How far is sleeve gastrectomy more effective than diet regimen in treating obesity-associated hyperlipidemia

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Background
The global epidemic of obesity is one of the major health issues in the 21st century that influences many aspects of public health, including psychosocial and socioeconomic aspects. Hyperlipidemia is one of the health hazards associated with morbid obesity.
Patients and methods
This was a prospective study conducted in Kasr Al-Aini University Hospital (sleeve gastrectomy group) and the National Nutrition Institute (diet group) during the period from June 2015 till December 2015 with a follow-up of 12 months till December 2016 for both groups. One hundred patients were included in the study and were equally divided into two groups: group A (sleeve gastrectomy group) and group B (diet group).
Objective
The objective of this study was to compare the effects of laparoscopic sleeve gastrectomy (LSG) and a dietary regimen on hyperlipidemia in morbidly obese patients.
Results
LSG significantly decreased total cholesterol in 70% of cases and triglycerides in 78% of cases; however, diet caused a decrease of total cholesterol in 30% of cases and triglycerides in 54% of case. Low-density lipoprotein was not significantly changed in both groups.
Conclusion
LSG is more effective than diet programs in treating obesity-associated hyperlipidemia due to more significant and sustained excess body weight loss.

Keywords:
diet, hyperlipidemia, morbid obesity, sleeve gastrectomy

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Introduction

Obesity is now considered to be the second leading cause of preventable death after cigarette smoking [1]. It is associated with multiple comorbidities including type II diabetes mellitus, hyperlipidemia, obstructive sleep apnea, cardiovascular diseases, kidney diseases, gall bladder stones, gastroesophageal reflux disease, osteoarthritis, psychological disorders, metabolic syndrome, and obesity-related cancers [2]. Hyperlipidemia is defined as elevated levels of any or all lipids and/or lipoproteins in the blood [3]. It is a potent risk factor for cardiovascular diseases. Control of hyperlipidemia can be achieved by dietary fat control, regular exercise, and oral medications. Sleeve gastrectomy leads to long-term weight loss and improvement or resolution of its associated comorbidities such as diabetes mellitus, hypertension, and hyperlipidemia [4]. The aim of this work was to compare the effects of laparoscopic sleeve gastrectomy (LSG) and dietary regimen on hyperlipidemia in morbidly obese patients.

Patients and methods

This was a prospective study conducted in Kasr Al-Aini University Hospital (sleeve gastrectomy group) and the National Nutrition Institute (diet group) during the period from June 2015 till December 2015, with a follow-up of 12 months till December 2016 for both groups. One hundred patients were included in the study and were equally divided into two groups: group A (sleeve gastrectomy group) and group B (diet group after exclusion of drop out cases).

Inclusion criteria included patients having BMI of at least 35 kg/m^2 and hyperlipidemia.

Exclusion criteria included the following:

(1) Endocrinal causes of obesity (hypothyroidism and Cushing disease).
(2) Pregnancy.
(3) Uncontrolled psychiatric disorders.

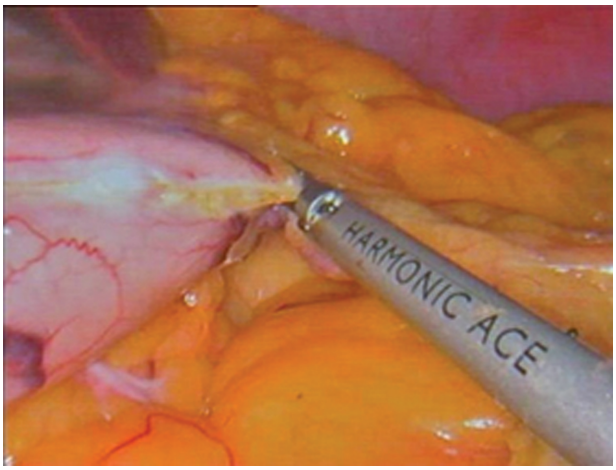
(4) Patients receiving treatment for hyperlipidemia to study the effect of only a single variable (sleeve or diet regimen) on hyperlipidemia.

All patients were subjected to proper history taking and complete physical examination. Preoperative investigations for group A included the following: complete blood count, coagulation profile, liver function tests, kidney function tests, fasting blood sugar, and the lipid profile including total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL), and low-density lipoprotein (LDL). The thyroid profile was determined to exclude hypothyroidism. Chest radiograph as well as pulmonary function tests were performed to detect associated chest disorders. An abdominal ultrasound was performed to detect gall bladder stones. Cardiological assessment was done by ECG and echocardiography.

The aims of preoperative assessment were to detect and control associated comorbidities. Moreover, preoperative psychiatric and anesthetic consultations were conducted and an informed consent about the expected complications was signed. Patients were instructed to follow a carbohydrate-free and fat-free diet regimen for 2 weeks before surgery.

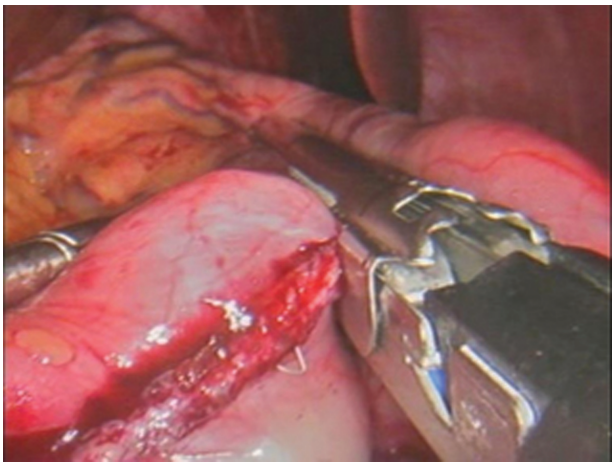
LSG was performed by mobilization of the greater curvature of the stomach proximal to the gastroesophageal junction and distally 6 cm proximal to the pylorus (Fig. 1). An orogastric 40-Fr bougie was passed till the first part of the duodenum. A 60-mm endoscopic gastrointestinal anastomosis stapler was used to divide the stomach along the line with the bougie creating a gastric tube about 20–25% of the original stomach (Figs 2 and 3).

Figure 1



Mobilization of the greater curvature of the stomach.

Figure 2



The endoscopic gastrointestinal anastomosis stapler dividing the stomach.

Postoperative care

In addition to the routine postoperative follow-up, the patients were instructed to receive the appropriate diet regimen in the form of sugar-free oral fluids for the first 3 weeks, and then sugar-free and fat-free semisolids were added, starting the fourth week. From the seventh week, they were allowed to have fat-free and carbohydrate-free steered food. Regular exercise (three times weekly-1 h each time) was strictly advised.

Diet group

Patients in this group were subjected to a specific diet regimen at the outpatient clinic of the National Nutrition Institute in Cairo. This regimen was about 1800–2000 calories for male patients and 1400–1600 calories for female patients. The diet regimen consisted of 55% carbohydrates, especially the complex form, 25% proteins, especially plant-based proteins, and 20% fats. Less than 7% of the fat percentage is derived from saturated fats, and the rest was mainly monounsaturated fatty acids. Dietary cholesterol did not exceed 200 mg daily. Other therapeutic lifestyle changes included an increase in dietary fiber intake (>8 g/day), omega-3 supplementation, and cessation of smoking. Regular physical exercise (three times weekly – 1 h each time) was encouraged.

Assessment of the lipid profile for both groups was performed at the start of the study as well as at 3, 6, and 12 months. The term hyperlipidemia refers to elevated lipid levels in the body including high cholesterol (total, LDL, and low HDL) and high TG levels.

Statistical analysis

Results are expressed as numbers (%). Comparison between categorical data was performed using χ^2-test. The statistical package for social science

Figure 3

The excised part of the stomach.

computer programs (version 19, Windows) (IBM Inc., Chicago, Illinois, USA) was used for data analysis. *P* value less than or equal to 0.05 was considered significant.

Results

One hundred morbidly obese patients were included in this prospective study and were equally divided into two groups: group A (sleeve gastrectomy group) and group B (low-carbohydrate and low-fat diet group). Table 1 shows the demographic data of the patients in both groups.

At the start of the study, in the sleeve group, 45 (90%) patients had hypercholesterolemia, which was the same as that in the diet group. After 3 months in the sleeve group, hypercholesterolemia improved in 15 (30%) patients, whereas in the diet group, it improved in five (10%) patients. Six months after surgery, 35 (70%) patients had a normal serum cholesterol level (60% resolution), whereas 17 (34%) patients had a normal serum cholesterol level in the diet group (resolution in 24%) within the same period. Sleeve gastrectomy caused complete resolution in 70% of patients with

Table 1 Demographic data of both groups

	Sleeve group	Diet group
Range of age (years)	25–55	28–50
Sex [*n* (%)]		
Male	15 (30)	12 (24)
Female	35 (70)	38 (76)
Range of BMI (kg/m^2)	36–60	35–53
Associated comorbidities		
Hypertension	5 cases	8 cases
Diabetes	6 cases	5 cases
Total number of cases	50	50

hypercholesterolemia 12 months after surgery, whereas the diet regimen corrected hypercholesterolemia in 30% of patients after the same period. Table 2 shows the changes in the serum cholesterol level in both groups.

LSG significantly normalized serum TG in 24, 58, and 78% of patients after 3, 6, and 12 months, respectively, whereas the diet regimen improved TG in 10, 30, and 54% of patients within the same period. Table 3 illustrates the changes in serum TG levels in both groups.

At the start of the study, in the sleeve group, 47 (94%) patients had low serum HDL. Sleeve gastrectomy caused improvement in 37 (74%) patients after 1 year. However, in the diet group, improvement occurred in 31 (62%) patients during the same period. Table 4 shows changes in serum levels of HDL in both groups.

Unfortunately, sleeve gastrectomy did not lower the serum level of LDL significantly after 1 year. Improvement occurred in 8% of the cases only and this was twice that in the diet group. Table 5 shows changes in serum levels of LDL in both groups.

In the sleeve group, we did not experience weight loss failure and the excess body weight loss (EBWL) ranged from 60 to 80%, whereas in the diet group, EBWL ranged from 30 to 45% after 1 year.

Discussion

The global epidemic of obesity is one of the major health issues in the 21st century, which influences many aspects of public health including psychosocial and socioeconomic aspects. According to the latest report of the WHO, in 2011, people with BMI of more than 30 kg/m^2 reached up to10% of the world population. It is worth noting that the percentage of people with morbid obesity has almost doubled during

Table 2 Serum total cholesterol level at different time intervals in both groups

Total cholesterol	*n* (%)				P value
	Sleeve group		Diet group		
	Normal	Elevated	Normal	Elevated	
At the start	5 (10)	45 (90)	5 (10)	45 (90)	1.000
After 3 months	20 (40)	30 (60)	10 (20)	40 (80)	0.029*
		15/50 (30)		5/50 (10)	
After 6 months	35 (70)	15 (30)	17 (34)	33 (66)	0.001*
		30/50 (60)		12/50 (24)	
After 12 months	40 (80)	10 (20)	20 (40)	30 (60)	0.001*
		35/50 (70)		15/50 (30)	

P>0.05, not significant. **P*<0.05, significant.

Table 3 Serum triglyceride level at different time intervals in both groups

Triglyceride	*n* (%)				*P* value
	Sleeve group		Diet group		
	Normal	Elevated	Normal	Elevated	
At the start	8 (16)	42 (84)	10 (20)	40 (80)	0.603
After 3 months	20 (40)	30 (60)	15 (30)	35 (70)	0.295
		12/50 (24)		5/50 (10)	
After 6 months	37 (74)	13 (26)	25 (50)	25 (50)	0.013*
		29/50 (58)		15/50 (30)	
After 12 months	47 (94)	3 (6)	37 (74)	13 (26)	0.006*
		39/50 (78)		27/50 (54)	

P>0.05, NS. **P*<0.05, significant.

Table 4 Serum high-density lipoprotein level at different time intervals in both groups

HDL level	*n* (%)				*P* value
	Sleeve group		Diet group		
	Normal	Low	Normal	Low	
At the start	3 (6)	47 (94)	2 (4)	48 (96)	0.646
At 3 months	10 (20)	40 (80)	7 (14)	43 (86)	0.424
		7/50 (14)		5/50 (10)	
At 6 months	17 (34)	33 (66)	15 (30)	35 (70)	0.668
		14/50 (28)		13/50 (26)	
At 12 months	40 (80)	10 (20)	33 (66)	17 (34)	0.115
		37/50 (74)		31/50 (62)	

HDL, high-density lipoprotein. *P*>0.05, NS.

Table 5 Serum low-density lipoprotein level at different time intervals in both groups

LDL level	*n* (%)				*P* value
	Sleeve group		Diet group		
	Normal	High	Normal	High	
At the start	40 (80)	10 (20)	41 (82)	9 (18)	0.799
At 3 months	40 (80)	10 (20)	41 (82)	9 (18)	0.799
		0/50 (0)		0/50 (0)	
At 6 months	42 (84)	8 (16)	43 (86)	7 (14)	0.779
		2/50 (4)		2/50 (4)	
At 12 months	44 (88)	6 (12)	43 (86)	7 (14)	0.766
		4/50 (8)		2/50 (4)	

LDL, low-density lipoprotein. *P*>0.05, NS.

the last 30 years [5]. In Egypt, 30.3% of the adult population is considered to be obese according to the latest figures [6].

Unfortunately, obesity has a variety of adverse health consequences associated with a high rate of death, such as type 2 diabetes mellitus, hyperlipidemia, hypertension,

metabolic syndrome obstructive sleep apnea, certain types of cancer, gall bladder stones, steatohepatitis, gastroesophageal reflux, arthritis, polycystic ovary syndrome, psychological instability, and infertility [7].

The term hyperlipidemia refers to the elevated lipid levels in the body including high cholesterol (total, LDL, and low HDL) and high TG levels [8]. Common causes of hyperlipidemia include cholesterol-rich food, overweight, alcohol abuse, diabetes, stress, and lack of exercise [9]. Hyperlipidemia is a potent risk factor for developing atherosclerosis, hypertension, cardiovascular strokes, gall bladder stones, hepatosteatosis, and a variety of cardiac diseases [9]. High cholesterol levels is a modifiable risk factor causing 4.4 million deaths annually [10,11].

Hyperlipidemia can be controlled by weight loss, decreasing dietary fat, regular exercise, and medications. These modalities of treatment decrease TC, LDL, and TG as well as increase the serum level of HDL cholesterol [10].

Currently, medications from five major classes of drugs have been reported to treat people with detrimental lipid levels, which include statins, nicotinic acid derivatives, fibric acid derivatives, bile acid-binding resins, and cholesterol absorption inhibitors [11]. Side effects of these medications include anorexia, nausea, vomiting, headache and dizziness, flushing, constipation, and joint pain [12].

LSG, or longitudinal/vertical gastrectomy, has recently gained popularity and acceptance as a single effective procedure for the treatment of morbid obesity and resolution or significant improvement of obesity-associated comorbidities including hyperlipidemia. It is an example of restrictive bariatric surgery. The procedure is relatively safe with low morbidity and mortality sleeve gastrectomy works by the standard principle of restriction and the removal of the anorexigenic cells that produce the hormone ghrelin, in the fundus of the stomach [13].

Complications of sleeve gastrectomy include hemorrhage, gastric leakage, gastroesophageal reflux disease, gall bladder stones, nutritional deficiency, weight loss failure, deep venous thrombosis, gastric obstruction, chest complications, abdominal collection, visceral injury, and port-site hernia [13].

Different types of diet programs are available for the treatment of obesity and its associated comorbidities. The most commonly used diet regimens are low-carbohydrate diet, low-fat diet, high-protein diet or a combination of these regimens. A single or a combined regimen can be applied. The term 'low-carbohydrate diet' is generally applied to diets that restrict carbohydrates to less than 20% of the caloric intake [14]. It is used to treat morbid obesity and control obesity-associated health hazards mainly metabolic syndrome [15]. Low-carbohydrate diet appears to be at least as effective as low-fat diet in inducing weight loss for up to 1 year [16]. Carbohydrate restriction may help prevent obesity and type 2 diabetes mellitus as well as atherosclerosis [17]. A low-fat diet restricts fat and often also saturated fat and cholesterol. It is intended to reduce diseases such as heart disease and obesity [18]. Lowering fat intake from 35–40% of the total calories to 15–20% of total calories has been shown to decrease total and LDL cholesterol [19].

Hady *et al.* [20] conducted their study including 130 patients who underwent LSG with a follow-up period for 1 year. They achieved a decrease in LDL cholesterol (20% of cases), TG (95% of cases), and TC (40% of cases) as well as an increase in HDL cholesterol (65% of cases). However, short-term results (before the third month after surgery) were not satisfying. The results obtained indicate that bariatric surgery may effectively control obesity-associated hyperlipidemia [20].

Schauer and Ikramuddin [21] conducted a study including 20 morbidly obese patients with hyperlipidemia, and concluded that 1 year after LSG, there was a significant increase of HDL cholesterol levels (72% of cases), with a significant decrease in TG (90% of cases), and LDL remained unchanged.

Wong *et al.* [22] studied the lipid profile of 37 patients who underwent LSG. The follow-up period was 9 months. They reported a significant improvement in parameters of lipid profile after LSG. However, compared with our results, they reported improvement not only in HDL (60% of cases), TG (75% of cases), and TC (20% of cases) but also in LDL cholesterol (20% of cases) [22].

Razak *et al.* [23] reported that a short period after LSG (6 months – 33 patient), there is a decrease in TC cholesterol (55% of cases), TG (90% of cases), and HDL (30% of cases), but LDL also unchanged.

In 2011, Marek Bužga and colleagues summarized that 6 months after LSG, 33 patients showed an increase in HDL cholesterol levels (40% of cases) and a reduction

Table 6 Lipid profile changes after laparoscopic sleeve gastrectomy in different studies

References	Number of patients and follow-up period	Cases (%)			
		Decrease in TC	Decrease in TG	Decrease in LDL	Increase in HDL
Schauer and Ikramuddin [21]	20 (12 months)	Unchanged	90	Unchanged	72
Wong *et al*. [22]	37 (9 months)	20	75	20	60
Buzga *et al*. [24]	35 (6 months)	Unchanged	85	Unchanged	40
Razak *et al.* [23]	33 (6 months)	55	90	Unchanged	30
Hady *et al.* [20]	130 (12 months)	40	95	20	65
Boza *et al.* [25]	50 (12 months)	70	100	Unchanged	Unchanged
This study	50 (12 months)	70	78	8	74

HDL, high-density lipoprotein; LDL, low-density lipoprotein; TC, total cholesterol; TG, triglycerides.

Table 7 Lipid profile changes after diet regimen in different studies

References	Number of patients and follow-up period	Type of diet	Cases (%)			
			Decrease in TC	Decrease in TG	Decrease in LDL	Increase in HDL
Nordmann *et al.* [26]	20 (12 months)	LC	Unchanged	85	Unchanged	70
Shai *et al.* (2011)	50 (6 months)	LC	5	Unchanged	Unchanged	40
Hu *et al*. 2012 [28]	40 (6 months)	LC	Unchanged	55	Unchanged	63
	70 (6 months)	LC	Unchanged	58	Unchanged	62
	40 (6 months)	LC	25	52	Unchanged	35
This study	50 (12 months)	LC+LF	30	54	4	62

HDL, high-density lipoprotein; LC, low carbohydrate; LDL, low-density lipoprotein; LF, low fat; TC, total cholesterol; TG, triglycerides.

in TG level (85% of cases), whereas LDL and TC remained unchanged [24].

Boza *et al*. [25] followed the lipid profile of 50 patients after LSG for 1 year, and concluded that there was a significant decrease in TG cholesterol levels (100% of cases), with a significant decrease in TC (70% of cases), whereas LDL and HDL remained unchanged [25].

In our study, 50 patients underwent LSG and their lipid profile was followed for 1 year. Sleeve gastrectomy significantly decreased TC (70% of cases), TG (78% of cases), and LDL (8% of cases). HDL increased in 74% of cases. Table 6 summarizes the changes in lipid profile after LSG in our study as well as others.

Low-fat diets had the most favorable effects on TC and LDL cholesterol levels, whereas low-carbohydrate diets had the most favorable effects on TG and HDL cholesterol levels [26].

Shai *et al*. [27] found that the total-to-HDL cholesterol ratio was reduced by 20% in participants after a low-carbohydrate diet compared with a 12% reduction in those following a low-fat diet; this was a statistically significant difference.

In 2012, Hu and colleagues compared low-carbohydrate diets with low-fat diets, and found that participants on low-carbohydrate diets had greater increases in HDL cholesterol (63%) and greater decreases in TG (95%), but experienced less reduction in total (22%) and LDL (12%) cholesterol compared with those on low-fat diets [28].

Exercise plus a low-saturated fat diet reduced LDL cholesterol levels by 7–15% and TG levels by 4–18%, while increasing HDL cholesterol levels by 5–14%. Exercise plus nutritional supplements reduced LDL cholesterol levels by 8–30% and TG levels by 12–39%, while increasing HDL cholesterol levels by 2–8%. Therefore, combining diet and exercise interventions appears to be additive or at least synergistic [29].

In our study, 50 patients followed low-carbohydrate and low-fat diet programs for 1 year, which caused a decrease in TC (30% of cases), TG (54% of cases), and LDL (4% of cases). HDL cholesterol increased in 62%

of cases. Table 7 summarizes changes in the lipid profile in the diet group in our study as well as others.

Conclusion

LSG is an effective and reliable solution for morbid obesity as well as its associated comorbidities including hyperlipidemia. LSG is more effective than diet programs at achieving such goals due to significant and sustained EBWL. LSG significantly improved TC and TG, whereas LDL was not significantly changed in both groups, emphasizing the importance of prophylaxis against cardiovascular risks.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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