Race-Specific Relationships Between Coronary and Carotid Artery Calcification and Carotid Intimal Medial Thickness

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Background and Purpose—Calcified arterial plaque has been proposed as a subclinical marker of atherosclerosis. We compared it to a well-validated surrogate—carotid intimal medial thickness (IMT).

Methods—Calcified arterial plaque was measured in 2 vascular beds (coronary and carotid) by computed tomography, and common carotid artery IMT was measured by B-mode ultrasonography, in 438 participants.

Results—Calcium was positively associated with IMT ($r=0.36$ for coronary and $r=0.45$ for carotid, both $P<0.0001$). Correlations were attenuated with adjustment for age, sex, and diabetes.

Conclusions—Calcified plaque in the coronary and carotid arteries is moderately associated with subclinical atherosclerosis.

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Key Words: epidemiology ■ ethnicity ■ coronary calcification ■ carotid intimal medial thickness ■ atherosclerosis

The risk of vascular disease increases with increasing burden of calcified plaque.1,2 Calcified plaque, as measured by computed tomography, is increasingly used as a marker of disease risk or of subclinical atherosclerosis. We compared coronary and carotid artery calcified plaque to a well-recognized marker of atherosclerosis, carotid intimal medial thickness (IMT). Carotid IMT predicts incident cardiovascular disease3 and is recognized by the Food and Drug Administration as a surrogate marker of atherosclerosis.

Patients and Methods

The sample consisted of families with ≥2 siblings concordant for type 2 diabetes (T2DM). Unaffected siblings were also recruited. Individuals with previous vascular surgeries were excluded.

Calcified plaque was measured in the coronary arteries and carotid bifurcation with single and multidetector row computed tomography (CT) (General Electric CTi, LightSpeed QXi) capable of 500 ms temporal resolutions.4,5 Images were obtained during suspended respiration and with electrocardiogram gating at 50% of the RR interval. The SmartScore software package (GE Advantage Windows) provided a calcium mass score using a 90-Hounsfield unit threshold. The calcium mass score was used because of reduced variability.6 For this report, calcified plaque burden was summed for the coronary arteries and for the carotid bifurcation (common, bulb, internal, and external), which was then averaged for the left and right sides.

High-resolution B-mode carotid ultrasonography was performed using a 7.5-MHz transducer and a Biosound Esaote (AU5) machine. Scans were performed of the near and far walls of the distal 10-mm portion of the common carotid artery (CCA) at 5 predefined interrogation angles on each side. The mean value of up to 20 the CCA IMT values is reported here.

Partial Pearson correlation coefficients, adjusted for age, sex, and diabetes, were computed to test for an association between IMT and the log of vascular calcium plus 1; statistical significance was assessed using generalized estimating equations to account for familial correlation. This report focuses primarily on 438 white participants; 88 black participants were excluded from most analyses because of small sample size.

Results

Mean values in the 438 white participants were: age, 61 years (range 34 to 83); body mass index, 32 kg/m²; and low-density lipoprotein, 2.8 mmol/L. Prevalence of T2DM was 80%; hypertension, 77%; smoking, 20%; and history of cardiovascular disease, 22%. Calcified plaque was present in the expected pattern with lower quantities observed in persons aged younger than 60 years compared with those aged 60 years or older, and in women compared with men (Table 1). Prevalence of detectable calcified plaque was high for the coronary arteries in all groups (≥85%) and lower for the carotid arteries in the group younger than 60 years.

Common carotid IMT was positively associated with log calcium mass in both the coronary and carotid arteries ($P<0.0001$) (Table 2). Adjustment for age, sex, and diabetes (correlates of carotid and coronary calcified plaque, $P<0.005$) attenuated the correlation coefficients. The adjusted correlation coefficients for carotid calcified...
plaque and IMT differed markedly between whites and blacks \( r=0.25 \text{ versus } r=-0.10 \), respectively; interaction: \( P=0.02 \).

**Discussion**

This is the first report to describe the relationship between carotid IMT and calcified plaque in 2 vascular beds. A moderate positive relationship was observed between carotid IMT and mass of calcified plaque in both the coronary and carotid arteries, with a stronger association observed for carotid calcium. The relationships were weaker in blacks, and for the carotid artery, there was evidence that its relationship to IMT differed from whites. Specifically, carotid calcified plaque was correlated with IMT in whites, with no relationship observed in blacks. Two previous studies have reported a graded relationship between coronary artery calcification and IMT, \(^7,^8\) neither reported data for the carotid artery or race-specific associations.

This is one of the first studies to describe the distribution and correlates of carotid artery calcified plaque. \(^9\) We observed a lower burden of calcified plaque in the carotid arteries relative to the coronary arteries, particularly in persons younger than 60 years. Age, diabetes, and male sex were significantly associated with increased carotid artery calcified plaque.

The strengths of this study are the measurement of both vascular calcium and IMT, and the measurement of calcified plaque in 2 anatomic locations. There are several limitations. First, the ultrasound examination was limited to the common segment, the segment that is frequently reported to differ in mean IMT between blacks and whites. \(^10\) This may partially explain why the relationships between IMT and carotid plaque by CT were observed to differ between the races. Measurement of a more distal segment may have also improved the correlation between IMT and coronary calcium as reported previously. \(^7\) Another limitation is the use of a cohort comprised primarily of persons with T2DM in whom the calcified plaque burden is high. If diabetes differentially affects the processes of wall thickening and calcification, then these results may not generalize to a population without diabetes. Finally, the small sample of blacks hindered our ability to make valid comparisons of the distribution of calcified arterial plaque across the 2 race groups. Despite this, a strong race interaction was detected for the relationship between carotid calcified plaque and IMT.

In summary, we have observed a moderate statistically significant relationship between calcified plaque by CT and a widely accepted surrogate of atherosclerosis, carotid IMT. The relationship was stronger in the carotid than in the coronary arteries. These modest correlations support the hypothesis that calcified plaque is associated with atherosclerotic burden but that it carries independent information, as well. Further work is needed to explore the independent contribution of these surrogate markers to disease risk, as recently reported. \(^2\)

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**References**


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