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Predictive Value of Pericoronary Adipose Tissue Attenuation Index and Left Main Coronary Artery Angle for High-Risk Plaques in Patients with Left-Dominant Coronary Artery Disease

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Research Article

Keywords: Left-dominant coronary artery, Pericoronary adipose tissue, Fat attenuation index (FAI), Left main coronary artery (LMCA) angle, High-risk plaques

Posted Date: March 21st, 2026

DOI: https://doi.org/10.21203/rs.3.rs-8865567/v1

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Additional Declarations: No competing interests reported.

Predictive Value of Pericoronary Adipose Tissue Attenuation Index and Left Main Coronary Artery Angle for High-Risk Plaques in Patients with Left-Dominant Coronary Artery Disease

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Abstract

Objective: To evaluate the predictive value of pericoronary fat attenuation index (FAI) and left main coronary artery (LMCA) angle for high-risk plaques in left-dominant coronary artery disease (CAD) using coronary computed tomography angiography (CCTA).

Methods: This study was a single-center retrospective cross-sectional study. A total of 106 patients with left-dominant coronary artery disease (CAD) who underwent coronary computed tomography angiography (CCTA) at our institution between January 2024 and March 2025 were enrolled. Based on the characteristics of proximal left anterior descending artery (LAD) plaques, the patients were stratified into a high-risk plaque group (n=45) and a non-high-risk plaque group (n=61). Baseline characteristics were compared between the two groups. Multivariate logistic regression analysis was then performed to investigate the independent associations of the pericoronary fat attenuation index (FAI) and the angle of the left main coronary artery (LMCA) with the risk of coronary atherosclerosis and high-risk plaques. Additionally, receiver operating characteristic (ROC) curves were constructed to evaluate their predictive value for high-risk plaques in these patients.

Results: Baseline characteristics: Statistically significant differences were noted in age , pericoronary fat attenuation index (FAI), and coronary artery angle between the two groups ($p < 0.05$).Multivariate analysis: Both the pericoronary fat attenuation index (FAI) and the left main coronary artery (LMCA) angle were significantly higher in the high-risk plaque group than in the non-high-risk plaque group ($P < 0.001$), and these two factors were identified as independent risk factors.ROC analysis: The AUCs of FAI and LMCA angle alone were 0.729 and 0.698 respectively, while the AUC of their combined prediction was 0.791, which was significantly better than that of single indicators ($P < 0.05$).

Conclusion: The pericoronary fat attenuation index (FAI) and left main coronary artery (LMCA) angle were identified as independent predictors of proximal left

anterior descending artery (LAD) high-risk plaque formation in patients with left-dominant coronary artery disease (CAD). The combined prediction model integrating both indicators significantly enhanced the diagnostic performance for high-risk plaque identification, which holds important implications for risk stratification and clinical management.

Keywords

Left-dominant coronary artery Pericoronary adipose tissue Fat attenuation index (FAI) Left main coronary artery (LMCA) angle High-risk plaques

1.Introduction

Coronary artery disease (CAD) and its complications are the leading cause of cardiovascular-related deaths globally [1]. The coronary artery system exhibits extensive anatomical variations; left-dominant coronary anatomy accounts for approximately 10% of the population [2]. In this anatomical subtype, the left coronary artery branches not only supplies the lateral and posterior walls of the left ventricle but also frequently undertakes partial perfusion of the inferior wall. Lesions in the left coronary artery may compromise blood supply to over 70% of the myocardium [3]. Existing studies have shown that in patients with left-dominant coronary arteries complicated by significant stenosis, the 3-year cumulative incidence of cardiovascular events reaches as high as 35%—far exceeding the 9.5% observed in right-dominant cases ($P < 0.001$) [4-8]. However, systematic research on the combined assessment of fat attenuation index (FAI) and left main coronary artery angle for predicting high-risk plaque formation in patients with left-dominant CAD remains scarce.The pathological basis of CAD lies in the formation, progression, and rupture of coronary atherosclerotic plaques, and the assessment of plaque vulnerability is crucial for risk stratification of acute coronary syndrome (ACS). Therefore, the evaluation of plaque vulnerability in patients with left-dominant CAD holds high clinical importance.

In the field of imaging-based plaque stability assessment, the fat attenuation index (FAI)—a vascular wall inflammation biomarker derivable from coronary computed tomography angiography (CCTA)—has been extensively validated. Elevated FAI indicates pro-inflammatory degeneration of local adipose tissue, and is closely associated with high-risk plaque features and cardiovascular event risk [9, 10]. As a non-invasive, easily quantifiable indicator, FAI exhibits strong clinical translatability. However, a single inflammatory marker may fail to fully capture the regulatory effects of anatomical structure on plaque progression—particularly in left-dominant coronary arteries (LDCAs) with marked anatomical variations.

Previous studies have demonstrated that coronary bifurcation angles influence local hemodynamics: a larger angle is more likely to induce low shear stress regions, thereby triggering inflammation and plaque instability [11-14]. Building on this evidence, the present study leverages CCTA to focus on patients with left-dominant coronary artery disease (CAD). We introduce the left main coronary artery (LMCA) angle as a key structural parameter, and perform a combined assessment of the inflammatory biomarker (FAI) and hemodynamic parameter (LMCA angle) to construct a multi-dimensional predictive model. This study aims to explore the model's predictive performance for high-risk plaque formation in the proximal left anterior descending artery (LAD) among patients with left-dominant CAD, thereby providing novel insights for individualized risk stratification and a basis for precision risk assessment in this patient population.

2.Materials and Methods

2.1. Demographic and Clinical Characteristics

A retrospective study was conducted on 106 patients with coronary artery disease (CAD) who underwent coronary computed tomography angiography (CCTA) at our institution between January 2024 and March 2025. Two independent researchers consecutively enrolled eligible patients during the case collection period, and collected baseline clinical data including body mass index (BMI), blood pressure, lipid profile, fasting blood glucose, smoking status, and alcohol consumption [15].Patients were stratified into two groups based on the presence of high-risk plaques: the high-risk plaque group (n = 45) and the non-high-risk plaque group (n = 61). The baseline characteristics of all patients were as follows: mean age, 57.2 ± 11.6 years; male, 43 cases (40.57%); female, 63 cases (59.43%); hypertension, 48 cases (45.28%); diabetes mellitus, 43 cases (40.57%); hyperlipidemia, 54 cases (50.94%); and smoking history, 44 cases (41.50%).

Inclusion Criteria

① Patients with confirmed coronary artery disease (CAD) (diagnosed by coronary angiography, myocardial perfusion imaging, or other established clinical criteria);
② Patients with left-dominant coronary artery anatomy confirmed by coronary computed tomography angiography (CCTA);
③ Patients with complete baseline clinical and imaging data.

Exclusion Criteria

① Patients with a history of coronary artery stenting or coronary artery bypass grafting (CABG);
② Patients with congenital coronary artery anomalies (e.g., anomalous origin of the coronary artery, coronary artery fistula);
③ Patients with intermediate branches between the left anterior descending artery (LAD) and left circumflex artery (LCX).

Criteria for Defining High-Risk Coronary Plaques.High-risk plaques were defined as those meeting ≥ 2 of the following criteria (assessed via coronary computed tomography angiography [CCTA]):Low-density plaque: Mean plaque CT attenuation < 30 Hounsfield Units (HU);Positive remodeling: Remodeling index (RI) > 1.1 (RI = [maximum cross-sectional area of the vessel with plaque] / [cross-sectional area of the proximal reference segment]);Punctate calcification: Focal calcification with a maximum diameter < 3 mm;"Napkin ring" sign: Annular hyperdense (enhanced) rim surrounding a low-density plaque core [16].

2.2.Imaging Protocol

Coronary computed tomography angiography (CCTA) was performed using a GE Revolution 256-slice spiral computed tomography (CT) scanner with prospective electrocardiogram (ECG)-gating (to minimize cardiac motion artifacts).Scanning parameters were set as follows:Tube voltage: Adjusted individually based on patient body habitus (range, 110–120 kV);Tube current: Automatically modulated via the scanner's dose-reduction algorithm;Reconstruction slice thickness: 0.625 mm.

Post-scan, single-segment freeze (SSF) technique was applied to acquire motion-free images at the optimal cardiac phase (mid-diastole, defined as 70–80% of the R-R interval). The reconstructed images were then imported into the Shukun Coronary AI platform for:Quantitative calculation of the fat attenuation index (FAI) (in the perivascular adipose tissue of the left anterior descending artery);Measurement of the left main coronary artery (LMCA) angle (defined as the angle between the LMCA trunk and the proximal left circumflex artery), As shown in Figure 1.

All image measurements were independently performed by two board-certified radiologists with ≥ 5 years of specialized experience in coronary computed tomography angiography (CCTA) interpretation. Inter-observer variability was assessed by calculating the relative difference between the two sets of measurements; if the relative difference exceeded 5%, a consensus measurement was derived by averaging the two values, and a third senior radiologist (with 10+ years of CCTA experience) was consulted to resolve persistent discrepancies.

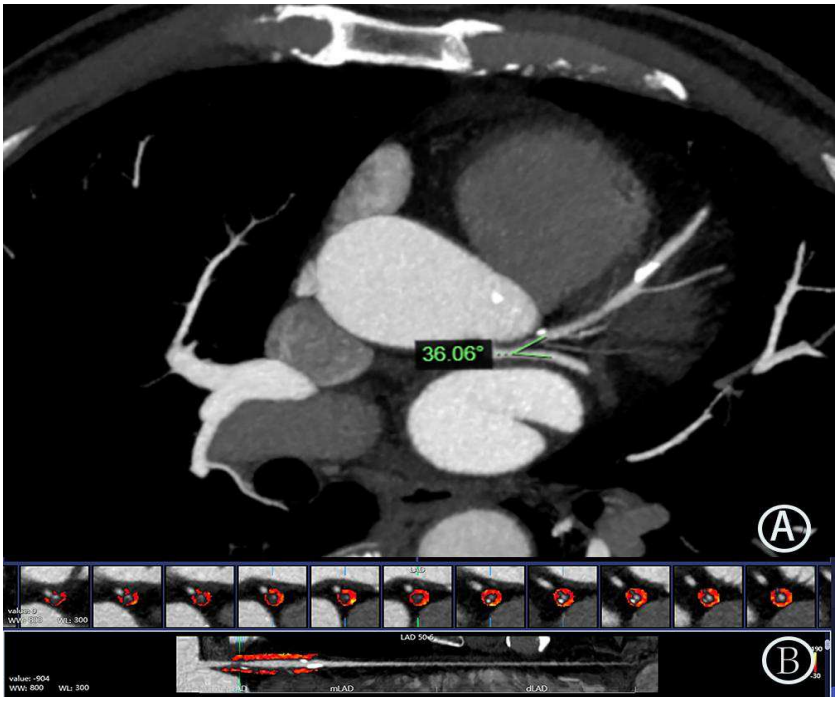


Figure 1 Schematic Representation of Fat Attenuation Index (FAI) and Left Main Coronary Artery (LMCA) Angle Measurement.A 65-year-old male patient presented with intermittent chest pain for 2 weeks (admission indication).Panel A: Multiplanar reconstruction (MPR) image generated via the Shukun Coronary AI platform, demonstrating a measured angle of 36° between the left anterior descending artery (LAD) and left circumflex artery (LCX) (consistent with the LMCA angle definition in Section 2.2).Panel B: Coronal view of the proximal left anterior descending artery (LAD) with a mixed plaque causing severe luminal stenosis (≥70% diameter reduction), classified as a high-risk plaque (per Section 2.3 criteria). The inset shows a cross-sectional view of perivascular adipose tissue (PCAT) analyzed by the Shukun AI platform; the red delineated region indicates the ROI (region of interest) for FAI measurement, with a calculated FAI value of -68 Hounsfield Units (HU).

2.3.Statistical Analysis

All statistical analyses were performed using R software (version 4.4.3) (R Foundation for Statistical Computing, Vienna, Austria).

Baseline Characteristics Comparison

Between-group comparisons of baseline clinical and imaging characteristics were conducted between the high-risk plaque group (n = 45) and non-high-risk plaque group (n = 61) using:Pearson's chi-square test for categorical variables (presented as n [%]);Welch's two-sample t-test for normally distributed continuous variables (presented as mean ± standard deviation [SD]);Wilcoxon rank-sum test (Z-statistic reported) for non-normally distributed continuous variables (presented as median [interquartile range, IQR]).

Multivariable Analysis & Predictive Performance

A multivariable logistic regression model was constructed to examine the independent associations of age, fat attenuation index (FAI), and coronary angle with the primary outcome (presence of high-risk plaques). The model was adjusted for potential confounders including body mass index (BMI) and hypertension (per clinical practice guidelines).The predictive performance of each variable was evaluated using:Receiver operating characteristic (ROC) curves (with area under the curve [AUC] reported);Sensitivity, specificity, and optimal cut-off values (determined via the Youden's J statistic).

3.Results

Baseline Characteristics Comparison

Intergroup comparisons revealed statistically significant differences in age, fat attenuation index (FAI), and coronary angle between the high-risk plaque group and non-high-risk plaque group (all $p < 0.05$). Subthreshold associations were observed for gender ($p = 0.058$) and hypertension ($p = 0.075$), while body mass index (BMI), hyperlipidemia, and smoking status showed no significant between-group differences ($p > 0.05$). Detailed results are presented in Table 1.

Table 1 Comparison of Clinical and Imaging Baseline Characteristics Between the High-Risk Plaque Group and Non-High-Risk Plaque Group

Variable	Non-HRP group（n=61）	HRPgroup（n=45）	x2/t/Z2	p-value2
Gender			**3.607**	**0.058**
Female	**41 (67.21%)**	**22 (48.89%)**		
male	**20 (32.79%)**	**23 (51.11%)**		
BMI	**25.45 (23.53, 26.90)**	**25.53 (24.80, 26.53)**	**-1.071**	**0.284**
age	**55.43±11.78**	**60.73±11.80**	**-2.290**	**0.024**
Hypertension	**24 (39.34%)**	**24(53.33%)**	**3.167**	**0.075**
diabetes	**20 (32.79%)**	**23 (51.11%)**	**3.607**	**0.058**
Hyperlipidemia	**29 (47.54%)**	**25 (55.56%)**	**1.681**	**0.194**

Variable	Non-HRP group （n=61）	HRPgroup （n=45）	x2/t/Z2	p-value2
Smoking	25 (40.98%)	19 (42.22%)	0.089	0.765
FAI	-76.97±8.19	-70.69±6.47	-4.405	<0.001
LMCA/°	66.13±18.31	79.98±19.51	-3.707	<0.001

Multivariate Logistic regression analysis was performed to identify independent risk factors for high-risk plaques. The results demonstrated that FAI(odds ratio [OR] = 1.11, 95% confidence interval [CI]: 1.04–1.18, p = 0.002) and LMCA(OR = 1.04, 95% CI: 1.01–1.07, p = 0.004) were independent risk factors for the target outcome. In contrast, age did not achieve statistical significance (p = 0.163). Detailed results are presented in Table 2.

Table 2: Logistic Regression Analysis of High-Risk Plaque Development Risk

Variable	OR	SE	Wald	95% CI	p-value
age	1.03	0.019	1.39	0.99-1.07	0.163
FAI	1.11	0.032	3.13	1.04-1.18	0.002
LMCA	1.04	0.014	2.88	1.01-1.07	0.004

Abbreviations: CI = Confidence Interval, OR = Odds Ratio, SE = Standard Error

Comparison of FAI Values and Left Main Coronary Artery (LMCA) Angles Between Two Groups. Comparisons of fatty acid index (FAI) values and left main coronary artery (LMCA) angles were performed between the high-risk plaque group and the non-high-risk plaque group. Results indicated that both FAI values and LMCA angles were significantly higher in the high-risk plaque group than in the non-high-risk plaque group (Figure 2).

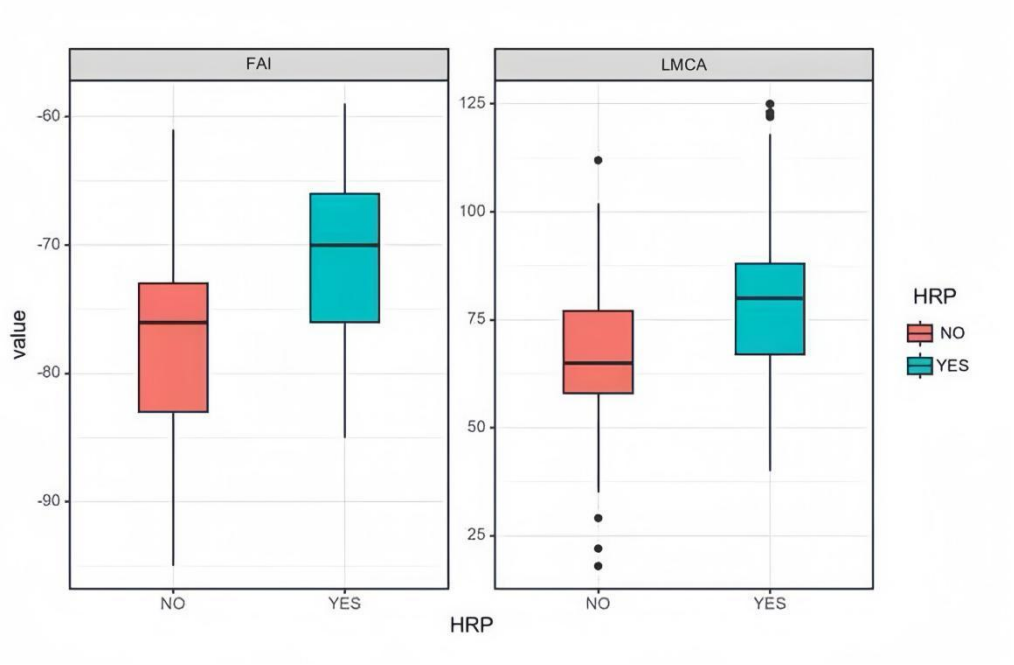


Figure 2: Schematic Comparison of Fatty Acid Index (FAI) Values and Left Main Coronary Artery (LMCA) Angles Between the Two Groups

Comparison of Predictive Performance of FAI, LMCA Angle, and Their Combined Model for High-Risk Plaques in Patients with Left-Dominant Coronary Artery Disease. Receiver operating characteristic (ROC) curve analysis demonstrated that the combined model (green line) exhibited the optimal predictive performance,See Figure 3. The optimal cut-off value for FAI was -72.5 Hounsfield units (Hu), and that for the left main coronary artery (LMCA) angle was 69.5 degrees (°). Detailed results are presented in Table 3.

Table 3: Comparison of Predictive Performance of FAI, LMCA Angle, and Their Combined Model for High-Risk Plaques in Patients with Left-Dominant Coronary Artery Disease

Variable	AUC value	AUC LCL	AUC UCL	Sensitivity	Specificity	Cutoff value	Youden's index
FAI	**0.729**	**0.631**	**0.827**	**0.733**	**0.754**	**-72.500**	**0.487**
LMCA	**0.698**	**0.596**	**0.800**	**0.733**	**0.607**	**69.500**	**0.340**

Variable	AUC value	AUC LCL	AUC UCL	Sensitivity	Specificity	Cutoff value	Youden's index
Joint model (FAI+LMCA)	**0.791**	**0.702**	**0.879**	**0.689**	**0.803**	**0.498**	**0.492**

Abbreviations: AUC=Area Under the Curve , LCL=Lower Confidence Limit,UCL=Upper Confidence Limit

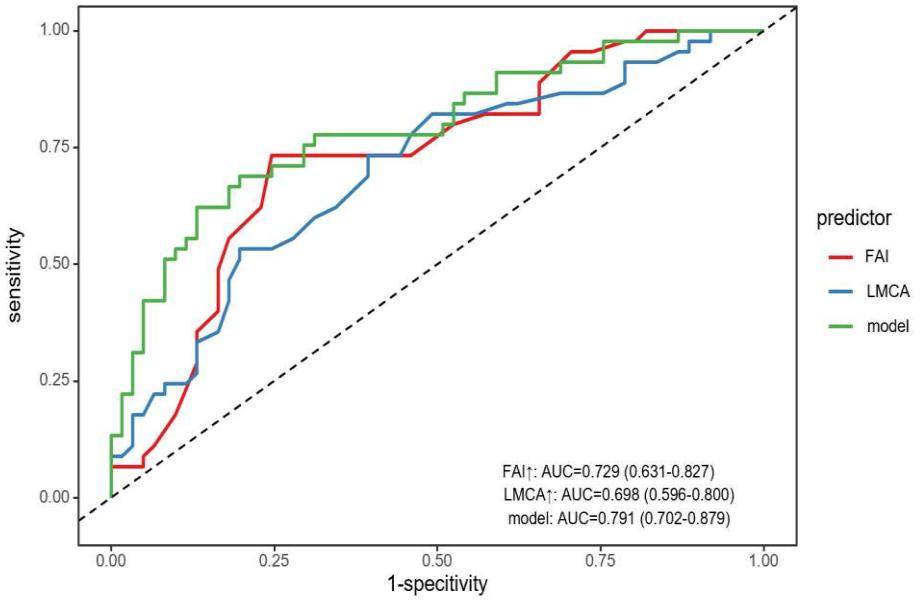


Figure (3) ROC Curve

4.Discussion

Results of this study demonstrated that, among patients with left-dominant coronary artery disease (CAD), multivariate logistic regression analysis identified fatty attenuation index (FAI) and the left main coronary artery (LMCA) angle as independent predictors of high-risk plaque formation. The area under the curve (AUC) of the combined prediction model incorporating both parameters was higher than that of either indicator alone, indicating that the integration of these imaging parameters confers superior predictive value for risk stratification in patients with left-dominant CAD. Notably, this study is the first to validate the complementary effects of FAI and the LMCA angle in individuals with left-dominant coronary

circulation, thereby providing a novel non-invasive approach for the identification of high-risk plaques in this specific patient population.

In this retrospective study, fatty attenuation index (FAI) and left main coronary artery (LMCA) angle were measured via a single coronary computed tomography angiography (CCTA) scan in patients with left-dominant coronary artery disease (CAD). We then evaluated the associations between FAI, LMCA angle, and high-risk plaque formation in this cohort. Our findings align with those of Ocana G et al. [17, 18], who reported that FAI—an imaging biomarker reflecting the inflammatory status of perivascular adipose tissue—correlates strongly with perivascular inflammatory activation and high-risk plaque features when elevated. As a structural parameter characterizing the geometric morphology of the left coronary bifurcation, the LMCA angle was significantly larger in the high-risk plaque group than in the non-high-risk plaque group, which is largely consistent with the results of Yahia M et al. [19]. However, the magnitudes of FAI and LMCA angle in our study were smaller than those reported in previous studies [20, 21]. This discrepancy is primarily attributed to our exclusive inclusion of patients with left-dominant coronary circulation, as opposed to the right-dominant or balanced coronary circulation cohorts in prior research.

The results of this study demonstrate that higher fatty attenuation index (FAI) values and larger left main coronary artery (LMCA) angles are independent predictors of high-risk plaques in patients with left-dominant coronary artery disease (CAD). The key physiological and pathological mechanisms by which left-dominant coronary circulation, FAI, and LMCA angle promote high-risk plaque formation are as follows:

① The left anterior descending artery (LAD) of left-dominant coronary circulation bears a greater hemodynamic load, increasing mechanical stress on the vascular adventitia. This activates the NF-κB pathway, stimulating perivascular adipose tissue to secrete pro-inflammatory cytokines (e.g., IL-6, TNF-α), which accelerate macrophage infiltration into plaques [22,23] and drive high-risk plaque formation—consistent with the higher incidence of major adverse cardiovascular events (MACE) and mortality observed in patients with left-dominant CAD [24].
② FAI values reflect the degree of inflammatory activation in perivascular adipose tissue. Perivascular adipose tissue inflammation promotes expansion of the plaque lipid core and thinning of the fibrous cap, thereby facilitating high-risk plaque development.
③ An increased LMCA angle induces turbulent flow in the proximal LAD, creating a persistent region of disturbed shear stress on the posterior wall of the proximal LAD. This leads to downregulated KLF2 expression, upregulated VCAM-1 expression in

endothelial cells, prolonged retention of oxidized low-density lipoprotein (ox-LDL), and promotion of endothelial dysfunction and lipid deposition—ultimately enhancing plaque instability. In contrast, physiological shear stress regulates vascular diameter and upregulates the expression of anti-inflammatory and anti-proliferative genes in endothelial cells [25-27]. Notably, the geometric morphology of the LMCA angle exerts a more pronounced impact on the hemodynamic environment in patients with left-dominant coronary circulation [28].

While this study excluded confounding effects of traditional cardiovascular risk factors (e.g., age, sex, smoking) via multivariate regression analysis—confirming the independent predictive value of fatty attenuation index (FAI) and left main coronary artery (LMCA) angle for high-risk plaques in left-dominant coronary artery disease (CAD)—several key limitations warrant acknowledgment.First, this is a single-center retrospective study with data collected from a cohort of patients who underwent coronary computed tomography angiography (CCTA) at our institution over a narrow timeframe. The small sample size may introduce selection bias, limiting the generalizability of our findings.Second, regarding measurement standardization: FAI was quantified using a fixed 3-mm radial region of interest (ROI) [29], but we did not compare our results with those derived from the "vessel diameter-adaptive method" advocated by prior studies [30, 31], which may affect the robustness of FAI as a predictive biomarker. Additionally, the LMCA angle exhibits a ~10 ± 5° variation between systole and diastole [32], yet phase control was not implemented during measurements, potentially introducing bias into angle quantification.Third, long-term follow-up data to validate clinical endpoints (e.g., major adverse cardiovascular events [MACE]) were unavailable, precluding assessment of the prognostic utility of FAI and LMCA angle.

Building on the findings and limitations of the current study, future research will prioritize two key directions to advance this work: first, conducting multi-center prospective cohorts to validate the predictive stability and external generalizability of our model; second, integrating computational hemodynamic simulation analyses to mechanistically elucidate the interactions between FAI, LMCA angle, and high-risk plaque pathophysiology. These efforts aim to enhance the clinical translatability of our findings and establish the utility of FAI-LMCA angle integration as a non-invasive risk stratification tool for left-dominant CAD patients.

5.Conclusion

In patients with left-dominant coronary artery disease (CAD), fatty attenuation index (FAI) > -72.5 HU and left main coronary artery (LMCA) angle > 69.5° were

identified as independent predictors of high-risk plaque formation in the proximal left anterior descending artery (LAD). Notably, the combined model integrating these two parameters significantly enhanced predictive performance (area under the curve [AUC] = 0.791), thereby providing a non-invasive, clinically actionable basis for risk stratification and early targeted intervention in this patient subgroup.

Funding

This study was supported by the Key Research Project of the Affiliated Hospital of Shandong Second Medical University (Grant No. 2024FYZ032).

Institutional Review Board (IRB) Statement

This study was performed in compliance with the ethical standards laid down in the Declaration of Helsinki and was approved by the Ethics Committee of Liaocheng People's Hospital (Approval No. 2024271).

Informed Consent Statement

This study is a retrospective investigation. Given its retrospective nature, direct contact with all patients to obtain informed consent was not feasible. Following confirmation that the data had been fully de-identified—with no risks to personal privacy or commercial interests—the requirement for written informed consent was waived upon review and approval by the Ethics Committee of Liaocheng People's Hospital (Approval No.: 2024271).

Data Availability Statement

The data supporting the findings of this study are available in the article and its supplementary materials.

Acknowledgments

We express our gratitude to the research team of our hospital for their work in the study.

Conflict of Interest

There is no conflict of interest among all authors.

References

1. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-20

16: a systematic analysis for the Global Burden of Disease Study 2016. Lancet 2017;390:115 1-210.

2. Wilkins CE, Betancourt BY, Palma RA, et al. Coronary artery dominance and prognosis. Cardiol Rev. 2017;25(4):175–180.

3. Chen XJ, Huang ZL, Zhang W. Research progress on revascularization strategies for mai n coronary artery lesions. Chin J Cardiol. 2021;49(2):165-168.

4. Pursnani A, Kanade G, Foster T, et al. Coronary CTA assessment of coronary dominanc e and its association with coronary artery disease. Radiology. 2012;264(3):694–701.

5. Veltman C E, de Graaf F R, Schuijf J D, et al. Prognostic value of coronary vessel do minance in relation to significant coronary artery disease determined with non-invasive comp uted tomography coronary angiography[J]. European heart journal, 2012, 33(11): 1367-1377.

6. Goldberg A, Southern D A, Galbraith P D, et al. Coronary dominance and prognosis of patients with acute coronary syndrome[J]. American heart journal, 2007, 154(6): 1116-1122.

7. Khan A R, Khan Luni F, Bavishi C, et al. Left dominant circulation increases mortality i n acute coronary syndrome: a systematic review and meta-analysis of observational studies involving 255,718 patients[J]. Catheterization and Cardiovascular Interventions, 2016, 88(2): 2 01-208.

8. Kuno T, Numasawa Y, Miyata H, et al. Impact of coronary dominance on in-hospital out comes after percutaneous coronary intervention in patients with acute coronary syndrome[J]. PLoS One, 2013, 8(8): e72672.

9. Antonopoulos AS, Sanna F, Sabharwal N, et al. Detecting human coronary inflammation by imaging perivascular fat. Sci Transl Med. 2017;9(398):eaal2658. https://doi.org/10.1126/sci translmed.aal2658

10. Goeller M, Achenbach S, Cadet S, et al. Pericoronary adipose tissue CT attenuation an d high-risk plaque characteristics in acute coronary syndrome. J Am Coll Cardiol. 2018;72(1 0):1281–1290. https://doi.org/10.1016/j.jacc.2018.05.077

11. Kim HY, Shim CY, Kim YJ, et al. Left main coronary artery bifurcation angle is associat ed with coronary artery disease. Atherosclerosis. 2015;240(2):228–235. https://doi.org/10.1016 /j.atherosclerosis.2015.03.026

12. Wang JG, Zhou YY, Tian WJ. Impact of left main coronary artery angle on coronary at herosclerotic plaque characteristics. Chin J Radiol. 2023;57(5):438-442.

13. Sun Z, Lin CH, Davidson R, Dong C. Coronary CT angiography in the quantitative ass essment of coronary plaques. Biomed Res Int. 2015;2015:648359. https://doi.org/10.1155/201

14. Huang ZQ, Chen C, Chen L. CTA-based study of the association between LAD-LCX branch angle and coronary atherosclerosis. Chin J Med Imaging Technol. 2022;38(6):850-854.

15. Yusuf, S., S. Hawken, and S. Ounpuu. "Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study." Journal of Cardiopulmonary Rehabilitation and Prevention 25.1 (2005): 56-57.

16. Expert Consensus on Coronary CT Atherosclerotic Plaque Imaging. 2020 International Society for Cardiovascular Computed Tomography and North American Society for Cardiovascular Imaging.

17. Ocana G, Michaud K, Magnin V, et al. Coronary CT angiography-derived pericoronary fat attenuation index: Post-mortem histopathological correlation in fatal plaques[J]. International journal of cardiology, 2025: 133388.

18. **g M, ** H, Wang Y, et al. Association between pericoronary fat attenuation index values and plaque composition volume fraction measured by coronary computed tomography angiography[J]. Academic Radiology, 2024, 31(9): 3579-3589.

19. Yahia M, Farid W, Lotfy M, et al. Association between bifurcation angle of the left main coronary artery and severity of stenosis of the proximal left anterior descending artery[J]. Cardiovascular Journal of Africa, 2023, 34(2): 93-97.

20. Lu Z F, Yin W H, Schoepf U J, et al. Prediction value of pericoronary fat attenuation index for coronary in-stent restenosis[J]. European Radiology, 2024, 34(8): 4950-4959.

21. Zhang D Q, Xu Y F, Dong Y P, et al. Coronary computed tomography angiography study on the relationship between the Ramus Intermedius and Atherosclerosis in the bifurcation of the left main coronary artery[J]. BMC Medical Imaging, 2023, 23(1): 53.

22. Nakahara T, Dweck M R, Narula N, et al. Coronary artery calcification: from mechanism to molecular imaging[J]. JACC: Cardiovascular Imaging, 2017, 10(5): 582-593.'

23. Otsuka F., Sakakura K., Yahagi K. et al: Has our understanding of calcification in human coronary atherosclerosis progressed?. Arterioscler Thromb Vasc Biol 2014; 34: 724.

24. Veltman C E, van der Hoeven B L, Hoogslag G E, et al. Influence of coronary vessel dominance on short-and long-term outcome in patients after ST-segment elevation myocardial infarction[J]. European heart journal, 2015, 36(17): 1023-1030.

25. Li C, Fang F, Wang E, et al. Engineering extracellular vesicles derived from endothelial cells sheared by laminar flow for anti-atherosclerotic therapy through reprogramming macrophage[J]. Biomaterials, 2025, 314: 122832.

26. Cunningham K S, Gotlieb A I. The role of shear stress in the pathogenesis of atherosc lerosis[J]. Laboratory investigation, 2005, 85(1): 9-23.

27. Pu L, Meng Q, Li S, et al. Laminar shear stress alleviates monocyte adhesion and ath erosclerosis development via miR-29b-3p/CX3CL1 axis regulation[J]. Journal of Cell Science, 2022, 135(14): jcs259696.

28. Pinho N, Castro C F, António C C, et al. Correlation between geometric parameters of the left coronary artery and hemodynamic descriptors of atherosclerosis: FSI and statistical s tudy[J]. Medical & biological engineering & computing, 2019, 57(3): 715-729.

29. Shen ZY, Xia K, Xing ZY. Pericoronary fat attenuation index for evaluation of coronary artery disease: A review of recent advances. J Med Imaging Technol, 2023, 39(4): 614-617.

30. Ma R, Van Assen M, Ties D, et al. Focal pericoronary adipose tissue attenuation is rel ated to plaque presence, plaque type, and stenosis severity in coronary CTA[J]. European R adiology, 2021, 31(10): 7251-7261.

31. Oikonomou E K, Marwan M, Desai M Y, et al. Non-invasive detection of coronary infla mmation using computed tomography and prediction of residual cardiovascular risk (the CRI SP CT study): a post-hoc analysis of prospective outcome data[J]. The Lancet, 2018, 392(1 0151): 929-939.

32. Watanabe Y, Naganuma T, Chieffo A, et al. The feasibility of double stent strategy in le ft main true bifurcation with small and large angle change between diastole and systole: Th e Milan and New-Tokyo (MITO) registry[J]. Catheterization and Cardiovascular Interventions, 2024, 104(7): 1362-1372.

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