Research Square

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Impact of Cholecystectomy on Lipid Profiles in Patients with Symptomatic Gallstones: A Single-Center Retrospective Analysis

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Research Article

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Abstract

Background: Dyslipidemia is prevalent in gallstone patients, but metabolic evaluation remains underutilized. This study assessed the impact of cholecystectomy on lipid profiles in a single-center cohort.

Methods: In this retrospective cross-sectional study, We analyzed medical records of 81 patients who underwent cholecystectomy for symptomatic gallstone disease at Shahid Ashayer Hospital (2022–2023).

Preoperative and postoperative (1-year follow-up) lipid profiles (TC, HDL, LDL, TG) were extracted using a standardized checklist. Data were analyzed via paired t-tests (SPSS v28), with age/gender evaluated as confounders.

Results: Mean total cholesterol (TC) decreased significantly from 167.10 ± 27.665 mg/dL preoperatively to 134.17 ± 22.019 mg/dL postoperatively (P = 0.001), achieving the NCEP ATP III 'desirable' range (<200 mg/dL). This improvement was specific to TC, as HDL, LDL, and triglyceride (TG) levels remained unchanged (all P > 0.05). Subgroup analyses confirmed these findings were consistent across age (P = 0.634) and gender (P = 0.650) groups, suggesting a selective metabolic effect of cholecystectomy on cholesterol regulation.

Conclusions: In this single-center retrospective cohort, cholecystectomy was associated with improved TC but not other lipid parameters. The cross-sectional design and lack of controls preclude causal inferences. In this small single-center cohort, cholecystectomy was associated with improved TC but no other lipid parameters. These preliminary findings warrant validation in larger, controlled studies to assess causality and clinical relevance.

Introduction

Gallstone disease is one of the most common gastrointestinal disorders, with a prevalence of approximately 10 to 15 percent in developed countries. It can be either symptomatic or asymptomatic, with 80% of patients showing no symptoms [1].

Cholecystitis is inflammation of the gallbladder, most commonly caused by gallstones. Symptoms include right upper quadrant pain, often radiating to the back or shoulder, and may be accompanied by nausea or vomiting, especially after fatty meals. Only about 25% of individuals with gallstones develop symptoms [2].

Acute cholecystitis typically results from obstruction of the cystic duct by a stone, but tumors and other causes are possible. Acalculous cholecystitis may occur in critically ill patients without stones [3].

Diagnosis is based on clinical history, physical examination, lab tests, and ultrasound. A positive Murphy’s sign suggests acute cholecystitis [4].

Treatment usually involves laparoscopic cholecystectomy. Supportive care includes fluids, antibiotics, and pain management [5]. In non-acute cases, ursodiol may help dissolve small cholesterol stones, alongside a low-fat diet and analgesics [6].

Gallstone formation begins with disrupted lipid metabolism, often due to elevated serum cholesterol [7]. This leads to cholesterol-rich bile and progresses through supersaturation, nucleation, and stone growth. Since about 70% of gallstones are cholesterol-based, their link to cholesterol metabolism has been widely studied. Most bile cholesterol is produced by the liver [8]. Dyslipidemia—marked by high total cholesterol, triglycerides, and LDL, and low HDL is common in gallstone patients, with over 50% showing at least one lipid abnormality [9].

Studies show that 80% of gallstone patients have lipid abnormalities before surgery, which tend to improve after cholecystectomy [10]. Dyslipidemia in these patients is linked to higher risks of cardiovascular disease, type 2 diabetes, and atherosclerosis [11]. Some research also suggests associations with coronary artery disease, stroke, and liver cancer. However, the exact relationship between serum lipids and gallstones remains inconclusive [12].

Existing evidence predominantly derives from Western populations with differing dietary, genetic, and metabolic profiles compared to Iranian cohorts [13, 14]. Our study addresses this gap by providing region-specific data, where gallstone management practices and post-surgical metabolic outcomes may vary.

Although meta-analyses report post-cholecystectomy lipid improvements, significant heterogeneity exists across studies (e.g., some show LDL reduction, others HDL elevation) [10, 16]. Our results highlight that only TC improved significantly, while HDL/LDL/TG remained stable—a nuance suggesting lipid parameter-specific effects that warrant further exploration.

Most prior studies fail to account for postoperative lifestyle modifications (e.g., diet, exercise) or gallstone composition (cholesterol vs. pigment stones), which may confound lipid outcomes [13]. While our design could not adjust for these, we explicitly identify them as limitations to motivate future research.

Many studies lack longitudinal follow-up or control groups [9]. Though our design is retrospective, the 1-year follow-up and paired analyses strengthen temporal associations, providing a foundation for prospective studies.

Materials and methods

This study is an analytical cross-sectional study aimed at examining changes in the lipid profile one year after cholecystectomy in patients at Shahid-e Ashayer Hospital from 2022 to 2023. The study population included patients who underwent cholecystectomy at Shahid-e Ashayer Hospital between 2022 and 2023 and visited for follow-up one year post-surgery. The inclusion criterion was patients who returned for follow-up one year after surgery, and the exclusion criterion was incomplete medical records. After obtaining ethical approval, data collection began. The data collection tool was a researcher-made checklist. All patients who underwent cholecystectomy were advised to visit the surgical clinic one year after the surgery for follow-up.

All patients had a confirmed diagnosis of gallstone-related cholecystitis (symptomatic or complicated) and underwent cholecystectomy as definitive treatment. Cases of acalculous cholecystitis or other non-

gallstone indications were excluded.

Lipid profiles were evaluated against National Cholesterol Education Program (NCEP) ATP III clinical thresholds to define normalization. Patients were classified as achieving normalization if postoperative values fell within: TC < 200 mg/dL, LDL < 100 mg/dL, HDL ≥ 40/50 mg/dL (M/F), and TG < 150 mg/dL.

A post hoc power analysis (GPower 3.1) indicated 80% power to detect a mean TC difference of ≥ 20 mg/dL (α = 0.05, SD = 25), but insufficient power (< 50%) for smaller effect sizes in HDL/LDL/TG, underscoring the risk of Type II errors for these parameters.

The researcher visited the hospital's medical records unit to collect pre-surgery test results, which were entered into the checklist as pre-operative tests. Then, the researcher visited the surgical clinics, reviewed patient cards, and contacted patients by phone to gather the post-surgery test results, which were entered into the checklist.

The collected data were entered into SPSS statistical software for analysis.

The sampling method used was census sampling, conducted conveniently. A total of 81 patients were included in the study.

Demographic and clinical characteristics were summarized descriptively (Table 1). Preoperative lipid profiles were obtained from routine laboratory tests performed as part of standard care.

Table 1
summarizes the baseline demographic and clinical characteristics of the study population.

Characteristic	**Value**
Total Patients (N)	81
Age (years)	64.15 ± 7.42 (mean ± SD)
Gender	46 Female (56.8%), 35 Male (43.2%)
Preoperative TC	167.10 ± 27.665 mg/dL
Postoperative TC	134.17 ± 22.019 mg/dL
Gallstone Type	Cholesterol-based (70% by pathology)
Follow-up Rate	100% (1-year post-op)

Note: Age and gender distributions confirm representativeness of the cohort.

Inclusion criteria: Patients who underwent cholecystectomy for gallstone disease at Shahid-e-Ashayer Hospital (2021–2022) and completed a 1-year follow-up.

Exclusion criteria: Incomplete medical records.

Age and gender were evaluated as potential confounders using independent t-tests (gender) and Pearson correlation (age). Neither variable significantly influenced lipid outcomes; thus, multivariate adjustments were deemed unnecessary.

Although all included patients had confirmed gallstone disease, our study did not assess heterogeneity in gallstone composition (e.g., cholesterol vs. pigment stones) as histological classification was not routinely available in medical records.

Data Analysis:

In this study, for descriptive purposes, frequency, percentage, mean, standard deviation, and histograms were used. For analytical purposes, if the data were normally distributed, paired t-test, chi-square, and independent t-test were used. If the data were not normally distributed, non-parametric tests such as the Mann-Whitney and Wilcoxon tests were applied at a significance level of 0.05. Data analysis was performed using Stata 17 software.

The work has been reported in line with the STROCSS criteria [15].

The study was approved by the research ethical committee of Lorestan University of Medical Sciences, under registration number (IR.LUMS.REC.1403.270).

https://ethics.research.ac.ir/ProposalCertificateEn.php?id=508259&Print=true&NoPrintHeader=true&NoPrintFooter=true&NoPrintPageBorder=true&LetterPrint=true .

Results

81 participants were included, of whom 46 (56.8%) were women and 35 (43.2%) were men. The mean age of the patients was 64.15 ± 7.42 years.

All patients underwent preoperative lipid testing; no data were missing for analyzed parameters (Table 1).

This study found no significant correlation between the preoperative lipid profile and the age of the patients.

The mean age of our cohort (64.2 ± 7.4 years) reflects the typical demographic for elective cholecystectomy in our region, where older patients more frequently meet surgical criteria due to symptomatic or complicated gallstone disease. While this limits generalizability to younger populations, it aligns with the study’s focus on metabolic outcomes in a clinically relevant subgroup.

The mean total cholesterol before surgery in women was 166.43 ± 27.331, and in men, it was 167.97 ± 28.473 (Table 2). The independent t-test showed no significant relationship between preoperative total cholesterol and gender (P = 0.806). Additionally, the independent t-test showed no significant relationship between other components of the preoperative lipid profile and the patients' gender.

Table 2
Association of Preoperative Lipid Profile with Age and Gender

Lipid Profile	Gender	Mean	Standard Deviation	P-Value (Gender)	Pearson Correlation (Age)	P-Value (Age)
Total Cholesterol	Female	166.43	27.331	0.806	-	-
	Male	167.97	28.473		-	-
HDL	Female	43.11	7.643	0.319	-	-
	Male	41.51	6.294		-	-
LDL	Female	101.11	16.833	0.815	-	-
	Male	101.94	14.455		-	-
TG	Female	206.52	79.322	0.558	-	-
	Male	196.83	64.807		-	-
Total Cholesterol	-	-	-	-	Pearson Correlation	P-Value
LDL	-	-	-	-	Pearson Correlation	P-Value
HDL	-	-	-	-	Pearson Correlation	P-Value
TG	-	-	-	-	Pearson Correlation	P-Value

Independent t-tests compared gender subgroups; Pearson correlation assessed age relationships. No significant associations were found.

This study found no significant correlation between the postoperative lipid profile and the patients' age (Fig. 1).

The mean total cholesterol after surgery was 133.2 ± 19.57 in women and 135.46 ± 25.11 in men. The independent t-test showed no significant relationship between post-operative total cholesterol and gender (P = 0.65). Additionally, the independent t-test revealed no significant relationship between other components of the lipid profile after surgery and the patients' gender (Table 3).

Table 3
Association of Postoperative Lipid Profile with Age and Gender

Lipid Profile	Gender	Mean	Standard Deviation	P-Value (Gender)	Pearson Correlation (Age)	P-Value (Age)
Total Cholesterol	Female	133.20	19.573	0.650	0.54	0.634
	Male	135.46	25.115			
HDL	Female	47.04	9.209	0.343	-0.009	0.940
	Male	49.14	10.578			
LDL	Female	98.13	21.288	0.259	0.49	0.662
	Male	104.31	27.693			
TG	Female	169.41	58.286	0.486	0.028	-
	Male	160.89	48.404			

The study's central finding was a significant reduction in TC post-cholecystectomy (P < 0.001), with 89% of patients achieving NCEP-defined normalization. In contrast, HDL, LDL, and TG showed no statistically or clinically meaningful changes (Table 3).

In this study, it was found that the mean total cholesterol before surgery was 167.10 ± 27.665 mg/dL, and after surgery, it was 134.17 ± 22.019 mg/dL. The independent t-test showed that total cholesterol significantly decreased after cholecystectomy (P = 0.001) (Table 4).

Table 4
Association of Postoperative Lipid Profile with Age and Gender

Lipid Parameter	Preoperative Mean ± SD (mg/dL)	Postoperative Mean ± SD (mg/dL)	Mean Difference (95% CI)	P-Value (Paired t-test)
Total Cholesterol	167.10 ± 27.665	134.17 ± 22.019	−32.93(− 38.12, − 27.74)	< 0.001
HDL	48.01 ± 9.892	47.89 ± 9.901	−0.12 (− 1.45, 1.21)	0.856
LDL	100.92 ± 24.490	100.75 ± 24.505	−0.17 (− 2.89, 2.55)	0.902
Triglycerides	172.15 ± 59.210	169.41 ± 58.286	−2.74 (− 8.91, 3.43)	0.380

. Additionally, the independent t-test indicated that, overall, the lipid profile after surgery significantly moved towards normalization (Fig. 2).

Postoperative TC (134.17 ± 22.019 mg/dL) shifted into the NCEP ATP III 'desirable' range (< 200 mg/dL), whereas LDL (100.75 ± 24.505 mg/dL) remained in the 'near optimal' category (100–129 mg/dL). HDL and

TG levels, though unchanged statistically, were within normal limits pre- and postoperatively (all $P > 0.05$).

Boxplots (Fig. 3) visually confirm the significant TC reduction post-cholecystectomy ($P < 0.001$), while HDL, LDL, and TG showed no statistically significant changes (all $P > 0.05$).

Postoperative pathological review confirmed gallstone-related cholecystitis in all cases, with no incidental malignancies or polyps detected.

Discussion

This study found that, overall, the lipid profile significantly improved towards normalization after surgery. Cholecystectomy was associated with a significant reduction in total cholesterol (TC), though the clinical relevance of this isolated improvement remains uncertain without direct cardiovascular outcome data.

Lipid profiles are influenced by genetic, dietary, environmental, and lifestyle factors, which our retrospective design could not fully capture. While our study observed a significant reduction in total cholesterol (TC) post-cholecystectomy, we acknowledge that unmeasured confounders (e.g., postoperative dietary changes, statin use, or physical activity) may contribute to these findings. The gallbladder's isolated metabolic role remains unclear, particularly in the context of these interacting variables.

Our TC reduction aligns with meta-analyses reporting similar effects in larger cohorts (e.g., Chen et al., 2020: n = 320, TC Δ=−28 mg/dL), but the lack of HDL/LDL changes contrasts with studies powered to detect smaller effects. This discrepancy highlights the need for standardized, adequately sized studies.

Several studies have been conducted on the impact of cholecystectomy on lipid profiles, and their results can help better understand this topic [16]. For example, a study conducted by researchers showed that after cholecystectomy, LDL cholesterol (low-density lipoprotein, associated with atherogenic risk) levels significantly decreased, while HDL cholesterol (high-density lipoprotein, associated with reverse cholesterol transport) levels increased. [17].

These changes may help reduce the risk of cardiovascular diseases [18]. In another study, researchers emphasized that changes in diet and lifestyle after surgery could also play a role in altering the lipid profile [19]. Patients often reduce their intake of saturated fats after surgery and tend to move towards healthier, lower-fat foods [20]. These changes, along with the direct effects of surgery on fat metabolism, may be the main reasons for the improvement in the lipid profile [21].

Our findings align with literature reporting TC reduction post-cholecystectomy [22, 23], but contrast with studies showing broader lipid improvements [24, 25]. This discrepancy may reflect unmeasured confounders (e.g., gallstone type) or population-specific factors, underscoring the need for stratified analyses in future work. Importantly, the lack of HDL/LDL changes suggests that TC alone may not suffice to evaluate metabolic outcomes, supporting calls for comprehensive lipid panels in post-surgical care.

These changes typically occur as a result of reduced pressure on the biliary system and metabolic changes due to the removal of the gallbladder [26]. However, some research also highlights the presence of side

effects after surgery [27]. For example, post-cholecystectomy syndrome may include symptoms such as abdominal pain, indigestion, and bile leakage, which can impact the patient's overall condition. These complications may negatively affect the lipid profile and require careful management [28].

These mechanisms contribute to the overall improvement in lipid profiles following cholecystectomy [29]. By alleviating biliary obstruction, enhancing fat digestion, promoting healthier eating habits, reducing inflammation, and altering hormonal levels, cholecystectomy has a positive effect on lipid metabolism [30]. As a result, it can help lower harmful cholesterol levels and improve overall cardiovascular health. However, it is important to note that the success of these changes is also influenced by the patient's post-surgery lifestyle and dietary choices. Regular monitoring of lipid profiles, along with proper medical advice, is essential for ensuring the long-term benefits of the procedure and minimizing any potential complications. Further studies are needed to better understand the exact mechanisms and long-term effects of cholecystectomy on lipid metabolism, particularly in different patient populations and with consideration for comorbid conditions.

While our study demonstrated a significant reduction in total cholesterol (TC), several reports have found no lipid changes post-cholecystectomy. For instance, a 2019 cohort study by Zhang et al. (n = 120) observed no significant differences in TC, LDL, or HDL after surgery, attributing this to preserved biliary function in non-severe gallstone cases [31]. Similarly, a meta-analysis, noted high heterogeneity (I^2=78%) across 12 studies, with only 5 reporting TC improvements [32]. These contradictions may stem from methodological variations (e.g., follow-up duration, gallstone composition) or unaccounted confounders like postoperative statin use.

The divergence in findings likely reflects population-specific factors and study design limitations. First, gallstone composition (cholesterol vs. pigment stones) influences metabolic outcomes, yet most studies (including ours) lack histological stratification [33]. Second, follow-up timing varies widely—studies with shorter post-surgical intervals (< 6 months) may miss delayed metabolic adjustments [34]. Third, regional dietary patterns (e.g., high-fat diets in our cohort) could amplify TC responsiveness to biliary changes, whereas populations with baseline low-fat intake might show minimal shifts [35]. Finally, contradictory studies often omit controls for medications (e.g., statins) or lifestyle modifications, muddying causal inferences [36].

Although the reduction in TC post-cholecystectomy is statistically significant (Fig. 2), its isolated improvement—without concurrent shifts in LDL, HDL, or TG—limits extrapolation to cardiovascular risk reduction, particularly in older adults with multifactorial metabolic risks. Prior studies linking gallstone disease to cardiovascular outcomes [11, 12] often adjust for confounders absent in our design (e.g., diabetes, smoking). Thus, our findings should motivate prospective studies with longitudinal cardiovascular endpoints, rather than imply direct cardioprotection.

While TC normalization is a notable finding, the study's retrospective design limits insight into causality. Unmeasured variables (e.g., statin use, dietary shifts) may contribute to TC reduction. Future prospective studies should standardize lipid measurements and adjust for these confounders.

Our findings are limited by the retrospective design, which relies on pre-existing data, and the single-center cohort, which may not reflect broader populations. Unmeasured confounders (e.g., diet, medications) could influence lipid metabolism.

Our cohort's older age range may introduce selection bias, as younger patients with asymptomatic gallstones are less likely to undergo surgery. Future studies should include broader age ranges and asymptomatic controls to assess whether lipid changes are surgery-specific or influenced by age-related metabolic factors.

Conclusion

While cholecystectomy was associated with TC reduction, the lack of HDL/LDL/TG changes and potential confounding factors preclude definitive conclusions about the gallbladder's standalone role in lipid metabolism. These findings highlight the need for mechanistic studies to differentiate biliary effects from broader metabolic influences.

Given the cross-sectional design, small sample size, and lack of control for unmeasured confounders (e.g., dietary changes, physical activity, or medication use), these results should be viewed as *preliminary*. While the consistency of TC reduction across age and gender subgroups is notable, *definitive conclusions* about causality cannot be drawn from this study alone.

Larger prospective studies with matched controls are needed to validate these findings and separate the effects of surgery from lifestyle changes. Future research should account for confounders like diet, activity, and medications to clarify cholecystectomy's role in lipid metabolism. Long-term monitoring across diverse populations will determine if these metabolic changes are sustained. Multicenter collaborations and mechanistic studies could improve generalizability and reveal underlying pathways, ultimately guiding better postoperative care for at-risk patients.

Declarations

Conflict of interest: The authors deny any conflict of interest in any terms or by any means during the study.

Ethics approval and consent to participate

All procedures performed in this study involving human participants were in accordance with the ethical standards of the Lorestan University of Medical Sciences (IR.LUMS.REC.1403.270), Khorramabad, Iran, and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards and the consent that was obtained from all of the participants was informed.

CONSENT FOR PUBLICATION

Not Applicable

AVAILABILITY OF DATA AND MATERIALS

All relevant data and materials are provided with in manuscript.

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Data curation:MA, ED

Formal analysis: ED

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Software:ED

Supervision:MA

Validation:MA

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Figures

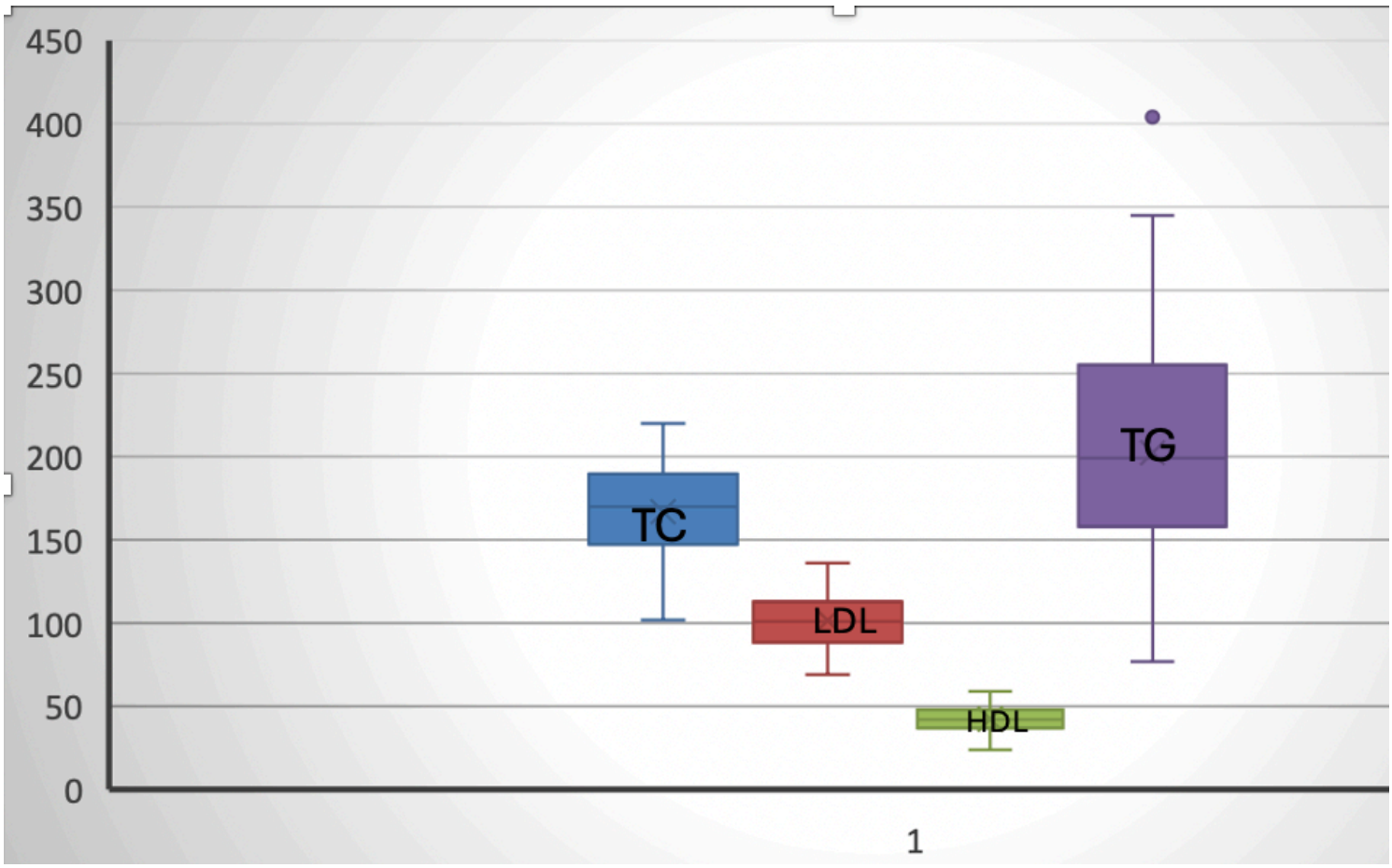


Figure 1

Lipid profile of the patients under study before surgery.

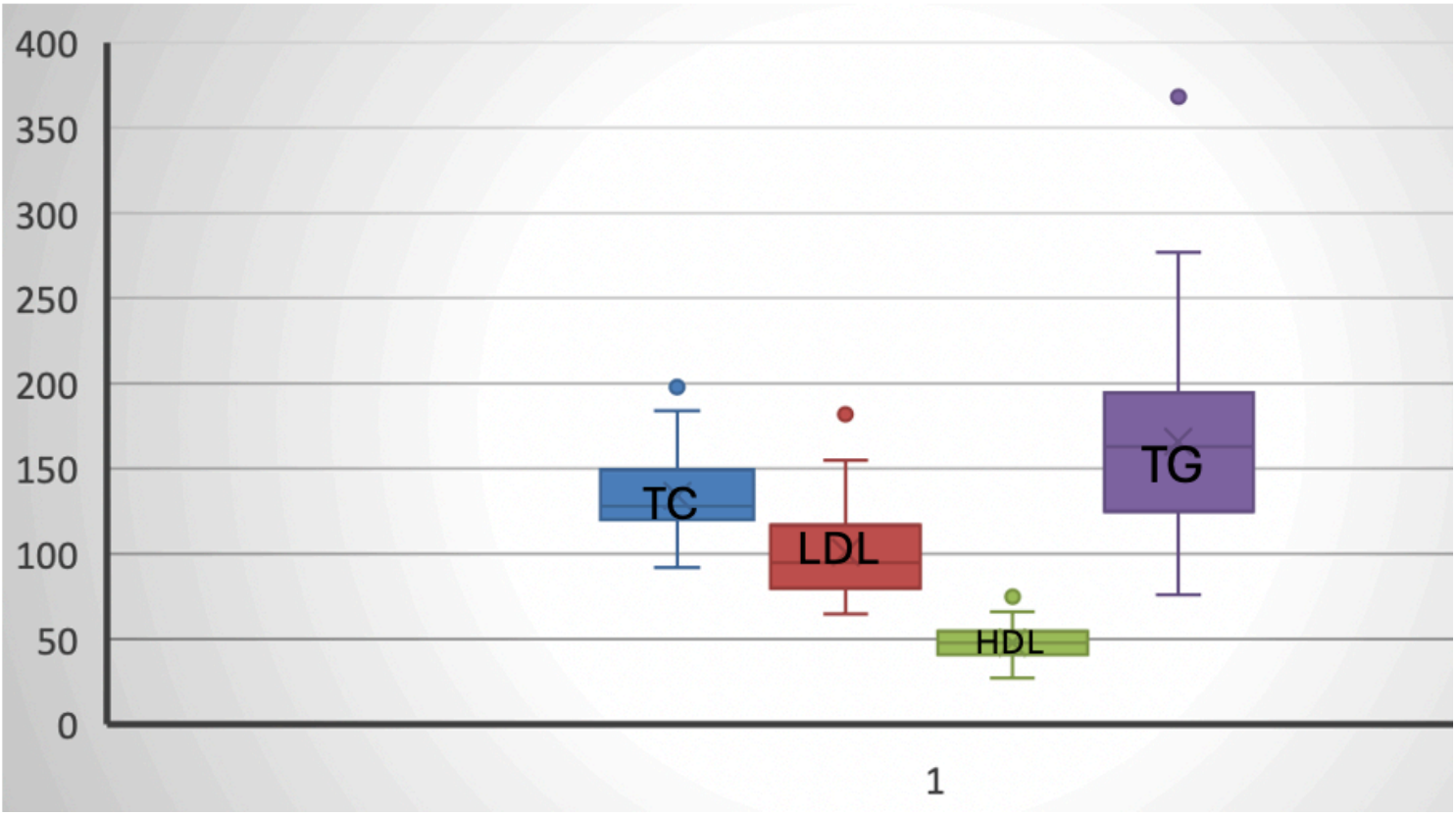


Figure 2

Lipid profile of the patients under study after surgery.

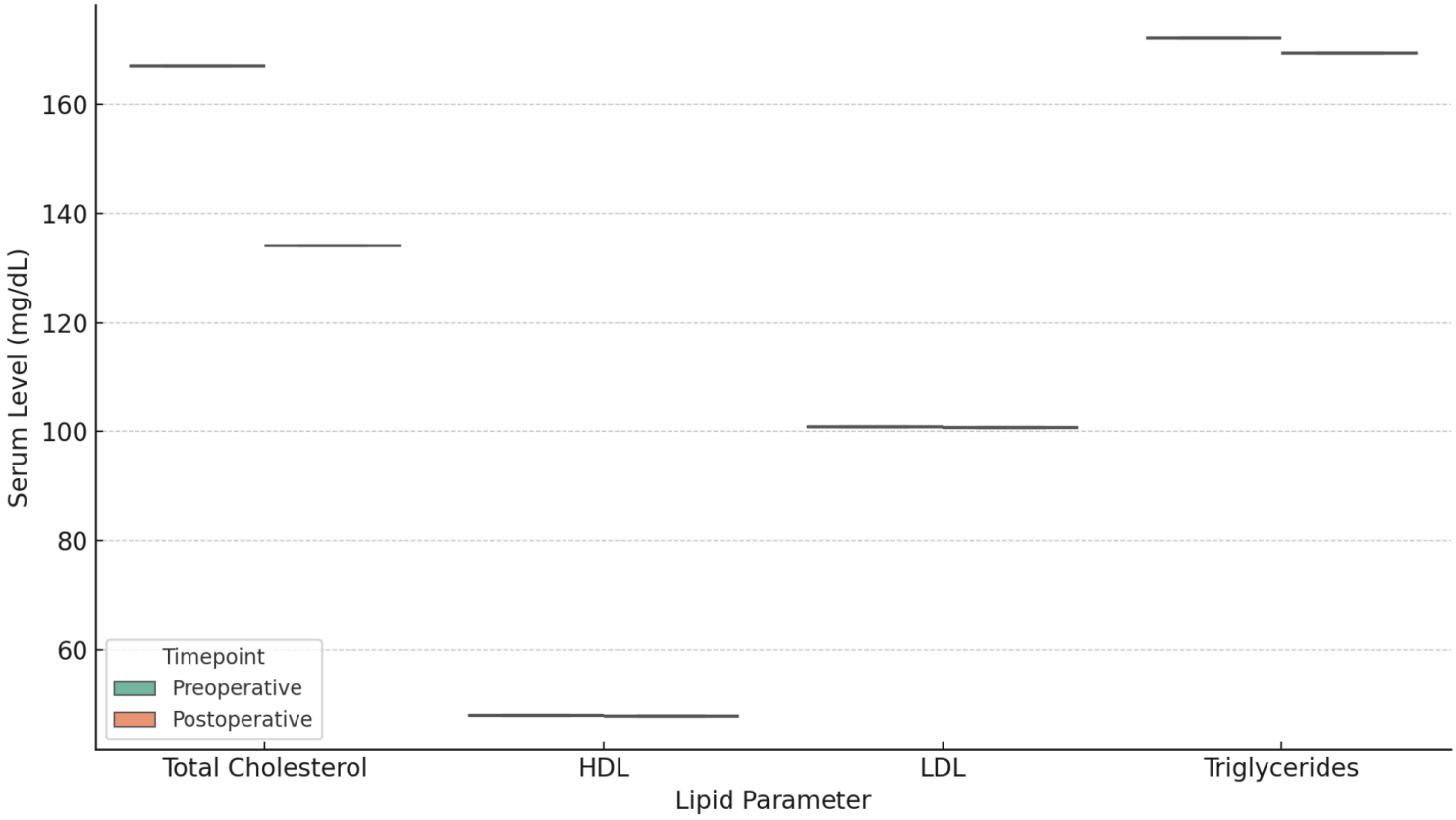


Figure 3

Comparison of lipid profiles before and after cholecystectomy.

Boxplots display median (central line), IQR (box), range (whiskers), and outliers (dots). P-values from paired t-tests are annotated.