Research Square

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Correlation of Agatston Calcium Scores in LAD, LCX and RCA with Gensini Scores of Their Corresponding Perfusion Territories

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Research Article

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Abstract

Objective To investigate the correlation between vessel-specific Agatston calcium scores of the left anterior descending artery (LAD), left circumflex artery (LCX), and right coronary artery (RCA) derived from coronary computed-tomography angiography (CCTA), and Gensini scores obtained by invasive coronary angiography (CAG) within corresponding perfusion territories, and to explore heterogeneity across coronary branches and sex subgroups.

Methods A total of 137 consecutive patients who underwent CCTA followed by CAG within a 15-day interval at the Department of Cardiology, Xingtai People's Hospital between May 2025 and October 2025 were retrospectively enrolled. Vessel-specific calcium scores were calculated using the Agatston method, and the Gensini scoring system was applied to quantify coronary atherosclerotic stenosis burden. Spearman rank-order correlation and partial correlation analyses were performed to adjust for clinical confounding factors.

Results In the overall cohort, vessel-specific calcium scores were positively correlated with corresponding Gensini scores: LAD (r = 0.307), LCX (r = 0.379), rCA (r = 0.493), all P < 0.001. After adjusting for confounding factors, partial correlation coefficients remained stable (r = 0.297, 0.358, 0.443, all P < 0.001). RCA demonstrated the strongest correlation. Subgroup analysis showed that females exhibited a significantly stronger correlation between LCX calcium score and LCX-specific Gensini score (r = 0.492) compared with males (r = 0.323).

Conclusion Vessel-specific coronary calcium scores derived from CCTA can serve as a valuable auxiliary indicator for evaluating coronary stenosis burden but cannot replace invasive CAG. RCA shows the highest correlation with stenosis severity, while LAD presents the weakest correlation. The predictive value of LCX calcium score for coronary stenosis in female patients deserves close clinical attention.

Introduction

Coronary atherosclerotic heart disease (CAD) remains the leading cause of cardiovascular mortality worldwide, with rising incidence driven by population aging and cumulative cardiovascular risk factors[1]. Invasive coronary angiography (CAG) is still the reference-standard modality for evaluating coronary stenosis and guiding clinical decision-making for revascularization[2]. The Gensini scoring system, derived from CAG findings, is widely accepted for quantitative assessment of atherosclerotic burden by weighting stenosis severity according to anatomical segments[3] .

Coronary computed-tomography angiography (CCTA) is a well-established non-invasive screening tool for coronary artery disease. The Agatston coronary artery calcium score (CACS) measured on CCTA reflects calcified plaque load of epicardial coronary arteries[4].Multiple previous studies have confirmed a positive correlation between total calcium score and overall coronary stenosis severity[4]. However, most existing reports combine the three major coronary arteries into a global total calcium score, ignoring

inter-arterial heterogeneity in anatomical course and plaque distribution across LAD, LCX and RCA. Moreover, confounding effects of traditional cardiovascular risk factors are seldom adequately controlled in most retrospective analyses.Using CAG-derived vessel-specific Gensini score as the reference standard, this retrospective study aimed to analyze correlations between individual-vessel Agatston calcium score and stenosis burden within its corresponding perfusion territory, so as to provide clinical evidence for precise vessel-level risk evaluation by CCTA.

Materials and Methods

Study population

This retrospective observational study screened patients who received both CCTA and subsequent CAG within 15 days in the Department of Cardiology, Xingtai People's Hospital from May 2025 to October 2025. Demographic, anthropometric and laboratory parameters including age, sex, body-mass index (BMI), serum lipid profiles, medical history and family history were collected.

Inclusion criteria:

(1) Patients underwent CCTA and CAG within ≤ 15-day interval with diagnostic image quality;

(2) Age ranged from 18 to 75 years;

(3) Complete clinical and laboratory datasets available.

undefined

Exclusion criteria:
(1) Contraindications to iodinated contrast medium;

(2) Previous cardiac surgery or coronary intervention history;

(3) Suspected cardiac tumor, congenital heart disease or severe valvular heart disease.

Ethics approval:

This study was approved by the institutional review board of Xingtai People's Hospital (Ethics No.2025 363). Written informed consent was waived because of the retrospective design using de-identified clinical data.

CCTA acquisition and Agatston calcium-score calculation

CCTA examinations were performed on a 64-slice dual-source CT scanner (SOMATOM Definition Flash, Siemens, Germany). Scan coverage extended from 1 cm below tracheal bifurcation to the cardiac

diaphragmatic surface. Iodixanol contrast medium was injected via cubital vein at a flow rate of 4.5 mL/s. Real-time ECG gating was applied throughout acquisition. Vessel-specific Agatston calcium scores for LAD, LCX and RCA were independently measured by two experienced cardiovascular radiologists using dedicated post-processing software[5]. Disagreements were resolved by consensus.

Coronary angiography and vessel-specific Gensini-score calculation

Diagnostic CAG was performed by at least two experienced interventional cardiologists in the catheter laboratory using an Allura CV20 digital subtraction angiography system (Philips, Netherlands). 6F diagnostic catheters were introduced via the right radial artery. Standard projection views were acquired and supplementary views obtained as needed. Stenosis severity for each coronary segment was evaluated by two independent operators[6].

The Gensini scoring system is calculated based on coronary angiography findings and serves as an important tool for assessing the burden and severity of coronary atherosclerotic lesions. The Gensini scoring integrates stenosis-severity grade and anatomical weighting factor. The system requires the calculation of three parameters: the severity score, the regional weighting factor (region multiplying factor), and the collateral adjustment factor[7]. Stenosis grading: 1%–25% = 1 point; 26%–50% = 2 points; 51%–75% = 4 points; 76%–90% = 8 points; 91%–99% =16 points; total occlusion (100%) = 32 points. Anatomical weighting coefficients: left main ×5; proximal-LAD ×2.5, mid-LAD ×1.5, distal-LAD ×1.0; proximal-LCX ×2.5, mid-LCX ×1.0, distal-LCX ×1.0; all RCA segments ×1.0; diagonal branch D1 ×1.0, obtuse marginal OM ×1.0, posterior descending artery PDA ×1.0, posterolateral branch PLB ×0.5. Branch lesions were allocated to the corresponding parent vessel. Vessel-specific Gensini score for LAD, LCX and RCA was obtained by summing weighted segmental scores for each artery and its downstream branches[7]–[8].

Statistical analysis

SPSS 25.0 software (IBM, USA) was used for all statistical analyses. Normality tests were performed for continuous variables. Normally distributed data were expressed as mean±standard deviation; skewed variables were presented as median with interquartile range (IQR). Spearman rank-order correlation was adopted to assess the correlation between vessel-specific calcium score and corresponding Gensini score. Correlation coefficient interpretation: $|r| \geq 0.7$ strong correlation; $0.4 \leq |r| < 0.7$ moderate correlation; $0.2 \leq |r| < 0.4$ weak correlation; $|r| < 0.2$ negligible correlation. For markedly right-skewed variables, natural-logarithm transformation $\ln(x + 1)$ was applied before partial correlation analysis. Partial correlation was performed to adjust confounders including age, sex, BMI, lipid profiles, hypertension, diabetes and smoking history. A two-tailed $P < 0.05$ was considered statistically significant.

Results

Baseline characteristics:One hundred thirty-seven patients were enrolled (85 males, 52 females). Age ranged from 30 to 75 years (mean 60.07 ± 11.27 years). Median BMI was 25.39 (IQR 23.88–27.94) kg/m². Laboratory results: total cholesterol 4.05 (3.30–4.71) mmol/L; triglyceride 1.36 (1.02–2.15) mmol/L; LDL-C 2.10 (1.62–2.62) mmol/L; HDL-C 0.97 (0.84–1.09) mmol/L. Comorbidities: hypertension (*n* = 91), diabetes mellitus (*n* = 43), smoking history (*n* = 21), family history of CAD (*n* = 8).

Correlation between vessel-specific calcium score and corresponding Gensini score

Following a Spearman correlation analysis of the total study population, it was found that: Significant positive correlations were observed for all three epicardial arteries. RCA calcium score showed moderate positive correlation with RCA-Gensini score ($r = 0.493$, $P < 0.001$). LAD ($r = 0.307$, $P < 0.001$) and LCX ($r = 0.379$, $P < 0.001$) exhibited weak positive correlations. It can be seen that LAD, LCX, and RCA all exhibit a positive correlation with the Gensini scores of their corresponding regions; furthermore, the RCA calcification score shows the strongest correlation with the Gensini score of the corresponding region(Table 1).

Table 1
:Spearman correlation coefficients in overall cohort

Correlation *r*	**LAD calcium score vs LAD-Gensini**	**LCX calcium score vs LCX-Gensini**	**RCA calcium score vs RCA-Gensini**
	0.307	**0.379**	**0.493**
P-value	0.000	0.000	0.000
Note: Spearman rank-order correlation analysis.			

Sex-stratified subgroup analysis showed that LAD correlation was weak in both males ($r = 0.311$, $P = 0.004$) and females ($r = 0.304$, $P = 0.028$). RCA maintained moderate correlation in both sexes (male $r = 0.499$, $P < 0.001$; female $r = 0.425$, $P = 0.002$). For LCX, correlation was weak in males ($r = 0.323$, $P = 0.003$) but reached moderate level in females ($r = 0.492$, $P < 0.001$). The correlation between female LCX calcification scores and the corresponding vessel Gensini scores is stronger than that in the overall population. (Table 2).

Table 2
Spearman correlation stratified by sex

Male *r*	**LAD calcium score vs LAD-Gensini**	**LCX calcium score vs LCX-Gensini**	**RCA calcium score vs RCA-Gensini**
	0.311	**0.323**	**0.499**
Male *P*	0.004	0.003	0.000
Female *r*	0.304	0.492	0.425
Female *P*	0.028	0.000	0.002
Note: Spearman rank-order correlation analysis.			

Adjust for confounding factors such as age at correction, sex, BMI, medical history, and blood lipid levels, and perform partial correlation analysis. Both the CTA calcification score and the Gensini score exhibited a pronounced right-skewed distribution. To avoid the influence of extreme values After ln(x + 1) transformation and adjusting for age, sex, BMI, serum lipids, hypertension, diabetes and smoking history, partial correlation coefficients were LAD $r = 0.297$; LCX $r = 0.358$; RCA $r = 0.443$, all $P < 0.001$(Table 3). Correlation magnitude only slightly decreased compared with unadjusted Spearman results. Furthermore, the overall correlation remains consistent, indicating that this correlation is minimally influenced by confounding factors.

Table 3
Partial correlation after adjusting confounding factors

Correlation *r*	**LAD calcium score vs LAD-Gensini**	**LCX calcium score vs LCX-Gensini**	**RCA calcium score vs RCA-Gensini**
	0.297	**0.358**	**0.443**
P-value	0.001	0.000	0.000
Note: Variables ln-transformed; adjusted for age, sex, BMI, lipid profile, hypertension, diabetes, smoking history.			

Trend analysis of the correlation between LAD, LCX, and RCA calcification scores and their corresponding Gensini scores.Scatter plots after logarithmic transformation showed a positive trend for all three arteries. Data points of RCA clustered more tightly with the steepest fitted trend line, visually confirming the strongest correlation of RCA (Fig. 1).

Note

X-axis: ln(calcium score + 1); Y-axis: ln(Gensini score + 1). Dashed lines represent linear-regression fitting.

Discussion

Coronary computed tomography angiography (CCTA) serves as a widely-used non-invasive screening modality for coronary artery disease, with the Agatston coronary artery calcium score representing a well-established surrogate marker of atherosclerotic plaque burden[4]. Invasive coronary angiography (CAG) remains the clinical reference standard for evaluating luminal coronary stenosis[9]. The Gensini score, calculated from CAG angiograms, incorporates stenosis severity, segment-specific weighting factors, and branch-related pathological changes to quantify the overall atherosclerotic burden of coronary arteries[7].

In the present single-center retrospective cohort of 137 patients, we observed significant positive correlations between vessel-specific calcium scores and corresponding regional Gensini scores across the LAD, LCX and RCA. However, correlation magnitudes were heterogeneous among epicardial vessels: a moderate correlation was noted for the RCA ($r = 0.493$, $P < 0.001$), whereas weak correlations were detected for the LAD ($r = 0.307$, $P < 0.001$) and LCX ($r = 0.379$, $P < 0.001$). After adjustment for age, sex, BMI, serum lipid profiles and clinical comorbidities via partial-correlation analysis following natural-logarithm transformation [Ln(x + 1)], the association patterns remained largely unchanged (LAD: $r = 0.297$; LCX: $r = 0.358$; RCA: $r = 0.443$; all $P < 0.001$). The absence of strong correlation between calcium score and Gensini score is biologically plausible. Positive arterial remodeling allows compensatory vessel enlargement in response to plaque accumulation, which may limit luminal narrowing despite substantial plaque deposition[10]. Furthermore, blooming artifacts caused by heavy coronary calcification on CCTA may distort stenosis estimation and contribute to measurement discrepancy[11]. Collectively, these findings support that vessel-specific calcium score provides incremental diagnostic hints for coronary stenosis but cannot replace invasive CAG. The stability of correlations after confounder adjustment also suggests calcium score is a reasonably robust screening metric, which may assist clinicians in risk stratification for patients with multiple cardiovascular comorbidities.

The inter-vessel heterogeneity, ranked as RCA > LCX > LAD in correlation strength, likely originates from anatomical variations and CCTA measurement constraints. The LAD artery gives off numerous side branches; branch-related lesions contribute to its total Gensini score, yet main-stem calcium quantification by CCTA cannot precisely map calcification burden to individual small branches, generating mismatches between calcification and stenosis grading[12]. Additionally, the proximal-mid segment of the LAD courses within the anterior interventricular groove and is vulnerable to motion artifacts related to cardiac pulsation and myocardial bridges, degrading measurement reliability[13]. Prior work has demonstrated higher overall plaque burden within the LAD territory compared with other major coronary arteries[14]. By contrast, the RCA has a long main trunk with fewer side branches and a relatively uncomplicated anatomical course. These features enable its calcium score to better reflect luminal atherosclerotic severity, explaining its stronger correlation with the Gensini score.

Notably, we identified sex-dependent differences for the LCX: the correlation between LCX calcium score and regional Gensini score was substantially higher in women ($r = 0.492$) than in men ($r = 0.323$), while

LAD- and RCA-related correlations were comparable between sexes. Post-menopausal loss of endogenous estrogen protection may alter plaque phenotype and exacerbate coronary microvascular dysfunction in female patients[15]. Moreover, women typically possess smaller and more tortuous LCX lumens, such that equivalent calcified plaque burden yields more pronounced luminal compromise[16]. Our observation aligns with a 2026 CREDENCE sub-study reporting stronger plaque-ischemia association within the LCX among female individuals[17]. This sex-specific finding carries clinical implications: LCX calcium score may confer higher predictive value for underlying stenosis in women undergoing CCTA screening, and interpretation should always integrate clinical symptomatology.

Several limitations deserve consideration. First, this retrospective single-center analysis enrolled only 137 participants, with a relatively small female subset (*n* = 52), which reduces statistical power for sex-stratified analyses. Second, we did not collect information regarding long-term lipid-lowering therapies such as statin use, a factor that could modify plaque characteristics and calcium deposition. Future large-scale, multi-center prospective cohorts are required to externally validate our vessel-specific and sex-stratified observations.

Conclusion

In summary, vessel-level CCTA calcium scores are positively associated with CAG-derived Gensini scores for the three major coronary arteries, yet correlation strength varies substantially across vascular territories. RCA calcium score shows the closest relationship with stenosis burden, whereas the LAD exhibits the weakest association. The prognostic hint provided by LCX calcification is particularly meaningful for women. In routine practice, calcium score offers supportive evidence for coronary stenosis assessment but is not a surrogate for invasive angiography. When marked calcification is detected in the RCA, clinicians should raise vigilance for significant underlying stenosis. Comprehensive evaluation combining calcium scoring, clinical presentation and complementary examinations is recommended for interpreting coronary atherosclerotic burden across different vessels and patient sexes.

Declarations

Conflict of interest: The authors declare no conflicts of interest.

Funding: None.

Ethics approval: This retrospective study was approved by the Institutional Review Board of Xingtai People's Hospital.

Author Contribution

M.R. designed the study, collected clinical data, performed statistical analysis, drafted the manuscript, and prepared figures. T.L. assisted with data collection and literature review. S.W. supervised the study and critically reviewed the manuscript. All authors read and approved the final manuscript.

Data Availability

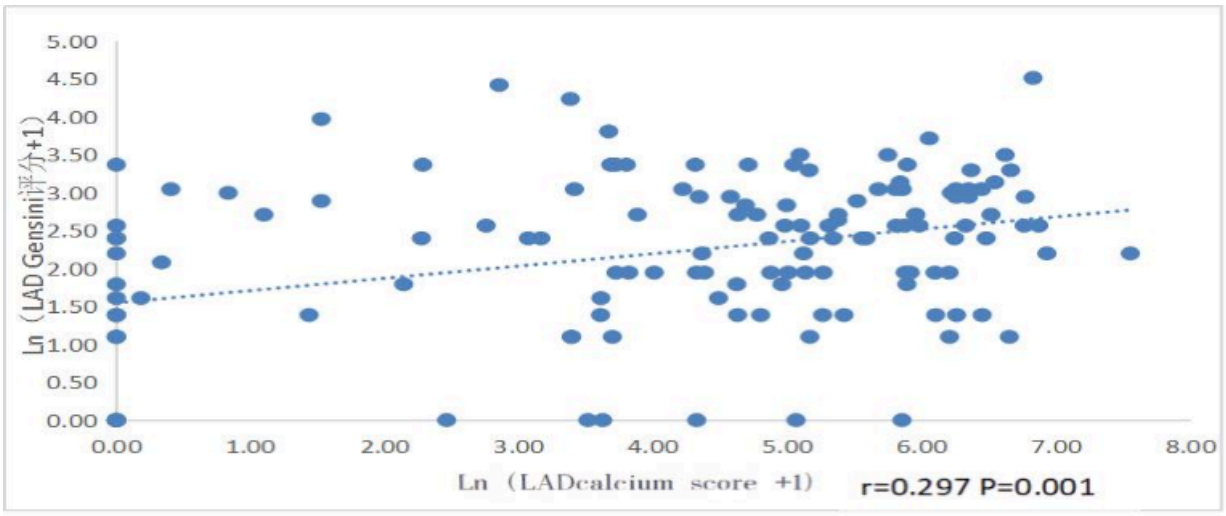
The datasets generated and analysed during the current study are not publicly available due to patient privacy protection, but are available from the corresponding author on reasonable request.

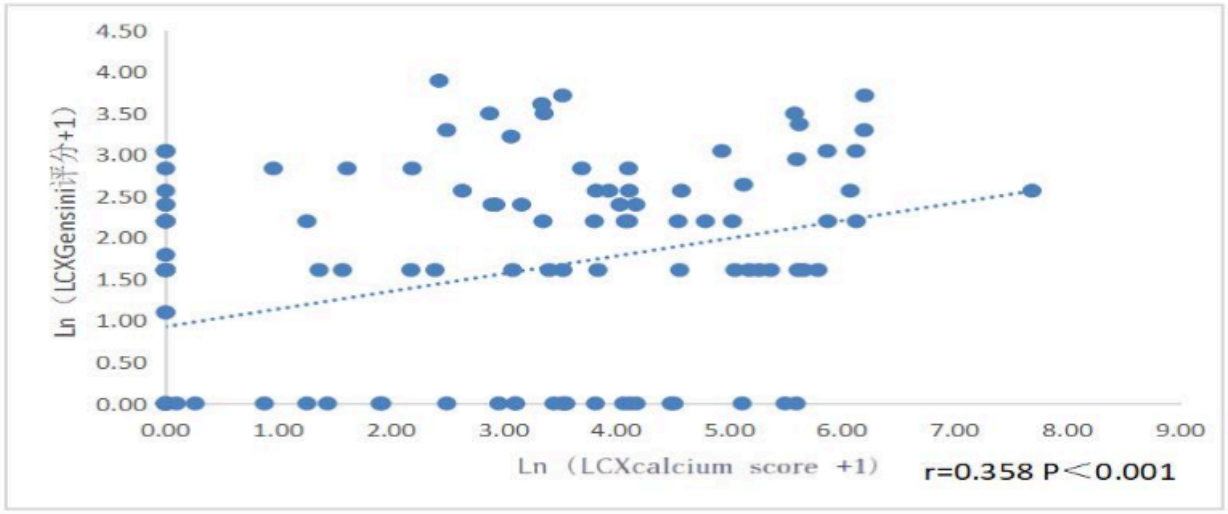
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Figures





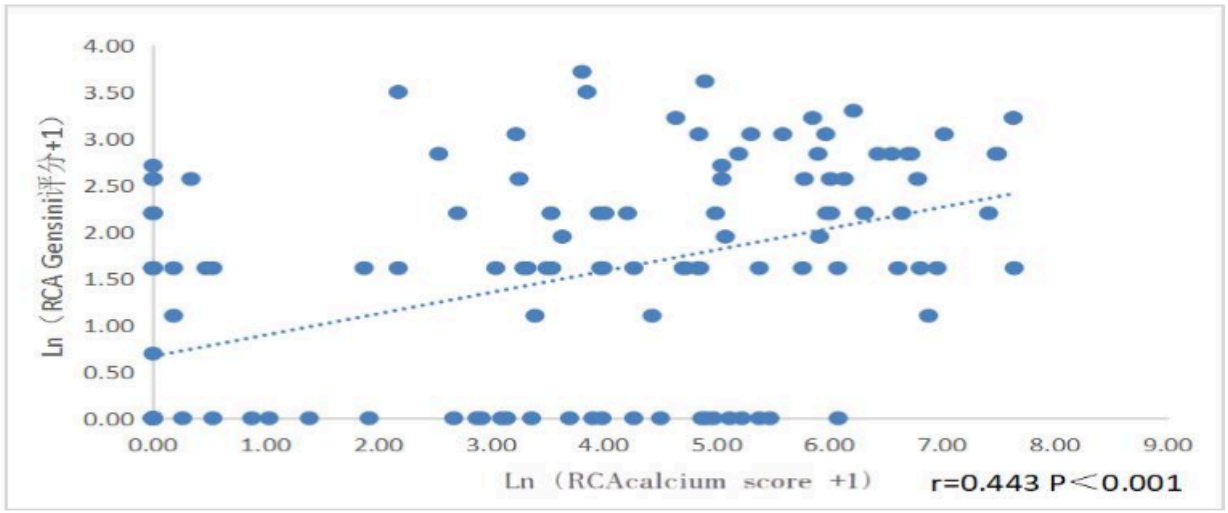


Figure 1

Scatter plots of ln-transformed vessel-specific calcium score versus ln-transformed corresponding Gensini score.

Note: X-axis: ln(calcium score +1); Y-axis: ln(Gensini score +1). Dashed lines represent linear-regression fitting.