Advanced Medical Journal, Vol.10, No.2, P.42-49,2025 https://doi.org/10.56056/amj.2025.341

Association Between Cholesterol and Low-Density Lipoprotein Levels with In-Hospital Complications of Percutaneous Coronary Intervention

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Abstract

Background and objectives: Percutaneous coronary intervention is the treatment of choice for revascularization in patients with coronary artery disease. The aim of the study is to investigate the relationship between cholesterol and low-density lipoprotein levels and percutaneous coronary intervention complications.

Methods: This prospective cohort study was conducted at Suleimani Cardiac Hospital from April to October 2023. The study included 115 patients who had acute coronary syndrome and underwent percutaneous coronary intervention within 72 hours of the symptoms. Venous blood samples were drawn from all patients; the basic investigation and lipid profile were measured. The patients were monitored in the ward for complications from percutaneous coronary intervention.

Results: The mean age of the participants was 60.90 years (SD = 11.27), 64.3% of the participants were male, and the mean body mass index of the participants was 28.37 (SD = 4.18). Seventy-six percent of the participants had a past medical history; hypertension was the most common (26.1%). Forty-six percent of participants were not using any medications, and 49.6% of the participants were nonsmokers. There were no statistically significant differences in the incidence of in-hospital complications of percutaneous coronary intervention or hospital stay duration among patients with different total cholesterol and low-density lipoprotein levels, as all p values are above 0.05.

Conclusion: There was no relationship between baseline total cholesterol and low-density lipoprotein levels and in-hospital complications of percutaneous coronary intervention.

Keywords: Coronary artery disease, Low-density lipoprotein cholesterol, Percutaneous coronary intervention complications, Total cholesterol

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Introduction

Coronary artery disease (CAD) is considered a leading cause of death globally, and over the past decades, percutaneous coronary intervention (PCI) has become the treatment of choice for revascularization in patients with CAD.[1] There is a dramatic advancement in the technology and applicability of percutaneous techniques in the treatment of CAD.[2] Nevertheless, PCI may lead to periprocedural complications and death.[3] The complications of PCI have a great impact on the survival of the patient and healthcare costs.[4] Several factors affect the procedure outcome, some of them related to the patient, such as patient age, nature of the lesion, presence of congestive heart failure class III or IV, and presence of multivessel disease. Some factors related to the operator's performance and the time of the procedure from the onset of symptoms.[5]. A high total cholesterol (TC) level is a well-known independent risk factor for atherosclerosis. Hypercholesteremia is strongly associated with higher mortality and morbidity in patients with atherosclerotic heart disease.[6] High low-density lipoprotein (LDL) has a major role in the development and progression of CAD.[7] Due to its important role in the evolution of atherosclerosis and associated cardiovascular events, and the efficient management of dyslipidemia associated with the prevention of cardiovascular diseases.[8] The association of TC and LDL with PCI complications is not well understood, and the impact of TC and LDL levels on PCI outcome is poorly studied, and there is some controversy in the literature. Some researchers postulate that high TC and LDL are associated with a greater risk for PCI complications, while others support the cholesterol paradox; they believe that low TC and LDL are associated with a greater risk for PCI complications. However, some authors report that there is no relevant correlation between TC and LDL levels and PCI outcomes. The aim of the study is to investigate the relationship between TC and LDL levels and PCI complications and determine optimal LDL levels for PCI.

Patients and methods

This prospective cohort study was conducted at Suleimani Cardiac Hospital. All patients who presented with acute coronary syndrome (ST elevation myocardial infarction, non-ST elevation myocardial infarction, and unstable angina) and underwent PCI within 72 hours of the symptoms were included. The patients with the following characteristics were excluded from the research: those who survived cardiac arrest, those who presented with cardiogenic shock, those delayed in the PCI for more than 72 hours from the time of symptoms, baseline investigations not available, younger than 18 and older than 80, who referred to coronary artery bypass surgery (CABG), severe heart failure (LVEF <30%), prior CABG, and chronic kidney disease. Therefore, only 115 patients were included in the analysis. Peripheral venous blood samples were drawn from all patients who underwent PCI, and the complete blood count (CBC), renal function test, and serum electrolytes were measured. A Cobas Pro analyzer is used to measure the levels of TC and LDL in the serum of the patient. A total cholesterol level of less than 200 mg/dL, 200 to 239 mg/dL, and ≥ 240 mg/dL were considered normal, borderlines, and high, respectively. [9] The data were collected from the patient after an explanation of the research and verbal consent were obtained. Patient variables such as sociodemographic data, medical history, vital signs, type of ACS, complications at the time of presentation, Echo findings, baseline urea, and creatinine were recorded. The details of the procedure, which include the time of PCI from symptoms, access site, culprit and other coronary vessel lesions, and type of intervention, were recorded. The patients

https://doi.org/10.56056/amj.2025.341

were followed up in the CCU ward until the discharge of the patients from the hospital. The duration of hospital stays and the PCI complications were documented. The complications included cardiac and non-cardiac complications. Arrythmia was defined as an abnormality in the rate or rhythm of the heartbeat, namely tachyarrhythmia and bradyarrhythmia. Cardiac death (in hospital mortality) was considered if there was documented death within the hospital due to cardiac events. Hypotension was defined if the systolic and diastolic blood pressures were <100 and <60, respectively. Pulmonary edema was diagnosed by the occurrence of new bibasilar crackles, with confirmation by imaging. A prolonged QT interval was diagnosed after correction by Bazett formula. A cerebrovascular accident, which includes ischemic and hemorrhagic strokes, was defined as experiencing focal neurological deficits or altered mental status with confirmation by imaging. Gastrointestinal bleeding was defined as new hematemesis, melena, or bleeding per rectum after PCI with confirmation by endoscopy. Access site complications include access site bleeding and hematoma. Acute kidney injury (AKI) was defined as an increase in serum creatinine of 0.5 mg/dl from baseline creatinine. The Statistical Package for the Social Sciences (SPSS, IBM, Chicago, USA, version 27), including Shapiro-Wilk and Kolmogorov-Smirnov tests, was used to determine the normal distribution of the data. The chi-square test was used for categorical variables. Data were expressed as numbers (%) for categorical data and a mean (standard deviation) for numerical data. Independent samples, t-test, and analysis of variance were used for parametric variables. Mann-Whitney U and Kruskal-Wallis tests were used for non-parametric variables, respectively.A p value ≤0.05 was considered a significant difference. This article was approved by the research ethics committee of the Kurdistan Higher Council of Medical Specialties.

Results

The study included 115 individuals. The mean age of the participants was 60.90 years (SD = 11.27), 74 (64.3%) of the participants were male, 71 (61.7%) of participants resided in rural areas. The mean BMI of participants was 28.37 (SD = 4.18), Table (1).

Table (1): Sociodemographic data

Variable	Frequency	Percentage
Age (mean±SD = 60.90 ± 11.27 years)		
< 60 years	50	43.5
60-75 year	55	47.8
> 75 years	10	8.7
Gender		
Female	41	35.7
Male	74	64.3
Residency		
Urban	44	38.3
Rural	71	61.7
BMI (mean±SD = 28.37 ± 4.18)		
Normal weight	32	27.8
Overweight	44	38.3
Obese	39	33.9

The majority of participants, 88 (76.1%), had a past medical history, with the most common being hypertension (HTN). Twenty-four (20.9%) of participants had been previously admitted to the Cardiac Care Unit (CCU), and the most common reason was PCI (91.6%). Fifty-three (46.1%) of the participants were not using any medications at the time of the study. Fifty-seven (49.6%) of the participants were nonsmokers, Table (2)

https://doi.org/10.56056/amj.2025.341

Table (2): Details of past medical history

Medical history	Frequency	Percentage
Past medical history		
No	27	23.5
D.M	13	11.3
HTN	30	26.1
DM and HTN	31	27.0
Others	14	12.2
Previous admission to CCU		
No	91	79.1
Yes	24	20.9
Reason for admission to CCU		
PCI	22	91.6
ACS	1	4.2
Angiography	1	4.2
Past surgical history		
No	47	40.9
PCI	22	19.1
Others	46	40.0
Using drugs		
No	53	46.1
Antiplatelet	3	2.6
Lipid-lowering agents	2	1.7
Antiplatelet and Lipid-lowering	21	18.3
Others	36	31.3
Smoking		
No smoker	57	49.6
Ex-smoker	30	26.1
Active smoker	25	21.7
Passive smoker	3	2.6

The mean window period was 13.8 hours (±15.1) for STEMI, 28.9 hours (±20.5) for NSTEMI 57.6 hours (±13.5) for UA. One hundred seven (93.0%) of the PCIs were performed via radial access. In 113 (98.3%) of PCIs the stent is inserted. The most common culprit lesion site was the Left Anterior Descending Artery, Table (3).

Table (3)*:* Detail of the PCI

PCI	Frequency	Percentage
Window period in hours		
STEMI (n=49)	13.8 ± 15.1	
NSTEMI (n=51)	28.9 ± 20.5	
UA (n=5)	57.6 ± 13.5	
Access site		
Femoral	8	7.0
Radial	107	93.0
Technique		
Ballon	2	1.7
Stent	113	98.3
Culprit lesion		
LAD	56	48.7
LCX	21	18.3
LMS	1	.9
RCA	37	32.2

Regarding cardiac complications, arrhythmia occurred in 5.0% of patients with borderline levels (BL). Hypotension was recorded in 8.1% of participants with Normal level (NL). Pulmonary edema was encountered in 11% of patients with high levels (HL). A prolonged QT interval was observed in 20.0% of patients with BL. Death is reported in only one case with NL which accounts for 1.2%. Regarding non-cardiac complications, GI bleeding, and CVA, there were no reported cases in any group. AKI occurred in 8.1% of participants with NL. Access site complications were observed in BL (5.0%). The HL group had the shortest duration (1.0 days). There are no statistically significant differences, as all p values are above 0.05, Table (4).

https://doi.org/10.56056/amj.2025.341

Table (4): The distribution of PCI complications in relation to total cholesterol categories

In-hospital complications	Normal level (*n*=86)	Borderline (*n*=20)	High level (*n*=9)	P Value
Cardiac complications				
Arrhythmia	4 (4.7%)	1 (5.0%)	0 (0.0%)	0.799
Death	1 (1.2%)	0 (0.0%)	0 (0.0%)	0.884
Hypotension	7 (8.1%)	4 (20.0%)	1 (11.1)	0.294
Pulmonary edema	5 (5.8%)	2 (10.0%)	1 (11.1)	0.705
Prolonged QT interval	10 (11.6%)	4 (20.0%)	1 (11.1%)	0.596
Non-cardiac complications				
GI Bleeding	0 (0.0%)	0 (0.0%)	0 (0.0%)	1
CVA	0 (0.0%)	0 (0.0%)	0 (0.0%)	1
AKI	7 (8.1%)	1 (5.0%)	0 (0.0%)	0.614
Access site	2 (2.3%)	1 (5.0%)	0 (0.0%)	0.698
Hospital stays (days)	1.2 ± 0.6	1.6 ± 1.7	1.0 ± 0.0	0.142

Regarding cardiac complications, the occurrence of arrhythmia had the highest rate (8.3%) in the 130-159 LDL range. Death was more prevalent in the 130-159 LDL range (4.2%). Hypotension was encountered at a higher rate in the 70-99 and 130-159 LDL groups (16.0% and 16.7%, respectively). Pulmonary edema was observed with the highest rate (16.7%) in the ≥160 LDL group. The occurrence of prolonged QT intervals had the highest rate in the 100-129 LDL range. Regarding non-cardiac complications, there were no reported cases of GI bleeding or CVA across all LDL-level groups. The 70-99 and 130-159 LDL groups have higher rates of AKI (12.0% and 12.5%, respectively). Access site complications were highest in the <70 and 130-160 LDL groups. Other complications (recurrent chest pain, dyspnea, and hypoxia) were highest in 130-160 and >160 LDL groups. The mean duration of hospital stay was longest among those in the 70-129 LDL range and shortest in the 130-159 LDL group. There were no statistically significant differences, as all P-values are above 0.05, Table (5).

Table (5): The distribution of PCI complications in relation to low-density lipoprotein cholesterol categories.

In-hospital complications	< 70 (*n*=24)	70-99 (*n*=25)	100-129 (*n*=30)	130-159 (*n*=24)	≥ 160 (*n*=12)	p value
Cardiac Complication						
Arrhythmia	0 (0.0%)	1 (4.0%)	2 (6.7%)	2 (8.3%)	0 (0.0%)	0.567
Death	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (4.2%)	0 (0.0%)	0.430
Hypotension	0 (0.0%)	4 (16.0%)	2 (6.7%)	4 (16.7%)	2 (16.7%)	0.233
Pulmonary edema	0 (0.0%)	2 (8.0%)	2 (6.7%)	2 (8.3%)	2 (16.7%)	0.454
Prolonged QT interval	3 (12.5%)	3 (12.0%)	4 (13.3%)	3 (12.5%)	2 (16.7%)	0.996
Non-Cardiac Complication						
GI Bleeding	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1
CVA	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1
AKI	2 (8.3%)	3 (12.0%)	0 (0.0%)	3 (12.5%)	0 (0.0%)	0.255
Access site	1 (4.2%)	0 (0.0%)	0 (0.0%)	1 (4.2%)	1 (4.0%)	0.777
Hospital stays (day)	1.2 ± 0.7	1.5 ± 1.4	1.1 ± 0.3	1.4 ± 0.9	1.2 ± 0.4	0.527

https://doi.org/10.56056/amj.2025.341


Discussion

The findings of this study have demonstrated that there was no relationship between baseline TC and LDL-C levels and the in-hospital complications of PCI. These findings were also reported by Ahn et al., who found that a low LDL level is not associated with a lower risk for cardiovascular events.[10] Cho et al. reported that there is no cholesterol paradox in patients with acute myocardial infarction treated by primary PCI.[11] Chen et al. found similar findings while investigating patients undergoing PCI for ACS; they concluded that clinical outcomes in patients undergoing their first PCI were not related to baseline LDL.[12] Maadani et al. observed that there is no correlation between lipid profile and periprocedural myocardial injury.[13] Kang et al. found that there is no relationship between LDL particle size and platelet reactivity in vivo.[14] Khang et al. found that plasma LDL level is not associated with plaque burden and lipid-rich plaque in coronary lesions requiring PCI.[15] In contrast to what we found in our research, some researchers propose that there is a relationship between LDL level and complications of PCI. Zeng et al. reviewed eight relevant studies on the relationship between lipid profiles and PCI outcomes. They found that lipid profiles, including TC and LDL, are positively correlated with the severity of periprocedural myocardial infarction;[16] however, all studies failed to show a definite mechanism for their findings. Reindl et al. studied STEMI patients who underwent PCI, and they found that baseline LDL level was an independent risk factor for microvascular injury. There is a relevant clinical relationship between LDL metabolism and microvascular injury in acute STEMI.[17] In this study, only STEMI cases were included. Buturak et al. found that elevated TC and LDL are associated with an increase in the degree of preprocedural myocardial injury (PMI).[18] Chen et al. studied patients with UA who underwent PCI. The result of the study was that baseline LDL level is important predictors of PMI.[19] Zhong et al. found that patients who had low LDL levels had a lower risk of PMI during PCI.[20] In these studies, the troponin titer is used as a marker of PMI. Maaike et al. showed that elevated LDL levels were associated with an increase in infarct size in patients who underwent PCI.[21] In this study, the creatinine kinase is used to measure the infarct size of the myocardium. Larsen et al. found that there is an important correlation between LDL level and the degree of microvascular vasoconstriction, which leads to more dysfunctional coronary endothelium in a patient with a high LDL level.[22] These studies focused on the effect of LDL and TC on coronary vessels and PMI, but no clinical outcomes were observed.The cholesterol paradox was supported by some researchers; they suggest that the lower the TC and LDL, the greater the patient's risk of PCI complications. Guedeney et al. observed that patients with pre-operative LDL levels < 70 mg/dl are at high risk for major adverse cardiovascular events (MACE). They found that low LDL is associated with a high persistent inflammatory risk, which is strongly related to MACE. However, they found that giving lipid-lowering agents before the PCI even in patients with optimal LDL improves clinical outcomes.[23] Sia et al. concluded that high LDL has a protective role in the prevention of MACE in patients with STEMI undergoing PCI; however, it has no role in NSTEMI patients, and they could not explain the reason behind this variation.[24] Our study has several limitations. First, the study was conducted at a single center; second, only patients with ACS and PCIs within 72 hours were included, which may restrict the significance of its findings.

Conclusion

The outcome of the PCI was not affected by baseline total cholesterol or LDL; in addition,

https://doi.org/10.56056/amj.2025.341

we could not determine the optimal LDL level for the PCI. Therefore, there was no relationship between baseline total cholesterol and LDL levels and in-hospital complications of PCI.

Conflicts of interest

The author reports no conflicts of interest.

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