Outcomes of Sleeve Gastrectomy in Obese Patients: A Retrospective Study

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ABSTRACT:
Background: Morbid obesity has become a serious health problem due to its fatal consequences and co-morbidities. It is well-accepted that obesity-related comorbidities may be effectively managed by bariatric surgery**.**
Objective: The aim of the current study is to assess the outcomes of laparoscopic sleeve gastrectomy (LSG) in morbidly obese patients, regarding weight loss, effects on associated comorbidities and post-operative complications.
Patients and methods: Our retrospective cohort study was conducted in Sohag University Hospitals. A total of 60 patients who underwent LSG were followed up in the period from January 2017 to May 2018. Participants were patients with BMI ≥40 or BMI = 35–39 with one or more obesity-related co-morbidities. **Results:** Statistically significant weight reduction occurred at 3, 6, 12, 18 and 24 months after LSG. Regarding the comorbidities, we found that 12 cases had diabetes (4 cases improved and 8 reached remission). The mean HbA1c was within the prediabetic or the controlled diabetic zone for the vast majority of cases, and 6 cases had Hypertension, improvement occurred in 5 cases and one case reached remission. All cases that had dyslipidemia in the study population (5 cases) were completely controlled.
Conclusion: LSG can be considered an effective single-stage procedure in morbidly obese patients showing excellent and reliable results for weight loss in obese patients with a significantly low complication rate. This procedure could significantly resolve obesity-related morbidity.
Keywords: Morbid obesity, Bariatric surgery, Sleeve gastrectomy, Excess weight loss, Cohort study, Sohag University.

INTRODUCTION

The last 30 years have brought a dramatic increase in the obesity epidemic worldwide and continues to grow [1]. 'obese-obesity' is derived from Latin, where the verb 'obedere' means 'eat too much' and the noun 'obese' refers to obesity [2] .

Obesity is defined as an excess of body fat that might have a negative impact on an individual's health. Body mass index (BMI) is often used as a proxy for the percentage of fat mass in the diagnosis of obesity. A person's BMI is based on their weight in kilograms divided by their square height in metres (kg/m2). people with BMI ≥ 30.0 kg/m² are considered obese. Obesity is further categorized into three classes: class I (Moderately obese) for BMI of 30.0 to 34.9 kg/m², class II (severely obese) for BMI of 35.0 to 39.9 kg/m², and BMI ≥ 40.0 kg/m² is class III (morbidly obese) [3].

Obesity is the outcome of a complex interplay of environmental, social, and biological variables [3]. Recent estimates suggest a huge jump in rates of childhood obesity. Over 40% of 10-11 year olds were overweight or obese in 2020-21 compared with 35.2% the year before [4].

To name just a few of the debilitating and often fatal consequences of being overweight or obese: hypertension, diabetes, osteoarthritis, strokes, non-alcoholic fatty liver disease, dyslipidemia, and even cancer [5]. It is well-accepted that comorbidities like type 2 diabetes and asthma may be effectively managed by bariatric surgery [6].

Dietary and physical activity changes as well as behavioral changes should be part of a complete lifestyle management programme to treat obesity [7]. Bariatric surgery is the only treatment that improves or eliminates obesity-related problems over time while simultaneously increasing survival. Malabsorptive, restrictive, and combination malabsorptive/restrictive procedures are all types of surgical procedures used to manage obesity [8].

Bariatric surgery grew by more than 400% between 1998 and 2002. Laparoscopic surgery is linked with a lower rate of problems and a shorter hospital stay than open surgery, which is why the frequency of laparoscopic surgeries has increased in recent years [9].

Patients with BMI over 40 kg/m2 or BMI over 35 kg/m2 with obesity-related diseases and age 18-60 years who have failed to respond to conservative therapy might consider bariatric surgery [10]. also the International Diabetes Federation advocates bariatric surgery for individuals with uncontrolled T2DM, even if their BMI is between 30 and 35 kg/m2 [10] . The laparoscopic sleeve gastrectomy (LSG) is the most frequent bariatric treatment done today, accounting for 54% of all global bariatric surgeries in 2016 [11].

The aim of the current study is to assess the outcomes of laparoscopic sleeve gastrectomy (LSG) in morbidly obese patients, regarding weight loss, effects on associated comorbidities and post-operative complications.

PATIENTS AND METHODS

Study Design: A retrospective cohort study was conducted on patients who were subjected to "laparoscopic sleeve gastrectomy" at Sohag University Hospitals in the period from January 2017 to May 2018.
Study Population: This study included 60 morbidly obese patients who fulfilled the following criteria:
Inclusion criteria: 1) Age from 18 to 65 years old; 2) Preoperative BMI ≥ 35 kg/m^2 with comorbidities such

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as (type 2 diabetes mellitus, hypertension, hyperlipidemia, severe osteoarthritis, obstructive sleep apnea, /obesity-induced cardiomyopathy, polycystic ovary syndrome) or BMI ≥ 40 kg/m^2, with failure of non-operative attempts to lose weight; 3) Minimum 2-year follow-up at our outpatient clinic.

Exclusion criteria: 1) Obesity's secondary causes (e.g. endocrine diseases); 2) Patients who are unable to follow up with their doctors; 3) Associated comorbidities or disorders that influence weight loss (e.g. malignancy).

Data were collected from the clinical records of the follow-up visits in our outpatient clinics and/or through follow-up phone calls.

All patients were subjected to the following:

Complete history taking:

Personal history including:

- Demographic data: age, sex, marital status.
- Feeding history and if the patient likes sweets much or less.
- Duration of obesity.
- History of previous trials of weight loss; medical, dietary or surgical.

Medical history: For comorbidities like DM (either type 1 or 2), hypertension or dyslipidemia.

Family history:

- Hypertension and or DM.
- Cardiac and respiratory diseases.
- Sleep symptoms.
- Obesity.

Past history:

- Previous DVT.
- Any other morbidity.
- Past surgical history.

Complete physical examination:

Measurement of weight per Kg, height per meter then calculation of BMI = (weight Kg/height m^2)

Abdominal examination for:

- Scars of past surgeries.
- Hernia orifices.
- Organomegaly and abdominal tenderness especially right hypochondrial.

Cardiac and pulmonary evaluation.

Medical consultation for assessment of surgical fitness and appropriate control of DM and hypertension.

Investigations:

Laboratory investigation:

Complete blood count, creatinine, liver function test, fasting blood glucose, thyroid function tests, lipid Profile (2 hours postprandial blood sugar, HbA1c in diabetic patients).

Other investigation:

Abdominal ultrasound (US), echocardiography (Echo), pulmonary function test if needed

Operative procedure

The patient was positioned in the reverse Trendelenburg position; splitting his legs (the French position) and abducted arms.

CO2 insufflation was done using a Verres needle located in the left subcostal region at the midclavicular line.

Five ports were implanted:

A 5-12-mm port was set under direct vision around 15 cm below the xiphoid and 3 cm left to the midline.

A 30-degree angled laparoscope was placed through the port into the peritoneal cavity and a 5-12-mm port was placed in the left lateral flank was placed at the level of the left midclavicular line with the patient positioned in the supine position and at the same level as the periumbilical port (right hand of the surgeon).

Then, a 5-mm trocar port was placed along the left subcostal margin between the xiphoid process and the left flank port in the left anterior axillary line (grasper of the assistant).

Another 12-15-mm port was placed in the right upper quadrant region at the midclavicular line and a 5 mm port was placed in the mid-epigastric region for retraction of the left liver lobe (left hand of the surgeon).

Thereafter, the pylorus of the stomach was identified and the greater curve of the stomach is elevated. A laparoscopic harmonic® scalpel (or Ligasure®) is then used to enter the lesser sac via division of the greater omentum (**Figure 1**). The greater curvature of the stomach is then dissected free from the omentum starting 2-4 cm from the pylorus and proceeds to the short gastric blood vessels (**Figure 2**).

A good exposure of the hiatus was done for optimum sleeve creation in order to effectively evaluate the hiatus for accidental hiatal hernia and full dissection the left crus to avoid retained fundus. The left gastro-phrenic ligament was separated to expose the angle of Hiss .

A 36 French bougie was used as a template to achieve the vertical sleeve gastrectomy commencing 2-4 cm proximal to the pylorus and extending to the angle of Hiss by a 60-mm stapler along, guided by the bougie,

The first used stapler was a green cartridge (due to more thick antral stomach) and the remaining staplers are blue cartridges staplers (**Figure 3**).

Before shooting, inspection was done for the posterior wall. Because the stomach is anchored medially but free laterally, lateral retraction was performed with mild gripping only to ensure equal traction on the anterior and posterior walls. Then vertical gastric pouch was totally separated from the small tubular (sleeve-like) stomach pouch.

The staple line along the remaining stomach was then tested for any leak through the methylene blue test. The staple line was reinforced by oversewing using absorbable sutures (**Figure 4**).

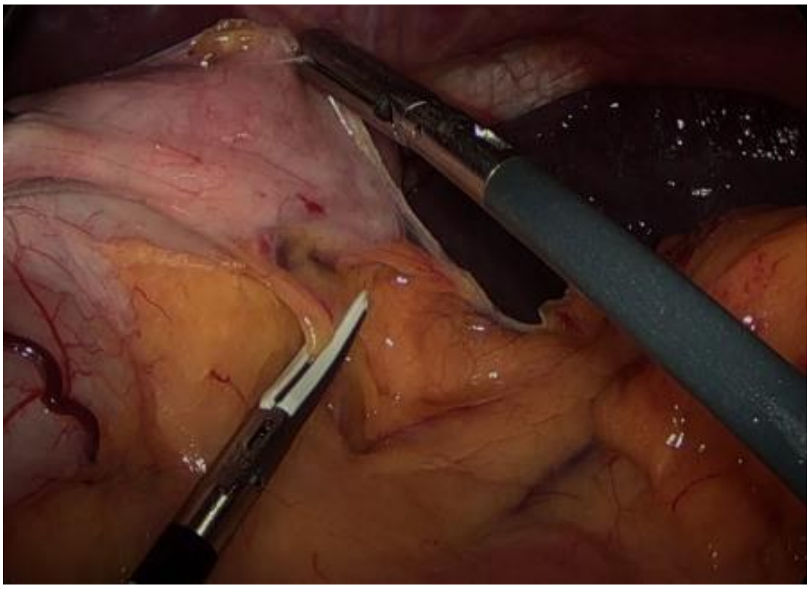


Figure (1): Greater omentum opened close to the stomach wall.

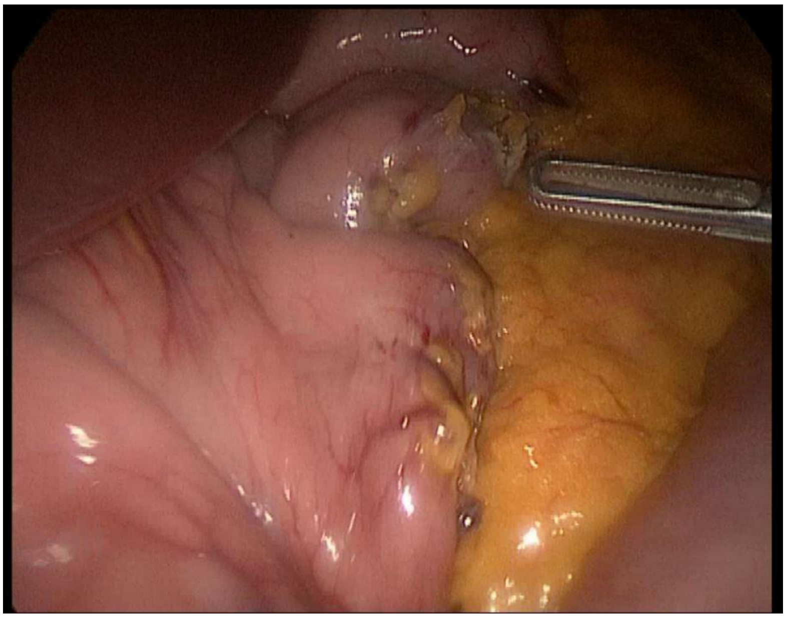
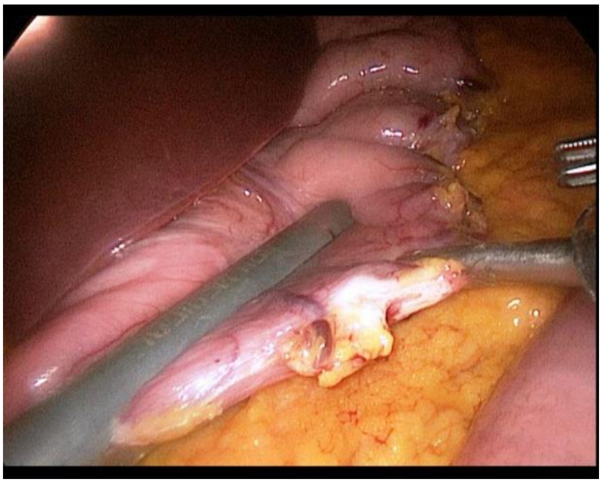
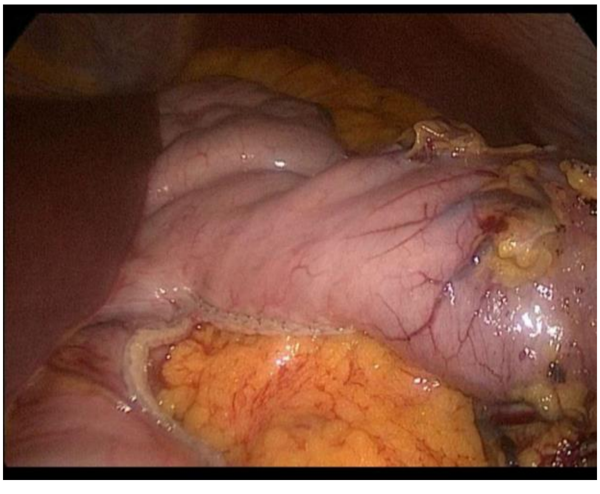


Figure (2): Greater omentum completely detached from the greater curvature.





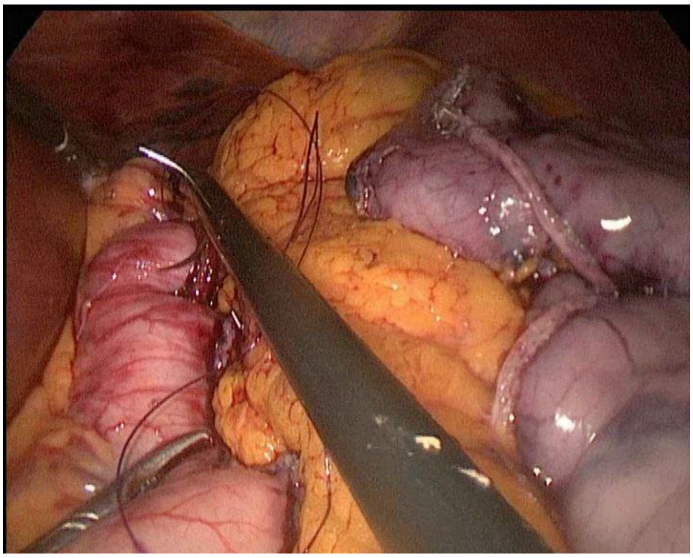


Figure (3): begin stapling from the antrum.

Figure (4): Over-sewing of staple line with absorbable suture

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Assessment of outcomes

Effects on weight

Weight loss was reported as percentage of excess weight loss (%EWL).

$$\%EWL = \frac{(pre\ operative\ weight - follow\ up\ weight)}{(\text{pre operative weight} - \text{ideal weight})} \times 100\%$$

Ideal weight is the weight corresponding to BMI of 25

Other method for reporting weight loss results include total absolute weight loss (TWL).

$$TWL = \frac{(pre\ operative\ weight - follow\ up\ weight)}{pre\ operative\ weight} \times 100\ \%$$

Effects on co-morbidities

- Hypertension is defined as either systolic blood pressure (SBP) of 140 mmHg or more and/or diastolic blood pressure (DBP) of 90 mmHg or more. Control or failure of control of hypertension on drug therapy.
- Diabetes mellitus type 2 (T2DM) is defined as fasting blood glucose $\geq$ 126 mg/dL or 2-hour postprandial blood glucose of $\geq$ 200 mg/dL. The success of control of DM on the antidiabetic drug with or without insulin therapy.
- Dyslipidemia: fasting high-density lipoprotein <40 mg/dL for men, <50 mg/dL for women, triglycerides>150 mg/dL and/or low-density lipoprotein >100 mg/dL.

In hypertension and dyslipidemia the following definitions were applied:

Remission: Defined as lack of symptoms and discontinuation of treatment.

Improved: Reduction in treatment.

Unchanged: No difference to baseline.

Worsened: New treatment necessary or treatment intensified.

New onset: Disease diagnosed postoperatively.

The remission of T2DM was defined according to the American Diabetes Association criteria for complete remission with HbA1c <6.0%, fasting glucose <100 mg/dL, and at least 1 year's duration in the absence of active pharmacologic therapy or ongoing procedures.

Postoperative complications

* Biliary complications: Cholecystitis, pancreatitis and CBD stones.

* Gastroesophageal reflux.

* Incisional hernia.

Ethical Consideration

This study was ethically approved by the Institutional Review Board of Sohag University

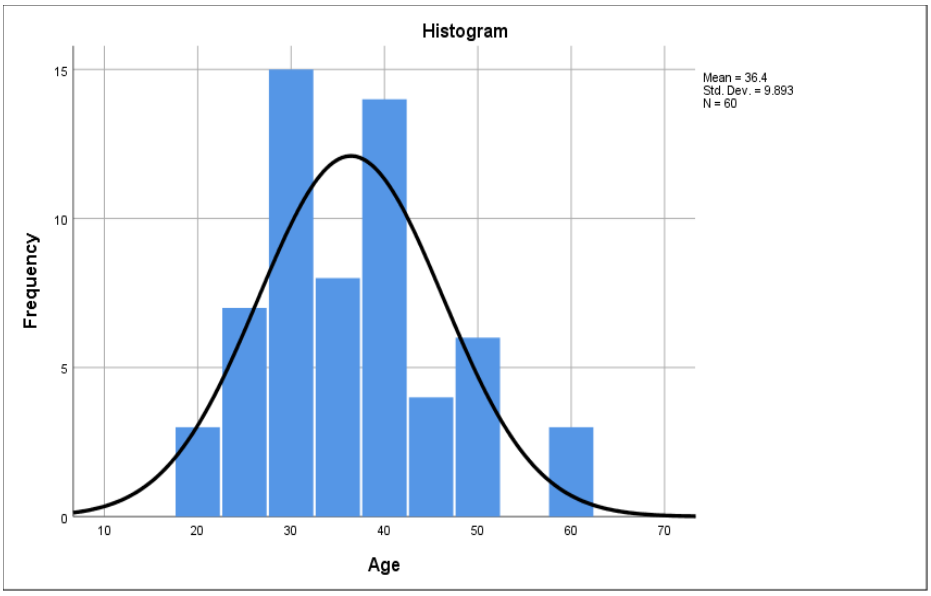
Hospital (Soh-med-21-07-13). An informed consent was obtained from each participant after receiving an explanation of the study protocol. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical Analysis:

Statistical Package for Social Sciences (IBM-SPSS), version 25 (IBM-Corporation, Chicago, USA; August 2017) was used for statistical data analysis. Data were expressed as mean, standard deviation (SD), number and percentage. Mean and standard deviation were used as a descriptive value for quantitative data. Paired t-test was used to compare the means of the same variable at different periods (including weight, EWL, TWL and BMI). The level of significance (P-value) was explained as: No significance P >0.05, significance P $\leq$0.05, and high significance P $\leq$0.001.

RESULTS

Out of 60 patients included in the current study, male participants were 20 (33.33%), while female participants were 40 (66.67%). The mean age was 36.4 (SD 9.9) years, while the median age was 35.5 years; range from 20 to 60 years (**Figure 5**).



Preoperative weight ranged from 104 to 183 kilograms (mean 134.1 ± 13.17 Kg) .Preoperative height ranged from 146 to 182cm (mean 167.52± 6.19 cm). Preoperative BMI ranged from 40 to 60.8 (mean 47.87 ± 4.88). All of the cases were in the morbid obese zone preoperatively (**Figure 6**).

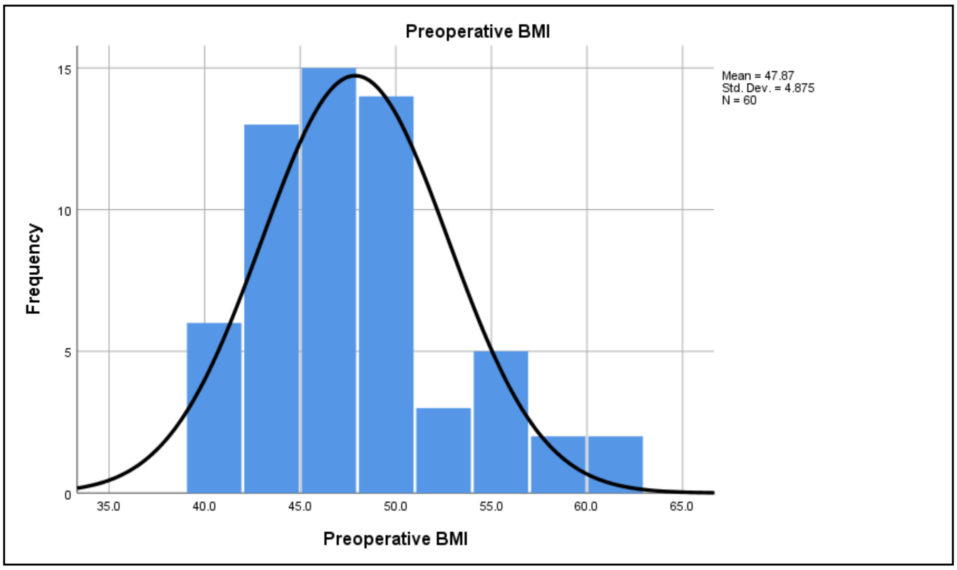


Figure (6): Preoperative BMI.

Table 1 shows that the mean weight of the study population decreased steadily from 134.1 (SD 13.2) Kg preoperatively, to 89.6 (SD 8.4) after 18 months postoperatively, with a slight increase of the weight at 24 months to reach 91.6 (SD 9.4) Kg.

Table (1): Weight changes postoperatively.

Variable	Mean	SD	P value (compared to the baseline)
Preoperative Weight	134.10	13.17	-
3 month	120.22	13.41	<0.001 (HS)
6 month	104.68	11.90	<0.001 (HS)
12 month	91.53	8.71	<0.001 (HS)
18 month	89.60	8.44	<0.001 (HS)
24 month	91.55	9.36	<0.001 (HS)

Percentage of excess weight loss (EWL%): The mean EWL of the study population increased steadily from 22.4% (SD 8) at 3 months postoperatively to 70.2% (SD 8.8) at 18 months, then decreased again to 66.9% (SD 11.2) % at 24 months (**Figure 7**).

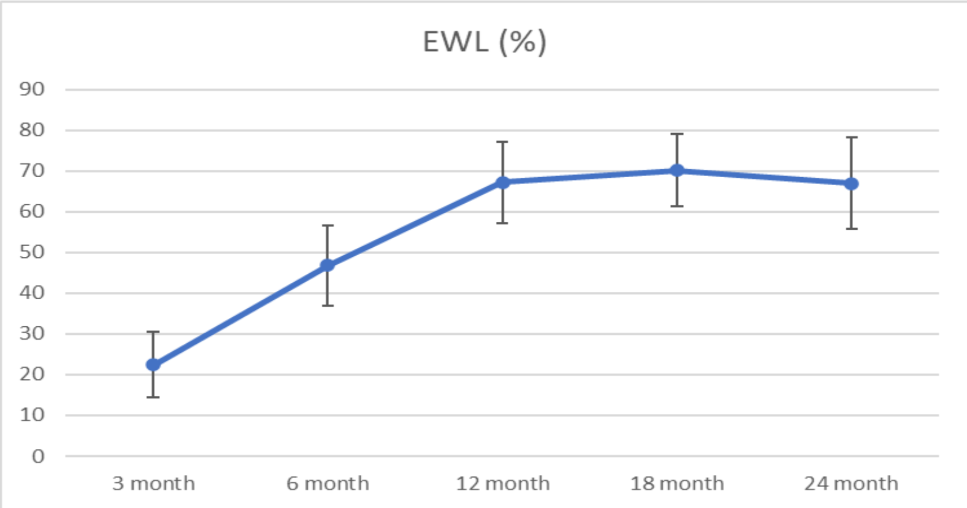


Figure (7): Percentage of excess weight loss.

Total absolute weight loss (TWL): The mean TWL of the study population increased steadily from 10.4% (SD 3.3) at 3 months postoperatively to 33% (SD 4.5) at 18 months, thereafter decreased again to 31.5% (SD 5.6) at 24 months (**Figure 8**).

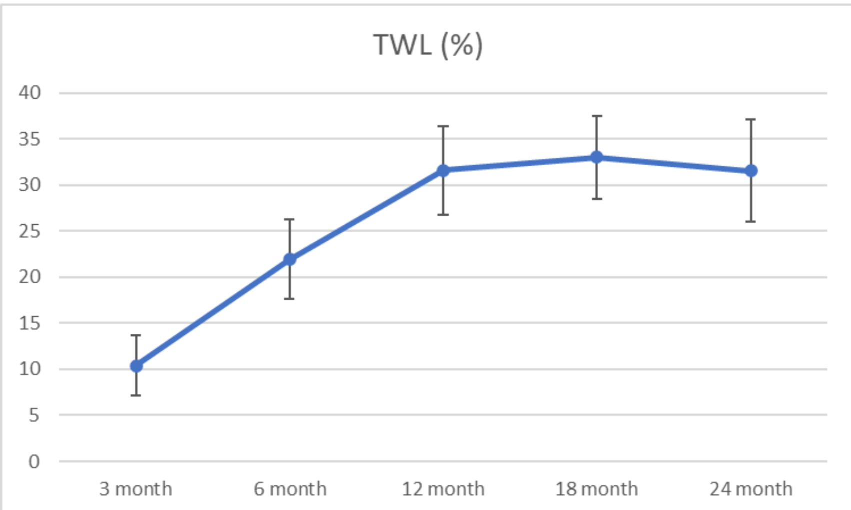


Figure (8): Total absolute weight loss.

Table 2 shows that the mean BMI of the study population decreased rapidly in the first year, as it decreased by around 10 within the first 6 months and by 5 more after 12 months (to reach around 32.7±3.2). However, this speed decreased so much in the following 6 months, reaching 32 (SD 2.9) at 18 months, and then the BMI increased slightly within the last 6 months of the study duration to reach 32.7 (SD 3.3) at 24 months postoperatively.

Table (2): Postoperative BMI.

Variable	Mean	Std. Deviation	P value compared to the baseline
Preoperative BMI	47.87	4.88	-
3 month	42.92	4.96	<0.001 (HS)
6 month	37.36	4.25	<0.001 (HS)
12 month	32.67	3.24	<0.001 (HS)
18 month	31.97	2.94	<0.001 (HS)
24 month	32.67	3.33	<0.001 (HS)

Regarding the comorbidities, we found that 12 cases had diabetes (4 cases improved and 8 reached remission). The mean HbA1c was within the prediabetic or the controlled diabetic zone for the vast majority of cases. And 6 cases had Hypertension, improvement occurred in 5 cases and one case reached remission. All cases that had dyslipidemia in the study population (5 cases) were completely controlled (Table 3).

Table (3): Effects on associated comorbidities.

Variable		No	Percent
DM	Improved	4	33.33%
	Remission	8	66.67%
HbA1c	Mean±SD	6.11±0.78	
Hypertension	Improved	5	83.33%
	Remission	1	16.67%
Dyslipidemia	Remission	5	100%

As regards the complications of the operation, the most common was gallbladder stones (seen in 13 cases; 22%) most of them were females (11 cases; 18.33%), followed by GERD (9 cases; 15%), then hernia (7 cases; 12%), common bile duct stone (2 cases; 3.3%) and lastly significant weight regain and joint pain (one case each; 1.7%) (**Figure 9**).

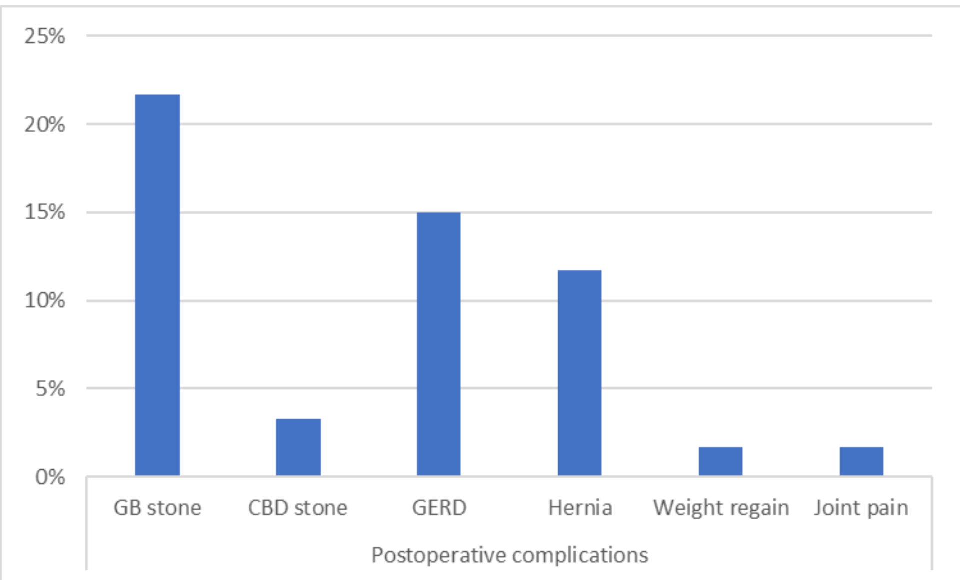


Figure (9): Post-operative complications.

DISCUSSION

Obesity is described as an excess of body fat that might negatively impact an individual's health [3]. Obesity treatment begins with a change in the individual's lifestyle (including dietary changes, increased physical activity, and behavioral adjustments) [5].

For long-term improvement or resolution of obesity-related comorbidities and improved survival, only bariatric surgery is an option. It's a great deal less expensive than other options [8].

With its increasing popularity, laparoscopic sleeve gastrectomy (LSG) has risen to the top of the list of bariatric procedures done globally [11].

It was first created as a first-step technique for extremely obese patients (BMI >50) to decrease surgery-associated morbidity and death, but it has since evolved into a procedure of its own. In morbidly obese individuals, LSG is becoming increasingly common as a single-stage treatment since the weight reduction outcomes are better than predicted. The American Society for Metabolic and Bariatric Surgery (ASMBS) authorized LSG as the main bariatric treatment in 2009, making it available to patients nationwide [11].

In this retrospective study, we reviewed outcomes of sleeve gastrectomy in obese patients (BMI ≥ 35 kg/m2 with comorbidities or BMI ≥ 40 kg/m2) over a period of 2 years follow-up, as regard post-operative weight loss, late post-operative complication and effect on associated co-morbidities. The data were collected from clinical records of follow-up visits in our outpatient clinic and through follow-up phone calls.

In our study, 60 patients were included with a mean age of 36.4 years most of them were females (66.67%). In agreement with **Gentileschi et al.** study [12], whose study was on 50 patients, 60% of them were females with a mean age of 43.7 years.

While in ***Salminen et al.*** study [13], the study was on 121 patients, 71.9% of them were females with a mean age of 48 years and in ***Peterli et al***. study [14] 107 patients were included 72% of them were females with mean age 43 years.

In our study pre-operative weight range from 104-183 kg, mean of 134.1 kg and height range from 146-182 cm, mean of 167.52 cm. The BMI was 47.87.

In comparison with ***Salminen et al.*** study [13], BMI was 45.5 and in ***Peterli et al.*** study [15] the BMI was 43.6.

The percentage of excess weight loss (%EWL) is one of the most accepted criteria for bariatric surgery success [16].

In our study, the %EWL (2 years post-operative) was 66.9%. the maximum %EWL occur after 18 months postoperative reaching 70.2%. The %EWL cutoff ≥50% has been proven to be a specific and sensitive criterion for bariatric surgery success [16].

Other methods used in the literature for reporting weight loss results include total absolute weight loss (TWL) [16].

In our study, TWL (2 years post-operative) reach 31.5% and the maximum TWL which is 33% occur 18 months post-operative.

In agreement with ***Peterli et al.*** study [14] that reports the mean %EWL 2 years postoperative 71.9% and the maximum occurs 1 year post-operative reaching 72.4%. but there is a difference in comparison with the results of ***Salminen et al.*** study [13] that report %EWL 2 years post-operative was 49%. while in ***Gentileschi et al.*** study [12] mean %EWL was 95% 36 months post-operative.

As regards the complications, in our study the most common was gallbladder stones 22% most of them were females (11 cases) in 4 cases cholecystectomy done, followed by GERD 15%, then incisional hernia 12%, in 2 cases hernioplasty done, common bile duct stone 3.3% and weight regain in 1.7%.

In comparison with ***Peterli et al.*** 2017 study [14], the most common complication was GERD (19.4%) then gallbladder stones (3.7%), hernia occurred in 1 % and weight regain 2%. reintervention operation was done in all cases that developed gallbladder stones and 4 cases converted to RYGB 2 of them due to severe GERD and others were due to weight regain.

While in ***Peterli et al.,*** 2018 study [15], the most common complication was GERD in 18% of cases half of them converted to RYGB, weight regain in 4.6% and hernia occurred in 1% of cases. Also, in ***Salminen et al.*** study [13], GERD was the most common complication 14.9% then hernia 2.5%.

As regards DM, in our study 20% of cases were diabetic, 2 years postoperative remission was 66.67% and improvement of glycemic control occurred in 33.33% of cases. That match with ***Peterli et al***., 2018 study [13] DM remission was 61.5%, improvement in 23.1% and the condition remained the same in 15.38% 5 years follow-up. Also in ***Peterli et al.***, 2017 study [14], remission was 60%, improvement in 35% and the condition remained the same in 5% in 3 years follow-up. However, more promising results were reported in ***Gentileschi et al.*** study [12] that remission reach 83.3%, 4 years post-operative.

As regard HTN, in our study 10% of cases (n=6) were hypertensive, remission occur in one case (16.67%) and improvement in 5 cases (83.33%).

In comparison with ***Gentileschi et al.*** study [12], remission was 61.9% 4 years post-operative. also in ***Peterli et al.*** study [15], remission was 64%, 5 years post-operative. These unanticipated results in our study may contribute to variations in sample size and duration of follow-up.

As regards dyslipidemia, in our study 8.3% of cases had dyslipidemia, remission occurred in all of them 2 years post-operative. But this result, therefore, needs to be interpreted with caution. As, in comparison with ***Peterli et al.*** study [14], 67% of the study population had dyslipidemia, remission was 43.8%, improvement was 35.4% and the condition remains the same in 20.8% after 3 years of follow-up.

The potential limitation of this study is the retrospective nature of it and this might have introduced some bias in our findings, however, despite this limitation, the study has provided local data that can help healthcare providers in the management of morbidly obese patients.

CONCLUSION

LSG can be considered an effective single-stage procedure in morbidly obese patients showing excellent and reliable results for weight loss in obese patients with a significantly low complication rate. This procedure can significantly resolve obesity-related morbidity. Further studies are required to confirm the impact of LSG on obese patients with long-term follow-up, as regards consistence of weight loss and comorbidity resolution.

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