

Calculation Method of Coronary Artery OCT Quantitative Flow Fraction (OFR) to Evaluate the Morphological and Functional Effects of Enhanced Lipid-Lowering Therapy on Primary Coronary Vulnerable Plaques

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Abstract: *Objective:* Based on the quantitative calculation method of coronary optical coherence tomography (OCT) for blood flow fraction (OFR), this study aimed to evaluate the intervention effects of intensive lipid-lowering therapy on plaque morphological characteristics and vascular functional parameters in patients with primary coronary vulnerable plaques, providing clinical evidence for precise lipid-lowering treatment and improvement of vascular function in coronary artery disease (CAD). *Methods:* A total of 40 patients with primary coronary vulnerable plaques admitted to our hospital from June 2025 to June 2026 were enrolled as study subjects and randomly divided into a control group and an experimental group, with 20 cases in each group. The control group received conventional-dose statin therapy, while the experimental group underwent intensive lipid-lowering therapy with atorvastatin calcium 40mg combined with tafolecimab 150mg administered subcutaneously once every two weeks, with an intervention period of 12 months. OCT was used to assess morphological indicators of vulnerable plaques before and after intervention in both groups, and standardized OFR calculation methods were employed to evaluate changes in vascular functionality. The improvements in plaque morphology and vascular function recovery were compared between the two groups. *Results:* After intervention, the plaque fibrous cap thickness in the experimental group was significantly greater than that in the control group; plaque lipid area, plaque burden, and minimum lumen area were all significantly superior to those in the control group ($P < 0.05$); the OFR value in the experimental group was significantly higher than that in the control group, and the incidence of vascular dysfunction was significantly lower ($P < 0.05$); the improvement in lipid profiles in the experimental group was significantly more pronounced than in the control group, with statistically significant differences between the groups. *Conclusion:* The OFR calculation method enables precise assessment of vascular functional status in coronary artery lesions. Intensive lipid-lowering therapy effectively improves the morphological characteristics of primary coronary vulnerable plaques, stabilizes plaques, reduces vascular stenosis, significantly enhances blood flow reserve function in affected vessels, and lowers the risk of cardiovascular adverse events, demonstrating high clinical value.

Keywords: OCT quantitative flow fraction; OFR calculation method; Enhanced lipid-lowering therapy; Coronary artery

1. Introduction

Coronary artery disease (CAD) has become one of the leading causes of death from cardiovascular diseases globally, with acute cardiovascular events such as acute myocardial infarction and sudden cardiac death mainly caused by the rupture of vulnerable coronary plaques followed by thrombogenesis. In recent years, increasing clinical evidence has shown that the instability of vulnerable plaques is closely associated with abnormal lipid metabolism, and lipid-lowering therapy is a core intervention measure to stabilize plaques and reduce the risk of adverse cardiovascular events. However, there is still controversy in clinical practice over whether enhanced lipid-lowering therapy can bring additional benefits in improving plaque characteristics and vascular function compared with conventional-dose statin therapy, and how to evaluate the intervention effect accurately.

Coronary optical coherence tomography (OCT) has high spatial resolution and can clearly display the microstructural characteristics of coronary plaques, which is recognized as an important means for identifying vulnerable plaques. The OFR technology derived from OCT imaging realizes the simultaneous evaluation of plaque morphology and vascular function by integrating morphological information with hemodynamic calculation, which avoids the additional damage and examination cost brought by invasive functional measurement. At present, relevant research on applying OFR to evaluate the effect of enhanced lipid-lowering therapy on primary vulnerable coronary plaques is still relatively limited in China. Based on this, this study took patients with primary coronary vulnerable plaques treated in our hospital as the research subjects and used the OCT-based OFR quantitative calculation method to evaluate the effect of intensive lipid-lowering intervention on plaque morphology and vascular function, aiming to provide a reliable reference for the optimization of clinical lipid-lowering treatment strategies for CAD.

2. Materials and methods

2.1. General information

A total of 40 patients who were diagnosed with primary coronary vulnerable plaques and who were admitted to the Cardiology Department of our hospital during the period from June 2025 to June 2026 participated in this study. All of the participants underwent a process of definitive confirmation of the primary vulnerable plaques by means of coronary optical coherence tomography (OCT) imaging, and this imaging consistently showed the hallmark morphological characteristics of such plaques, that is to say, thin fibrous caps that enclose large cores that are rich in lipid. Then, the patients were randomly assigned, using a computer-generated random number table, to either a control group or an experimental group, and there were 20 cases allocated to each group to ensure a balanced distribution. The attributes at the demographic and clinical baseline of the two cohorts were as follows: The group that was taken as the control included 12 males and 8 females. There was an age distribution ranging from 48 years old to 75 years old. The age which was an average was 61.36 plus or minus 5.82 years. As for the involvement of coronary artery disease, 14 cases were

found to have single-vessel disease. However, the remaining 6 cases were found to have dual-vessel disease. On the contrary, the group that was set as the experimental group had 11 males and 9 females. The ages ranged from 47 years old to 76 years old. The age which was a mean was 60.92 plus or minus 5.65 years. Inside this group, 13 cases were identified to have single-vessel lesions, and 7 cases were shown to have dual-vessel lesions. Prior to the initiation of the study interventions, comprehensive statistical analyses were conducted to compare these baseline parameters between the two cohorts. The results showed that there were no statistically significant differences that could be seen between the control group and the experimental group when it comes to important baseline characteristics. These characteristics include things like age, the proportion of genders, the number of diseased coronary arteries, the profiles of baseline serum lipids, and relevant medical histories (and all of the *P* values were greater than 0.05). This lack of remarkable differences in the baseline data successfully proved the equality of the two groups for the comparative research. The whole research project was reviewed formally and was authorized by the Medical Ethics Committee of our institution. Also, in strict accordance with ethical standards, all of the patients who were enrolled were fully informed about the nature of the study, the procedures involved, the possible risks, and the advantages. As a consequence, each and every patient provided their informed consent and officially signed the formal consent forms prior to joining the study.

2.2. Case selection criteria

To do this research, there was a series of standards that were strictly set out, and these standards were applied to ensure that a cohort of uniform and suitable patients was recruited. The requirements for entry were multi-dimensional, and it was required that every participant should meet four different conditions. First, it was necessary to have a clear diagnosis of primary coronary vulnerable plaques, and this diagnosis was confirmed through a full optical coherence tomography (OCT) assessment of the coronary arteries. Second, candidates did not have any previous experience of having coronary interventional therapies, like percutaneous coronary intervention (PCI), and they had not gone through any intensive or long-lasting lipid-lowering drug plans before being enrolled. Third, participants had to be in the age range of 45 to 76 years old. Finally, they needed to show dyslipidemia that met the clinical criteria which were pre-specified for starting statin - based pharmaceutical lipid-lowering therapy. Fifth, it is required that the participants who take part in the trial have to do the thing of maintaining the condition of clinical stability, which is characterized by the state of having stable vital signs. They should be both able and willing to carry out all of the follow-up imaging assessments that have been scheduled, and they must have clinical medical documentation that can be fully retrieved. The criteria for exclusion encompass the following: some individuals have severe impairment of the liver or the kidney; some are hypersensitive to statins or have had unfavorable reactions to them; some patients have a previous history of having coronary stent placed or coronary artery bypass grafting (CABG) done; some subjects have been found to have acute myocardial infarction, severe cardiac arrhythmias, or severe heart failure (NYHA Classes III to IV) during the screening phase; some patients have active autoimmune disorders or a history of cancer; some are expected to stop the study treatment ahead of time, to become lost during the follow-up process, or to withdraw from the study on their own initiative; and some individuals have coronary artery lesions that are mainly made up of multiple severe calcified plaques.

2.3. Method

2.3.1. Control group

The control group received conventional-dose statin therapy for the purpose of lipid regulation. Specifically, it involved orally taking 20 mg atorvastatin calcium tablets each night before sleep for a period of 12 months. At the same time, these patients carried out the action of following standard coronary heart disease basic management protocols. These protocols included standardized antiplatelet treatment, strict control of blood pressure and blood glucose, adherence to a low-salt, low-fat diet, and moderate physical activity. The action of using aggressive lipid-lowering regimens was not carried out. During the entire treatment phase, the action of regularly assessing lipid panels and liver/renal function was done, and patients had the action of educating them be carried out so that they would strictly abide by the standardized medication schedule in order to ensure the action of treatment adherence be achieved.

2.3.2. Experimental group

The cohort that was used for the experiment was given a strategy of lowering lipids in an intensified way along with standard and fundamental care. Oral atorvastatin calcium tablets 40mg once every bedtime, combined with tafolecimab 150mg subcutaneous injection once every two weeks (ih Q2w), for a total intervention duration of 12 months. The management protocols at the starting point were made to be the same as those of the group that was used for control. This included the act of avoiding, in a rigorous manner, the risk factors that can be changed. These risk factors included patterns of diet that lead to high lipid levels, the act of using tobacco, and the intake of alcohol. There was also a systematic surveillance of lipid profiles and indicators of liver and kidney function. And there was the act of creating treatment regimens that were made for each person. These regimens were adjusted according to the tolerability of each individual patient so as to guarantee both the safety and the effectiveness. Before the intervention took place and after the intervention was finished, both groups underwent evaluations using coronary optical coherence tomography (OCT). The status of blood vessel function was measured in a quantified way through the standardized calculation of the oxidative flow reserve (OFR).

OFR calculation method: A specialized system for OCT hemodynamic analysis is used to carry out three-dimensional reconstruction of the vessel of the target lesion, automatically delineate the contour of the lumen, and identify the branch vessels. By using a velocity of congested blood flow that is population-standardized and has a value of 0.35 m/s as a reference, the state of congestion of the coronary artery is simulated to calculate the ratio of pressure between the segment of the proximal part and the segment of the distal part of the lesion vessel, and this ratio is used to determine the value of the OFR. When an OFR is greater than or equal to 0.80, it shows that the function of the blood flow of the vessel is normal, while when an OFR is less than 0.80, it shows that there is functional ischemia. All the analysis of the image and the computation of the data were carried out independently by two radiologists who are senior, and cross-validation was applied in order to make sure that the accuracy of the result and to cut down the bias that is subjective.

2.4. Observation indicators

- (1) Plaque morphological parameters
- (2) Vascular functional indicators.

(3) Lipid parameters.

2.5. Statistical analysis

Data were analyzed using SPSS 26.0 statistical software.

3. Results

3.1. Comparison of plaque morphology and lipid profile parameters between the two patient groups after intervention

See Table 1 for details.

Table 1. Comparison of plaque morphology and lipid profile parameters

Group	Number of Cases	Hair cap thickness (μm)	Lipid area (mm ²)	Plaque burden (%):	Minimum lumen area (mm ²)	LDL-C(mmol/L)
Control group	20	132.36 ± 15.24	3.85 ± 0.62	72.35 ± 6.85	2.15 ± 0.42	2.86 ± 0.52
Experimental group	20	186.52 ± 12.38	2.12 ± 0.45	58.62 ± 5.36	2.89 ± 0.36	1.62 ± 0.38
<i>t</i>	-	12.458	10.265	7.965	6.125	8.752
<i>P</i>	-	<0.05	<0.05	<0.05	<0.05	<0.05

3.2. Comparison of vascular functional indicators between the two groups

See Table 2 for details.

Table 2. Comparison of vascular functional indicators

Group	Number of Cases	OFR	Incidence of vascular ischemia [n (%)]
Control group	20	0.76 ± 0.05	9 (45.00)
Experimental group	20	0.85 ± 0.04	2 (10.00)
<i>t/χ²</i>	-	6.258	5.625
<i>P</i>	-	<0.05	<0.05

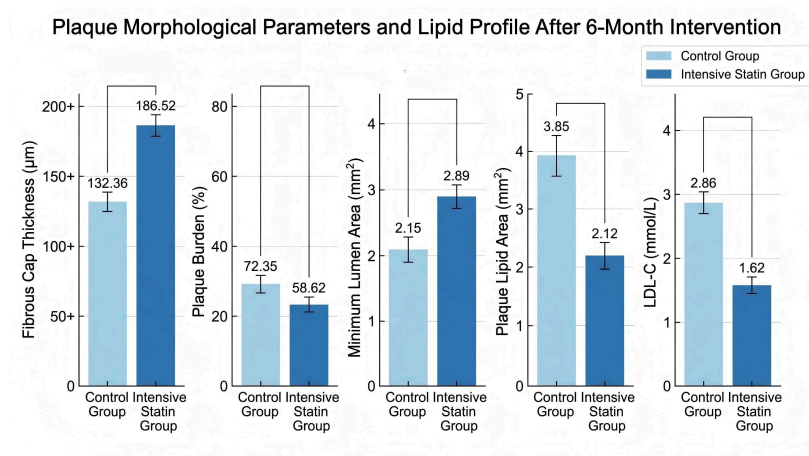


Figure 1. Plaque morphological parameters and lipid profile comparison

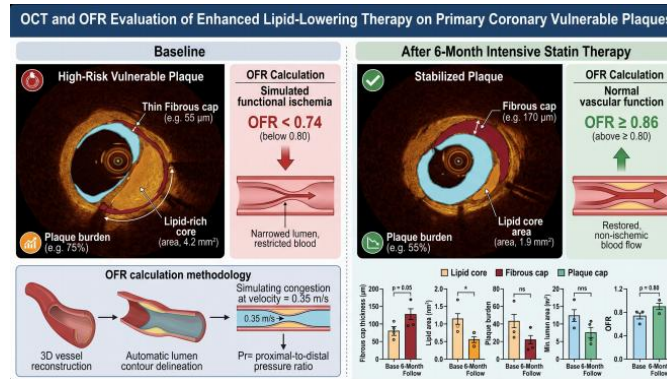


Figure 2. Schematic mechanism of plaque stabilization and hemodynamic restoration assessed by OCT/OFR

4. Discussion

Acute coronary syndrome and sudden cardiac death are mainly caused by vulnerable coronary plaques ^[1]. These vulnerable plaques are defined in such a way that they have a fibrous cap that is thin, a lipid core that is large, a susceptibility to rupture that is heightened, and a tendency for secondary thrombosis ^[2]. These features make it so that their risk of having adverse cardiovascular events is elevated when compared to stable plaques.

Statins are the cornerstone drug for stabilizing coronary vulnerable plaques. Conventional lipid-lowering therapy can slightly improve blood lipid levels, but has limited efficacy in stabilizing high-risk vulnerable plaques ^[3]. Intensive therapy of lowering lipid can very obviously make the cholesterol of low-density lipoprotein go down, carry out the suppression of inflammation of vascular endothelial, do the reduction of lipid accumulation, make the thickening of fibrous caps speed up, and bring about the reduction of lipid cores ^[4]. All of these things work in order to make vulnerable plaques become stable and reverse the early progression of plaque lesions.

The improvement of vascular function is a key indicator to evaluate the long-term prognosis of coronary heart disease, because the improvement of plaque morphology alone cannot fully reflect the real blood perfusion capacity of blood vessels ^[5]. In the course of the present and ongoing investigation, a method that has been standardized was employed for the purpose of calculating what is known as the oxygen flow reserve (OFR) so as to carry out an assessment of vascular function ^[6]. The outcomes of the investigation demonstrated that after the intervention had taken place, the measurement of the OFR in the experimental group showed an increase that was quite notable.

To summarize, the quantitative assessment method of the OFR makes it possible to carry out an accurate and straightforward evaluation of the vascular function of the coronary artery lesion ^[7]. When it is integrated with the morphological analysis based on OCT, it helps to carry out a comprehensive assessment of the efficacy of lipid-lowering therapy ^[8]. Intensive lipid-lowering therapy can effectively improve the morphological features of the primary coronary vulnerable plaques, stabilize the high-risk plaques ^[9], remarkably improve the blood flow function in the diseased vessels ^[10], reduce the risk of myocardial ischemia, and show therapeutic outcomes that are superior compared with the conventional lipid-lowering regimens. Therefore, it is very suitable for being applied widely among the patients who have high-risk coronary artery disease and vulnerable plaques ^[11].

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Disclosure statement

The authors declare no conflict of interest.

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