# Changes in lipid profile of obese patients undergoing sleeve gastrectomy with Transit Bipartition surgery

*Ann. Ital. Chir., 2023 94, 3: 252-261*
pii: S0003469X23035868

Kerim Güzel*, Samet Sahin**

**Department of General Surgery, Biruni University, Faculty of Medicine, Samsun Medicana International Hospital, Turkey*
***Department of General Surgery, Muğla Sıtkı Koçman Universtiy, Faculty of Medicine, Muğla, Turkey*



**Changes in lipid profile of obese patients undergoing sleeve gastrectomy with Transit Bipartition surgery.**

*The aim of this study was to investigate the short- and long-term changes in lipid profile caused by Sleeve Gastrectomy with Transit Bipartition Surgery (SG+TBS), which is one of the current metabolic surgery techniques.*
*The study included patients who underwent SG+TBS between June 2015 and May 2019. The analyzed data included patients' demographic datas, obesity classification (Overweight, Class 1, 2, 3), and cardiovascular risk groups. Total Cholesterol (TC), triglycerides, Low-Density-Lipoprotein-Cholesterol (LDL-C), High-Density-Lipoprotein-cholesterol (HDL-C) serum concentrations of patients were measured at the time of admission to the outpatient clinic and at 3 and 12 months postoperatively.*
*The study population consisted of a total of 499 patients, 263 males and 236 females, with a mean BMI of 34.86 ± 4.90 kg/m2 and a mean age of 53.84 ± 8.93 years, who underwent SG+TBS. There was a significant decrease in the 3-month and 12-month TC levels, in the 12-month triglyceride levels of all classification groups, compared to the baseline value ($p<0.001$), There was also a significant decrease in the 3-month and 12-month LDL-C levels of overweight, class 1 and 2 obese patients compared to the baseline values. Although the change in the 3-month value of class 3 obese patients was insignificant, there was a significant decrease in the 12-month value, as in other obesity classification groups ($p<0.05$) and a significant increase in the 12-month HDL-C values for all classification groups compared to both baseline and 3-month values ($p<0.05$).*
*There were significant improvements in serum lipid profiles on SG+TBS patients, which are thought to be important in reducing the risks of cardiovascular disease.*

KEY WORDS: Lipid profile, Obesity, Sleeve gastrectomy with Transit Bipartition

## Introduction

A normal healthy adult synthesizes about 1 gram of cholesterol per day and consumes about 0.3 grams [1]. A relatively constant level of cholesterol (150-200 mg/dL) in the body is maintained primarily by controlling the level of de novo synthesis [1,2]. Individuals with hypercholesterolaemia have a much higher risk of developing cardiovascular disease compared to normal individuals. The risk of heart attack is higher than normal individuals [3,4]. In addition to being an independent risk factor for cardiovascular diseases, evidence that obesity contributes to the development of other risk factors such as hypertension is becoming stronger. The majority of diabetic patients have been reported to be overweight or obese in varying classes in terms of body mass index (BMI), and it has been observed that obese patients with a high BMI index are insulin-resistant and dyslipidaemic, as well as have a high risk of developing cardiovascular disease [5]. In recent years, many studies have been published, suggesting that better glycaemic control is achieved with metabolic surgery techniques in obese patients with diabetes, and these operations improve the dyslipidaemic picture in these patients, reducing the risk of developing cardiovascular disease [6-8]. Many bariatric surgery techniques have been used for the treatment of obese patients, and one of the most preferred and studied techniques today is laparoscopic sleeve gastrectomy (SG) [9]. Sleeve gastrectomy + transit bipartiton surgery

*Pervenuto in Redazione Febbraio 2021. Accettato per la pubblicazione Luglio 2022*
*Correspondance to: Samet Sahin, Department of General Surgery, Faculty of Medicine, Muğla Sıtkı Koçman Universty, 48000 Muğla, Turkey, (e-mail: sametsahin@mu.edu.tr)*

(SG+ TBS) is a bariatric surgery technique that has been commonly used in metabolic surgery centres in recent years and has an increasing popularity, and the research results of metabolic changes caused by this surgery are kept up-to-date in the literature [10, 11]. In a study by Bilecik, it was reported that no sign of malnutrition was observed in any patient since SG+TBS minimized the malabsorptive component in patients with type 2 DM [12].

The expectation from these metabolic surgical procedures is the long-term remission of hypertension or improvement in obesity-related comorbidities such as hypertension and hyperlipidaemia, and accordingly a decrease in cardiovascular risks. The aim of this study was to investigate the short - and long - term changes in lipid profiles of patients who were overweight or obese of different classes after SG+TBS.

## Materials and Methods

### Study Design and Population

The data of this study were obtained by receiving the informed consent of consecutive patients, who preferred to have SG+TBS and underwent this surgery among the overweight class 1, class 2 and class 3 obese patients admitted to the Private Samsun Buyuk Anadolu hospital for the treatment of excess weight and obesity between June 2015 - May 2019. The ethics committee approval for the study was obtained from the Private Samsun Buyuk Anadolu Hospital and the study was prepared in accordance with the *Declaration of Helsinki*. The data of the study were collected from the electronic record system of the hospital where the operation was performed, as well as from the patient files. Overweight obesity was defined as patients with a BMI of 25.0 to 29.9, Class 1 obesity as patients with a BMI of 30.0 to 34.9, Class 2 obesity as patients with a BMI of 35.0 to 39.9, and Class 3 obesity was defined as patients with a BMI of ≥ 40.0 or above. The demographic data of the patients included age, gender, body mass index (overweight, class 1, 2, 3), operations and interventions (cholecystectomy, liver biopsy) performed in the same session as the bariatric surgery, common channel length (≤100 cm (60, 70, 80, 90, 100 cm), >100 cm (110, 120, 130, 140, 150, 160, 200 cm), the distance from the first anastomosis to the pylorus (6, 8, 10 cm) and cardiovascular risk groups (low, moderate, high). The preoperative and post-TB 3-month and 12-month TC, triglycerides, LDL-C, HDL-C values were analysed according to the obesity classification of the patients.

### Data Extraction and Quality Assessment

The study included patients aged 18 and over, while patients under the age of 18 years were excluded from the study. In addition, patients who underwent a different operation for the treatment of obesity other than SG+TBS were excluded from the study. Moreover, patients who were lost to the 3-, and 12- month follow-ups and whose TC, triglycerides, LDL-C, HDL-C data were not available or were incomplete were excluded from the study. Patients who smoked and had a previous smoking history were excluded from the study. The patients were classified as low, moderate and high risk using the risk scoring system of the European Society of Cardiology to calculate the cardiac risk.

### Operative Technique

Following antibiotic and deep vein thrombosis prophylaxis, the patient is placed on the operating table. After the induction of general anaesthesia, pneumoperitoneum was established using a Veress needle. The first trocar (15 mm) used for the optic camera insertion site is placed 2 cm below the umbilicus and 3 cm left from the right anterior axillary line, and the second trocar (10 mm) is placed 7 cm superior from the first trocar site in the anterior axillary line and 2 cm away from the costal arch. The third trocar (5 mm) is placed in the epigastric region, below the xiphoid, the fourth trocar (15 mm) is placed in the left midclavicular line, 6 cm left lateral of the umbilicus, and finally the fifth trocar (5 mm) is placed in the left midclavicular line, in the middle of the xiphoid and the umbilicus (Fig. 1).

First, the omental bursa is opened, and then, the greater curvature of the stomach is released by dissecting the greater omentum up to the angle of his 2 cm proximal to the pylorus. With the help of a laparoscopic linear

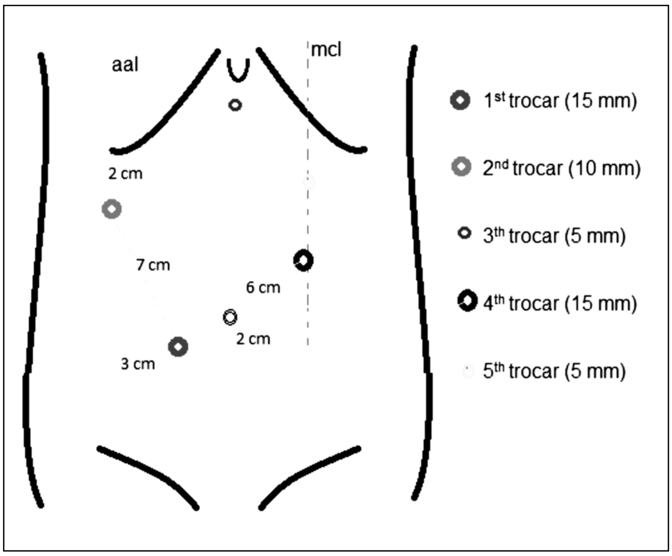


Fig. 1: Trocar entrances of the operation (aal: Anterior axillar line, mcl: mid clavicular line).

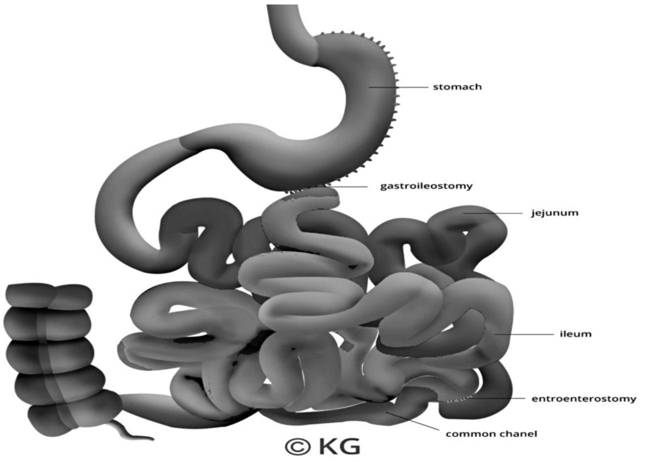

Fig. 2: Sleeve gastrectomy with bipartition surgery.

stapler, the stomach is divided into two at 6, 8 and 10 cm distance from the pylorus (depending on body mass index, >40, 35-40, <35 respectively) and 0.5 cm close to the angle of his using a 46 Forogastric tube so that the remnant stomach remained along the lesser curvature, and the specimen is removed out of the abdomen. Bleeding in the stapler line is controlled with seromuscular sutures on all along staple line.
Following sleeve gastrectomy, the ileocecal transition site is identified. The small intestine is separated 250 cm proximal to the ileocecal valve with the help of a laparoscopic linear stapler. The distal end of ileocecal transection is anastomosed to the gastric antrum.
The diameter of the anastomosis, made with the help of a stapler, is determined as 2.5-3 cm. The proximal end of the ileocecal transition is anastomosed side-to-side to the distal ileal segment with the help of a stapler by deciding the length of the common channel from a distance to the ileocecal valve. The length of the common canal leading to the ileocecal valve was planned as 80-120 cm. Residual anastomosis defects are closed up using 3/0 absorbable sutures. After placing a drain near each of two anastomoses, the trocar insertion sites are sutured primarily and the surgery ended (Fig. 2).

### Follow-up

The short-term (3 months) and long-term (12 months) changes in TC, Triglycerides, LDL-C, HDL-C of the patients included in the study were analysed after SG+TBS.

### Statistical Analysis

The SPSS version 25.0 (IBM Corporation, Armonk, New York, United States) and PAST3 (Hammer, Ø. Harper, D.A.T., Ryan, P.D. 2001. Paleontological statistics) software were used in the analysis of variables. The normality of univariate data was evaluated with the Lilliefors-corrected Kolmogorov-Smirnov test and homogeneity of variance was evaluated with Levene's test, while the normality of multivariate data was evaluated with Mardia's test (Dornik and Hansen omnibus) and homogeneity of variance was evaluated with Box's M test. In the comparison of two independent groups according to quantitative data, the Independent-Samples T-test was used with Bootstrap results, while the Mann-Whitney U test was used with the Monte Carlo simulation technique. In the comparison of more than two groups according to quantitative data, a One-way Anova (Robust Test: Brown-Forsythe) test, one of the parametric tests, was used, while the Jonckheere-Terpstra test was used with Monte Carlo simulation results.
Friedman's Two-Way test was used to compare more than two repeated measures of dependent quantitative variables, while Dunn's Test was used for Post Hoc analyses. In the comparison of categorical values, Pearson's chi-squared test was tested using Exact and Monte Carlo results, the Fisher-Freeman-Halton exact test was tested using Monte Carlo Simulation results, and the column rates were compared with each other and expressed according to Benjamini-Hochberg adjusted p-value results.
The quantitative variables were expressed as mean ± SD (Standard Deviation) (Minimum-Maximum) and median ± IQR (Interquartile Range), while categorical variables were shown as n (%) in the tables. The variables were analysed at a confidence level of 95% and a p-value of $\leq 0.05$ was considered statistically significant.

## Results

Between the dates of the study, a total of 499 patients, of whom 52.7% (n=263) were male and 47.3% (n=236) were female, underwent SG+TBS for the treatment of excess weight or obesity. The mean age of the patients was 53.84±8.93 years old, and the mean BMI was 34.86±4.90 kg/m2. Of the patients, 44.1% (n=220) had a low risk, 52.9% (n=264) had a moderate risk, and 3% (n=15) had a high risk in the preoperative cardiac risk assessment. The most common procedure performed in the same session as SG+TBS was cholecystectomy (87.9%), which was performed on 124 patients, while the second most common procedure was a liver biopsy (12.1%), which was taken from 17 patients. Of the patients, 54.3% (n=271) had a length of common channel longer than 100 cm, while 45.7% (n=228) had a length of common channel shorter than 100 cm. Of the patients, 43.3% (n=216) had a distance of 8 cm from the anastomosis to the pylorus, 29.9% (n=149) had a distance of 10 cm, and 26.9% (n=134) had a distance of 6 cm. The distribution of the patients is given in (Table I).

TABLE I - *Distribution of demographic data of patients who underwent SG+TBS.*

| | | N | % |
|---|---|---|---|
| Gender | | | |
| | Female | 236 | 47.3% |
| | Male | 263 | 52.7% |
| BMI | | | |
| | 25.0–29.9 | 66 | 13.2% |
| | 30.0–34.9 | 188 | 37.7% |
| | 35.0–39.9 | 161 | 32.3% |
| | 40 | 84 | 16.8% |
| Additional Surgery | | | |
| | Pouch | 124 | 87.9% |
| | Liver Bx | 17 | 12.1% |
| Cardiac risk | | | |
| | Low | 220 | 44.1% |
| | Moderate | 264 | 52.9% |
| | High | 15 | 3.0% |
| Common Channel Length | | | |
| | <100 cm | 228 | 45.7% |
| | >100 cm | 271 | 54.3% |
| Distance from the pylorus | | | |
| | 6 cm | 134 | 26.9% |
| | 8 cm | 216 | 43.3% |
| | 10 cm | 149 | 29.9% |
| | Mean±SDMedian (Min/Max) | | |
| Age | 53.84±8.9354 (27/77) | | |
| BMI | 34.86±4.9034.8 (26/53.1) | | |

SD: Standard Deviation, Min: Minimum, Max: Maximum

Of the patients who underwent TB surgery, 13.22% (n=66) were overweight, 37.67% (n=188) were class 1 obese, 32.26% (n=161) were class 2 obese, and 16.83% (n=84) were class 3 obese.

Of the patients whose lipid data were available and who were included in the study, 12.5% (n=47) were in the overweight obesity group, 37.23% (n=140) in the class 1 obesity group, 33.24% (n=125) in the class 2 obesity group, and 17.02% (n = 64) were in the class 3 obesity group, 376 patients in total.

One-hundred and twenty-three (123) patients whose lipid data could not be reached during the follow-ups were excluded from the study.

## Total Cholesterol

In the overweight obesity group, there was a significant decrease in the 3-month (158±58) and 12-month (148±41) TC levels compared to the baseline value (192±80) (p<0.001, p<0.001). Although there was some decrease in TC between the third and twelfth months, the difference was statistically insignificant (p>0.05).

In the class 1 obesity group, there was a significant decrease in the 3-month (154±53.50) and 12-month (149.5±44) TC levels compared to the baseline value (197.5±63.50) (p<0.001, p<0.001). There was a significant decrease in the 12-month total cholesterol compared to the 3-month value (p<0.001).

In the class 2 obesity group, there was a significant decrease in the 3-month (167±42) and 12-month (149 ± 44) TC levels compared to the baseline value (197±63) (p<0.001, p<0.001). There was a significant decrease in the 12-month TC level compared to the 3-month value (p<0.001).

In the class 3 obesity group, there was a significant decrease in the 3-month (161±54.50) and 12-month (156.5±44) TC levels compared to the baseline value (191±49.50) (p<0.001, p<0.001). Although there was some decrease in the 12-month TC level compared to the 3-month value, the difference was statistically insignificant (p>0.05).

In addition, it was determined that the difference in distance from the anastomosis to the pylorus (6, 8, 10 cm) and the difference in common canal length (<100 cm, >100 cm) did not cause any difference in the TC values of the patients (p>0.05, p>0.05).

## Triglycerides

In the overweight obesity group, there was a decrease in the 3-month (119±76) and 12-month (103±58) triglyceride levels compared to the baseline value (145±149) (p<0.023, p<0.003). Although there was some decrease in triglyceride levels between the third and twelfth months, the difference was statistically insignificant (p>0.05).

Although there was a decrease in the 3-month triglyceride (127.5±76) of the class 1 obesity group compared to the baseline value (160.5±132), the difference was statistically insignificant (p>0.05). There was a significant decrease in the 12-month value (115±68) compared to the baseline (p<0.001). There was a significant decrease in the 12-month triglyceride compared to the 3-month value (p<0.001).

Although there was a decrease in the 3-month (144±80) triglyceride of the class 2 obesity group compared to the baseline value (169±164.50), the difference was statistically insignificant (p>0.05). There was a significant decrease in the 12-month triglyceride (115±57.50) compared to the baseline value (p<0.001). There was a significant decrease in the 12-month triglyceride compared to the 3-month value (p<0.001).

Although there was a decrease in the 3-month triglyceride level (157±76) of the class 3 obesity group compared to the baseline value (157±115), the difference was statistically insignificant (p>0.05).

There was a significant decrease in the 12-month triglyceride (128±61) compared to the baseline value (p<0.003). There was a significant decrease in the 12-month triglyceride compared to the 3-month value (p<0.020).

However, the 3-month triglyceride value (119±76) of the overweight obesity group was significantly lower than the

TABLE II - *Changes in serum lipids by classification groups*

| | BMI | | | | |
|---|---|---|---|---|---|
| | **25.0–29.9 (Overweight) Median±IQR** | **30.0–34.9 (Class 1) Median±IQR** | **35.0–39.9 (Class 2) Median±IQR** | **40 (Class 3) Median±IQR** | **P[j]** |
| Total Cholesterol | n=47 | n=140 | n=125 | n=64 | |
| baseline value (A) | 192±80 | 197.5±63.50 | 197±63 | 191±49.50 | 0.602 |
| 3-month (B) | 158±58 | 154±53.50 | 167±42 | 161±54.50 | 0.355 |
| 12-month (C) | 148±41 | 149.5±44 | 149±44 | 156.5±44 | 0.299 |
| Change | | | | | |
| (B-A) | -35±55 | -35.5±55.50 | -33±46 | -33.5±49 | 0.815 |
| (C-A) | -35±53 | -46.5±60.50 | -49±45 | -40±50.50 | 0.849 |
| (C-B) | -4±31 | -5±29.50 | -6±30 | -5±22 | 0.861 |
| [f] p-value for intragroup | <0.001 | <0.001 | <0.001 | <0.001 | |
| Pairwise comparison | A B | <0.001 | <0.001 | <0.001 | <0.001 |
| A C | <0.001 | <0.001 | <0.001 | <0.001 | |
| B C | 0.180 | 0.001 | <0.001 | 0.190 | |
| Triglycerides | n=47 | n=138 | n=124 | n=65 | |
| baseline value (A) | 145±149 | 160.5±132 | 169±164.50 | 157±115 | 0.479 |
| 3-month (B) | 119±76 | 127.5±76 | 144±80[AB] | 157±76 AB | 0.001 |
| 12-month (C) | 103±58 | 115±68 | 115±57.50 | 128±61 | 0.148 |
| Change | | | | | |
| (B-A) | -36±117 | -32±120 | -44.5±154 | -18±114 | 0.669 |
| (C-A) | -51±119 | -39±116 | -53.5±154.50 | -22±120 | 0.993 |
| (C-B) | -8±28 | -11.5±40 | -19.5±45.50[AB] | -16±59 | 0.021 |
| [f] p-value for intragroup | 0.006 | <0.001 | <0.001 | 0.002 | |
| Pairwise comparison | A B | 0.023 | 0.174 | 0.052 | 0.999 |
| | A C | 0.003 | <0.001 | <0.001 | 0.003 |
| | B C | 0.470 | <0.001 | <0.001 | 0.020 |
| LDL-Cholesterol | n=50 | n=147 | n=125 | n=66 | |
| baseline value (A) | 105.5±53 | 107±56 | 108±57 | 102.5±55 | 0.416 |
| 3-month (B) | 85.5±50 | 90±45 | 96±39 | 89±40 | 0.789 |
| 12-month (C) | 85±31 | 79±41 | 82±38 | 80.5±29 | 0.662 |
| Change | | | | | |
| (B-A) | -16.5±41 | -18±46 | -11±46 | -17.5±43 | 0.418 |
| (C-A) | -24.5±51 | -21±49 | -23±42 | -16.5±52 | 0.344 |
| (C-B) | -7.5±22 | -7±27 | -10±26 | -6±22 | 0.785 |
| f p-value for intragroup | <0.001 | <0.001 | <0.001 | <0.001 | |
| Pairwise comparison | A B | <0.028 | <0.001 | <0.007 | 0.203 |
| | A C | <0.001 | <0.001 | <0.001 | <0.001 |
| | B C | <0.008 | <0.008 | <0.001 | 0.110 |
| HDL-Cholesterol | n=50 | n=147 | n=129 | n=64 | |
| baseline value (A) | 39±12 | 40±13 | 42±12 | 40.5±14 | 0.113 |
| 3-month (B) | 39.5±9 | 38±10 | 37±10 | 38±11.50 | 0.163 |
| 12-month (C) | 44.5±13 | 44±13 | 45±12 | 45±11 | 0.651 |
| Change | | | | | |
| (B-A) | 1±11 [CD] | -1±11 [CD] | -2±8 | -4±11 | 0.001 |
| (C-A) | 5.5±10 | 4±10 | 3±9 | 1.5±10 [AB] | 0.025 |
| (C-B) | 5.5±6 | 4±7 | 5±8 | 6±8 | 0.101 |
| [f] p-value for intragroup | <0.001 | <0.001 | <0.001 | <0.001 | |
| Pairwise comparison | A B | 0.881 | 0.062 | <0.001 | <0.001 |
| | A C | <0.001 | <0.001 | <0.001 | <0.005 |
| | B C | <0.001 | <0.001 | <0.001 | <0.001 |

[J] Jonckheere-Terpstra Test (Monte Carlo), [f] Friedman Test (Monte Carlo); Post-hoc Test: Dunn's Test, IQR: Interquartile Range



triglyceride value (144±80) of the class 2 obesity group and the triglyceride value (157±76) of the class 3 obesity group (p<0.028, p<0.006).

Similarly, the 3-month triglyceride value (127.5±76) of the class 1 obesity group was significantly lower than the triglyceride value of the class 2 obesity group and the triglyceride value of the class 3 obesity group (p<0.045, p<0.005).

In the 3-month measurements of triglyceride values, there was no statistical difference when those with a distance of 6 cm (149±80) and 8 cm (134±76) from the anastomosis to the pylorus were compared, while there was a significant decrease when those with a distance of 6 cm and 10 cm (118.5±80.5) were compared ($p>0.05$, $p<0.009$). There was also a significant decrease when those with a distance of 8 cm and 10 cm from the anastomosis to the pylorus were compared ($p<0.029$).
In the 12-month measurements of triglyceride values, it was determined that the difference in distance from the anastomosis to the pylorus (6, 8, 10 cm) did not cause any difference in triglyceride values ($p>0.05$).
In addition, it was found that the difference in common channel length (<100 cm, >100 cm) did not cause any difference in the triglyceride values of the patients ($p>0.05$).

### LDL-Cholesterol

In the overweight obesity group, there was a significant decrease in the 3-month (85.5±50) and 12-month (85±31) LDL-C compared to the baseline value (105.5±53) ($p<0.028$, $p<0.001$). There was a significant decrease in LDL-C between the third and twelfth months ($p<0.008$).
In the class 1 obesity group, there was a significant decrease in the 3-month (90±45) and 12-month (79±41) LDL-C compared to the baseline value (107±56) ($p<0.001$, $p<0.001$). There was a significant decrease in LDL-C between the third and twelfth months ($p<0.008$).
In the class 2 obesity group, there was a significant decrease in the 3-month (96±39) and 12-month (82±38) LDL-C compared to the baseline value (108±57) ($p<0.007$, $p<0.001$). There was a significant decrease in LDL-C between the third and twelfth months ($p<0.001$).
Although there was some decrease in the 3-month LDL-C (89±40) of the class 3 obesity group compared to the baseline value (102.5±55), the difference was statistically insignificant ($p>0.05$). There was a significant decrease in the 12-month LDL-C (80.5±29) compared to the baseline value ($p<0.001$). The change between the 3-month and 12-month LDL-C values was insignificant ($p>0.05$).
In addition, it was found that the difference in distance from the anastomosis to the pylorus (6, 8, 10 cm) and the difference in common channel length (<100 cm, >100 cm) did not cause any difference in the LDL-C values of the patients ($p>0.05$, $p>0.05$).

### HDL-Cholesterol

In the overweight obesity group, there was no statistically significant difference in the 3-month HDL-C (39.5±9) compared to the baseline value (39±12) ($p>0.05$). There was a significant increase in the 12-month HDL-C (44.5±13) compared to the baseline value ($p<0.001$). There was a significant increase in the 12-month HDL-C compared to the 3-month value ($p<0.001$).
In the class 1 obesity group, there was no statistically significant difference in the 3-month HDL-C (38±10) compared to the baseline value (40±13) ($p>0.05$). There was a significant increase in the 12-month HDL-C (44±13) compared to the baseline value ($p<0.001$). There was a significant increase in the 12-month HDL-C compared to the 3-month value ($p<0.001$).
In the Class 2 obesity group, there was a statistically significant decrease in the 3-month HDL-C (37±10) compared to the baseline value (42±12) ($p<0.001$). There was a significant increase in the 12-month HDL-C (45±12) compared to the baseline value ($p<0.001$). There was a significant increase in the 12-month HDL-C compared to the 3-month value ($p<0.001$).
In the Class 3 obesity group, there was a statistically significant decrease in the 3-month HDL-C (38±11.5) compared to the baseline value (40.5±14) ($p <0.001$). There was a significant increase in the 12-month HDL-C (45±11) compared to the baseline value ($p<0.005$). There was a significant increase in the 12-month HDL-C compared to the 3-month value ($p<0.001$).
In addition, it was found that the difference in common canal length (<100 cm, >100 cm) did not cause any difference in the HDL-Cholesterol values of the patients ($p>0.05$).
In the 3-month measurements of HDL-Cholesterol values, there was no statistical difference when those with a distance of 6 cm (37±12) and 8 cm (37±10) from the anastomosis to the pylorus were compared, while there was a significant decrease in the comparison between those with a distance of 6 cm and 10 cm (39±8) ($p>0.05$, $p<0.013$).
There was also a significant decrease when those with a distance of 8 cm and 10 cm from the anastomosis to the pylorus were compared ($p<0.003$). In the 12-month measurements of HDL-C values, it was determined that the difference in distance from the anastomosis to the pylorus (6, 8, 10 cm) did not cause any difference in HDL-C values ($p>0.05$).
The baseline, 3- and 12- month changes in serum TC, triglycerides, LDL-C, HDL-C by obesity classification are shown in detail in (Table II).

## Discussion

The high mortality rate caused by obesity, a metabolic disease with increasing incidence worldwide, is attempted to be explained by dyslipidaemia, which is a cardiovascular risk factor. Dyslipidaemia refers to the plasma lipoprotein levels out of normal ranges or functional dysfunction of lipoproteins. Increased postprandial triglycerides in overweight or obese patients with diabetes are defined as dyslipidaemia with low HDL and slightly high or high LDL concentration [13].

Since dyslipidaemia and obesity increase the risk of developing atherosclerosis and myocardial infarction, positive improvements in serum lipid levels can decrease the incidence of cardiovascular diseases. An increased adipose tissue mass in both obese and type 2 DM patients has been shown to cause oxidative stress by increasing the formation of reactive oxygen species. These free radicals cause atherogenesis by inducing LDL-C oxidation [14].

It is known that obesity, the prevalence of which is increasing especially in developed countries, is associated with many comorbidities such as type 2 DM, metabolic syndrome, development of some tumour types, and cardiovascular diseases [15].

In obesity and comorbid type 2 DM, there is an increase in mortality rates due to low quality of life, dyslipidaemia, cardiovascular diseases, and metabolic syndrome. Today, the use of metabolic surgery techniques as a treatment tool with proven metabolic effects and efficacy in eligible patients such as weight loss, glycaemic control, and lipid profile has increased in many centres [16]. In a study evaluating the effect of metabolic surgery techniques on cardiovascular risk factors, it was stated that 65% of patients achieved improvement in hyperlipidaemia [17].

A study analysing the postoperative metabolic results, preoperative and postoperative TC, triglycerides, LDL-C, HDL-C concentrations of patients who underwent laparoscopic sleeve gastrectomy for the treatment of obesity reported that there were improvements in the dyslipidaemia state on postoperative day 7 and afterward [18]. In another study evaluating the metabolic results of patients after sleeve gastrectomy, it was found that there was a significant decrease in 3-month HDL-C levels, while there was no significant change in LDL-C levels [19]. In another similar study, no significant change was observed in the comparison between preoperative and postoperative first day LDL-C levels and LDL-C subfractions [20].

Fukui and Hirano reported a significant increase in HDL-C concentrations of patients in the early period after sleeve gastrectomy, whereas Asztalos et al. reported a significant increase in plasma HDL-C levels in the late period (month 12) following significant weight loss in the early postoperative period after metabolic surgery [21,22]. Asztalos et al also reported a decrease in plasma triglyceride levels in the postoperative first month, but a significant increase above the baseline level at month 12 following the operation [22].

A study with metabolic surgery showed that there was a decrease in cholesterol absorption along with less absorption of cholesterol and bile salts by the intestine thanks to the disabsorptive techniques, followed by significant reductions in serum LDL-C levels. The same study also reported an increase in hepatic cholesterol catabolism, which contributes to the maintenance of low serum LDL-C levels [23].

Lira et al reported that LDL-C levels of patients who underwent sleeve gastrectomy were significantly decreased at 3 and 24 months during long-term follow-up [24]. In this study comparing sleeve gastrectomy and RYGB metabolic surgery techniques, it was reported that there was a greater decrease in total cholesterol levels with sleeve gastrectomy according to the results obtained at the end of 24-month postoperative follow-up[24].

According to the results obtained in other studies analysing the metabolic results of patients who underwent metabolic surgery, significant improvements have been observed in TC and LDL-C levels, and sleeve gastrectomy management has been shown to be more effective than other metabolic surgery techniques, especially in reducing LDL-C levels [25,26].

Despite the numerous positive effects of procedures such as Roux-en-Y Gastric Bypass, biliopancreatic diversion, mini-gastric bypass and sleeve gastrectomy, which are some the surgical techniques used for the treatment of overweight or obese patients, they have been reported to cause nutritional restriction in patients and promote malabsorption, which may cause symptoms of poor nutrition [12]. The SG+TBS technique, which was first defined by Santoro et al, is a bariatric surgery technique that has been commonly used in metabolic surgery centres and has an increasing popularity, and the research results of metabolic changes caused this surgery to be kept up-to-date in literature [10,11,27]. In a study by Bilecik, it was reported that no sign of malnutrition was observed in any patient since SG+TBS minimized the malabsorptive component in patients with type 2 DM [12].

Nevertheless, the number of specific studies into what short- and long-term changes it metabolically causes in patient groups undergoing this procedure is limited. When we reviewed the English online literature, we realized that this study was one of the specific pioneering studies on the lipid subfraction profile in which a large patient population was analysed, including the preoperative and postoperative periods of overweight or obese diabetic patients who underwent SG+TBS.

In the present study, the SG+TBS technique, one of the metabolic surgery techniques, was performed on all 376 diabetic patients included in the study, who were overweight or obese of different classes.

As a result of the study, there was a significant decrease in the 3-month and 12-month TC levels of all classification groups compared to the baseline value ($p<0.001$). However, the change between the 3-month and 12-month TC levels varied according to the obesity classification. The change in the TC between these months was insignificant in the overweight and class 3 obese patients, while there was a significant decrease in the values of the class 1 and 2 obese patients ($p>0.05$, $p<0.001$).

In addition, the difference in distance from the anastomosis to the pylorus and the difference in common channel length did not cause any difference in the TC values of the patients ($p>0.05$, $p>0.05$).

Although the change in the 3-month triglyceride levels of the class 1, 2 and 3 obese patients was insignificant compared to the baseline value, there was a significant decrease in the values of the overweight patients ($p>0.05$, $p<0.001$). Although the change in the 12-month triglyceride level of the overweight patients was insignificant compared to the 3-month value, there was a significant decrease in the values of the class 1, 2 and 3 obese patients ($p>0.05$, $p<0.001$). There was a significant decrease in the 12-month triglyceride levels of all classification groups compared to the baseline value, regardless of the obesity class ($p<0.001$). Common channel length did not cause any difference in the triglyceride values of the patients ($p>0.05$). However, it was concluded that the patients with a distance of 10 cm from the anastomosis to the pylorus had a significant decrease in the 3-month triglyceride level, which returned to the preoperative values at 12 months, and the decrease was not permanent.

There was also a significant decrease in the 3-month and 12-month LDL-C levels of overweight, class 1 and 2 obese patients compared to the baseline value. However, although the change in the 3-month value of class 3 obese patients was insignificant, there was a significant decrease in the 12-month value, as in other obesity classification groups. The difference in distance from the anastomosis to the pylorus and the difference in common channel length did not cause any difference in the LDL-C values of the patients ($p>0.05$).

Although there was no change in the 3-month HDL-C levels of the overweight and class 1 obese patients compared to the baseline value, there was a decrease in the values of class 2 and 3 obese patients. However, there was a significant increase in the 12-month HDL-C values of all classification groups compared to both baseline and 3-month values. It was found that the patients with a distance of 10 cm from the anastomosis to the pylorus had a significant decrease in the 3-month HDL-C compared to those with a distance of 6 and 8 cm, but it was similar to the preoperative values at 12 months.

Although the differences in distance from the anastomosis to the pylorus led to significant changes in HDL-C in the early postoperative follow-up (third month), this was temporary and did not make any difference in the long-term.

### Limitations

The limitations of this study are short follow-up duration of the patients, not calculating the changes in body mass indices, and different dietary habits of some patients that may lead to a change in lipid profile.

## Conclusion

In conclusion, despite some partial differences in the results obtained from obese diabetic patients undergoing SG+TBS related to overweight and different classification groups, there were significant improvements in serum lipid profiles, which are thought to be important in reducing the risks of cardiovascular disease.

It was found that this technique was reliable and effective in diabetic patients with comorbid conditions who were overweight and obese according to various classes, and had positive health effects in terms of patient health. Therefore, it was concluded that this technique should be considered in bariatric surgery when planning the treatment of the patient in order to control diseases with a high cardiovascular risk and dyslipidaemia.

*Compliance with Ethical Standards:* Ethical approval numbered 01 and dated 16.12.2019 was obtained from the Academic Ethics Committee of Private Medicana International Samsun Hospital.

*Conflict of Interest:* The authors declare that they have no conflict of interest.

*Informed Consent:* Informed consent was obtained from each patient.


## Riassunto

Lo scopo di questo studio era di indagare i cambiamenti a breve e lungo termine nel profilo lipidico causati dalla Sleeve Gastrectomy con Transit Bipartition Surgery (SG+TBS), che è una delle attuali tecniche di chirurgia metabolica.

Lo studio ha incluso pazienti sottoposti a SG+TBS tra giugno 2015 e maggio 2019. I dati analizzati includevano dati demografici dei pazienti, classificazione dell'obesità (sovrappeso, classe 1,2,3) e gruppi a rischio cardiovascolare. Le concentrazioni sieriche di colesterolo totale (TC), trigliceridi, colesterolo delle lipoproteine™ a bassa densità (LDL-C), colesterolo delle lipoproteine™ ad alta densità (HDL-C) sono state misurate al momento del ricovero in ambulatorio e a 3 e 12 mesi dopo l'intervento.

La popolazione dello studio era composta da un totale di 499 pazienti, 263 maschi e 236 femmine, con un BMI medio di 34,86 ± 4,90 kg / m2 e un'età media di 53,84 ± 8,93 anni, sottoposti a SG+TBS. C'è stata una diminuzione significativa nei livelli di TC a 3 e 12 mesi, nei livelli di trigliceridi a 12 mesi di tutti i gruppi di classificazione, rispetto al valore basale ($p <0,001$), C'è stata anche una diminuzione significativa nel 3 - livelli di C - LDL al mese e 12 mesi di pazienti obesi di classe 1 e 2 in sovrappeso rispetto ai valori basali. Sebbene la variazione del valore a 3 mesi dei pazienti obesi di classe 3 fosse insignificante, c'è stata una significativa diminuzione del valore di 12 mesi, come in altri gruppi di classificazione dell'obesità ($p<0,05$) e un

aumento significativo dell'HDL a 12 mesi - C valori per tutti i gruppi di classificazione rispetto ai valori basali e a 3 mesi (p<0,05).
Ci sono stati miglioramenti significativi nei profili lipidici sierici nei pazienti con SG + TBS, che si ritiene siano importanti per ridurre i rischi di malattie cardiovascolari.

## References


1. Soliman GA, *Dietary cholesterol and the lack of evidence in cardiovascular disease. Nutrients,* 2018; 10(6), Epub 2018/06/20, doi: 10.3390/nu10060780, Pub Med PMID: 29914176, Pub Med Central PMCID: PMCPMC6024687.

2. Kumar M, Nagpal R, Kumar R, Hemalatha R, Verma V, Kumar A, et al.: *Cholesterol-lowering probiotics as potential biotherapeutics for metabolic diseases*. Exp Diabetes Res, 2012; 2012:902917, Epub 2012/05/23, doi: 10.1155/2012/902917, Pub Med PMID: 22611376, Pub Med Central PMCID: PMCPMC3352670.

3. Hajar R: *Risk factors for coronary artery disease: Historical perspectives*. Heart Views. 2017; 18(3):109-14, Epub 2017/12/01, doi: 10.4103/HEARTVIEWS.HEARTVIEWS_106_17, Pub Med PMID: 29184622, Pub Med Central PMCID: PMCPMC5686931.

4. de Ferranti SD, de Boer IH, Fonseca V, Fox CS, Golden SH, Lavie CJ, et al.: *Type 1 diabetes mellitus and cardiovascular disease: A scientific statement from the american heart association and american diabetes association*. Circulation; 2014; 130(13):1110-30, Epub 2014/08/13, doi: 10.1161/CIR.0000000000000034, Pub Med PMID: 25114208.

5. Milone M, Lupoli R, Maietta P, Di Minno A, Bianco P, Ambrosino P, et al.: *Lipid profile changes in patients undergoing bariatric surgery: A comparative study between sleeve gastrectomy and mini-gastric bypass*. Int J Surg, 2015; 14:28-32, Epub 2015/01/13, doi: 10.1016/j.ijsu.2014.12.025, Pub Med PMID: 25576760.

6. Rubino F, Nathan DM, Eckel RH, Schauer PR, Alberti KG, Zimmet PZ, et al.: *Metabolic surgery in the treatment algorithm for type 2 diabetes: A joint statement by international diabetes organizations*. Surg Obes Relat Dis, 2016; 12(6):1144-62, Epub 2016/08/29, doi: 10.1016/j.soard.2016.05.018, Pub Med PMID: 27568469.

7. Mingrone G, Panunzi S, De Gaetano A, Guidone C, Iaconelli A, Nanni G, et al.: *Bariatric-metabolic surgery versus conventional medical treatment in obese patients with type 2 diabetes: 5 year follow-up of an open-label, single-centre, randomised controlled trial*. Lancet, 2015; 386(9997):964-73. Epub 2015/09/16, doi: 10.1016/S0140-6736(15)00075-6, Pub Med PMID: 26369473.

8. Ikramuddin S, Korner J, Lee WJ, Connett JE, Inabnet WB, Billington CJ, et al.: *Roux-en-Y gastric bypass vs intensive medical management for the control of type 2 diabetes, hypertension, and hyperlipidemia: The diabetes surgery study randomized clinical trial*. JAMA, 2013; 309(21):2240-9, Epub 2013/06/06, doi: 10.1001/jama.2013.5835, Pub Med PMID: 23736733, Pub Med Central PMCID: PMCPMC3954742.

9. Cengiz E, Emre A, Şanlı AN, Sertkaya M, Bülbüloğlu E: *Evaluation of operative complications in obese patients who underwent laparoscopic sleeve gastrectomy: Single-center experience*. Laparoscopic Endoscopic Surgical Science (LESS), 2018; 25(2):47-53.

10. Arslan E, Sipahi M, Banli O: *Early results of laparoscopic sleeve gastrectomy with loop bipartition*. Surg Laparosc Endosc Percutan Tech, 2018; 28(6):385-9, Epub 2018/05/22, doi: 10.1097/SLE.0000000000000541, Pub Med PMID: 29782429.

11. Yormaz S, Yilmaz H, Ece I, Sahin M: *Laparoscopic ileal interposition with diverted sleeve gastrectomy versus laparoscopic transit bipartition with sleeve gastrectomy for better glycemic outcomes in t2dm patients*. Obes Surg, 2018; 28(1):77-86. Epub 2017/07/07, doi: 10.1007/s11695-017-2803-6, Pub Med PMID: 28681261.

12. Bilecik T: *Metabolic effects of sleeve gastrectomy with transit bipartition in obese females with type 2 diabetes mellitus: Results after 1-year follow-up*. Obes Surg, 2019; 29(3):805-10, Epub 2018/11/19, doi: 10.1007/s11695-018-3603-3, Pub Med PMID: 30448981.

13. Klop B, Elte JW, Cabezas MC: *Dyslipidemia in obesity: mechanisms and potential targets*. Nutrients, 2013; 5(4):1218-40, Epub 2013/04/16, doi: 10.3390/nu5041218, Pub Med PMID: 23584084, Pub Med Central PMCID: PMCPMC3705344.

14. Murri M, Garcia-Fuentes E, Garcia-Almeida JM, Garrido-Sanchez L, Mayas MD, Bernal R, et al.: *Changes in oxidative stress and insulin resistance in morbidly obese patients after bariatric surgery*. Obes Surg, 2010; 20(3):363-8, Epub 2010/03/11, doi: 10.1007/s11695-009-0021-6, Pub Med PMID: 20217956.

15. Berrington de Gonzalez A, Hartge P, Cerhan JR, Flint AJ, Hannan L, MacInnis RJ, et al.: *Body-mass index and mortality among 1.46 million white adults*. N Engl J Med, 2010; 363(23):2211-9, Epub 2010/12/03, doi: 10.1056/NEJMoa1000367, Pub Med PMID: 21121834, Pub Med Central PMCID: PMCPMC3066051.

16. Dixon JB, Zimmet P, Alberti KG, Rubino F: *International diabetes federation taskforce on e, prevention. Bariatric surgery: An idf statement for obese type 2 diabetes*. Arq Bras Endocrinol Metabol, 2011; 55(6):367-82, Epub 2011/10/21, doi: 10.1590/s0004-27302011000600003, Pub Med PMID: 22011853.

17. Vest AR, Heneghan HM, Agarwal S, Schauer PR, Young JB: *Bariatric surgery and cardiovascular outcomes: A systematic review*. Heart, 2012; 98(24):1763-77, Epub 2012/10/19, doi: 10.1136/heartjnl-2012-301778, Pub Med PMID: 23077152.

18. Hady HR, Golaszewski P, Zbucki RL, Dadan J. *The influence of laparoscopic adjustable gastric banding and laparoscopic sleeve gastrectomy on weight loss, plasma ghrelin, insulin, glucose and lipids*. Folia Histochem Cytobiol, 2012; 50(2):292-303, Epub 2012/07/06, doi: 10.5603/fhc.2012.0039, Pub Med PMID: 22763970.

19. Benaiges D, Flores-Le-Roux JA, Pedro-Botet J, Ramon JM, Parri A, Villatoro M, et al.: *Impact of restrictive (sleeve gastrectomy) vs hybrid bariatric surgery (Roux-en-Y gastric bypass) on lipid profile*. Obes Surg, 2012; 22(8):1268-75, Epub 2012/05/01, doi: 10.1007/s11695-012-0662-8, Pub Med PMID: 22544352.

20. Dogan S, Aslan I, Eryilmaz R, Ensari CO, Bilecik T, Aslan M: *Early postoperative changes of HDL subfraction profile and HDL-associated enzymes after laparoscopic sleeve gastrectomy*. Obes Surg, 2013; 23(12):1973-80, Epub 2013/06/14, doi: 10.1007/s11695-013-1011-2, Pub Med PMID: 23760763.

21. Fukui T, Hirano T: *High-density lipoprotein subspecies between patients with type 1 diabetes and type 2 diabetes without / with intensive insulin therapy*. Endocr J, 2012; 59(7):561-9, Epub 2012/04/17, doi: 10.1507/endocrj.ej11-0329, Pub Med PMID: 22504174.

22. Asztalos BF, Swarbrick MM, Schaefer EJ, Dallal GE, Horvath KV, Ai M, et al.: *Effects of weight loss, induced by gastric bypass surgery,*

*on HDL remodeling in obese women*. J Lipid Res, 2010; 51(8):2405-12, Epub 2010/07/16, doi: 10.1194/jlr.P900015, Pub Med PMID: 20631298, Pub Med Central PMCID: PMCPMC2903819.

23. Benetti A, Del Puppo M, Crosignani A, Veronelli A, Masci E, Frige F, et al.: *Cholesterol metabolism after bariatric surgery in grade 3 obesity: Differences between malabsorptive and restrictive procedures*. Diabetes Care, 2013; 36(6):1443-7, Epub 2013/01/01, doi: 10.2337/dc12-1737, Pub Med PMID: 23275360, Pub Med Central PMCID: PMCPMC3661782.

24. Lira NS, Macedo CES, Belo GM, Santa-Cruz F, Siqueira LT, Ferraz AAB: *Analysis of the lipid profile of patients submitted to sleeve gastrectomy and Roux-en-Y gastric bypass*. Rev Col Bras Cir, 2018; 45(6):e1967, Epub 2018/12/13, doi: 10.1590/0100-6991e-20181967, Pub Med PMID: 30540098.

25. Jamal M, Wegner R, Heitshusen D, Liao J, Samuel I: *Resolution of hyperlipidemia follows surgical weight loss in patients undergoing Roux-en-Y gastric bypass surgery: A 6-year analysis of data*. Surg Obes Relat Dis, 2011; 7(4):473-9, Epub 2010/11/03, doi: 10.1016/j.soard.2010.08.009, Pub Med PMID: 21036105.

26. Pihlajamaki J, Gronlund S, Simonen M, Kakela P, Moilanen L, Paakkonen M, et al.: *Cholesterol absorption decreases after Roux-en-Y gastric bypass but not after gastric banding*. Metabolism, 2010; 59(6):866-72, Epub 2009/12/18, doi: 10.1016/j.metabol.2009.10.004, Pub Med PMID: 20015521.

27. Santoro S, Castro LC, Velhote MC, Malzoni CE, Klajner S, Castro LP, et al.: *Sleeve gastrectomy with transit bipartition: a potent intervention for metabolic syndrome and obesity*. Ann Surg, 2012; 256(1):104-10, Epub 2012/05/23, doi: 10.1097/SLA.0b013e31825370c0, Pub Med PMID: 22609843.