

# Accepted Manuscript

Changes in the lipid profile 5 years after bariatric surgery:  
Laparoscopic Roux-en-Y gastric bypass versus laparoscopic sleeve  
gastrectomy

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PII: S1550-7289(18)30252-1  
DOI: [10.1016/j.soard.2018.05.006](https://doi.org/10.1016/j.soard.2018.05.006)  
Reference: SOARD 3370

To appear in: *Surgery for Obesity and Related Diseases*

Received date: 12 February 2018  
Revised date: 23 April 2018  
Accepted date: 11 May 2018

Please cite this article as: Climent Elisenda MD , Benaiges David MD, PhD ,  
Juana A. Flores-Le Roux MD, PhD , Jose M. Ramón MD, PhD , Pedro-Botet Juan MD, PhD ,  
Goday Albert MD, PhD , Changes in the lipid profile 5 years after bariatric surgery: Laparoscopic  
Roux-en-Y gastric bypass versus laparoscopic sleeve gastrectomy , *Surgery for Obesity and Related  
Diseases* (2018), doi: [10.1016/j.soard.2018.05.006](https://doi.org/10.1016/j.soard.2018.05.006)



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**Highlights:**

- Few studies have evaluated lipid profile evolution at mid-term after surgery.
- LRYGB was superior to LSG as to hypercholesterolemia remission.
- LRYGB was superior to LSG as to hypertriglyceridemia remission, although type of surgery was not an associated factor.
- Both surgical techniques were equivalent as to low HDL cholesterol remission.

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**Full title:** Changes in the lipid profile 5 years after bariatric surgery: Laparoscopic Roux-en-Y gastric bypass versus laparoscopic sleeve gastrectomy.

**Running title:** Lipid profile 5 years after bariatric surgery.

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**Disclosure:** The authors have no conflicts of interest to declare.

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**ABSTRACT**

**Background:** Few studies have compared mid-term results of laparoscopic Roux-en-Y gastric bypass (LRYGB) versus laparoscopic sleeve gastrectomy (LSG) and none have focussed on lipid profile.

**Objectives:** Compare LRYGB versus LSG with respect to lipid disturbance evolution and remission at mid-term after bariatric surgery (BS) and to assess associated factors with the remission of lipid disturbances at 5 years.

**Setting and methods:** A retrospective analysis of a non-randomized prospective cohort was conducted on patients undergoing BS at Hospital del Mar, Barcelona, from January 2005 to January 2012 with  $\geq 5$  years follow-up.

**Results:** 151 out of 259 patients (58.3%) completed 5 years follow-up. The proportion of patients who achieved normal low-density lipoprotein (LDL) cholesterol levels at 5 years post-LRYGB was greater than after LSG [30/49 (61.2%) versus 6/23 (26.1%);  $p = 0.005$ ], being male sex, absence of statins treatment and type of BS technique (LRYGB) the associated factors with remission. Hypertriglyceridemia remission was also higher after LRYGB [23/25 (92.0%) versus 10/15 (66.7%);  $p = 0.041$ ], although type of surgery was not an associated factor. No differences were found in remission rates of low high-density lipoprotein (HDL) cholesterol between groups. Absence of fibrates treatment and 5-year percentage of excess weight loss were independently associated with hypertriglyceridemia remission and only the latter was independently associated with low HDL cholesterol remission 5 years after surgery.

**Conclusions:** Five-year outcome data showed that, among patients with severe obesity undergoing BS, LRYGB was associated with a higher total and LDL cholesterol reduction and remission in comparison to LSG, with no differences in hypertriglyceridemia and HDL cholesterol normalization.

**Keywords:** dyslipidemia; bariatric surgery; laparoscopic Roux-en-Y gastric bypass; laparoscopic sleeve gastrectomy; associated factors.

## INTRODUCTION

Dyslipidemia of obesity, involving different qualitative and quantitative lipid alterations, is at least partially responsible for the high cardiovascular risk of this population <sup>(1)</sup>.

Laparoscopic sleeve gastrectomy (LSG) use has been increasing in the last ten years owing to its technical simplicity and similar short-term results to those of laparoscopic Roux-en-Y gastric bypass (LRYGB) in terms of weight loss and comorbidity remission <sup>(2,3)</sup>. These advantages placed LSG for the first time as the most widely used bariatric surgery (BS) technique worldwide in 2014, overtaking LRYGB <sup>(4)</sup>. In this context, the pros and cons of both techniques are crucial in the clinical decision of selecting the most appropriate BS procedure <sup>(5)</sup>. One of the main differences between LRYGB and LSG in terms of metabolic changes is their short-term effect on the lipid profile. Few studies comparing both surgical techniques at mid-term (3-5 years) have been conducted <sup>(6-8)</sup> including two recent randomized trials <sup>(9,10)</sup> and none specifically focused on lipid abnormalities. Furthermore, a recurring issue in BS studies was the assessment of dyslipidemia remission, defined in some occasions as lipid-lowering medication withdrawal and others as whole lipid profile normalization together with medication withdrawal, without evaluation of the lipid subfractions <sup>(9,10)</sup>. Thus, taking into account the potential differences between LRYGB and LSG with respect to the evolution of the different lipoproteins, it may be more appropriate to separately analyze the remission rates of hypertriglyceridemia, high low-density lipoprotein (LDL) and low high-density lipoprotein (HDL) cholesterol.

In addition, identifying clinical characteristics associated with lipid remission at 5 years can be of clinical use for deciding on the most fitting surgical procedure for a certain patient, as has been described for other comorbidities <sup>(2,3)</sup>.

Thus, the aim of the present study was to compare LRYGB versus LSG with respect to lipid disturbance evolution and remission at 5 years after BS. Furthermore, secondary outcomes included relapse, late remission and incidence rates of the different lipid disorders and evaluation of factors associated with mid-term remission.

## **MATERIALS AND METHODS**

### Study protocol

A retrospective analysis was conducted of a non-randomized prospective cohort of patients with severe obesity undergoing BS at the Hospital del Mar, Barcelona, from January 2005 to January 2012. Patients were between 18 and 55 years of age and met the 1991 BS criteria of the National Institutes of Health <sup>(11)</sup>. The indication for the type of surgical procedure (LRYGB or LSG) was based on clinical criteria and the consensus of the BS Unit. In this respect, LSG was preferred in younger patients, in those with a body mass index (BMI) of 35-40 kg/m<sup>2</sup>, as a first-step treatment in cases with a BMI > 50 kg/m<sup>2</sup> and when drug malabsorption was to be avoided <sup>(12)</sup>.

All patients were evaluated preoperatively and at 3, 6, and 12 months after surgery, and then annually until completing 60 months of follow-up. Lipid-lowering therapy was supervised by the endocrinologist of the BS Unit throughout the preoperative, in-hospital and post-surgery periods. Protocol visits included measurements of weight, waist and hip circumferences and blood pressure, and laboratory tests for glucose, total cholesterol, HDL cholesterol, triglycerides and information on the use of lipid-lowering drugs.

All patients provided their written informed consent for the procedure and the study. The

Ethics Committee of our Institution approved the protocol in accordance with the ethical guidelines of the 1975 Declaration of Helsinki.

#### Anthropometric and biochemical measurements

BMI was calculated as weight in kilograms divided by height in square metres and the percentage of excess weight loss (EWL) was based on excess weight compared to the weight corresponding to BMI of 25 kg/m<sup>2</sup> for each patient <sup>(13)</sup>.

Total cholesterol and triglycerides were determined using enzymatic methods in a Cobas Mira automatic analyzer (Baxter Diagnostics AG, Düringen, Switzerland). HDL cholesterol was measured using separation by precipitation with phosphotungstic acid and magnesium chloride, and LDL cholesterol concentration was estimated with the Friedewald formula <sup>(14)</sup>. Non-HDL cholesterol was calculated as total cholesterol minus HDL cholesterol. Definitions of different lipid disturbances as well as postoperative outcomes are available in **Supplement 1**.

#### Surgical techniques

The LRYGB technique consisted of a 150-cm antecolic Roux limb with a 25-mm circular pouch-jejunostomy and exclusion of 50 cm of the proximal jejunum. In LSG, longitudinal resection of the stomach from the angle of His to approximately 5 cm proximal to the pylorus was performed using a 35 French bougie inserted along the lesser curvature. The same team of surgeons performed all operations.

#### Statistical analysis

Data were expressed as mean  $\pm$  standard deviation for continuous variables following a normal distribution, as median with interquartile range for those continuous variables with a non-normal distribution and as percentages and frequencies for categorical variables. Normality of the models was evaluated visually and using the Kolmogorov-Smirnov test. For skewed variables (triglycerides), a logarithmic transformation was used to achieve normality.



Student's t-test was performed to assess differences between two means. Chi-square or Fisher's exact tests were used to evaluate the degree of association among categorical variables. ANOVA models were used to study the evolution of continuous variables in each group and analyze differences between groups at each time point from baseline. A multivariate analysis with a step back procedure was performed to evaluate factors independently associated with hypercholesterolemia, hypertriglyceridemia and low HDL cholesterol remission 5 years after BS. A two-sided p value < 0.05 was considered statistically significant. Statistical analysis was calculated with SPSS (version 19.0 for Windows; SPSS, Chicago, IL).

## RESULTS

Of the 259 patients who underwent BS between 2005 and January 2012, 108 were lost during follow-up. 151 out of 259 patients (58.3%) completed 5 years follow-up, 103 (68.2%) of whom had undergone LRYGB and 48 (31.8%) LSG. Eighty-seven percent of the patients were women; mean age of the total cohort was  $46.1 \pm 8.7$  years and mean BMI  $45.2 \pm 4.8$  Kg/m<sup>2</sup>. Both groups were comparable at baseline except for BMI, baseline LDL cholesterol and the percentage of patients on statin treatment (**Table 1 and Table 2**).

No differences were found in the 5-year % EWL between groups ( $73.6 \pm 18.1$  versus  $72.8 \pm 23.5$ ;  $p = 0.199$ ), nor in the percentage excess BMI loss at 5 years ( $73.9 \pm 18.2$  versus  $72.8 \pm 23.5$ ;  $p = 0.185$ ) after LRYGB and LSG respectively. However, percentage total body weight loss at 5 years was superior after LRYGB in comparison to LSG ( $32.9 \pm 8.6$  versus  $29.2 \pm 8.3$ ;  $p = 0.017$ ). Evolution of different lipid subfractions during follow-up is illustrated in **supplement 2** and baseline, 5-year values and concentration change in **Table 2**.

### Hypercholesterolemia and LDL cholesterol

Hypercholesterolemia remission had occurred more frequently after LRYGB than after LSG at 5 years of follow-up [26/58 (44.8%) versus 6/26 (23.1%);  $p = 0.047$ ]. LRYGB was also superior to LSG regarding the 1-year remission rate, and the incidence of the latter was higher during follow-up (**supplement 3**).

In the multivariate analysis, male gender, no statin therapy at baseline and LRYGB intervention were independently associated with hypercholesterolemia remission 5 years after BS (**supplement 4**).

The number of patients who had achieved normal LDL cholesterol levels at 5 years post-LRYGB was greater than after LSG [30/49 (61.2%) versus 6/23 (26.1%);  $p = 0.005$ ]. Similar to total cholesterol, LRYGB presented a higher 1-year remission rate compared to LSG, with the latter presenting a higher incidence during follow-up (**supplement 3**).

In the multivariate analysis, male gender, no statin therapy at baseline and LRYGB intervention were independently associated with LDL cholesterol remission 5 years after BS (**supplement 4**).

#### Low HDL cholesterol

The number of patients achieving normal HDL cholesterol 5 years after surgery was similar in both groups [39/47 (83.0%) and 18/23 (78.3%) after LRYGB and LSG respectively;  $p=0.633$ ]. Moreover, no differences were observed between groups regarding 1-year remission, late remission, relapse or incidence rates (**supplement 3**).

Only the 5-year percentage of excess weight loss was independently associated with low HDL cholesterol remission rates 5 years after BS (**supplement 4**).

#### Hypertriglyceridemia

The hypertriglyceridemia remission rate at 5 years was higher after LRYGB compared to LSG [23/25 (92.0%) versus 10/15 (66.7%);  $p = 0.041$ ]. Moreover, LSG presented a greater

relapse rate compared to LRYGB, with no differences between groups in incidence or late remission rates (**supplement 3**).

Absence of fibrate therapy at baseline and the 5-year percentage of excess weight loss were independently associated with hypertriglyceridemia remission 5 years after BS (**supplement 4**).

## DISCUSSION

The present study is the first to directly compare the remission rates of hypercholesterolemia, high LDL cholesterol, hypertriglyceridemia and low HDL cholesterol 5 years after LRYGB and LSG, and establish associated factors.

The effect of LRYGB on total and LDL cholesterol was the main differential effect on the lipid profile compared with LSG. Multivariate analysis showed LRYGB to be associated with a 5-fold higher probability of achieving LDL cholesterol remission. This superiority of LRYGB was described in several short-term studies <sup>(7,15,16)</sup> and a recent meta-analysis <sup>(17)</sup>. Concurring with the present study, two recent randomized trials, the SLEEVEPASS trial <sup>(9)</sup> and the SM-BOSS trial <sup>(10)</sup>, which compared mid-term results after LRYGB and LSG, found both techniques comparable with respect to weight loss and comorbidity remission, but with significant differences in LDL cholesterol reduction.

However, the only study to date evaluating the remission rates of the different lipid subfractions up to 5 years after BS was published by Brethauer et al <sup>(18)</sup>. Two hundred and seventeen patients with type 2 diabetes mellitus (T2D) were included (162 LRYGB, 32 gastric band and 23 LSG), although the different surgical procedures were not directly compared. A 72% remission rate of hypercholesterolemia at 6 years after surgery was reported, higher than the present results, probably due to a higher percentage of patients undergoing LRYGB in the former.

A possible explanation for the superiority of LRYGB over LSG regarding LDL cholesterol reduction may be its malabsorptive effect. A correlation seems to exist between the extent of the malabsorptive area of the surgical technique and LDL cholesterol decline: purely malabsorptive procedures, such as biliopancreatic diversion, achieve up to a 50% reduction in LDL cholesterol levels <sup>(19)</sup> compared to 20% with hybrid techniques such as LRYGB with a lower degree of malabsorption <sup>(20)</sup>. In contrast, LSG and other restrictive procedures do not have an effect on LDL cholesterol lowering <sup>(21,22)</sup>.

Male sex was also found to be associated with high LDL cholesterol remission. However, no differences were found between gender regarding baseline characteristics or % EWL (data not shown). These results contrast with those of Perrone et al <sup>(23)</sup> who found no significant differences in long-term comorbidity outcomes between genders after both procedures. However, in this study they did not evaluate dyslipidemia for separate, but combined it together with T2D, hypertension and obstructive sleep apnea. There is a great variability in LDL cholesterol reduction depending on different lipid-lowering strategies. In this respect, gender differences in lipid metabolism could at least partially explain this phenomenon <sup>(24,25)</sup>, although future investigation in this field could provide more robust conclusions.

Lack of statin treatment at baseline was also associated with a high LDL cholesterol remission rate. This probably indicates that patients who at baseline did not receive specific lipid-lowering treatment had “milder” hypercholesterolemia, and thus can more easily achieve remission than others who require a more aggressive lipid-lowering therapy. The results are in accordance with those of other comorbidities where the number of antihypertensive drugs or the absence of insulin therapy were also described as remission-associated factors <sup>(26,27)</sup>.

As for HDL cholesterol, both techniques were equivalent with respect to the low HDL cholesterol remission rate at 5 years of follow-up. In the present study, LSG seemed to be superior to LRYGB regarding HDL cholesterol concentration increase in the first 2 years after

BS, which could explain the differences observed between techniques in previous short and mid-term studies<sup>(7,16)</sup>. However, a meta-analysis<sup>(17)</sup> comparing both surgical procedures in the short-term and the recent randomized trials<sup>(9,10)</sup> with mid-term follow-up did not detect differences in HDL cholesterol changes or remission. Moreover, 5-year weight loss was the only factor associated with low HDL cholesterol remission at mid-term after surgery. A direct relationship between weight loss after surgery and improvement in HDL cholesterol has been reported in previous short and mid-term studies<sup>(28,29)</sup>.

High triglyceride levels are also common in patients with morbid obesity, and suppose a higher risk of cardiovascular events. The hypertriglyceridemia remission rate at 5 years was significantly higher after LRYGB compared with LSG (92.0% versus 66.7%), probably because the relapse rate was higher after LSG (4.5% versus 30.8%). Nevertheless, these differences cannot be attributed to the type of surgical procedure per se since this was not an independent factor associated with hypertriglyceridemia remission. A possible explanation may be that baseline triglycerides and the percentage of patients receiving fibrate treatment were higher in the LSG group compared to LRYGB [5/15 (33%) versus 4/25 (16%), respectively], although these differences did not reach statistical significance. This hypothesis is supported by the fact that the absence of fibrate treatment was found to be an independent factor associated with hypertriglyceridemia remission, similar to other obesity-related comorbidities<sup>(26,27)</sup>. In agreement with the present findings, previous studies also found no differences between both techniques regarding the remission rate of hypertriglyceridemia or concentration change in the short and mid-term after BS<sup>(9,10,30)</sup>.

Similar to HDL cholesterol, the percentage of excess weight loss at 60 months was also a factor associated with hypertriglyceridemia remission at 5 years, thereby highlighting the close relationship between weight loss and lipid profile evolution<sup>(28)</sup>.

As mentioned earlier, few studies reported dyslipidemia remission directly when comparing

both techniques at mid-term<sup>(6,9,10,23,31,32)</sup>, and highly variable remission rates (9-92%) were reported. Therefore, it is not possible to compare the results of the present study with previous literature for several reasons. First, the definitions used for dyslipidemia vary widely: not reported<sup>(6,9,23,31,32)</sup> or the presence of “low HDL cholesterol and/or hypercholesterolemia and/or hypertriglyceridemia and/or under lipid-lowering treatment”<sup>(10)</sup>. Second the differences defining dyslipidemia remission: not reported<sup>(32)</sup>, withdrawal of lipid-lowering medication alone<sup>(6,10,23,31)</sup> or normalization of LDL cholesterol levels with withdrawal of lipid-lowering medication<sup>(9)</sup>. Moreover, none of the studies evaluated the different lipid subfraction remission rates individually. Thus, the main strength of the present study lay in evaluating hypercholesterolemia, hypertriglyceridemia and low HDL cholesterol individually, which may highlight the differences between procedures.

Certain limitations of the present study should be acknowledged. Firstly, the non-randomized design, as patients were assigned either to LRYGB or LSG according to clinical criteria. Therefore, future randomized prospective studies are necessary to confirm the present findings. Secondly, since a significant number of patients were lost to follow-up, the results cannot thus be extrapolated to the whole BS cohort. Nevertheless, adjustment for several possible confounders may minimize its impact. It should be emphasized that the majority of studies on BS patients with a mid-term follow-up reported similar numbers lost to follow-up<sup>(33)</sup>. Thirdly, study groups were not equivalent at baseline (regarding BMI, LDL cholesterol and statin therapy), which may have influenced the final results. However, several confounding factors were included in the multivariate analysis. Finally, data on lifestyle such as dietary habits, physical activity, alcohol consumption or smoking cessation were not available, and the male sample size was smaller than the female, reflecting that fewer men than women choose BS.

**CONCLUSIONS**

In the present study, LRYGB was associated with better mid-term results compared to LSG in terms of high LDL cholesterol remission, without significant differences in hypertriglyceridemia and low HDL cholesterol remission. Future randomized prospective studies in this field with long term follow-up are mandatory to confirm the present results.

**DISCLOSURES**

All authors have equally participated in the work, have reviewed and agree with the content of the article. The authors have no conflict of interest to declare. We thank Miss Christine O'Hara for review of the English version of the manuscript.

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**TABLE LEGENDS****Table 1: Baseline characteristics of the 151 patients included in the study**

Legend: BMI, body mass index; T2D, type 2 diabetes; LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy.

**Table 2: Baseline and 5-year concentrations of the different lipid subfractions.**

Legend: LDL, low-density lipoproteins; HDL, high-density lipoproteins; LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy; IQR, interquartile range.

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**Table 1:** Baseline characteristics of the 151 patients included in the study.

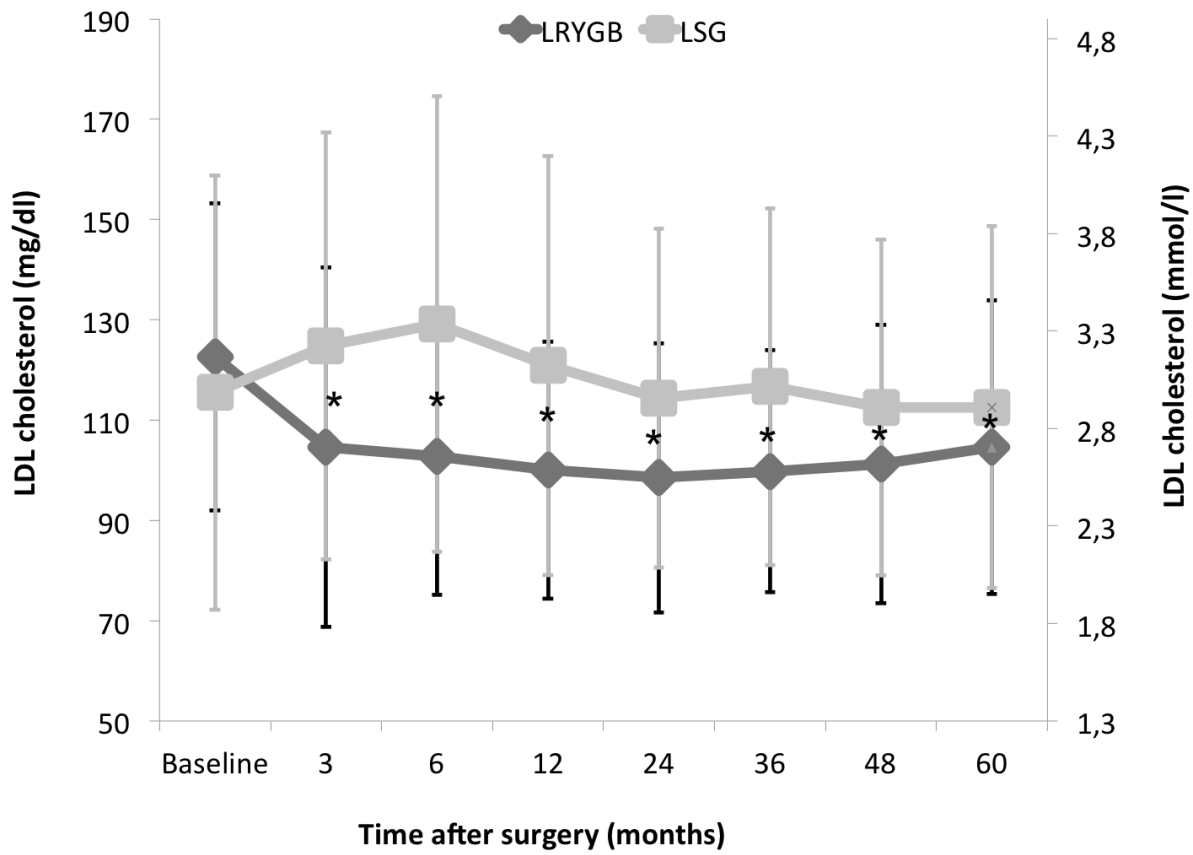
	<b>LRYGB (n= 103)</b>	<b>LSG (n=48)</b>	<b>P</b>
Sex, n (% females)	92 (89.3)	39 (81.3)	0.175
Age (years), mean $\pm$ SD	45.9 $\pm$ 8.5	46.6 $\pm$ 9.1	0.642
Weight (kg), mean $\pm$ SD	119.3 $\pm$ 16.0	117.3 $\pm$ 17.8	0.469
BMI (kg/m <sup>2</sup> ), mean $\pm$ SD	45.8 $\pm$ 4.5	43.7 $\pm$ 5.2	<b>0.013</b>
Abdominal circumference (cm), mean $\pm$ SD	126.3 $\pm$ 10.5	124.2 $\pm$ 11.5	0.414
Smoking habit, n (%)	27 (26.2)	9 (18.8)	0.319
Statin therapy, n (%)	11 (10.7)	11 (22.9)	<b>0.048</b>
Fibrate therapy, n (%)	4 (3.9)	5 (10.4)	0.708
T2D, n (%)	28 (27.2)	13 (27.1)	0.990
Hypertension, n (%)	46 (44.7)	24 (50.0)	0.543

BMI, body mass index; T2D, type 2 diabetes; LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy.

**Table 2:** Baseline and 5-year concentrations of the different lipid subfractions.

	<b>LRYGB</b>	<b>LSG</b>	<b>p</b>
<b>Total cholesterol</b>			
Baseline hypercholesterolemia, n (%)	58 (56.3)	26 (54.2)	0.471
Baseline total cholesterol, (mg/dl), mean $\pm$ SD	199.5 $\pm$ 34.2	198.4 $\pm$ 39.3	0.870
Baseline total cholesterol (mmol/l), mean $\pm$ SD	5.2 $\pm$ 0.9	5.1 $\pm$ 1.0	
5-year total cholesterol (mg/dl), mean $\pm$ SD	189.9 $\pm$ 35.5	203.4 $\pm$ 39.4	<b>0.046</b>
5-year total cholesterol (mmol/l), mean $\pm$ SD	4.9 $\pm$ 0.9	5.3 $\pm$ 1.0	
5-year total cholesterol change (mg/dl), mean $\pm$ SD	- 9.6 $\pm$ 33.3	5.0 $\pm$ 33.7	<b>0.013</b>
5-year total cholesterol change (mmol/l), mean $\pm$ SD	- 0.2 $\pm$ 0.9	0.1 $\pm$ 0.9	
<b>LDL cholesterol</b>			
Baseline high LDL cholesterol, n (%)	49 (47.6)	23 (47.9)	0.969
Baseline LDL cholesterol, (mg/dl), mean $\pm$ SD	123.7 $\pm$ 30.6	117.8 $\pm$ 43.3	<b>0.033</b>
Baseline LDL cholesterol (mmol/l), mean $\pm$ SD	3.2 $\pm$ 0.8	3.0 $\pm$ 1.1	
5-year LDL cholesterol (mg/dl), mean $\pm$ SD	102.9 $\pm$ 29.3	115.4 $\pm$ 36.1	<b>0.038</b>
5-year LDL cholesterol (mmol/l), mean $\pm$ SD	2.7 $\pm$ 0.8	3.0 $\pm$ 0.9	
5-year LDL cholesterol change (mg/dl), mean $\pm$ SD	- 20.9 $\pm$ 30.0	- 2.4 $\pm$ 42.9	<b>0.003</b>
5-year LDL cholesterol change (mmol/l), mean $\pm$ SD	- 0.5 $\pm$ 0.8	- 0.1 $\pm$ 1.1	
<b>HDL cholesterol</b>			
Baseline low HDL cholesterol, n (%)	47 (45.6)	23 (47.9)	0.796
Baseline HDL cholesterol (mg/dl), mean $\pm$ SD	51.3 $\pm$ 12.3	52.0 $\pm$ 23.7	0.833
Baseline HDL cholesterol (mmol/l), mean $\pm$ SD	1.3 $\pm$ 0.3	1.3 $\pm$ 0.6	
5-year HDL cholesterol (mg/dl), mean $\pm$ SD	70.5 $\pm$ 17.3	68.4 $\pm$ 20.3	0.542
5-year HDL cholesterol (mmol/l), mean $\pm$ SD	1.8 $\pm$ 0.4	1.8 $\pm$ 0.5	
5-year HDL cholesterol change (mg/dl), mean $\pm$ SD	19.2 $\pm$ 14.0	16.4 $\pm$ 29.1	0.522
5-year HDL cholesterol change (mmol/l), mean $\pm$ SD	0.5 $\pm$ 0.4	0.4 $\pm$ 0.8	
<b>Triglycerides</b>			
Baseline hypertriglyceridemia, n (%)	25 (24.3)	15 (31.3)	0.365
Baseline triglycerides (mg/dl), median (IQR)	107.0 (85.0-146.0)	130.5 (84.5-159.8)	0.147
Baseline triglycerides (mmol/l), median (IQR)	1.2 (1.0-1.6)	1.5 (1.0-1.8)	
5-year triglycerides (mg/dl), median (IQR)	71.0 (56.0-90.0)	82.0 (60.3-124.5)	<b>0.039</b>
5-year triglycerides (mmol/l), median (IQR)	0.8 (0.6-1.0)	0.9 (0.7-1.4)	
5-year triglycerides change (mg/dl), mean $\pm$ SD	- 39.8 $\pm$ 60.4	- 44.9 $\pm$ 72.5	0.671
5-year triglycerides change (mmol/l), mean $\pm$ SD	- 0.4 $\pm$ 0.7	- 0.5 $\pm$ 0.8	

LDL, low-density lipoproteins; HDL, high-density lipoproteins; LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy; IQR, interquartile range.



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