Cardiovascular Reviews, 2025, Volume 3, Issue 4
http://ojs.bbwpublisher.com/index.php/CR
Online ISSN: 2981-8109
Print ISSN: 3083-4880

Clinical Diagnostic Value of Serum Low-Density Lipoprotein Cholesterol Combined with Carotid Artery Ultrasound Parameters in Patients with Coronary Heart Disease

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Abstract: *Objective*: To analyze and study the results of carotid artery ultrasound examination and serum low-density lipoprotein cholesterol (LDL-C) detection in patients with coronary heart disease, aiming to explore their application effectiveness and value in the clinical diagnosis of coronary heart disease. *Methods*: A retrospective analysis was conducted on the diagnostic conditions of suspected coronary heart disease patients who visited our hospital from May 2023 to June 2025. Using coronary angiography results as the gold standard, 60 patients diagnosed with coronary heart disease were selected as the study group, and 60 patients without coronary heart disease were selected as the control group. LDL-C levels and carotid artery ultrasound parameters were compared between the two groups to evaluate their diagnostic value. *Results*: The IMT and plaque semi-quantitative scores in the study group were higher than those in the control group ($P < 0.05$); carotid artery plaques were detected in 47 patients in the study group, with a total of 103 plaques. The proportion of patients with ≥ 2 types of plaques was 66.67%, mainly consisting of heterogeneous plaques (34.95%) and soft plaques (56.31%), which were significantly higher than those in the control group ($P < 0.05$); LDL-C and TC levels in the study group were significantly higher than those in the control group ($P < 0.05$). *Conclusion*: The detection of serum LDL-C and carotid artery ultrasound parameters holds significant application value in the diagnosis of coronary heart disease (CHD). A combined detection approach can serve as an important reference for screening coronary artery lesions and provide a reference basis for formulating clinical diagnosis and treatment strategies.

Keywords: Serum low-density lipoprotein cholesterol; Carotid artery ultrasound parameters; Coronary heart disease; Diagnostic value

Online publication: December 31, 2025

1. Introduction

Coronary heart disease, as the most prevalent type of atherosclerotic cardiovascular disease, exhibits a high incidence rate among middle-aged and elderly populations. It is primarily characterized by cardiac circulatory disturbances and myocardial ischemia and hypoxia, with clinical manifestations including dyspnea, palpitations, chest pain, arrhythmia, decreased physical strength, and easy fatigue, posing a severe threat to patient health and safety. Early diagnosis and effective intervention are thus imperative. However, due to the disease's strong concealment and lack of specific symptoms in the early stages, early diagnosis presents certain difficulties [1].

Currently, although coronary angiography is widely recognized as the "gold standard" for diagnosing CHD, this examination faces issues such as high technical thresholds, exorbitant costs, and significant invasiveness to patients, making it challenging to popularize in clinical practice. Relevant studies have indicated that carotid artery ultrasound parameters and certain serum markers hold potential application value in the diagnosis of cardiovascular diseases. Among them, serum low-density lipoprotein cholesterol (LDL-C) is a commonly used assessment indicator. Elevated LDL-C levels can induce coronary atherosclerosis, and the occurrence and development of cardiovascular diseases are closely related to arteriosclerosis. Therefore, LDL-C is considered an independent risk factor for CHD and holds a significant reference value in its diagnosis [2,3].

In addition, due to its advantages of being safe, non-invasive, cost-effective, and efficient, ultrasound examination is increasingly widely used in clinical practice. Studies have confirmed that intima-media thickness (IMT) of the carotid artery is a reliable non-invasive assessment indicator for the early diagnosis of coronary heart disease [4]. Based on this, this study selected 120 patients with suspected coronary heart disease as the research subjects and further explored the application value of carotid artery ultrasound and LDL-C detection in the diagnosis of coronary heart disease by conducting these two tests.

2. Materials and methods

2.1. General information

The study selected patients with suspected coronary heart disease who visited our hospital from May 2023 to June 2025 as the sample selection period. Using coronary angiography results as the gold standard, 60 patients diagnosed with coronary heart disease were selected as the study group, and 60 patients without coronary heart disease were selected as the control group.

In the control group, there were 27 female patients and 33 male patients; the age range was 46-78 years, with an average age of (62.43 ± 4.77) years; the body mass index (BMI) range was 22.1-27.6 kg/m^2, with an average BMI of (25.28 ± 1.30) kg/m^2. In the study group, there were 28 female patients and 32 male patients; the age range was 48–77 years, with an average age of (63.08 ± 4.91) years; the BMI range was 22.6–27.3, with an average BMI of (25.35 ± 1.02) kg/m^2. There were no statistically significant differences in baseline data between the two groups ($P > 0.05$), meeting the basic requirements for comparative studies.

2.2. Inclusion and exclusion criteria

The inclusion criteria are as follows: The diagnostic gold standard was based on the results of coronary angiography. Patients in the study group were confirmed to have coronary heart disease and met the relevant diagnostic criteria outlined in the "Guidelines for the Diagnosis and Treatment of Stable Coronary Artery Disease" [5]. For all suspected coronary heart disease patients included in the study, carotid ultrasound examination and serum indicator testing had to be completed on the same day, with the interval between

coronary angiography and these tests not exceeding three days. Patients who had not received coronary heart disease-related treatment within the past six months and had complete medical records were also included.

The exclusion criteria are as listed:

(1) Patients with concurrent immunodeficiency diseases or hematological system disorders;

(2) Patients with impaired liver or kidney function;

(3) Patients with confirmed malignant tumors;

(4) Patients with a history of allergy to iodine contrast agents or those unable to tolerate relevant imaging examinations.

2.3. Methods

The methodology is as follows:

(1) Carotid ultrasound examination: The examinee was placed in a supine position, with the neck area fully exposed. A color ultrasound diagnostic instrument was used, with the probe frequency set at 7.5 MHz. During the examination, the examinee was instructed to turn their head 45° away from the side being examined, and the probe was used to scan both carotid arteries. The detected indicators included carotid IMT, plaque types, plaque characteristics, and plaque semi-quantitative scores;

(2) Serum indicator testing: Five milliliters of fasting blood was collected from the examinee's elbow vein in the morning, and the serum was separated through centrifugation and stored for testing;

(3) Coronary angiography: A digital flat-panel angiography machine was used for the examination, with its results serving as the diagnostic gold standard. The examinee was placed in a supine position, and local disinfection was performed, followed by the placement of a surgical drape according to standard operating procedures. A puncture site was selected approximately 2 cm above the transverse crease of the right wrist, at a location with a palpable radial artery pulse. After administering local anesthesia to the puncture area with 1% lidocaine, the right radial artery was punctured, and a sheath was inserted. Subsequently, iopromide contrast agent was injected. Two experienced interventional physicians independently evaluated the coronary artery lesions using a blinded method. If their opinions were consistent, the results could be directly recorded. In cases of discrepancies, they should jointly review the angiographic video, each explaining their rationale for judgment until a consensus was reached. If consensus could not be reached after discussion, a chief physician with SCAI coronary imaging certification who had not participated in the initial discussion should be brought in for review to reach a final conclusion. When at least one of the following vessels (the right coronary artery or its major branches, the left main coronary artery, the left circumflex artery, or the left anterior descending artery) exhibited a diameter stenosis exceeding 50%, combined with the overall condition of the patient, a diagnosis of coronary heart disease could be made.

2.4. Observation indicators

The observation indicators are as follows:

(1) Carotid artery ultrasound parameters: Ultrasound examination data from all patients were summarized and analyzed, with plaque scores, IMT, and specific types and categories of plaques recorded. Comparative studies were then conducted after data organization. The specific criteria for judgment are as follows:

(i) Semi-quantitative scoring of plaques: A score of 0 is assigned when there is no intimal thickening; a score of 1 is given when there is localized intimal thickening, but the IMT value does not exceed 1.5 mm; a score of 2 is recorded when a plaque has formed but has not caused significant vascular stenosis; a score of 3 is assigned for mild stenosis with a lumen stenosis rate below 50%; a score of 4 is given for moderate to severe stenosis, where the lumen stenosis rate exceeds 50% but is not completely occluded; and a score of 5 is recorded for complete vascular occlusion;

(ii) IMT measurement and determination: The measurement locations are selected at the bilateral carotid artery bifurcations and 1.0 cm proximal to them. Continuous monitoring is performed over three cardiac cycles, and the average value is calculated. An IMT < 1.0 mm indicates normal intima; an IMT between 1.0–1.5 mm is determined as intimal thickening; and an IMT ≥ 1.5 mm is judged as plaque formation;

(iii) Plaque classification: Plaques are classified into three types: hard plaques, soft plaques, and heterogeneous plaques. In terms of the number of types, 0 types represent no plaques, 1 type represents the presence of only one of the hard, soft, or heterogeneous plaques, and ≥ 2 types represent the simultaneous presence of two or three of the aforementioned plaque types;

(2) Serum index detection. After collecting and processing the patient's venous blood, serum index levels are measured within 0.5–2.0 hours using a fully automated biochemical analyzer. These include LDL-C, high-density lipoprotein cholesterol (HDL-C), total cholesterol (TC), and triglycerides (TG).

2.5. Data processing

This study utilized SPSS 22.0 statistical software for analysis. Count data were analyzed using the χ^2 test and presented as rates (%). Measurement data were tested using the *t*-value and presented as mean ± standard deviation (SD). A *P*-value less than 0.05 was considered the baseline for statistical significance.

3. Results

3.1. Ultrasonic examination results

The IMT and semi-quantitative plaque score in the study group were higher than those in the control group. In the study group, carotid artery plaques were detected in 47 patients, totaling 103 plaques, while in the control group, carotid artery plaques were detected in 9 patients, totaling 10 plaques. The proportion of patients with two or more types of plaques in the study group was 66.67%, significantly higher than that in the control group ($P < 0.05$), as shown in **Table 1** and **Table 2**.

Table 1. Comparison of IMT and semi-quantitative plaque scores (mean ± SD)

Group	Number of cases (n)	Plaque score (points)	IMT (mm)
Research group	60	2.35 ± 0.91	1.42 ± 0.23
Control group	60	0.92 ± 0.26	0.68 ± 0.19
t-value	-	11.704	19.214
P-value	-	< 0.001	< 0.001

Table 2. Comparison of plaque types and varieties [n (%)]

Group	Number of cases (n)	Plaque number diversity			Plaque echogenicity type		
		0 type	1 type	≥ 2 types	Hard plaque	Heterogeneous plaque	Soft plaque
Research group	60	13 (21.67)	7 (11.67)	40 (66.67)	9 (8.74)	36 (34.95)	58 (56.31)
Control group	60	51 (85.00)	9 (15.00)	0 (0.00)	3 (30.00)	7 (70.00)	0 (0.00)
χ^2-value	-	48.348	0.289	60.000	1.543	4.750	11.569
P-value	-	< 0.001	0.591	< 0.001	0.214	0.029	0.001

3.2. Serum indicators

There were no significant differences in the levels of TG and HDL-C between the two groups ($P > 0.05$). The levels of LDL-C and TC in the study group were significantly higher than those in the control group ($P < 0.05$), as shown in **Table 3**.

Table 3. Comparison of serum indicators (mean ± SD, mmol/L)

Group	Number of cases (n)	LDL-C	HDL-C	TC	TG
Research group	60	4.97 ± 1.67	1.71 ± 0.48	5.88 ± 1.53	3.59 ± 1.20
Control group	60	3.13 ± 1.60	1.68 ± 0.36	4.05 ± 1.42	3.61 ± 1.09
t-value	-	6.163	0.387	6.791	0.096
P-value	-	< 0.001	0.699	< 0.001	0.924

4. Discussion

As the most prevalent clinical cardiac disease, CHD arises when the endothelial cells of the coronary arteries are damaged, allowing lipid components to infiltrate and deposit on the coronary artery walls. This triggers the proliferation of fibroblasts, monocytes, and smooth muscle cells, accompanied by platelet adhesion and aggregation, forming atherosclerotic plaques that protrude into the lumen. These plaques can narrow the coronary lumen, obstruct blood flow, and result in myocardial ischemia and hypoxia, leading to myocardial dysfunction and subsequent organic lesions. Hence, it is also known as ischemic heart disease. Currently, CHD has emerged as one of the leading causes of mortality worldwide.

According to relevant survey data, the number of CHD patients in China exceeds ten million, with the death toll ranking second globally and still on the rise [6,7]. Therefore, early identification of CHD and timely and effective prevention and treatment hold significant public health implications. In the diagnosis of CHD, coronary angiography is internationally recognized as the gold standard. However, its clinical application is somewhat limited due to its invasive nature, high examination costs, the need for hospitalization, and the risk of surgical complications. At this stage, the search for more accurate, cost-effective, and early diagnostic measures has become a focal point of clinical research, with ultrasound examination consistently playing a pivotal role. Coronary arteries and carotid arteries share similar characteristics, both exhibiting slow blood flow phenomena and a high risk of atherosclerosis [8].

Ultrasound examination offers the advantages of being simple to operate and highly reproducible, making it a widely utilized clinical examination method. Carotid artery ultrasound demonstrates high sensitivity in detecting plaques, facilitating easier identification of carotid artery plaque conditions in patients and providing a basis for formulating treatment plans. IMT serves as a hallmark indicator of early atherosclerosis, with each 0.1mm increase in IMT in patients with coronary heart disease elevating the risk of concurrent acute myocardial infarction by 11% [9]. Moreover, the occurrence of atherosclerosis is frequently associated with abnormal lipid metabolism, which constitutes the pathological foundation for various cardiovascular diseases. Specifically, the extensive deposition of lipid particles such as LDL-C on the arterial intima promotes plaque formation and continuous enlargement, eventually leading to rupture, thrombus formation, lumen occlusion, or even complete blockage, thereby triggering adverse cardiovascular events. Therefore, LDL-C level detection can be employed to assess the degree of atherosclerosis and holds significant guiding value for the prevention and treatment of cardiovascular diseases [10].

According to the findings of this study, LDL-C levels in patients with coronary heart disease were (4.97 ± 1.67) mmol/L, and TC levels were (5.88 ± 1.53) mmol/L, both significantly higher than those in patients without coronary heart disease. Cholesterol indicators are among the important metrics for assessing cardiovascular disease risk. After undergoing oxidative modification, LDL-C leads to extensive cholesterol deposition within the arterial wall, precipitating arteriosclerosis. Consequently, its detection level can serve as an effective basis for diagnosing cardiovascular diseases. In addition to cholesterol, IMT also holds significant reference value in the diagnosis of CHD. It can, to a certain extent, reflect the severity of coronary artery lesions and can be considered as an independent risk factor for CHD. Observing the morphological changes in IMT through carotid artery ultrasound examination can effectively predict the progression trend of CHD at a stage before arterial plaque formation.

Moreover, plaque formation is a typical characteristic of atherosclerosis, providing a visual reflection of the severity of arteriosclerosis [11,12]. In this study, patients with CHD had a plaque score of 2.35 ± 0.91 points and an IMT of 1.42 ± 0.23 mm, both of which were higher than those in patients without CHD. Furthermore, the proportion of patients with ≥ 2 types of plaques (66.67%) was higher than that in patients without CHD, indicating that carotid artery ultrasound parameters can effectively reflect the extent of coronary artery lesions in patients, thereby clarifying the occurrence and progression of CHD.

5. Conclusion

In summary, both carotid artery ultrasound parameters and LDL-C levels are closely associated with the degree of coronary artery stenosis in patients with CHD. Combining these two factors can significantly improve the accuracy of predicting the risk of CHD occurrence. Therefore, when dealing with patients suspected of having CHD, joint detection of these two indicators can enhance diagnostic accuracy and facilitate the timely formulation and implementation of targeted intervention plans.

Disclosure statement

The authors declare no conflict of interest.

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