, and conversion to open procedures and its cause.

Postoperative assessment

Postoperative assessment included duration of hospital stay, pulse, blood pressure, temperature, blood glucose level, drain assessment including the nature and amount in 24 h and complication of bed recumbence including DVT and chest infection.

Operative technique: laparoscopic sleeve gastrectomy

The patient is positioned in reverse Trendelenburg to allow for better exposure of the upper abdomen with the arms spread apart and legs abducted. The surgeon stands between the patient's legs, the assistant to the patient's left and the cameraman to the patient's right. Abdominal insufflation is set at 15 mmHg. Trocars are placed as fellows: a 10-mm trocar (T1) 20 cm below the xiphoid process for the 30° optical system, a 5-mm trocar (T2) on the left anterior axillary line, a 12-mm trocar (T3) on the left mid-clavicular line just between the first and the second trocars, a 12-mm trocar (T4) on the right mid-clavicular line, and a 5-mm trocar (T5) below the xiphoid process. The liver is retracted medially using a Nathanson retractor placed in the subxiphoid area.

The stomach is decompressed at the beginning of the operation by placing an orogastric tube. The angle of His is taken down bluntly using the Goldfinger dissector (Ethicon Endo-surgery), exposing the left crus of the diaphragm. Dissection is srarted about 6 cm proximal to pylorus by taking down the gastrocolic ligament using the Harmonic scalpel (Ethicon Endo-surgery). Dissection is carried out proximally toward the short gastric vessels. This releases attachments to the greater curvature of the stomach and gastric fundus. The orogastric tube is then removed and replaced by a 40-Fr bougie placed in the stomach by the anesthesiologist and guided laparoscopically to sit in the lesser curvature of the stomach just distal to pylorus. A 60 mm Endo GIA tri-stapler is then used to divide the stomach. We use two green cartridges initially to divide the distal stomach, starting 6 cm proximal to pylorus. Next, four to six blue cartridges are used to complete the division of the remainder of the stomach. The specimen is taken out of the abdominal cavity through the 15 mm port. The bougie is then removed, patients receive nothing by mouth after surgery for 2 days postoperatively. Anticoagulation (Clexane) is started in the second day postoperatively.

Statistical analysis

Required data were collected and tabulated and then statistically analyzed. Analysis of data was done using IBM SPSS software (Statistical Program for the Social Science, version 20, IBM corporation, Armonk, New York, USA). Data analysis was performed by the usual methods of descriptive statistics frequencies and percentages for discrete variables and average, median, and SDs for continuous variables. The homogeneity of the data between the groups was tested by the χ^2 test for discrete variables and the *t* test for independent data for continuous variables. The results were significant (S) with *P* value less than 0.05 and highly significant (HS) with *P* value less than 0.01. *P* values more than or equal to 0.05 were regarded as nonsignificant (NS).

Results

Demographic characteristics of patients

From November 2015 to April 2017, 54 patients underwent LSG in our unit, comprising 39 (72.2%) women and 15 (27.8%) men, with a mean age of

32.5 ± 10.8 years. Preoperative mean body weight (BW) and BMI were 125.8 ± 21.4 kg and 46.5 ± 7 kg/m^2, respectively. The most common comorbid conditions were type 2 diabetes mellitus (*n* = 4, 7.4%), osteoarthritis (*n* = 4, 7.4%), hypertension (*n* = 3, 5.6%), and obstructive sleep apnea (*n* = 2, 3.7%). The baseline demographic and clinical data are shown in Table 1.

Perioperative data

All of the SG procedures were completed laparoscopically with percentage of conversion to open procedure 0%. Mortality of one case due to postoperative pulmonary embolism occurred in the fourth postoperative day with percentage of 1.8% and the case was excluded from our study. Early complications occurred in two (3.7%) patients, which were resolved by corresponding managements (Table 2).

Weight loss

Weight loss follow up was done at 1, 3, 6, and 12 months.

Table 1 Baseline characteristics of the study group

Characteristics	LSG patients (*n*=54)	
	Mean±SD	Range
Age (years)	32.52±10.81	18.0-60.0
Sex [*n* (%)]		
Male	15 (27.8)	
Female	39 (72.2)	
Initial body weight (kg)	125.80±21.41	92.0-211.0
Initial BMI	46.51±7.02	35-70.50
T2DM points [*n* (%)]	4 (7.4)	
Osteoarthritis [*n* (%)]	4 (7.4)	
Hypertension [*n* (%)]	3 (5.6)	
Obstructive sleep apnea [*n* (%)]	2 (3.7)	

LSG, laparoscopic sleeve gastrectomy; T2DM, type 2 diabetes mellitus.

Table 2 Early complications and treatment

Complications	*n* (%)	Treatment
Leakage (minor)	1 (1.8)	Conservative
Intestinal injury	1 (1.8)	Repair

The weight loss was measured in terms of absolute weight loss (kg), change in BMI and percentage of excess weight loss (%EWL) (Table 3).

Body weight

After LSG, the mean BW significantly declined to 116.78 ± 20.83 kg at 1 month, 103.26 ± 18.47 kg at 3 months, 90.65 ± 16.23 kg at 6 months, and 79.33 ± 14.89 kg with weight loss of 36.9% of initial weight at 1 year, which were all significantly lower than the preoperative value (*P* = 0.00, Fig. 1).

BMI

Postoperative BMI was 43.3 ± 6.7 kg/m^2 at 1 month, 38.3 ± 6 kg/m^2 after 3 months, 33.7 ± 5.3 kg/m^2 after 6 months, and 29.5 ± 5 kg/m^2 after 1 year. There was significant difference between preoperative and postoperative values (*P* = 0.00, Fig. 2).

Percentage of excess weight loss

The %EWL gradually increased from 13.9 ± 6 at 1 month to 34.5 ± 8.8 at 3 months, 53.4 ± 12.6 at 6 months, and 70.6 ± 14.8 at 1 year (Fig. 3). The proportion of patients having successful weight loss (%EWL < 50%) were 92.6% (*n* = 50).

(1) It is also noted that the mean value of %EWL in the first 6 months was 53.37 (75.6% EWL), while in the second 6 months was 17.21 (24.4% EWL).

Evaluating factors that may affect weight loss

Sex

The mean value of %EWL in male group after 1 year was 74.84 ± 16.48, whereas in female group was 68.94 ± 14.00. There was no significant difference between both groups with *P* = 0.293 (Table 4).

Table 3 Weight loss measures for 1 year after laparoscopic sleeve gastrectomy

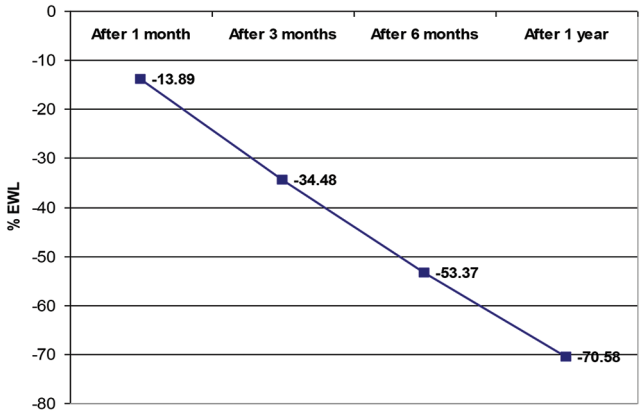
	Baseline	After 1 month	After 3 months	After 6 months	After 1 year
Body weight (kg)					
Mean±SD	125.80±21.41	116.78±20.83	103.26±18.47	90.65±16.23	79.33±14.89
Range	92.0-211.0	82.0-200.0	75.0-180.0	62.0-164.0	53.0-146.0
P		0.000*	0.000*	0.000*	0.000*
BMI (kg/m^2)					
Mean±SD	46.51±7.02	43.34±6.71	38.34±6.03	33.66±5.27	29.46±4.96
Range	34.6-70.5	32.6-66.8	27.9-60.1	24.3-54.8	20.7-48.8
P		0.000*	0.000*	0.000*	0.000*
%EWL					
Mean±SD	-	13.89±6.09	34.48±8.84	53.37±12.58	70.58±14.81
Range	-	–8.6 to 40.0	15.1-64.0	19.4-87.7	32.3-111.2
P		0.000*	0.000*	0.000*	0.000*

%EWL, percentage of excess weight loss. *The results were significant (S) with P<0.05 and highly significant (HS) with P <0.01. P ≥ 0.05 values were regarded as non-significant (NS).

Age

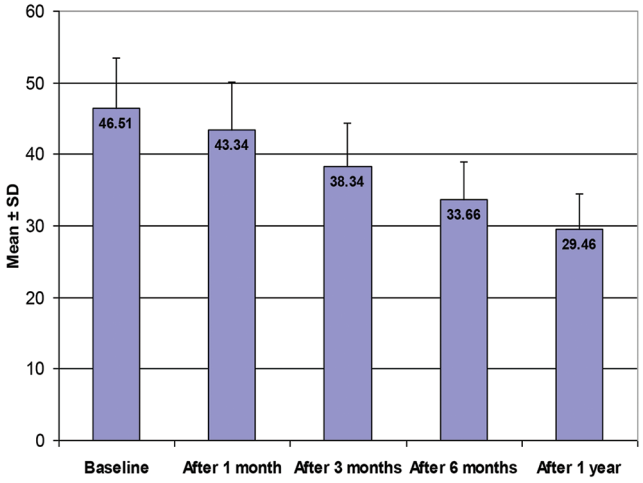
The mean value of %EWL in group A with age less than 40 after 1 year was 71.62 ± 12.90, whereas in group B with age more than or equal to 40 was 66.54 ± 20.99. There was no significant difference between both groups with $P = 0.637$ (Table 5).

Figure 1



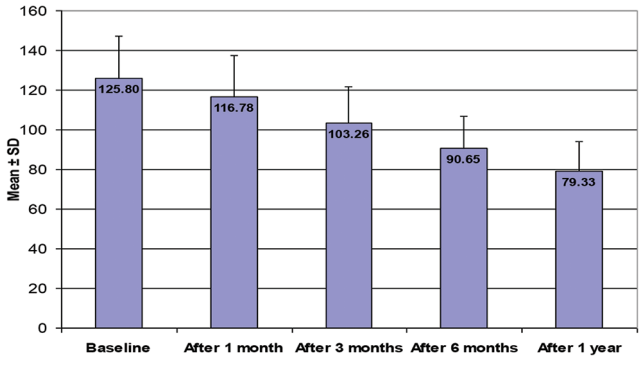
Total weight loss during first year after LSG. LSG, laparoscopic sleeve gastrectomy.

Figure 2



Change in BMI with time after LSG. LSG, laparoscopic sleeve gastrectomy.

Figure 3



Percentage of excess weight loss in 1 year after LSG. LSG, laparoscopic sleeve gastrectomy.

BMI

The mean value of %EWL in group A with BMI less than 40 after 1 year was 76.52 ± 24.04, whereas in group B with BMI more than or equal to 40 was 69.39 ± 12.26. There was no significant difference between both groups with $P = 0.260$ (Table 6).

Diabetes mellitus

The mean value of %EWL in nondiabetic group after 1 year was 70.19 ± 13.57, whereas in diabetic group was 75.44 ± 28.84. There was no significant difference between both groups with $P = 0.209$ (Table 7).

Discussion

LSG has evolved as a standalone bariatric procedure over the last 9 years. Several recent publications have documented significant weight loss in the period under study [3]. These publications suffer, to some extent, from a lack of standardization. The bougie size varies considerably between surgeons from 32 to 60 Fr. The antrum has been spared in some papers and removed in others. Undoubtedly some surgeons stapling flush with the bougie at the esophagogastric junction while other are leaving a larger cuff of tissue here. Whether the greater curve is being held out under retraction while stapling up to the bougie will probably cause a significant difference in pouch size.

The outcomes reported in this study are based on standardized variables for all the 54 patients in the

Table 4 Percentage of excess weight loss according to sex

%EWL	Sex (mean±SD)		*P*
	Male (*n*=15)	Female (*n*=39)	
After 1 year	74.84±16.48	68.94±14.00	0.293

%EWL, percentage of excess weight loss.

Table 5 Percentage of excess weight loss according to age

%EWL	Age (years) (mean±SD)		*P*
	Group A <40 (*n*=43)	Group B ≥40 (*n*=11)	
After 1 year	71.62±12.90	66.54±20.99	0.637

%EWL, percentage of excess weight loss.

Table 6 Percentage of excess weight loss according to BMI

%EWL	Group A BMI <40 (*n*=9) (mean±SD)	Group B BMI ≥40 (*n*=45) (mean±SD)	*P*
After 1 year	76.52±24.04	69.39±12.26	0.260

%EWL, percentage of excess weight loss.

Table 7 Percentage of excess weight loss according to diabetes mellitus

%EWL	DM (mean±SD)		*P*
	Non-diabetic (*n*=50)	Diabetic (*n*=4)	
After 1 year	70.19±13.57	75.44±28.84	0.209

%EWL, percentage of excess weight loss; DM, diabetes mellitus.

series. All cases were performed with a 40 Fr bougie by a single surgeon, with preservation of the last 5 cm of antrum and a small cuff of gastric tissue of less than 1 cm in size at the esophagogastric junction. The results of this study underlined that the LSG is an effective procedure in reducing weight. With regard to operating time and convalescence it is a feasible technique.

Our study included 54 patients suffering from morbid obesity. They underwent LSG:

(1) The baseline characteristics for our study group were comparable with the results published in other centers, with slight longer duration of follow up
(2) Rates of complications have varied significantly between authors with gastric leak being the complication of greatest concern. In this series of 54 patients reported in this study, there was one case of gastric leak which was managed conservatively. The early complications in our series included gastric leak and intestinal injury which occurred in two (3.7%) patients and this percentage agrees with published papers focused on early complications. Frezza *et al.* [4] reported that early complications (leak and hemorrhage) were 5.6% of 53 patients underwent LSG
(3) All of the SG procedures were completed laparoscopically with 0% conversion to open procedure. Our results agrees with Vuolo *et al.* [5]
(4) Our patients were subjected to preliminary follow-up data. The prospective collection of data allowed a careful evaluation of time-related results. Our study showed a deep decrease in BMI and %EWL just in the first 3 months after surgery, which continued progressively until 12 months as follows:
    (a) After 1 year of LSG, the mean BW significantly declined from 125.8 ± 21.4 kg preoperatively to 79.3 ± 14.9 kg with weight loss of 36.9% of initial weight. With *P* value 0.00 which was highly significant. Wang and colleagues reported decline in the mean BW from 121.4 ± 27.2 to 80.8 ± 11.3 kg with weight loss of 34.4% at 1 year and this was similar to our results
    (b) The mean BMI preoperatively was 46.5 ± 7.02 kg/m^2 which also declined to 29.46 ± 4.96 kg/m^2 after 1 year with *P* value 0.00 which is highly significant. And this is also matched with Wang *et al.* [6] who reported mean BMI loss from 40.8 ± 5.9 to 27.9 ± 3.3 kg/m^2 at 1 year
    (c) The %EWL after 1 year was 70.6 ± 14.8%. Looking at similar short-term follow-up studies, we found that our results agree with the wide range observed. Thus, %EWLs between 64.3% (*n* = 111) and 86% (*n* = 75) were reported 1 year after LSG [7,8].

This is also matched by Noun that stated that:

Ninety percent of weight loss occurred at 6 months and then stabilized after postoperative month 12 at an EWL value of 76%. The mean preoperative BMI decreased to 24.7 ± 2 at 12 months. At that time the mean percentage of weight loss was 25.3% of the initial weight. Substantial weight loss occurred in most patients with 96.8% achieving the 50% EWL at 1 year [9].

Comparison between our study and Noun and Wang and colleagues studies is summarized in Table 8.

Our study showed that there is no difference in weight losses among groups according to their BMI. We divided our patients into high and low BMI groups using 40 kg/m^2 as the threshold. The %EWL in the group with BMI less than 40 kg/m^2 was 76.52 ± 24.04 versus 69.39 ± 12.26 in group with BMI more than or equal to 40 kg/m^2 (*P* = 0.260), and this is not matched by Boza *et al.* [10] who found that the patients with a preoperative BMI more than 40 kg/m^2 achieved significant lower %EWL in comparison with the patients with BMI less than 40 kg/m^2 (50.2 vs. 72.7%) at 5 years. Also, Wang *et al.* [6] found that patients with a BMI less than 40 kg/m^2 could achieve significant weight loss from LSG compared with patients with a BMI more than or equal to 40 kg/m^2 (%EWL, 83.9 ± 17.6 vs. 74.1 ± 15.2 at 1 year). This may be explained by the following reasons:

(1) The high BMI group had a significant reduction in weight but did not get as close to their ideal weight as the low BMI patients [11]
(2) The %EWL may be affected by baseline weight than percentage of TWL [12].

Although our result is statistically insignificant it is apparently resembles other studies, and insignificance may be due to less number of cases included in group with BMI less than 40 kg/m^2 (*n* = 9).

Table 8 Comparison between results of our study and other studies

Parameters	Our study	Wang *et al.* [6]	Noun [9]
Number of cases	54	70	122
% of initial weight loss after 1 year	36.9	34.4	25.3
%EWL after 1 year	70.6	77.1	76
Decrease in BMI after 1 year	17.04±2.06	12.9±2.6	8.5±2.0
% of success rate with % of EWL >50 after 1 year	92.6	89.8	96.8

%EWL, percentage of excess weight loss.

Different authors investigated the correlation between age and weight loss after bariatric surgery. Aslaner *et al.* [13] showed that younger patients lost a greater amount of excess BMI than older ones. A recent report by Perrone and colleagues focused on the influence of sex on weight loss. He demonstrated as LSG was more effective in obese male than in obese female patients in terms of weight loss [14]. These results match our results regarding age and sex as we found that weight loss is higher in males than female patients and younger than older ones.

It has been reported that LSG has a lower complication rate than other bariatric surgeries [15]. In line with these studies [16], we observed early complications in two (3.7%) patients during follow up in this study. Most complications were mild and were relieved with conservative therapy. Taken together, our report added objective evidence in support that LSG is an effective and safe surgical procedure in morbid obese patient.

There are several limitations to our study. The first limitation of this work is the small number of patients. Also, the small number of patients with a lower BMI (35–40 kg/m^2) is attributed to the fact that the indication for operation was strictly controlled and most patients have not accepted surgical treatment of metabolic diseases. Consequently, we also cannot compare the difference between LSG and other surgical procedures. Second, the short-tem follow up did not allow evaluating late complications and weight regain. Finally, we cannot rule out the influence on the effect of diet for weight loss because the differences in dietary habits of patients.

Conclusion

Although, initially developed as part of a complex bariatric procedure, SG has actually become a popular primary treatment for bariatric surgery with minimal complications. We believe SG is a simple and efficacious bariatric procedure that should be among the choices when surgeons discuss bariatric procedures with patients, in particular high-risk patients. LSG is a low-risk procedure that can significantly reduce the BMI, with near 70% EWL with success rate about 92% after 1 year.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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