Journal of Cardiovascular Computed Tomography 9 (2015) 337–344

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.JournalofCardiovascularCT.com

Original Research Article

Distribution and burden of newly detected coronary artery calcium: Results from the Multi-Ethnic Study of Atherosclerosis

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ARTICLE INFO

Article history:
Received 14 October 2014
Received in revised form
23 March 2015
Accepted 30 March 2015
Available online 7 April 2015

Keywords:
Coronary artery calcium
Left anterior descending artery

ABSTRACT

Background: The transition from no coronary artery calcium (CAC) to detectable CAC is important, as even mild CAC is associated with increased cardiovascular events. We sought to characterize the anatomic distribution and burden of newly detectable CAC over 10-year follow-up.
Methods: We evaluated 3112 participants (mean age, 58 years; 64% female) with baseline CAC = 0 from the Multi-Ethnic Study of Atherosclerosis. Participants underwent repeat CAC testing at different time intervals (between 2–10 years after baseline) per the Multi-Ethnic Study of Atherosclerosis protocol. Among participants who developed CAC on a follow-up scan, we used logistic regression and marginal probability modeling to describe the coronary distribution and burden of new CAC by age, sex, and race after adjustment for cardiovascular risk factors and time to detection.

Conflicts of interest: Atherotech Diagnostics Lab and the Scientific Advisory Board at Atherotech Diagnostics Lab provided grant support (in kind, diagnostic testing). Steven Jones is a consultant to Sanofi and Regeneron. Other authors report no conflicts of interest.
Support: This research was supported by contracts N01-HC-95159, N01-HC-95160, N01-HC-95161, N01-HC-95162, N01-HC-95163, N01-HC-95164, N01-HC-95165, N01-HC-95166, N01-HC-95167, N01-HC-95168, and N01-HC-95169 from the National Heart, Lung, and Blood Institute and by grants UL1-TR-000040 and UL1-TR-001079 from National Center for Research Resources.
This publication was developed under a STAR research assistance agreement, number RD831697 (MESA Air), awarded by the US Environmental Protection Agency (EPA). It has not been formally reviewed by the EPA. The views expressed in this document are solely those of the authors and the EPA does not endorse any products or commercial services mentioned in this publication.
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1934-5925/$ – see front matter
http://dx.doi.org/10.1016/j.jcct.2015.03.015

Right coronary artery
Left main artery
Left circumflex artery

Results: A total of 1125 participants developed detectable CAC during follow-up with a mean time to detection of 6.1 ± 3 years. New CAC was most commonly isolated to 1 vessel (72% of participants), with the left anterior descending artery (44% of total) most commonly affected followed by the right coronary (12%), left circumflex (10%), and left main (6%). These patterns were similar across age, sex, and race. In multivariate models, residual predictors of multivessel CAC (28% of total) included male sex, African American or Hispanic race, hypertension, obesity, and diabetes. At the first detection of CAC >0, burden was usually low with median Agatston CAC score of 7.1 and <5% with CAC scores >100.

Conclusion: New-onset CAC most commonly involves just 1 vessel, occurs in the left anterior descending artery, and has low CAC burden. New CAC can be detected at an early stage when aggressive preventive strategies may provide benefit.

1. Introduction

Coronary artery calcium (CAC) is an imaging marker that is nearly pathognomonic for the presence of coronary atherosclerosis[1,2] and can be detected using noncontrast cardiac CT. Indeed, CAC testing is specific for the presence of coronary atherosclerosis and highly sensitive for increasing burden of obstructive atherosclerotic coronary artery disease.[3]

CAC is also highly effective for risk stratification of selected asymptomatic patients. For example, elevated CAC >300 is associated with a nearly 10-fold increased risk of adverse coronary events after multivariate adjustment.[4] Equally important, the absence of CAC in asymptomatic adults is associated with a low mortality rate of 1% over 10 years.[5–7] Even mildly elevated CAC denotes risk, as patients with CAC scores between 1 and 10 have a 2- to 3-fold increased risk of cardiovascular adverse events and death compared with those with CAC = 0.[6,8,9]

Given these prognostic differences, a clinical finding of zero vs nonzero CAC has important implications for clinical decision making, including the decision to treat risk conditions with lifestyle vs pharmacotherapy.[10] Thus, there is a great deal of interest in studying the transition from zero to nonzero CAC. However, little is known about the characteristics of newly detected CAC, including its typical coronary distribution and burden.

To fill this gap, we used longitudinal CAC data from the Multi-Ethnic Study of Atherosclerosis (MESA) to describe the imaging characteristics related to the transition from zero to nonzero CAC. In particular, we asked the following questions: (1) At the first detection of new CAC, does CAC occur more commonly in 1 vessel vs multiple vessels? (2) Does new CAC preferentially occur in particular coronary arteries? (3) At the first detection of new CAC, what is the CAC score burden? (4) Does the coronary distribution and burden of new CAC vary by age, sex, or race?

2. Methods

2.1. The Multi-Ethnic Study of Atherosclerosis

MESA was designed to study the prevalence, risk factors, and progression of subclinical cardiovascular disease in individuals without known cardiovascular disease.[11] Between July 2000 and September 2002, MESA enrolled 6814 individuals at 6 field centers in the United States (Baltimore; Chicago; Forsyth County, North Carolina; Los Angeles; New York; and St. Paul, Minnesota) as part of a prospective cohort study that has now spanned 5 in-person visits. Participants included women and men aged 45 to 84 years who identified themselves as White, Chinese, Black, or Hispanic. The institutional review board at all participating centers approved the study, and all participants gave written informed consent.

2.2. Patient population

The study population for this analysis consisted of 3112 participants who had CAC = 0 at baseline and had at least 1 additional CT scan (scored on a per-vessel basis) during MESA follow-up.

After the initial baseline scan, participants underwent repeat CT scans during different follow-up visits as per the prespecified MESA protocol. MESA visits 2, 3, 4, and 5 included subjects who had follow-up CT scans at mean 1.7 ± 0.3, 3.2 ± 0.4, 4.9 ± 0.5, and 9.7 ± 0.6 years, respectively, after the initial baseline scan. In MESA, not all participants had follow-up scan at each of the visits. As part of the study design, approximately half (n = 1522) of the participants received repeat scan at visit 2 and the other half (n = 1425) at visit 3. Visit 4 prioritized participants without scan at visit 3 and included 677 participants with CAC = 0 on prior visits. During visit 5, a total of 1461 participants with CAC = 0 on prior visits received repeat scan and preferentially included participants with scan from visits 3 and 4 (Supplementary Fig. 1). Repeat CT scanning in MESA was unrelated to specific individual participant characteristics. All participants with CAC = 0 at baseline received at least 1 repeat scan (100%), whereas 47% had 2 total scans, 42% had 3 total scans, and 11% had 4 total scans over MESA follow-up.

2.3. Cardiac CT protocol and CAC scoring

Baseline cardiac CT was performed at 3 sites using a cardiac-gated electron-beam CT scanner and at 3 sites using 4-slice multidetector CT. Each participant was scanned twice consecutively, and the images were interpreted at the MESA CT reading center at Harbor-UCLA Medical center, Los Angeles, CA. The results of the 2 scans were averaged to