Outcomes of laparoscopic SG and laparoscopic one-anastomosis gastric bypass in terms of improvement in the lipid profile

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Introduction
Obesity is associated with an increased mortality rate, particularly of cardiovascular origin, due to the close association between obesity and cardiovascular risk factors such as dyslipidemia. The efficacy of different bariatric Surgeries in weight reduction and in glycemic homeostasis improvement has been widely described. In contrast, little is known about the effects of bariatric surgery on lipid profile. Few studies have compared the effect of different surgical techniques on lipid profile changes. So, we aim at assessing and comparing the effect of SG and OAGB in terms of improvement in the lipid profile.

Patients and methods
This is a prospective comparative study that included 46 morbidly obese patients. Patients were divided into two groups: SG group (23 patients), and OAGB group (23 patients). Preoperative and 3 months post-operative cholesterol levels, triglycerides, LDL (Low-density lipoprotein), and HDL (High-density lipoprotein) were measured. The results were documented, analyzed, and correlated to baseline results, and results from the two groups were compared together.

Results
This study revealed that most of our patients who were candidates for bariatric surgeries either SG or OAGB presented with elevated mean LDL, Cholesterol, and triglyceride and decreased mean HDL. The results showed a significant improvement of lipid profile after both SG and OAGB over a 3-month interval. There was a statistically significant difference between the two operations in the decrease of cholesterol over 3 months postoperatively in favour of the OAGB operation; hence the significant difference is observed in the change of the cardiovascular risk and improvement of quality of life of those patients underwent OAGB.

Conclusion
Obese patients have shown an association with elevated LDL, Cholesterol, and triglyceride and decreased HDL. SG and OAGB both result in a significant decrease in LDL, Cholesterol and triglyceride and an increase in HDL.

Keywords:
cholesterol, lipid profile, morbid obesity, one anastomosis gastric bypass, sleeve gastrectomy

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Introduction

Obesity is becoming a world pandemic that affects more than one-third of the population around the globe; obesity-related comorbidities are top listed as the leading causes of death.

Obesity is associated with elevated blood lipids and lipoproteins [1]. The mechanism by which obesity leads to premature death from cardiovascular disease probably involves risk factors such as hypertension, lipid disturbances, and impaired glucose tolerance [2]. A negative association between HDL and the incidence of obesity has been reported in several studies [3]. A direct correlation between plasma triglycerides and body weight has been noticed [4] as a high percentage of patients with myocardial infarction exhibit hypertriglyceridemia [5].

This study aims to assess the effect of sleeve gastrectomy and one anastomosis gastric bypass on the lipid profile changes for patients after bariatric surgery and the interrelation between these changes in the lipid profile and changes in the BMI.

It also aims to determine whether there is a significant difference between sleeve gastrectomy and one anastomosis gastric bypass operations in terms of improving the lipid profile.

Patients and methods

This is a prospective comparative study that included 46 morbidly obese patients. Patients were divided into two groups: SG group (23 patients), and OAGB group (23 patients).

The study was conducted over a period of one year at Kasr Al-Ainy Teaching Hospital and all patients were conducted from the outpatient clinic.

Preoperative and postoperative evaluation followed the same standard protocol and included a thorough personal, medical, and surgical history, endocrinal evaluation, psychological testing, and counseling by a dietician, lastly a low caloric diet in a range of one to three weeks according to BMI was advised.

Patients on cholesterol lowering medications were excluded from the study.

After the routine preoperative investigations, patients were maintained on low caloric diet for two weeks prior to operation. Subcutaneous antithrombotic low molecular weight heparin 12 h preoperative, then continued daily for 2 weeks postoperative.

Both operations for all patients were carried out under general anesthesia. While patients were in the supine position, five ports technique was used.

In LSG; After induction of pneumoperitoneum, devascularization of the greater gastric curve starting about 3–4 cm proximal to the pylorus till reaching the angle of His to confirm visualization of the left diaphragmatic crus and ensure complete mobilization of the gastric fundus, then a 36-Fr bougie was introduced for caliberation, and Endo GIA 60-mm linear stapler was used for division of the stomach along the described devascularized portion, then staple line reinforcement with the use of absorbable 3–0 PDS in continual running suturing manner.

In OAGB; A long narrow gastric pouch was created based on the lesser curve by dividing the stomach nearly at the incisura using a 30-mm Endo GIA Universal Stapler then a 36-F bougie was introduced through the mouth and the pouch was completed by sequential vertical deployment of a 60-mm Endo GIA until pouch separation from the excluded stomach. The greater omentum was then divided to decrease the tension on the bowel before the gastrojejunal anastomosis. Counting of the intestine started by elevating the transverse colon to identify the DJ, a 180 cm biliopancreatic limb was measured, and a gastrojejunal anastomosis was created with a 30 mm Endo GIA stapler (3.5-mm blue cartridge). The common stapling defect was closed over the bougie with a single layer 2–0 absorbable V-Loc sutures in a running fashion.

Lastly, methylene blue leak test was carried out to assess any potential leakage, abdominal drain was not routinely introduced. Removal of the dissected part of the stomach in sleeve patients was achieved via a 12-mm port at the left flank.

Post-operatively; All patients were advised to have oral fluids only for the first 10 days followed by a soft diet until the first postoperative month, and then gradually proceed to regular diet with exception of high-sugar and fatty foods.

The selected patients were followed up; BMI, Serum cholesterol, triglycerides, LDL, and HDL were assessed 1–3 days preoperatively and 3 months postoperatively. Cardiovascular risk (CVR) was calculated as total cholesterol divided by HDL cholesterol. Percentage excess body mass index loss was calculated putting into consideration that the ideal body weight was defined by the weight corresponding to a BMI of 25 kg/m^2]%EBMIL=[(pre-operative BMI−current BMI)/ (pre-operative BMI–25)]×100 [6].

The adult treatment panel III (ATP-III) of the National Cholesterol Education Program (NCEP) defined normal total cholesterol as less than 200 mg/dl, borderline high total cholesterol as between 200 and 239 mg/dl, and high total cholesterol as greater than 240 mg/dl [7]. LDL cholesterol levels were classified as follows: optimal: 100 mg/dl, near optimal: 100–129 mg/dl, borderline high: 130–159 mg/dl, high: 160–189 mg/dl, and extremely high: 190 mg/dl. At 40 mg/dl, the HDL cholesterol level was regarded low, while at >60 mg/dl, it was labelled excessive. A triglyceride level of less than 150 mg/dl was considered normal. Borderline high is defined as 150–199 mg/dl, high is 200–499 mg/dl, and extremely high is 500 mg/dl. A cardiovascular risk score of 3.27 or less was also considered to be half the typical risk, 4.44 or more was considered to be the average risk, 7.05 or more was considered to be twice the average, and 11.04 or more was considered to be three times the average. Class I obesity was classified as having a BMI between 30 and 34.9 kg/m2, class II as having a BMI between 35 and 39.9 kg/m2, class III as having a BMI between 40 and 49.9 kg/m2, and class IV as having a BMI over 50 kg/m2 [8].

Patients were asked to fast from 10–12 h before blood samples withdrawal. All samples were sent to the laboratory of kasr Al-Ainy Hospitals –Clinical chemistry unit, where the electrochemiluminescence technique was used on the Cobas 6000 instrument. The results were usually expected to take from 24–48 h.

Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 28 (IBM Corp., Armonk, NY, USA). Data was summarized using mean, standard deviation, median, minimum and maximum for quantitative variables and frequencies (number of cases) and relative frequencies (percentages) for categorical variables. Comparisons between groups were done using an unpaired t test in normally distributed quantitative variables while the non-parametric Mann-Whitney test was used for non-normally distributed quantitative variables. Comparison between pre and post in each group was done using a paired *t* test [9].

For comparing categorical data, the Chi-square ($\chi 2$) test was performed. Exact test was used instead when the expected frequency is less than 5 [10]. Correlations between quantitative variables were done using the Spearman correlation coefficient [11]. *P* values less than 0.05 were considered statistically significant.

Results

Forty-six morbidly obese patients who were enrolled in the study, were divided into two groups: SG group (23 patients), and OAGB group (23 patients).

The sample included 11 males (7 SG and 4 OAGB) and 35 females (16 SG and 19 OAGB), their age ranged in the SG group between 20 years and 45 years (Mean=33.22) and in the OAGB group between 22 years and 39 years (Mean=36.48).

There was no statistically significant difference between both groups in terms of % EBMIL with *P* value (0.878) (Table 1).

The correlation coefficient between BMI reduction ratio and Lipid profile changes ratio showed a linear direct weak relationship in the two groups (Table 2).

By comparing the results of the two surgeries it was found that no statistically significant difference between the two operations in the decrease of either LDL or triglycerides over 3 months postoperatively. While there was a statistically significant difference between the two operations in the decrease of cholesterol over 3 months postoperatively in favour of the OAGB operation; hence the significant difference is observed in the change of the cardiovascular risk and improvement of quality of life of those patients underwent OAGB.

Triglycerides also showed a statistically significant difference in the correlation coefficient between BMI reduction ratio and CVR ratio with *P* value 0.007 and 0.029 in SG group and OAGB group respectively (Fig. 1).

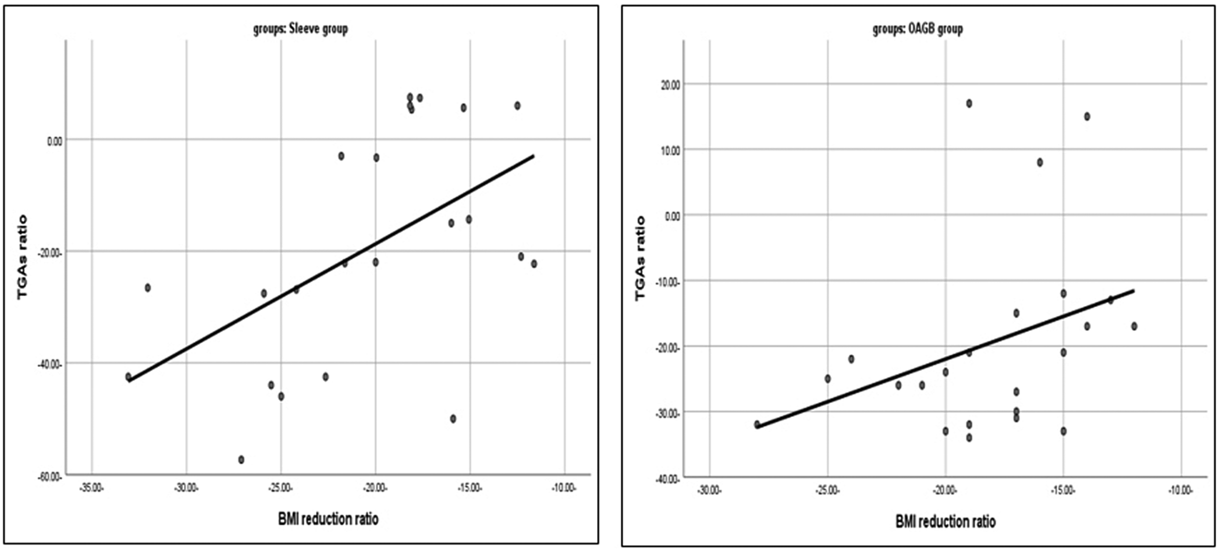
Table 1 BMI change before and 3-months after surgery (SG and OAGB)

	SG group			
	Mean±SD	Minimum	Maximum	*P* value
Pre-operative BMI	51.59±7.62	40.00	68.00	< 0.001
3 Months Post-operative BMI	41.10±7.41	32.60	60.10	
%EBMIL		41.4%		
OAGB group				
Pre-operative BMI	44.91±3.76	36.00	52.00	< 0.001
3 Months Post-operative BMI	36.74±2.99	31.00	43.00	
%EBMIL		41.13%		

Table 2 Lipid profile and CVR changes before and 3-months after surgery (SG and OAGB)

	SG group			OAGB group			
	Mean±SD			Mean±SD			
Lipid profile	Pre	3 Mo. Post	*P* value	Pre	3 Mo. Post	*P* value	*P* value between both groups
LDL	151.52±56.18	127.26±41.31	0.007	129.57±25.52	113.43±23.88	0.01	0.709
Triglycerides	152.30±67.84	114.41±37.28	0.001	152.87±27.59	123.61±34.25	<0.001	0.921
Cholesterol	227.70±50.26	196.23±48.84	< 0.001	217.13±46.66	167±37.11	< 0.001	0.047
HDL	43.35±9.46	43.63±6.38	0.890	38.26±12.91	40.35±7.84	0.268	0.391
CVR RISK	5.65±2.26	4.54±1.19	0.006	6.08±1.82	4.3±1.25	< 0.001	0.041

Figure 1



Correlation between BMI reduction ratio and triglycerides in both groups.

Discussion

The present study has evaluated the effect of two bariatric surgeries: SG and OAGB on lipid profile and BMI changes. Even though our follow-up period was short (3 months) postoperatively there were a lot of statistically significant changes noticed either for each surgical technique separately on the BMI and lipid profile or when comparing the two techniques or even when correlating the changes in BMI with the changes in the lipid profile.

Effect on BMI

Comparing the reduction ratio in BMI between the two operations, the mean of the BMI reduction ratio in the sleeve group was decreased by 20% while in the OAGB was decreased by 18.17%, the excess BMI loss in the sleeve group show 41.4% while in the OAGB shows 41.13% which showed no statistically significant in excess weight loss between the two groups.

Excess body weight loss couldn't be properly assessed over this short period of follow-up, but that wasn't the main aim of our study, it was rather concerned with the correlation between the BMI change and lipid profile improvement which will strongly support that any significant change in the upcoming elements is not related to the excess BMI loss.

A Systematic Review and Meta-Analysis study, that included 17 other studies, over a total of 6761 patients showed that the %EWL after one year was increased in the OAGB group (; P=0.01). However, the %EWL after 2 years was similar between the two groups (P=0.14) [12]. (Table 3).

Benaiges *et al.* study suggested that the reason why sleeve gastrectomy is different from other restrictive techniques is that resection of the gastric fundus in sleeve gastrectomy, cause a reduction in ghrelin as described [16]. There has been some correlation described between ghrelin and HDL metabolism, as the presence of certain nucleotide polymorphisms in ghrelin may affect HDL concentrations [17].

Effects on cardiovascular risk

The cardiovascular risk reflected by Total cholesterol /Total HDL. In SG group there is statistically significant changes in the CVR over our period of follow up 3 months postoperative the mean CVR was preoperatively 5.65 and decreased into 4.54 three months post-operative, thus the change was from average borderline risk to half the average which is low risk for development of cardiovascular disease.

In OAGB group, there is statistically significant change in CVR 3 months post-operative. The mean CVR was 6.08 preoperatively decreased into 4.30 three months post-operative. The change from borderline risk to low risk to develop cardiovascular disease. Comparing the two groups, there is statistically significant change in the CVR postoperatively in favor of OAGB. The mean change in CVR ratio is −12.04 post sleeve gastrectomy while the mean change in CVR ratio is −27.49% which show P value of 0.041.

Table 3 Comparison between effect of SG and OAGB on lipid profile and CVR as elicited in various studies

	Current study (2022)	Milone *et al.* (2015) [13]	Bettini *et al.* (2021) *** [14]	Jiménez *et al.* (2020) [15]
Operations studied	SG vs OAGB	SG vs OAGB	SG vs OAGB	OAGB
No. of cases	23 vs 23	74 vs 86	88 vs 46	100
Follow-up duration	3 months	12 months	18 months	24 months
LDL				
SG	S.S.* decrease	12% decrease	S.S. decrease	–
OAGB	S.S. decrease	12% decrease	S.S. decrease	S.S. decrease
SG vs OAGB	No significant difference	No difference	S.S. difference in favor of OAGB	–
HDL				
SG	N.S.S.** increase	4% increase	20.4% increase	–
OAGB	N.S.S. increase	5% decrease	16.6% increase	N.S.S. decrease
SG vs OAGB	Better improvement after OAGB	N.S.S. difference in improvement in both short and long-term results	Better improvement after SG	–
Cholesterol				
SG	S.S. decrease	6% decrease	N.S.S. decrease	–
OAGB	S.S. decrease	8% decrease	S.S. decrease	S.S. decrease
SG vs OAGB	S.S. difference in favor of OAGB	Better improvement after OAGB	S.S. difference in favor of OAGB	–
Triglycerides				
SG	S.S. decrease	7% decrease	24.2% decrease	–
OAGB	S.S. decrease	10% decrease	32.6% decrease	S.S. decrease
SG vs OAGB	N.S.S. difference	Better improvement after OAGB	S.S. difference in favor of OAGB	–

*S.S.: Statistically significant.** N.S.S.: Not Statistically significant.*** All results tabulated are after 3 months post-operative except for the results of Bettini *et al.* study are after 18 monthspost-operatively.

According to Jiménez *et al.* 2020 .'s trial, there was a significant decrease in cardiovascular risk relative to pre-operative levels at each checkpoint. That is Regarding their lipid profile characteristics, individuals with various cardiovascular risks were observed to differ significantly from one another (P 0.001). In patients who received OAGB, which produced effects similar to those in our research, the mean CVR reduced from 4.32 before surgery to 3.93 three months afterwards [15].

Correlation between reduction in BMI and lipid profile changes

In sleeve gastrectomy group, the correlation coefficient between BMI reduction ratio, LDL ratio, HDL ratio, cholesterol ratio and CVR ratio show linear direct weak relationship, while the correlation coefficient between BMI reduction ratio and triglycerides ratio shows linear direct moderate relationship with value of 0.548.

In OAGB group, the correlation coefficient between BMI reduction ratio, LDL ratio, HDL ratio, cholesterol ratio, triglycerides ratio and CVR ratio show linear direct weak relationship with values less than 0.5.

Coinciding with our results, Milone *et al.* in 2015 study, at 3 months post SG the change in the BMI ratio show a direct correlation with the change in total cholesterol ($r=0.811$, $P>0.001$) and change in the LDL ratio ($r=0.244$, $P=0.002$) and change in triglycerides ratio ($r=0.489$, $P>0.001$) but not with the change in HDL ratio. In OAGB, the change in BMI showed a direct correlation with the change in total cholesterol ($r=0.892$, $P>0.001$) and change in the triglycerides ($r=0.635$, $P>0.001$) but not with the change in HDL ratio ($r=0.139$, $P=0.080$) and change in the LDL ratio ($r=0.139$, $P=0.168$) [13].

On contrary to our study results, **Bettini *et al.*** found that there is no correlation coefficient between the weight loss and improvement in the lipid profile. That the change happens in the lipid profile is because of the OAGB itself and not related to the change in the BMI after the surgery. This could be explained as in OAGB we create a long gastric tube that allow food to have a faster passage to the intestine in a form that is different from what it used to deal with before. As result of this new mechanism, the emulsification of fat decrease together with the absorption of lipid in the ileum [14].

Another explanation for this might be the decrease in food intake following those operations as a result of lack of appetite, changes to gut hormones, and early satiety. As a result, mechanisms other than restriction and malabsorption are being proposed as the cause of the improvement of comorbidities associated with obesity [18]. These pathways might not be connected to weight reduction but rather to the interplay of the gut microbiota, bile acids, neurological system, and hormones of the gut.

Despite the largest weight reduction observed in the first six months following OAGB, LDL levels steadily decreased over the course of the next two years, according to a 2016 study by Carbajo *et al*. LDL levels at the conclusion of the follow-up period are not associated with weight reduction as a result [19].

Conclusion

Obesity is associated with dyslipidemia, obese patients are frequently seen with elevated LDL, cholesterol and triglycerides and low HDL.
SG and OAGB are effective bariatric operations with a significant effect on BMI reduction, lipid profile improvement and CVR reduction.
Serum cholesterol, triglycerides, and LDL are decreased significantly after SG and OAGB, signifying lipid profile improvement.
HDL rises after SG and OAGB but is not statistically significant over a short period of follow up.
There is a significant difference between SG and OAGB in terms of cholesterol reduction and hence cardiovascular risk reduction in favor of OAGB over 3 months postoperatively.
There is a linear direct correlation Coefficient relationship between BMI reduction ratio and LDL, triglycerides, cholesterol, and HDL seen in both SG and OAGB
More studies are needed to elaborate on the long-term effect of bariatric surgeries on the lipid profile of obese individuals and the impact of these changes in improving the quality of life and increasing the life expectancy of these patients.

Limitations

Small sample size, short duration of follow up.

Acknowledgements

Declarations Ethical Approval: This study has been approved by the appropriate institutional and/or national research ethics committee and has been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. All the patients were given an explanation of the study and about the investigative and operative procedures with their merits and demerits, expected results, and possible complications.

Informed Consent: Informed consent was obtained from all individual participants included in the study and all the patient data was used anonymously. Conflict of Interest The authors declare no competing interests.

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Conflicts of interest

There are no conflicts of interest.

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