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High-Risk Carotid Plaques Identified by CT-Angiogram can Predict Acute Myocardial Infarction

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Abstract

Purpose—Prior studies identified the incremental value of non-invasive imaging by CT-angiogram (CTA) to detect high-risk coronary atherosclerotic plaques. Due to their superficial locations, larger calibers and motion-free imaging, the carotid arteries provide the best anatomic access for the non-invasive characterization of atherosclerotic plaques. We aim to assess the ability of predicting obstructive coronary artery disease (CAD) or acute myocardial infarction (MI) based on high-risk carotid plaque features identified by CTA.

Methods—We retrospectively examined carotid CTAs of 492 patients that presented with acute stroke to characterize the atherosclerotic plaques of the carotid arteries and examined development of acute MI and obstructive CAD within 12-months. Carotid lesions were defined in terms of calcifications (large or speckled), presence of low-attenuation plaques, positive remodeling, and presence of napkin ring sign (NRS). Adjusted relative risks were calculated for each plaque features.

Results—Patients with speckled (<3mm) calcifications and/or larger calcifications on CTA had a higher risk of developing an MI and/or obstructive CAD within one year compared to patients without [adjusted RR of 7.51, 95%CI 1.26 to 73.42, P= 0.001]. Patients with low-attenuation plaques on CTA had a higher risk of developing an MI and/or obstructive CAD within one year than patients without [adjusted RR of 2.73, 95%CI 1.19 to 8.50, P= 0.021]. Presence of carotid calcifications and low-attenuation plaques also portended higher sensitivity (100% and 79.17%, respectively) for the development of acute MI.

Conclusions—Presence of carotid calcifications and low-attenuation plaques can predict the risk of developing acute MI and/or obstructive CAD within 12-months. Given their high sensitivity, their absence can reliably exclude 12-month events.

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Keywords

Myocardial Infarction; Imaging; CT-Angiogram; Carotid Plaques

Introduction

The life-threatening complications of atherosclerotic disease such as stroke and myocardial infarction (MI) are often caused by acute intra-plaque thrombosis, which is triggered by the atherosclerotic plaque instability [1,2]. CT angiogram (CTA) has emerged as a non-invasive tool to detect, quantify and characterize such atherosclerotic lesions [3]. In 1999, a pilot study by Oliver and associates examined the predictive role of different plaque characteristics visualized by conventional 3-mm thick CTA to predict carotid plaque stability [4]. This study revealed that plaques with elements of fat density on CTAs were usually composed predominantly of necrotic lipid, often associated with varying degrees of intra-plaque hemorrhages. These data identified CTA as a promising technique for evaluating the lumen and wall of the carotid artery, and that the apparent correlation between histologic appearance and plaque density on CTAs has important implications for the prediction of plaque stability.

Atherosclerosis is a systemic disease that affects major organs. Consequently, it is expected that plaque composition correlates between different arterial segments within individuals. Therefore, if high-risk plaques can be detected prospectively and accurately, and effective therapeutic interventions initiated before cardiovascular events occur, then major cardiovascular events can be prevented. CTA features of low-attenuation (soft) plaque, spotty calcification (speckles) and positive vascular remodeling have previously been described as the surrogates of lesion instability leading to high risk for coronary plaque rupture [5]. Furthermore, the napkin-ring sign (NRS), has been described as a specific signature of high-risk atherosclerotic plaques, and when visualized by CTA, strongly correlates with the fibroatheroma and large necrotic core observed by histological examination of the coronary arteries [6,7].

There has been growing clinical evidence which emphasizes the significance of coronary plaque characteristics on acute coronary syndrome (ACS) outcomes. For example, a prospective study by Otsuka and associated investigated the prognostic value of vulnerable coronary plaques, including features of positive remodeling, low-attenuation plaques, and ring-like sign, on coronary CTA for predicting future ACS events [8]. In this study also demonstrated that even physiologically non-obstructive but vulnerable coronary plaques can be associated with development of future cardiac death, non-fatal MI, and unstable angina.

Until recently, it is uncertain whether the features of plaque vulnerability are interchangeable and represent comparable outcomes among different vascular beds [9,10]. For instance, a high risk marker validated in carotid arteries are not yet been proven to be relevant in studying plaque vulnerability in coronary arteries. Therefore, we conducted this comprehensive study to examine symptomatic ischemic-stroke patients with evidence of vulnerable plaques visualized by carotid CTA, and identify and characterize high-risk atherosclerotic plaques that are associated with development of acute MI within one year.

This study will provide insights into the significance of high-risk plaque characteristics (i.e. soft plaque, positive remodeling, spotty or large calcifications and presence of NRS) for the development of major adverse cardiovascular events. Defining imaging criteria or management guidelines based on in-depth plaque characterization allows the formation of prevention strategies for coronary artery disease. Consequently, this can lay the foundation for future longitudinal studies utilizing modern high-resolution CT scanners, to identify and characterize high-risk atherosclerotic plaques that are strongly associated with major adverse cardiovascular outcomes.

Methods

Patient Selection

At Gates Vascular Institute, Buffalo General Medical Center and Millard Fillmore Suburban Hospital, we retrospectively analyzed all identifiable patients from the 01/01/2012 to 02/28/2013 who met our inclusion criteria, including- 1) Age more than 18 years, 2) Symptoms suggestive either transient ischemic attack (TIA) or stroke, including focal neurologic deficits affecting one side of the body, speech, or vision, 3) CT-scans performed as a stroke-protocol, 4) CTA of the carotid arteries for suspected or manifest presentations of carotid atherosclerosis, 5) CTA of the head and neck extended from upper thorax to the skull base to evaluate the carotid arteries, using standard protocols. Exclusion criteria included patients less than 18 years of age, patients with hemorrhagic stroke or CT-head ordered for reasons other than ischemic strokes. The study protocol was approved by the institutional review board of the University at Buffalo.

Data Abstraction

Data abstraction was performed independently by four abstractors (AC, NR, SV and JP). Discrepancy between abstractors were settled by joint review and discussions. For each patient, hospital records and CTA reports over a 12-month period from hospitalization were reviewed for demographic and baseline characteristics, CTA image, and pre-specified outcomes. Demographic and baseline characteristics including age, sex, race, body mass index (BMI), baseline left ventricular ejection fraction (LVEF), past medical history of medical conditions including type-2 diabetes mellitus (DM), CAD, congestive heart failure (CHF), prior cerebrovascular accident (CVA), atrial fibrillation, hypertension (HTN), hyperlipidemia (HLP), smoking history, aspirin use, anticoagulation use, and length of hospital stay. CTA image evaluation was then performed as described below. Analyzed CTA data characteristics included presence of right and left carotid stenosis, percentage of stenosis, presence of soft plaque, presence of calcification and number of speckles.

Clinical Outcomes

The primary outcome was the composite outcome of developing an acute MI and/or obstructive coronary artery disease on angiogram (defined as coronary stenosis of >50%) within one year from date of hospitalization. Secondary outcomes included the presence of ischemic stroke on presentation and length of hospitalization as an early outcome. Acute MI was defined as ischemic symptoms and an elevation of CK-MB or troponin I above the upper limit of normal, with or without ST-T changes or development of Q waves. Ischemic

stroke at presentation as an outcome was defined by the evidence of brain ischemia based on head CT findings.

CTA Imaging Protocol and Radiation Dose

Toshiba Aquilion ONE dynamic volume CT, 320-detector row scan was used at the study sites. For the carotids, multiple axial scans were taken from the aortic arch to the skull base with and without IV administration of 80 mL of Omnipaque (Iohexol) 350. For our study sample, the mean CDTIvol and DPI were 466.9 mGy and 600.3 mGy.cm, respectively. The mean calculated effective dose was 3.54 mSv.

CTA Image Evaluation

Analysis of the CTA images was performed independently by three cardiovascular imagers (KA, RK, and UCS), who assessed the images for the presence and composition of atherosclerotic plaques. On CT images, carotid arteries were divided into 5 segments: two 10-mm segments proximal to the carotid bulb, carotid bulb, and two 10-mm segments of the internal carotid artery distal to the carotid bulb.

Plaque Characterization

Atherosclerotic plaques in each patient were characterized for the presence of the following high-risk characteristics: 1. Large calcifications and/or spotty calcifications (speckles). 2. Positive vessel remodeling. 3. Low attenuation (soft) plaque 4. NRS. Furthermore, the number of speckles were visually quantified. Carotid arterial remodeling was defined as a change in the vessel diameter at the plaque site in comparison to the reference segment set proximal to the lesion in a normal-appearing vessel segment (reference diameter). Manual inspection, in both cross-section and longitudinal reconstruction, was used for defining the remodeling index (lesion diameter/reference diameter). The remodeling index was reported as positive remodeling when the diameter at the plaque site was at least 10% larger than the reference segment. Spotty calcification was defined as <3 mm in size on curved multiplanar reformation images and occupied only one side on cross-sectional images. Large calcifications were defined as the calcification larger than spotty calcification. Soft plaque is defined as a plaque that has <30 Hounsfield units [11]. The NRS was defined as the presence of low attenuation plaque core surrounded by a circumferential area of higher attenuation [12].

Statistical Analysis

Patient's demographics and CTA findings were categorically reported. Categorical variables including demographic characteristics and CTA findings were expressed as percentages, and the Chi-squared test was used for comparisons between those with and without clinical outcomes. Crude Relative risk (RR) with 95% confidence interval (CI) was used to study whether high risk plaque characteristics are predictors of acute MI and/or coronary stenosis of >50% on coronary catheterization. A two-sided p-value of <0.05 was considered statistically significant. The sensitivity, specificity, positive and negative predictive value of each for developing MI or >50% coronary artery stenosis within one year for each high-risk plaque feature were calculated. In one of the contingency tables, there was one cell

containing zero observations, this issue was resolved by adding a constant of 1 to each cell counts before conducting the analysis. Finally, to control for potential confounding variables, multivariate log-binomial models were used to calculate adjusted RR (95% CI) for plaque characteristics that had a significant crude RR. The RR was adjusted for age, sex, race, BMI, history of diabetes mellitus, coronary artery disease, hypertension, smoking, and stroke on admission.

Results

Baseline Characteristics

Our comprehensive search using pre-defined inclusion and exclusion criteria identified 492 total eligible patients for further analysis and follow up. Their demographic characteristics were categorized as total study subjects (Table 1), and as a group-cohorts based on their race (Caucasian vs. African American) as listed in Table S1 in the Supplement. Approximately, 47% of all patients had evidence of cerebral ischemia based on head CT findings indicating an ischemic stroke on that admission. Of note, African American (AA) patients had earlier presentation to hospital compared to Caucasians (mean age at presentation: AA, 69.51 ± 16.5 vs. 59.08 ± 17.1 , p-value <0.0001). In addition, AA patients had longer length of hospital stay (mean hours: Caucasians, 111.2 ± 146.7 vs. AA, 172.8 ± 252.5 ; p-value 0.0063), and history of DM (Caucasians, 21% vs AA, 40%, p-value 0.0007).

Ethnic Discrepancies on Carotid Atherosclerotic Plaques

CTA findings were also categorized based on ethnicity in Table S2 in the Supplement. Caucasians had a significantly higher percentage for presence of calcification than AA in the right carotid artery (59.55% vs 44.26%, p-value 0.0243), and in the left carotid artery (59.8% vs 45.9%, p-value 0.04). Caucasians also had a significantly higher percentage for presence of speckles in the right carotid artery (50.62% vs. 36.07, p-value 0.0340). There were no significant differences in other high risk plaque features between the two races.

Predictive Role of High Risk Plaque Features for ACS and Obstructive Coronary Lesions

A) Presence of any high risk features—Data for the incidence of MI within one year was compared to the presence of any of the high risk features above on CTA (Table 2a). This data showed that patients with any high risk features on CTA had significantly higher risk of developing MI and/or $>50\%$ coronary artery stenosis within one year than patients without high risk features [RR 9.83, 95% CI 1.35 to 71.86, $P = 0.002$]. Of note, difference in the length of stay was also statistically significant between patients with any high risk features compared to patients without [mean hours $\pm$ SE: 133.90 ± 9.27 vs 77.51 ± 11.78 , $p=0.0007$] where patients with any high risk features had significantly longer duration of hospital stay.

In order to identify possible confounding baseline variables, a comparison of presence versus absence of any high risk features by patient demographic characteristics was performed (Supplement Table S3). It was found that patients with high-risk plaque characteristics were significantly older, had longer length of hospital stay, more likely to be Caucasians, more likely to have DM, history of HTN, CAD, atrial fibrillation, HLP, smoking, aspirin use, and more likely to have had a stroke during that admission. Therefore,

RR was adjusted for the potential confounding variables (age, sex, race, BMI, history of DM, CAD, HTN, smoking, and stroke on admission) and showed adjusted RR of 7.63 [95% CI 1.19 to 50.27, $p=0.009$].

B) Presence of any calcification—Data for the incidence of MI within one year was examined for the presence of large calcifications and/or speckles on CTA (Table 2b). These data showed that patients with calcifications on CTA had a significantly higher risk of developing an MI and/or >50% coronary artery stenosis within one year than patients without calcifications [RR 13.27, 95% CI 1.81–97.11, $p=0.0007$]. Of note, difference in the length of stay was also statistically significant between patients with carotid artery calcification or speckles compared to patients without [mean hours $\pm$ SE: 130.0 ± 8.85 vs $93.71.8 \pm 13.75$, $p=0.0183$] whereas patients with speckles had a longer duration of hospital stay (Supplement Table S4). In order to identify possible confounding baseline variables, a comparison of presence versus absence of calcification by patient demographic characteristics was also performed (Supplement Table S4). We found that patients with calcifications were significantly older, more likely to be Caucasian, have history of DM, CAD, CHF, HTN, atrial fibrillation, HLP, smoking, aspirin use, and more likely to have had a stroke during that admission. Therefore, RR was adjusted for the potential confounding variables (age, sex, race, BMI, history of DM, CAD, HTN, smoking, and stroke on admission) and showed adjusted RR of 7.51 [95% CI 1.26 to 73.42, $P=0.001$].

C) Presence of positive vessel remodeling—Data for the incidence of MI within one year was compared in relation to the presence of positive remodeling on CTA (Table 2c). These data showed that patients with positive remodeling on CTA did not have a higher risk of developing an MI and/or >50% coronary artery stenosis within one year than patients without positive remodeling [RR 1.60, 95% CI 0.70–3.65, $P=0.26$].

D) Presence of low-attenuation (soft) plaques—Data for the incidence of MI within one year was compared in relation to the presence of soft plaques on CTA (Table 2d). These data showed that patients with soft plaques on CTA had significantly higher risk of developing an MI and/or >50% coronary artery stenosis within one year than patients without soft plaques [RR 3.56, 95% CI 1.35 to 9.38, $P=0.006$]. RR was adjusted for the potential confounding variables (age, sex, race, BMI, history of DM, CAD, HTN, smoking, and stroke on admission) and showed adjusted RR of 2.73 [95% CI 1.19 to 8.50, $P=0.021$].

E) Presence of NRS—Only two patients were found to have a NRS. Therefore, given the very small number of this finding with our sample size, its independent statistical significance in predicting the incidence of MI within one year could not be calculated.

Table 3 summarizes the relative risks for development of MI in one year for patients with different high risk features compared to patients without, along with the sensitivity, specificity, positive predictive value and negative predictive value of each high-risk plaque feature, presence of any high-risk features, and for the presence of the combined features which were found to have a statistically significant RR (calcification, and soft plaque).

Discussions

The American Heart Association (AHA) and American Stroke Association (ASA) have recently published a statement recommending an individual risk assessment based largely on risk score to identify patients with the highest likelihood of morbidity and mortality from unrecognized CAD after a stroke [13]. A systematic review and a meta-analysis of randomized clinical trials and observational studies investigating the absolute risk of MI and vascular death after stroke or transient ischemic attack (TIA) showed that after a stroke/TIA, the risk of MI is approximately 2% per year [14]. Therefore, finding a potential imaging method to estimate the absolute risk of MI after stroke and identify high-risk patients is of great importance in achieving this goal. However, such imaging methods are yet to be validated in terms of clinical outcomes. Our study, therefore, provide better understanding of the potential role of CTA in identifying these high risk populations.

First, comparing the demographic characteristics of the patients gives insight into difference in prevalence of carotid calcifications between ethnicities in our community. We found that larger proportion of Caucasian patients had carotid calcification and speckles than AAs in the right carotid artery, and higher proportion of calcifications in the left carotid artery. However, since our study shows a striking difference of about 10 years for the mean age at presentation between Caucasians and AAs, the latter being younger, the lower prevalence of carotid calcifications in AAs may be secondary to their earlier presentations with stroke/TIA symptoms. This is consistent with the fact that stroke mortality rates are approximately 50% higher in AAs than Caucasians, with a larger difference at younger ages [15]. Comparable to prior studies, higher prevalence of DM observed in AAs may have also contributed to the excess stroke mortality among AAs [16].

Second, assessment of plaque characteristics including positive remodeling, low-attenuation plaques, and ring-like sign as vulnerable features associated high risk plaques, independent of the severity of coronary artery luminal stenosis, have been reported in previous studies [17–19,8]. However, whether the same high risk characteristics in different vascular beds such as carotid arteries are also associated with increased ACS outcomes was yet to be demonstrated. Therefore, perhaps the most important finding in our study is that the presence of any calcification (large and/or speckles), and the presence of soft plaques on CTA are associated with increased risk of MI and/or >50% coronary artery stenosis within one year. This also supports our hypothesis that CTA utilizing modern high-resolution CT scanners can identify high-risk atherosclerotic plaques that are strongly associated with major adverse cardiovascular outcomes. Given the negative predictive values of both tests being 100% and 97.9%, for presence of large calcification and presence of soft plaque respectively, one can surmise that these features can rule out the future incidence of MI within one year when absent. The positive predictive values, however, were low (7.45% and 7.48%, respectively) for the risk prediction, and therefore their use as independent predictors in ruling-in a risk of MI within one year is limited. It is also important to note that, while the presence of these two features independently showed high sensitivity (100% and 79.17%, respectively), their value is compromised with a low specificity (36.3% and 49.79 %, respectively). In an attempt to improve the positive predictive value, and specificity of

predicting the risk of MI, the combined presence of both features was analyzed which showed a marginally higher specificity of 56.4% and PPV of 8.52%.

Our study shows that the presence of calcification, and the presence of soft plaques on CTA both predict significantly increased risk for MI and/or >50% coronary artery stenosis within one year even after adjusting for these variables. Most of these variables are similar to the ones in the Framingham Risk Score (FRS). FRS is a multivariable statistical model that uses age, sex, smoking history, blood pressure, cholesterol, high-density lipoprotein cholesterol (HDL-C), and blood glucose levels or history of DM to estimate coronary event risk among individuals without previously diagnosed CAD [20]. Guidelines suggest that all adults should undergo CAD risk assessment to guide preventive strategy. The FRS is often recommended for this, however it has also been suggested that risk assessment may be improved by additional tests such as coronary artery calcium scoring (CACS) [21]. In fact, a recent study investigated whether coronary CTA high-risk plaques have prognostic values incremental to the FRS and the severity of luminal obstruction [22]. The study illustrated that evaluation of coronary CTA plaque characteristics may provide incremental prognostic value to the number of diseased vessels and the FRS. Another study has also showed that low attenuation plaque volume, positive remodeling and presence of the NRS are predictors of major adverse cardiac events independently of clinical risk presentation [23]. Low attenuation plaque volume carried additional prognostic information beyond the calcium score and conventional coronary CTA analysis.

Therefore, following the same reasoning in the setting of stroke patients, CTA assessment of calcification and high risk features, which were found to be independently predictive of MI from the above mentioned variables through an adjusted RR calculation, combined with FRS may also provide additive prognostic information and risk prediction superior to either method alone and thus more accurately guide primary preventive strategies for patients with CAD risk factors. Therefore, these new findings paves way for future studies, but there remains a need for a well-designed longitudinal study with combined utilization of vascular imaging with direct comparison between imaging and histological findings, and correlation of such findings with major cardiovascular adverse events.

It is also important to note that our study examines the risk of MI in patients presenting with symptoms of stroke rather than proven stroke, where CTA still exhibits a potential predictor for MI in these patients. Though, our data also show that patients who had high risk features were significantly more likely to have had a stroke at presentation (Supplement Table S3), and thus the incidence of stroke in a patient at presentation itself may be a confounding cause for increased risk of MI in one year. This has been previously illustrated in a meta-analysis, where patients with TIA or stroke have a relatively high risk of MI and non-stroke vascular death [14].

In conclusion, this novel study shows that the presence of carotid large calcifications and/or speckles, and soft plaque can predict the higher risk of developing acute MI and/or obstructive CAD within 12-months. Given their high sensitivity, absence of these plaque characteristics in initial carotid CTA can reliably exclude the future (12-month) coronary events. These results emphasize the systemic nature of atherosclerosis, and offers possibility

for the utility of comprehensive non-invasive CTA as an emerging tool to identify the patients who are at higher risk of developing acute MI or obstructive CAD. This facilitates the achievement of AHA goals of improving the cardiovascular health of all Americans by 20 percent while reducing deaths from cardiovascular disease by 20 percent by 2020.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Abbreviations

ACS	Acute coronary syndrome
BMI	body mass index
CHF	Congestive heart failure
CTA	CT angiogram
CVA	cerebrovascular accident
DM	diabetes mellitus
HTN	hypertension
HLP	hyperlipidemia
LVEF	left ventricular ejection fraction
MI	Myocardial infarction
MRA	Magnetic resonance angiogram
NRS	napkin-ring sign

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Table 1

Demographic characteristics of the total study participants

	Total (n = 492)
Age (Mean $\pm$ SE)	67.67 $\pm$ 0.78
Length of stay (Mean $\pm$ SE)	118.1 $\pm$ 7.53
Sex	
Male	57.32%
Female	42.68%
BMI	28.75 $\pm$ 0.31 kg/m ²
History of DM	23.78%
History of CAD	21.59%
History of CHF	8.54%
History of CVA	22.97%
History of atrial fibrillation	16.46%
History of HTN	71.14%
History of hyperlipidemia	50.41%
Smoking history	32.72%
Anti-coagulation therapy	11.99%
Aspirin treatment	33.54%
LVEF (Mean $\pm$ SE)	57.89 $\pm$ 0.50
Stroke on this admission	47.36%

BMI, body mass index; LVEF, left ventricular ejection fraction; CHF, congestive heart failure; CVA, cardiovascular accident; SE, standard error of mean.

Table 2

Data comparison for the development of acute MI and/or >50% coronary artery stenosis in one year for patients with presence of (a) any high-risk plaque characteristics versus patients without; (b) calcification or speckles on CTA versus patients without; (c) positive remodeling on CTA versus patients without; (d) soft plaque on CTA versus patients without; and (e) both calcification and/or speckles and soft plaque versus patients without any high-risk features

(a)		
	MI and/or >50% coronary artery stenosis	No MI or >50% coronary artery stenosis
Presence of any High risk features	24 (6.8%)	330 (93.2%)
Absence of high risk features	0 (0%)	138 (100%)

(b)		
	MI and/or >50% coronary artery stenosis	No MI or >50% coronary artery stenosis
Calcification or speckles	24 (7.5%)	298 (92.5%)
No calcification or speckles	0 (0%)	170 (100%)

(c)		
	MI and/or >50% coronary artery stenosis	No MI or >50% coronary artery stenosis
Positive remodeling	8 (7.5%)	109 (92.5%)
No positive remodeling	16 (4.3%)	359 (95.7%)

(d)		
	MI and/or >50% coronary artery stenosis	No MI or >50% coronary artery stenosis
Presence of soft plaque	19 (7.5%)	235 (92.5%)
Absence of soft plaque	5 (2.1%)	233 (97.9%)

(e)		
	MI and/or >50% coronary artery stenosis	No MI or >50% coronary artery stenosis
Calcification and/or speckles, and Soft plaque	19 (8.5%)	204 (91.5%)
Absence of Calcification or speckles, or Soft plaque	5 (1.9%)	264 (98.1%)

Table 3

The relative risks for development of MI in one year for patients with different high risk features compared to patients without, along with the sensitivity, specificity, positive predictive value and negative predictive value of each variables

Characteristic	Crude RR (95% CI) P-value	Adjusted RR (95% CI) P-value	Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)
Calcification and/or speckles	13.27 (1.81– 97.11) P=0.0007	7.51 (1.26– 73.42) P=0.001	100.00% (85.75% – 100.00%)	36.32 % (31.96% – 40.86%)	7.45% (4.83% – 10.89%)	100.00 % (97.85% – 100.00%)
Positive remodeling	1.60 (0.70– 3.65) P=0.26	1.29 (0.53– 2.98) P=0.43	33.33% (15.63% – 55.32%)	76.71 % (72.61% – 80.47%)	6.84% (3.00% – 13.03%)	95.73 (93.16% – 97.54%)
Soft plaque	3.56 (1.35 – 9.38) P = 0.006	2.73 (1.19– 8.50) P=0.021	79.17% (57.85% – 92.87%)	49.79 % (45.16% – 54.41%)	7.48% (4.56% – 11.44%)	97.90 % (95.17% – 99.31%)
Calcification and/or speckles, and Soft plaque	4.58 (1.7394 to 12.0 801) P = 0.0006	3.67 (1.56– 10.73) P = 0.008	79.17% (57.85% – 92.87%)	56.41 (51.78% – 60.96%)	8.52% (5.21% – 12.99%)	98.14 % (95.72% – 99.39%)
Any High risk features	9.83 (1.3450– 71.86) P=0.002	7.63 (1.19– 50.27) P=0.009	100.00% (85.75% – 100.00%)	29.49 % (25.39% – 33.85%)	6.78% (4.39% – 9.92%)	100.00 % (97.36% – 100.00%)