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Positively remodeled coronary artery lesion detected by multislice CT as a predictor of future cardiovascular events

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Abstract
Background: Positively remodeled coronary artery lesions, despite causing non-significant arterial stenosis, have been implicated in adverse cardiovascular events. This study aims to identify the morphological characteristics of positively remodeled coronary lesions detected by multi-slice computed tomography (MSCT) coronary angiography and evaluate their predictive value for cardiovascular events over a 90-day follow-up.
Methods: This prospective cohort study included 50 patients undergoing MSCT coronary angiography at the National Heart Institute. Patients with a single-vessel disease exhibiting positive arterial remodeling with non-significant stenosis were selected. Clinical assessments, including demographic data, cardiovascular risk factors, and MSCT findings, were collected. Follow-up was conducted at 90 days to record adverse cardiovascular events
Results: Among the 50 patients, 20 (40%) developed cardiovascular events within 90 days. Significant predictors of future events included dyslipidemia ($p = 0.012$), diabetes mellitus ($p = 0.001$), LDL levels ($p < 0.001$), total cholesterol ($p = 0.004$), HDL levels ($p = 0.048$), and the remodeling index ($p < 0.001$). CT measurements revealed that higher wall/lumen area percentage ($p < 0.001$), plaque burden percentage ($p < 0.001$), and high-attenuation plaque area ($p < 0.001$) were significant predictors. Wall/lumen area percentage and plaque burden percentage showed the highest predictive performance, with 100% sensitivity and specificity.
Conclusions: Positively remodeled coronary lesions, particularly those with higher wall/lumen area and plaque burden, are strong predictors of future cardiovascular events. Comprehensive analysis of plaque characteristics and arterial measurements can enhance risk stratification, aiding in the prevention and management of cardiovascular disease.

Keywords: Positively remodeled coronary artery lesion, multislice CT, cardiovascular events

Introduction
While some coronary plaques may be asymptomatic, others can experience abrupt activation and rupture, leading to acute coronary events. Approximately 66% of acute coronary events are directly linked to the instability of atherosclerotic plaques. Unstable plaques are typically characterized by their considerable dimensions, extensive regions of necrotic tissue, and a thin coating of fibrous tissue. Non-calcified plaques with modest density have been identified as the most potent predictors of cardiac events. They have the potential to serve as indicators for the susceptibility of plaques [1].
Multislice coronary angiography (MSCA) is increasingly acknowledged as a valuable diagnostic tool, particularly for patients experiencing chest discomfort but exhibiting normal electrocardiogram (ECG) readings and cardiac enzyme levels in emergency scenarios. The MSCA technique allows for the evaluation of coronary plaques through a combination of quantitative and qualitative analysis, providing vital information about their distinct characteristics. The numerical value [2].
Sites where plaque is disrupted often exhibit positive remodeling, which is defined as an increase in the diameter of the blood vessel at the plaque site by at least 10% compared to a normal reference segment in the vessel. The remodeling index, ascertained by the use of MSCT, exhibits a robust correlation with the susceptibility of plaque [3].

Lesions that display hemorrhage, significant necrotic tissue, lipid buildup, inflammation driven by macrophages, and calcification are more prone to positive remodeling. This is a distinctive trait of vulnerable plaques referred to as thin cap fibroatheroma (TCFA). Conversely, stable plaques typically do not exhibit indications of positive remodeling [4].

The progression of plaque is often associated with the expansion of arteries (Positive remodeling), whereas regression is linked to the decrease in size of arteries (Negative remodeling). Studies have shown that sudden changes in slightly narrowed blood vessel blockages, particularly those that result in the artery expanding, might cause acute coronary syndrome [5].

Coronary lesions that have undergone positive remodeling, as seen by MSCT, are associated with increased vulnerability to plaque formation. This is corroborated by an increased quantity of necrotic core material and a higher frequency of TCFA (thin-cap fibroatheroma) shown on virtual histology intravascular ultrasound (VH IVUS) [6].

This research aims to determine the morphological features of positively remodeled coronary lesions that lead to non-significant arterial stenosis, as identified through MSCT coronary angiography, and to assess their predictive value for cardiovascular events over a 90-day follow-up period.

Material and methods

Study design and population

This prospective cohort study involved 50 patients who were candidates for CT coronary angiography and were diagnosed with single-vessel disease characterized by lesions exhibiting positive arterial remodeling with non-significant stenosis. These patients were selected from the National Heart Institute between August 2022 and February 2024. For each patient, either the solitary lesion or the most prominent one was chosen for analysis. A 90-day follow-up was performed to evaluate the occurrence of adverse cardiovascular events. The study was done after being approved by the Ethics Committee of the Faculty of Medicine at Benha University. Informed written consent was obtain from all cases included.

Patient Selection Criteria

The criteria for patient selection included both inclusion and exclusion factors. The inclusion criteria were patients with atypical chest pain with high pretest probability of cardiovascular disease based on the ACC/AHA 2002 guidelines, according to age, gender [7], typical chest pain but with low pretest probability of cardiovascular disease, high cardiovascular risk without cardiac symptoms that were referred for coronary evaluation before high risk non cardiac surgery, and patients who were found to have a single-vessel disease with lesions showing positive arterial remodelling causing non-significant stenosis selected by CTCA. The exclusion criteria involved patients with history of previous ABG, previous PCI history, lesions causing significant stenosis, contrast (iodine) allergy, renal impairment (Creatinine > 1.5 mg/dl), active asthma or inability to breath hold for at least 10 seconds, morbid obesity (Weight > 140 kg), atrial fibrillation or any irregular heart rhythm, hyperthyroidism, and pregnant females.

Patient Procedures and Data Collection

All the studied cases were subjected to the following: A comprehensive history was taken, cardiovascular risk factors, clinical examination, chest X-ray, transthoracic echocardiography, and laboratory tests.

Twelve-lead surface ECG: This was performed to identify evidence of any ischemic changes, chamber enlargement, abnormal axis deviation, rate and rhythm disturbances, and Q-T prolongation.

MSCT Coronary angiography: The CT angiography was conducted at the National Heart Institute using a dual source scanner (Somatom Definition Flash, Siemens) with a slice configuration of 64 × 0.625 mm and a gantry rotation time of 330 ms. Subjects were given specific instructions to abstain from consuming caffeine and smoking for a period of 12 hours prior to the operation in order to reduce heart stimulation. Additionally, they were required to refrain from eating solid food for a duration of 4 hours prior to the study. Prior to the exam, the individual was advised to consume a higher quantity of fluids. Heart rate regulation was accomplished by administering oral bisoprolol (5 mg) one hour before to the scan, with an additional dose delivered if the heart rate exceeded 70 bpm. Occasionally, an extra dose of propranolol was given through an intravenous injection. Patients were additionally educated on breath-holding techniques and provided with information regarding potential side effects of the contrast agent, including a sensation of warmth. Prior to the test, a sublingual dose of 5 mg of isosorbide dinitrate was administered to widen the coronary arteries and improve vision.

Coronary CT angiography (CCTA) was conducted using a dual-source CT (DSCT) scanner, with contrast administration managed through bolus tracking in the ascending aorta, set at a threshold of 120 HU. The scan was initiated after a 7-second delay, and images were promptly reconstructed to capture motion-free coronary artery images. Post-processing techniques included axial, multiplanar reformat, maximum intensity projection, and short-axis views, allowing for the evaluation and scoring of each arterial segment.

Coronary calcium scoring was conducted as a non-contrast study with ECG-gated prospective sequential scans, generating the Agatston calcium score. Contrast-enhanced images were acquired with an 85 mL contrast agent injection followed by 60 mL IV saline. Segments with plaques were evaluated using an 18-segment model. Plaques were classified as obstructive or non-obstructive based on the degree of stenosis, with obstructive plaques showing ≥50% arterial lumen stenosis. Plaque composition was assessed based on Hounsfield units: plaques with <30 HU were classified as low-attenuation plaques (LAP), those with 30-349 HU as mixed plaques (MP), and plaques with ≥350 HU as calcified plaques (CP). Measurements were taken for various vessel and plaque characteristics, including segment length, diameter stenosis, remodeling index, area stenosis, and volume [8-12].

Statistical analysis

The data were analyzed using IBM SPSS version 20.0, developed by IBM Corp and based in Armonk, NY. Qualitative data were quantified as numerical values and proportions, and quantitative data were characterized by

their range, average, variability, middle value, and spread between the first and third quartiles. The threshold for statistical significance was established at a p-value of less than 0.05. The tests employed were as follows: Chi-square for categorical variables, Fisher's Exact for small sample sizes, Student t-test for normally distributed quantitative variables, and Mann-Whitney test for non-normally distributed quantitative variables.

Results

The study included 30 female (60%) and 20 male patients (40%). The mean age was 60.70±8.23 years. The mean BMI (kg/m2) 29.45±3.45. Among different coronary artery disease risk factors, dyslipidemia was found in the majority of patients 32patients (64%), Lipid profile test was the Mean of LDL (mg/dl) 127.8±45.94, the mean of TC (mg/dl) 198.6±66.27, the mean of HDL (mg/dl) 37.80±5.42, the mean of TG (mg/dl) 169.3±101.7. Diabetes was found in 26 patients (52%), according to type of DM type1 DM was in 3 patient (11.5%), type 2 DM was in 23 patient (88.5), hypertension was in 30 patients (60%). Family history of cardiovascular disease found in 8 patient (16%). Most of the patients, 27 (54%) had history of dyspnea on their initial presentation, 16 (32%) patients were classified to have atypical chest pain, and 7 (14%) patients had stable angina, 0 (0%) patient had history of ACS.

The average ejection fraction among them was 63.62±6.29, which suggests that all patients had a normal left ventricular systolic function. The majority of the selected lesions were located in the LAD, accounting for 48% of the cases. The next most common were lesions in the RCA with 26%, followed by the LCX with 14%, the first diagonal branch (D1) with 6%, the LM with 4%, and the first obtuse marginal branch (OM1) with 2%.

The CT measurements for both remodeling and reference segments are provided in Table 1.

A 90-day follow-up was undertaken to evaluate any negative cardiovascular occurrences. A total of 20 patients experienced adverse effects. Thirteen patients, accounting for 26% of the total, were treated medically for CAD without undergoing PCI. Additionally, seven patients, representing 14% of the total, received PCI specifically for the index lesion. There were no deaths or cases of heart failure during the follow-up period. The results indicate that the patients were categorized into two groups: group I, consisting of 30 patients (60%) who did not experience cardiovascular events, and group II, consisting of 20 patients (40%) who did experience cardiovascular events.

In the comparison between the two studied groups, significant predictors of future clinical events included dyslipidemia (p = 0.012), diabetes mellitus (DM) (p = 0.001), duration of DM (p = 0.039), hypertension (HTN) (p = 0.003), LDL (p < 0.001), total cholesterol (TC) (p = 0.004), HDL (p = 0.048), and remodeling index (p < 0.001). Non-significant predictors included gender, age, BMI, triglycerides, positive family history of cardiovascular disease, initial presentation, and ejection fraction. Table 2

CT measurements identified larger total plaque area (p = 0.034) and higher high-attenuation plaque area (p = 0.001) as significant predictors of future clinical events. Significant correlations were also found for higher wall/lumen area percentage, plaque burden percentage, lower low-attenuation plaque area percentage, and higher high-attenuation plaque area percentage (all p< 0.001). Increased plaque-specific calcification and total calcium score (both p< 0.001) were additional significant predictors. Non-significant predictors included vessel area, wall area, low-attenuation plaque area, medium-attenuation plaque area, and mean density (HU). Table 3

Diagnostic performances of LDL, remodeling index, high-attenuation plaque area (mm), wall/lumen area, plaque burden, low-attenuation plaque area, high-attenuation plaque area, plaque-specific, and total CA score to discriminate Group 1 from Group2 were detailed showing that the highest performance predictors of cardiovascular events were wall/lumen area percentage (p< 0.001, cutoff >243.5%, sensitivity 100%, specificity 100%) and plaque burden percentage (p< 0.001, cutoff >68.5%, sensitivity 100%, specificity 96%). Table 4

Discussion

Positively remodeled coronary plaques, detectable by multislice CT (MSCT), are key indicators of plaque instability and potential cardiovascular events [13]. Understanding these lesions is crucial for predicting and preventing acute coronary incidents.

Each plaque was subjected to semi-automated computations to determine the presence of three distinct types of plaque components: low-attenuation, medium-attenuation, and high-attenuation plaques. Our analysis revealed that the remodeling segments had increased vessel and wall areas, along with the presence of substantial plaques characterized by low, medium, and high-attenuation. The remodeling index and plaque burden were elevated, suggesting significant arterial remodeling and a varied plaque composition. Plaques with low attenuation were susceptible to damage, whereas plaques with medium and high attenuation exhibited different levels of calcification. The calcium scores were elevated, indicating the existence of calcified plaques.

In line with our results, Galal *et al*. studied 55 patients undergoing MSCT CA and reported that the mean vessel area at the remodeling segment was 26.49±10.63, the mean wall area was 17.49±6.92, and the mean total plaque area was 17.22±6.64. The median areas were 5.00 for low-attenuation plaques, 8.00 for medium-attenuation plaques, and 2.00 for high-attenuation plaques. The mean wall/lumen area percentage was 222.82±98.19, and plaque burden was 66.80±8.29. Densities for low, medium, and high-attenuation plaques were 6 (−21 to 21) HU, 94.18±7.05 HU, and 185 (162 to 230) HU, respectively. The median calcium score for plaques was 0 (0 to 91), and the total CA score was 0 (0 to 850) [14]. However, they reported a median-based approach for attenuation plaques, which shows some differences in specific values when compared to our mean-based calculations [14]. The differences observed may stem from variations in patient demographics, imaging techniques, or specific methodologies used for plaque analysis.

Higher plaque burden in remodeling segments indicates significant changes and greater plaque complexity, with low-attenuation plaques posing a higher risk of rupture and acute cardiovascular events, while medium and high-attenuation plaques add to the overall risk [15, 16].

A 90-day follow-up showed that 20 patients (40%) developed cardiovascular events, with 13 treated medically and 7 undergoing PCI. Gender, age, and BMI were not significant predictors, but dyslipidemia, diabetes, longer

diabetes duration, and hypertension were significant predictors, all more prevalent in Group 2, which developed events.

Hypertension, elevated blood lipids, and diabetes contribute to cardiovascular events by promoting plaque formation, arterial stiffness, and atherosclerosis. Longer diabetes duration further increases cardiovascular risk through prolonged vascular damage, inflammation, and compounded effects from other risk factors like hypertension and dyslipidemia [17-20].

Similarly, Galal *et al*. found no significant differences between the 2 groups regarding demographics and EF. Contradictory to our results, no significant difference were found regarding risk factors except duration of diabetes which was significantly higher in group 2 than group 1 (p value = 0.048) [14]. Differences in findings regarding hypertension, diabetes, and dyslipidemia can be attributed to variations in sample size, population characteristics, diagnostic criteria, and possibly the severity and management of these conditions.

In our study, Group II patients had higher LDL and total cholesterol (TC) and lower HDL than Group I patients. LDL, TC, and HDL were found to predict future clinical events. However, the average triglyceride (TG) levels between groups did not differ significantly and did not predict future events.

High LDL cholesterol increases the risk of atherosclerosis, heart attacks, and strokes [20]. Total cholesterol levels over normal indicate lipid processing disturbance, which causes plaque and cardiovascular disease [21]. However, low HDL levels reduce cholesterol elimination, increasing cardiovascular disease risk [22].

In our study, mean value of remodeling index in group 1 was 1.50±0.08 Vs. 1.61±0.09 in group2, remodeling index was found to be significant predictors of future clinical events, p <0.001. In contrast, Galal *et al*. found no significant difference (P value = 0.479) [14].

In our study, group II had slightly larger vessel and wall areas compared to Group I, but these were not significant predictors of future clinical events. However, Group II also had larger total plaque areas, which were significant predictors of future cardiovascular events. Low-attenuation plaque areas did not significantly differ between the groups. Medium-attenuation plaque areas were larger in Group II but were not significant predictors. High-attenuation plaque areas were significantly larger in Group II and were significant predictors of future clinical events. Schmid *et al*. showed that lipid-rich plaques with low CT attenuation are associated with positive remodeling and an increased risk of plaque rupture. Their investigation revealed a remodeling index with a mean value of 1.17 ± 0.30, which is lower than our value of 1.61±0.09. This difference could potentially be attributed to variations in the location of the lesions. In contrast to our findings, there was no statistically significant correlation observed between the remodeling index and coronary risk factors. The average area of the blood vessels in the lesions was 0.25 ± 0.08 cm², with an average plaque density of 71 ± 26 HU [23]. Similarly, Galal *et al*. found no significant variations between group I and group II regarding vessel, wall, low-attenuation plaque, and medium attenuation plaque areas, and higher significant areas in high-attenuation plaque in group II than group I (P value=0.025). Total plaque area was found to be nonsignificant contrasting our results [14].

In the current work, Group II showed significantly higher average wall/lumen area, plaque burden, and high-attenuation plaque area percentages than Group I. These traits strongly predicted clinical events. Group II had a significantly lower average proportion of low-attenuation plaque area, another predictor. The percentage of plaque area with medium attenuation did not predict or differ across groups. Compatibly, Pflederer and colleagues found that acute coronary syndrome patients had more positively changed culprit lesions than stable coronary artery disease patients. The acute coronary syndrome group had a higher remodeling index and plaque and media complex area than stable angina [24]. In addition, Motoyama *et al*. compared CT coronary lesions in ACS and stable angina patients. The study included 38 ACS and 33 stable angina patients. Both groups' coronary plaques were assessed utilizing CT plaque features like vascular remodeling and non-calcified plaque consistency. They found that acute coronary syndrome (ACS) patients had more positive remodeling (87% vs. 12%), non-calcific plaques (NCP) with a density of fewer than 30 Hounsfield units (HU) (79% vs. 9%), and patchy calcification (63% vs. 21%) [25].

Similar to our results except for high-attenuation plaque area, Galal *et al*. found that patients with clinical events had significantly higher wall/lumen area percentages and plaque burdens (P values were 0.004 and 0.016, respectively). They also had a lower significant percentage of low-attenuation plaque area (P value = 0.003). Medium and high-attenuation plaque areas were not significantly different between the groups [14]. The difference in high attenuation plaque area percentage could be due to variations in study populations, imaging and measurement techniques, and sample sizes.

Furthermore, group II had significantly higher mean values for plaque-specific calcium scores and total calcium scores compared to Group I. Both plaque-specific calcification and total calcium scores were significant predictors of future clinical events. Mean density (HU) was not a significant predictor of future clinical events.

In alignment with our results, Galal *et al*. found no significant differences in mean density for low, medium, and high-attenuation plaques between groups. However, plaque-specific and total calcium scores were significantly higher in patients with clinical events (P values were 0.010 and 0.009, respectively) indicating these calcium measures are strong predictors of future cardiovascular events [14].

By analyzing patient demographic data, risk factors, and CT findings, we identified key predictors of cardiovascular events. The analysis identified several significant predictors of cardiovascular events, highlighting the importance of both traditional lipid measures and detailed plaque characteristics. Elevated LDL levels were a strong predictor, emphasizing the role of cholesterol management in preventing cardiovascular events. The remodeling index, indicating arterial changes, was also a key predictor, suggesting that structural changes in the arteries are critical in assessing risk.

Nadjiri and Tesche found that plaque traits including positive remodeling and low-attenuation plaque area predicted cardiovascular clinical outcomes [26, 27]. Galal *et al*. likewise found that these metrics were important markers, but they had different threshold values and less accuracy in predicting outcomes. Clinical events are predicted by wall/lumen area percentages over 226 and plaque burden percentages over 69%. These predictors exhibited 68% sensitivity, 86.6% specificity, and 81% PPV. 14. These

variations may be due to study participant demographics, research methodologies, or clinical occurrence criteria [14].

In 1168 patients, Nadjiri *et al*. found a strong association between coronary CT angiography low-attenuation plaque volume (LAPV) and MACE over five years. The MACE rate was 3.9% [26]. Tesche *et al*. found that MACE patients had more obstructive lesions, non-calcific plaque, and plaque burden than other patients [27]. Yamamoto *et al*. noted that non-calcified atherosclerotic lesions with low-attenuation plaques and positive remodeling on CT coronary angiography predicted future coronary events [28]. These longer-term investigations had worse outcomes than our shorter-term ones.

Previously, CT coronary angiography-detected lesions that underwent positive remodeling were associated with VH IVUS plaque susceptibility. Thus, remodeling on CT coronary angiography can indicate plaque vulnerability. Comparison of CT coronary angiography and IVUS shows that CCTA accurately quantifies coronary plaques. Nakazato *et al*. found no significant differences between CCTA and IVUS total plaque volumes. In addition, the CCTA accurately detected low-attenuation plaque, positive remodeling, and patchy calcification. No significant statistical differences were found between IVUS and these findings [29].

Limitations

The study's small sample size of 50 patients, short 90-day follow-up period, and single-center design at the National Heart Institute may limit the generalizability and long-term applicability of the findings.

Table 1: CT measurements at both remodeling and reference segments (n=50) area (mm2), percentage (%), mean density (HU) and calcium score (Agatston method).

CT measurement			Remodeling segment	Reference segment
Area (mm2)	Vessel	Mean ±SD	31.19±4.21	20.06±3.37
	Wall	Mean ±SD	21.35±2.42	8.66±1.66
	Total plaque	Mean ±SD	20.69±2.41	9.25±1.71
	Low-attenuation plaque	Mean ±SD	5.89±3.06	3.34±2.71
	Medium attenuation plaque	Mean ±SD	11.14±5.49	6.08±3.70
	High-attenuation plaque	Mean ±SD	5.64±5.13	1.40±2.24
Percentage (%)	Wall/lumen area	Mean ±SD	249.7±64.13	92.74±8.50
	Plaque burden	Mean ±SD	67.97±5.60	42.85±4.11
	Low-attenuation plaque area	Mean ±SD	34.50±7.43	31.43±4.86
	Medium attenuation plaque area	Mean ±SD	57.34±5.75	59.22±8.89
	High-attenuation plaque area	Mean ±SD	25.72±23.67	9.33±13.29
Mean density (HU)	Low-attenuation plaque	Mean ±SD	7.62±8.15	9.40±10.97
	Medium attenuation plaque	Mean ±SD	97.67±2.88	87.57±13.09
	High-attenuation plaque	Mean ±SD	151.9±218.0	82.60±102.4
Calcium score (Agatston method)	Plaque-specific	Mean ±SD	28.0±29.61	18.42±13.80
	Total CA score	Mean ±SD	174.8±251.5	163.4±232.4

CT: Computed Tomography, HU: Hounsfield Units, SD: Standard Deviation, CA: Calcium

Table 2: Comparison between the two studied groups according to demographic data, risk factors, lipid profile test, family history of cardiovascular disease, initial presentation, ECHO finding, and remodeling index

			Group I (n = 30)		Group II (n = 20)		Test of Sig.	p
Gender	Female	N (%)	16	53.3	14	70.0	χ^2= 1.389	0.239
	Male	N (%)	14	46.7	6	30.0		
Age (years)		Median (IQR)	65.0 (55.0 - 70.0)		59.50 (53.0-63.50)		t= 1.716	0.093
BMI (kg/m^2)		Median (IQR)	29.05 (26.1 - 31.1)		30.35(27.85 -31.25)		t= 1.068	0.291
HTN		N (%)	13	43.3	17	85.0	χ^2=8.681*	0.003*
PAD		N (%)	0	0.0	0	0.0	-	-
Smoker		N (%)	12	40.0	7	35.0	χ^2=0.127	0.721
Dyslipidemia		N (%)	15	50.0	17	85.0	χ^2=6.380	0.012*
DM		N (%)	10	33.3	16	80.0	χ^2=10.470*	0.001**
Type DM	Type I	N (%)	0	0.0	3	18.8	χ^2= 2.120	0.262
	Type II	N (%)	10	100.0	13	81.3		
Duration of DM (years)		Median (IQR)	10.0 (10.0-16.0)		15.0 (12.5-17.5)		t= 2.181*	0.039*
LDL (mg/dl)		Median (IQR)	105.5 (77.0-150.0)		150.0 (127.0-190.0)		t= 3.926*	<0.001**
TC (mg/dl)		Median (IQR)	160.0 (130.0-215.0)		211.0 (190.0-300.0)		t= 2.989*	0.004*
HDL (mg/dl)		Median (IQR)	40.0 (35.0-45.0)		35.0 (32.0-37.50)		t= 2.032*	0.048*
TG (mg/dl)		Mean ±SD.	166.7±111.9		173.3±86.79		U= 274.500	0.612
+ve Family history		N (%)	5	16.7	3	15.0	0.025	1.000
Initial presentation	ACS	N (%)	0	0.0	0	0.0	-	-
	Atypical chest pain	N (%)	11	36.7	5	25.0	χ^2=0.751	0.386
	Dyspnea	N (%)	17	56.7	10	50.0	χ^2=0.215	0.643
	Stable angina	N (%)	2	6.7	5	25.0	χ^2=3.350	0.100
EF (%)		Median (IQR)	64.50 (59.0 - 66.0)		63.50 (59.0 - 72.0)		t= 0.976	0.336
Remodeling index		Median (IQR)	1.51 (1.41 - 1.59)		1.61 (1.55 - 1.68)		t=4.563*	<0.001**

n: Number of participants, Sig.: Significance, p: p-value (probability value), IQR: Interquartile Range, BMI: Body Mass Index, HTN: Hypertension, PAD: Peripheral Arterial Disease, DM: Diabetes Mellitus, LDL: Low-Density Lipoprotein, TC: Total Cholesterol, HDL: High-Density Lipoprotein, TG: Triglycerides, ACS: Acute Coronary Syndrome, EF: Ejection Fraction.

Table 3: Comparison between the two studied groups according to Area (mm2), Mean density (HU), and Calcium score (Agatston method).

			Group I (n = 30)	Group II (n = 20)	Test of Sig.	P
Area (mm^2)	Vessel	Median (IQR)	30.50 (26.50 - 34.10)	31.0 (29.60 - 37.40)	t= 2.102*	0.051
	Wall	Median (IQR)	21.0 (19.27 - 23.10)	22.40 (20.20 - 23.90)	t= 2.279*	0.067
	Total plaque	Median (IQR)	20.50 (19.50 - 21.90)	20.90 (20.0 - 23.30)	t= 2.180*	0.034*
	Low-attenuation plaque	Mean ±SD.	5.63±3.42	6.28±2.47	U= 262.500	0.454
	Medium attenuation plaque	Mean ±SD.	9.67±4.84	13.34±5.79	U= 189.500*	0.078
	High-attenuation plaque	Mean ±SD.	3.60±5.39	8.70±2.68	U= 144.00*	0.001**
Percentage (%)	Wall/lumen area	Median (IQR)	199.4 (190.5 - 209.3)	316.0 (285.3 - 355.3)	t= 13.243*	<0.001**
	Plaque burden	Median (IQR)	64.52 (62.37 - 66.50)	71.98 (70.15 - 75.80)	t= 9.609*	<0.001**
	Low-attenuation plaque area	Median (IQR)	36.95 (36.60 - 41.50)	28.50 (24.65 - 28.90)	t= 10.978*	<0.001**
	Medium attenuation plaque area	Median (IQR)	58.0 (50.90 - 63.50)	59.45 (55.30 - 60.20)	t= 0.478	0.635
	High-attenuation plaque area	Median (IQR)	9.83±14.65	49.55±11.0	U= 15.500*	<0.001**
Mean density (HU)	Low-attenuation plaque	Mean ±SD.	8.17±8.77	6.80±7.26	U= 285.00	0.758
	Medium attenuation plaque	Median (IQR)	99.0 (95.50 - 100.0)	97.0 (95.75 - 98.75)	t= 0.261	0.795
	High-attenuation plaque	Mean ±SD.	129.9±180.8	184.8±266.0	U= 276.00	0.580
Calcium score (Agatston method)	Plaque-specific	Mean ±SD.	9.63±7.73	55.50±29.01	U= 42.00*	<0.001**
	Total CA score	Mean ±SD.	29.03±21.83	393.4±280.4	U= 16.00*	<0.001**

n: Number of participants, Sig.: Significance, p: p-value (probability value), IQR: Interquartile Range, SD: Standard Deviation, HU: Hounsfield Units, CA: Calcium.

Table 4: Diagnostic performance of LDL, remodeling index, High-attenuation plaque area (mm), other different parameters, plaque-specific, and total CA score to discriminate Group 1 from Group 2

	AUC	P	95% C. I	Cut off#	Sensitivity	Specificity	PPV	NPV
LDL	0.782	<0.001*	0.656 - 0.908	>117	75.0	73.33	65.2	81.5
Remodeling index	0.798	<0.001*	0.674 - 0.923	>1.52	80.0	70.0	64.0	84.0
High-attenuation plaque	0.760	0.002*	0.615 - 0.905	>7	70.0	73.33	63.6	78.6
Wall/lumen area	1.000	<0.001*	1.0 - 1.0	>243.5	100.0	100.0	100.0	100.0
Plaque burden	0.989	<0.001*	0.966 - 1.0	>68.5	100.0	96.67	95.2	100.0
Low-attenuation plaque area	0.998	<0.001*	0.993 - 1.0	≤35.5	100.0	96.67	95.2	100.0
High-attenuation plaque area	0.974	<0.001*	0.939 - 1.0	>30	90.0	83.33	78.3	92.6
Plaque-specific	0.930	<0.001*	0.840 - 1.0	>18	85.0	100.0	100.0	90.9
Total CA score	0.973	<0.001*	0.921 - 1.0	>80	95.0	100.0	100.0	96.8

AUC: Area Under the Curve, p: p-value (probability value), 95% C.I.: 95% Confidence Interval, PPV: Positive Predictive Value, NPV: Negative Predictive Value, LDL: Low-Density Lipoprotein, CA: Calcium.

Conclusions

In conclusion, this study revealed that specific plaque characteristics and arterial measurements, particularly wall/lumen area, plaque burden, and plaque composition, are key predictors of future cardiovascular events. This detailed analysis enhances risk stratification, informing more effective prevention and treatment strategies by emphasizing both structural and compositional plaque evaluation in managing cardiovascular health.

Conflict of Interest

The authors declare that there are no conflicts of interest.

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