Short-term effect of laparoscopic sleeve gastrectomy on hyperlipidemic obese patients

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Introduction
Obesity has become a global epidemic and a major health problem in the twenty-first century. Studies have demonstrated that weight loss lowers increased serum total cholesterol and low-density lipoprotein (LDL) cholesterol and raises high-density lipoprotein (HDL) cholesterol. One of the most recent procedures for managing weight loss in obese people with other options is laparoscopic sleeve gastrectomy (LSG).

Objectives
The aim of this study was to evaluate the short-term effect of laparoscopic sleeve gastrectomy on lipid profile in hyperlipidemic obese patients during the nine months of postoperative care.

Methods
From July 2020 to October 2021, 50 hyperlipidemic obese patients who were eligible for bariatric surgery underwent this prospective study at Main University Hospital in Alexandria, Egypt. Before and one, three, six, and nine months after the surgical intervention, measurements of body weight, body mass index (BMI), waist circumference, fasting and postprandial blood sugar, serum cholesterol, triglyceride, HDL, and LDL levels were taken.

Results
The patients' average age was 33.72±7.95 years. BMI, weight, blood sugar, and other measurements all significantly decreased. The mean body mass index (BMI) of the patients was 48.59±5.78 kg/m^2 before surgery, however, it was reduced to 32.58±3.91 kg/m^2 nine months afterwards. Studies revealed a statistically significant rise in HDL levels in the serum and a statistically significant fall in triglycerides, total cholesterol, and LDL levels. Results also revealed a favorable association between preoperative differences in age, BMI, and diabetes state and postoperative lipid profile alterations.

Conclusion
Laparoscopic sleeve gastrectomy (LSG) decreases body mass index, improves glucose and lipid metabolism, and alters the lipid profile by significantly lowering total cholesterol, triglycerides, and LDL cholesterol while significantly raising HDL cholesterol.

Keywords:
hyperlipidemia, obesity, sleeve gastrectomy

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Introduction

Obesity is a very serious condition in the world nowadays; obesity as a current global epidemic and major health problem has significant physical, psychological, and financial implications for the patients and for the clinicians caring for them [1]. The World Health Organization (WHO) defines obesity and overweight as abnormal or excessive fat accumulation that presents a risk to health [2].

With regard to overweight, more than a third of the world's population is currently affected by obesity, which is a complicated, multifaceted condition that is largely avoidable [3]. If secular trends continue, by 2030, 38% of adults worldwide will be overweight and 20% of adults will be obese. 39.8% of adult Egyptians (BMI 30 kg/m^2) were obese, according to the '100 million health' study, which was carried out in Egypt in 2019 and examined 49.7 million adult Egyptians. Females were more likely than males to be obese (49.5% of Egyptian adult females were obese vs 29.5% of males) [4].

First, changes in the quantity and quality of food consumed, and second, changes in the amount of energy expended by the population via physical activity, are the key environmental variables that have led to the obesity epidemics [5]. Although dyslipidemia is defined as elevated serum total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), triglycerides (TGs), or both, or even low levels of high-density lipoprotein (HDL) cholesterol (HDL-C), there is no natural cut-off between normal and abnormal lipid levels because lipid measurements are continuous [6].

Laparoscopic sleeve gastrectomy (LSG) was indicated as a definitive treatment in patients with BMI > 40 kg/m^2 or BMI > 35 kg/m^2 associated with co-morbidities, and it has also been proposed for patients with moderate obesity BMI < 35 kg/m2 and metabolic syndrome [7].

Because of the relative technical ease of performance compared to other bariatric procedures, acceptable operative duration, low complication rate and reports of average excess weight loss of 51–83% at 1 year with improvement in co-morbidity, many began to consider LSG as a primary single-stage bariatric procedure [8].

Methods

From July 2020 to October 2021, 50 hyperlipidemic obese candidates for LSG treatment underwent this prospective trial at Alexandria Main University Hospital. The IFSO parameters were taken into consideration when determining who recommended for surgery, which included anyone with a BMI of 40 kg/m^2 or 35 kg/m^2 who had an obesity-related comorbid condition(s). Exclusion criteria include thyroid gland diseases, renal impairment, and prior therapy with hyperlipidemic medications.

Measurements of waist circumference, body weight, and body mass index (BMI) before and one, three, six, and nine months after the surgical intervention, serum cholesterol, triglyceride, HDL and LDL levels, fasting and postprandial blood sugar, and serum cholesterol, HDL and LDL levels were recorded.

Surgical technique

LSG started with the standard placement of five ports and careful examination of the abdomen. The greater curvature was devascularized, reaching upward to the left diaphragmatic crus and downward to about 4–6 cm from the pylorus. Before the cartilages firing, a 36-Fr bougie was introduced. The greater curvature towards the crow's foot was divided by the first stapler, and the greater curvature of the stomach to the angle of His was resected by the next staplers. Methylene blue test was done to ensure negative leakage test after stomach division. Finally, a drain was inserted beside the staple line and the resected part was removed.

Results

The study included 50 cases, age ranged between 26 and 52 years with a mean of 33.72±7.95 years. With female predominance (62%) and 17 patients (34%) were diabetic. Demographic profile of patients' data is shown in Table 1.

In lipid profiles as regard total cholesterol, triglycerides, LDL and HDL there were a significant statistical difference between the baseline preoperative measurements and measurements in all postoperative periods where P value < 0.001,also there were statistically significant differences between each other periods as P value < 0.001. (Table 2).

There was also a significant relation between age, preoperative diabetic condition, and BMI and changes in lipid profile. Improvement in lipid profile among younger age group was greater than older and it was more rapid in non-diabetic than diabetic patients as regard TC and LDL. Finally, in patients with lower BMI improvement of TG was better than whose higher BMI.

In comparison between non-diabetic group ($n=33$) and diabetic group ($n=17$). First, as regard changes in total cholesterol there were significant statistical difference between means in post-operative periods; after 1 month ($P=0.003$), after 3 months ($P=0.043$). Second, as regard triglycerides there were significant statistical difference only after 9 months ($P=0.028$) . Third, in LDL there was only a significant statistical difference after 1 month ($P=0.029$). And finally, in HDL there was a significant statistical difference after 9 months (P= 0.001) (Table 3).

In comparison between lower BMI group (<45, $n=15$) and higher BMI group (≥45, n=35). First, as regards changes in total cholesterol there was no significant statistical difference between means in

Table 1 Demographic profile of patients' data

Parameters	Values	Values
Age (years) range (mean ±SD)	26–52 (33.72 ±7.95)	26–52 (33.72 ±7.95)
Sex (%)		
Males	19 (38%)	19 (38%)
Females	31 (62%)	31 (62%)

Table 2 Pre- & Post-operative Patients' Lipid Profiles

	Preop	1 month	3 months	6 months	9 months	*P* value
BMI						
Min- Max	35.9–62	30.6–58	29.3–49.9	24.4–46.4	25.3–46.1	<0.001*
Mean±S.D	48.5±5.7	43.7±5.6	38.6±4.7	33.2±4.2	32.5±3.9	
TC						
Min- Max	216–265	202–249	162–243	155–201	150–193	<0.001*
Mean±S.D)	237±12.2	224±12.8	194±21.2	176.0±12.9	169±11.6	
TG align="center"						
Min- Max	108– 248	99–210	86–167	80–152	76–140	<0.001*
Mean±S.D	166±42.8	143±33.3	112±21.6	99±18.0	92±15.6	
LDL						
Min- Max	122–181	115–177	95–150	87–137	83–130	<0.001*
Mean±S.D)	154±14.5	147±15.5	127±14.5	112±14.4	109±12.9	
HDL						
Min- Max	27–40	30–46	35–48	39–48	41–48	<0.001*
Mean±S.D	33.0±3.90	37.6±3.96	41.4±3.34	43.5±2.37	44.6±1.85	

Table 3 Comparison between changes of lipid profile after LSG in diabetic and nondiabetic groups

	DM		
	Non diabetic (*n* = 33)	Diabetic (*n* = 17)	*P*
Total cholesterol			
Baseline	236.3±13.30	238.5±10.20	0.549
1 month	220.7±12.20	231.7±11.23	0.003*
3 months	189.70±19.69	202.47±22.15	0.043*
6 months	175.48±12.64	178.53±13.78	0.438
9 months	168.39±11.21	170.94±12.58	0.469
TG			
Baseline	160.15±46.28	177.82±33.54	0.130
1 month	137.94±35.58	154.06±26.36	0.106
3 months	108.91±22.28	118.24±19.46	0.151
6 months	97.42±17.82	104.65±17.91	0.182
9 months	89.18±14.58	99.35±15.89	0.028*
LDL			
Baseline	155.5±15.10	151.2±13.24	0.335
1 month	144.45±15.51	154.47±13.64	0.029*
3 months	129.03±14.72	123.82±13.85	0.233
6 months	114.9±14.84	108.2±12.75	0.117
9 months	111.1±12.97	105.4±12.34	0.145
HDL			
Baseline	32.94±3.97	33.12±3.87	0.880
1 month	38.18±4.07	36.71±3.64	0.215
3 months	41.91±3.28	40.41±3.32	0.134
6 months	43.94±2.28	42.82±2.46	0.116
9 months	45.24±1.52	43.41±1.87	0.001*

Table 4 Comparison between changes of lipid profile after LSG according to BMI

	BMI (kg/m^2)		
	<45 (*n* = 15)	≥45 (*n* = 35)	*P*
Total cholesterol			
Baseline	237.27±12.29	236.97±12.44	0.939
1 month	223.40±12.18	224.83±13.33	0.723
3 months	191.07±18.68	195.31±22.37	0.522
6 months	175.67±12.17	176.89±13.47	0.764
9 months	167.93±10.17	169.83±12.29	0.602
TG			
Baseline	149.40±35.05	173.34±44.34	0.050*
1 month	123.67±24.47	151.89±33.34	0.005*
3 months	100.47±13.64	117.06±22.64	0.003*
6 months	93.80±12.26	102.49±19.54	0.119
9 months	87.87±11.84	94.69±16.76	0.160
LDL			
Baseline	149.67±16.27	155.89±13.49	0.167
1 month	140.53±16.76	151.0±14.06	0.027*
3 months	123.60±13.65	128.83±14.77	0.247
6 months	109.73±13.69	113.89±14.71	0.355
9 months	106.27±11.93	110.37±13.29	0.308
HDL			
Baseline	32.53±3.80	33.20±3.98	0.585
1 month	37.93±3.35	37.57±4.23	0.770
3 months	42.07±2.99	41.11±3.48	0.361
6 months	44.20±2.08	43.29±2.47	0.216
9 months	44.80±1.37	44.54±2.03	0.606

postoperative periods. Second, as regard triglycerides there were significant statistical differences in the preoperative measure ($P=0.050$) and postoperative after 1 month ($P=0.005$) and after 3 months ($P=0.003$). Third, in LDL there was only a significant statistical difference after 1 month ($P=0.027$). And finally, in HDL there was no significant statistical difference between both groups. (Table 4).

Discussion

In the twenty-first century, obesity has become a serious health problem that affects different populations. Obesity is rising dramatically in Egypt. According to the most recent STEPS study, which was done in 2017, over 35.7% of adult Egyptians in the same age category are obese [9].

In obese people, dyslipidemia is a significant comorbidity and a prevalent risk factor for the development of atherosclerosis and subsequent heart-related disorders. Elevated total cholesterol, low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) cholesterol, triglycerides, and a decrease in serum HDL cholesterol are among the abnormalities in lipid profile related to obesity [10].

LSG has grown in prominence as a top surgical technique for treating morbid obesity. The restrictive nature of the sleeve gastrectomy and the lower plasma ghrelin levels achieved by the removal of the stomach's fundus, which results in more appetite suppression and less stimulation of hunger, appear to be the causes of this procedure's ability to reduce weight.

In this study, lipid profile parameters in morbidly obese individuals were examined both before and after LSG to assess how well it controlled dyslipidemia and reduced its risk to the cardiovascular system.

In our study, independent of the patients' age or sex, the mean BMI significantly decreased by 4.85 kg/m^2 at one month postoperatively, 9.98 kg/m^2 at 3 months, 15.35 kg/m^2 at 6 months, and 16.01 kg/m^2 at 9 months, demonstrating the effectiveness of the treatment.

This finding is quite similar to that of Abd El-aziz *et al.* which revealed that patients who received LSG saw average decreases in mean BMI of 8.4 kg/m^2 after 3 months and 19 kg/m^2 after 9 months [11].

In the present study, lipid parameters were investigated both before and after surgery and its relation to patients' age, gender, diabetes, and BMI was evaluated.

It was discovered that LSG had a highly substantial impact on the total cholesterol level's improvement 1, 3, 6, and 9 months after surgery. LSG had positive effects on all of the examined instances, resulting in lower TC levels. Comparing this finding to that of related studies, Pulkit Sethi *et al.* found that total serum cholesterol levels significantly decreased from preoperative values of [274.9351.99 mg/dl] to [219.3040.76 mg/dl ($P=0.00$)] at three months and [176.2726.85 mg/dl ($P=0.00$)] at 6 months postoperatively, with the majority of patients displaying resolution of dyslipidemia at the end of six months [12].

While outcomes in some other trials were not statistically significant, Khalaj A *et al.* found no significant difference in blood cholesterol levels 3 months after surgery ($P=0.381$) [13]. No relationship was seen between the TG levels in the current investigation and the age or gender of the patients, who underwent LSG surgery. These results were similar to those of Wozniewska *et al.*, who found that mean blood TG levels following SG dropped consistently in both groups during follow-up periods of 1, 3, 6, and 12 months (p 0.001) [14]. Szczuko *et al.*, on the other hand, found a brief increase in TG levels one month after surgery and a non-significant decline after 12 months [15].

The follow-up LDL readings in this study were discovered to significantly decrease 1, 3, 6, and 9 months after LSG with a very significant P value of 0.001, which is regarded as another crucial proof for the effectiveness of the surgical technique in treating hyperlipidemia. Serum LDL levels also significantly decreased 1, 3, and 6 months after surgery.

In a study by Zaki *et al.* there was no statistically significant change in levels of LDL cholesterol LDL cholesterol mean pre-operative level was 2.55±1.1 compared to 3.09±2.15 postoperatively ($P\geq 0.83$) [16].

In our study, it was discovered that there had been a highly significant improvement in HDL levels with a P value of (0.001). These results consistent with those by Woniewska *et al.* The first, third, sixth, and nine months of follow-up for both groups revealed a statistically significant rise in mean HDL cholesterol levels (P 0.001) [14]. HDL cholesterol blood levels did not significantly rise following LSG, according to Hady *et al.* and a few other investigations [17].

Results showed that all patients, regardless of age, benefit from the surgical operation in terms of improvement of lipid and metabolism when compared between the two age groups in our research (patients $\leq$33 vs. >33 years old). In contrast to the group of patients who are older than 33, those who are younger likely to have greater and quicker benefits.

We discovered no statistically significant difference between the two groups when we divided our sample based on gender and looked at the outcomes of the follow-up tests.

After LSG, patients with obesity and Type 2 diabetes whose poor preoperative glycemic control displayed less improvement in lipid profile compared to nondiabetic obese patients, this result suggests that glycemic control before surgery is important to consider for a better outcome.

Diedisheim *et al.* compared the effect of LSG among obese patients but no T2D, and those with T2D they we observed an increased number of individuals with T2D in the "poor responders"' group. T2D remained significantly associated with poorer weight response even after the adjustment of other preoperative obesity-related comorbidities as hypertension, OSA, dyslipidemia, and CVD [18].

Finally according to preoperative BMI, patients with basal BMI less than 45 kg/m^2 exhibited better improvement in the postoperative TG and LDL levels, then patients with BMI more than 45 kg/m^2

Hussein concluded in his study that a significant strong correlation was found between the loss of weight or BMI and the improvement of lipid profile after 1 year of LSG in the studied parameters as TC, TG, and LDL but not with HDL [19]. But Zaki *et al.* showed no significant correlation between patients' BMI and changes of the serum level of total cholesterol, LDL, HDL, and triglycerides after LSG [16].

Conclusion

Dyslipidemia as a major co-morbidity of obesity is considered the main cause of atherosclerosis and coronary heart disease. Currently, bariatric surgery is the only proved interventional approach to induce significant long-term weight reduction with subsequent clinical improvement in the co-morbidities.

Laparoscopic sleeve gastrectomy (LSG) is a bariatric procedure that is effective in the treatment of morbid obesity. It is regarded as a main approach that improves the body mass indices and lipid profile in morbidly obese patients during the postoperative nine-month period.

For this improvement to be confirmed over the long term and to demonstrate a true decline in the incidence of cardiovascular insults, more studies with a longer follow-up time are needed.

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Conflicts of interest

There are no conflicts of interest.

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