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Baseline Subclinical Atherosclerosis Burden and Distribution Are Associated With Frequency and Mode of Future Coronary Revascularization

Multi-Ethnic Study of Atherosclerosis

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OBJECTIVES The aim of this study was to evaluate the impact of coronary artery calcium (CAC) burden and regional distribution on the need for and type of future coronary revascularization—percutaneous versus surgical (coronary artery bypass graft [CABG])—among asymptomatic subjects.

BACKGROUND The need for coronary revascularization and the chosen mode of revascularization are thought to be functions of disease burden and anatomic distribution. The association between the baseline burden and regional distribution of CAC and the risk and type of future coronary revascularization remains unknown.

METHODS A total of 6,540 participants in the MESA (Multi-Ethnic Study of Atherosclerosis) (subjects aged 45 to 84 years, free of known baseline cardiovascular disease) with vessel-specific CAC measurements were followed for a median of 8.5 years (interquartile range: 7.7 to 8.6 years). Annualized rates and multivariate-adjusted hazard ratios for revascularization and revascularization type were analyzed according to CAC score category, number of vessels with CAC (0 to 4, including the left main coronary artery), and involvement of individual coronary arteries.

RESULTS A total of 265 revascularizations (4.2%) occurred during follow-up, and 206 (78% of the total) were preceded by adjudicated symptoms. Revascularization was uncommon when CAC score was 0.0 (0.6%), with a graded increase over both rising CAC burden and increasingly diffuse CAC distribution. The revascularization rates per 1,000 person-years for CAC scores of 1 to 100, 101 to 400, and >400 were 4.9, 11.7, and 25.4, respectively; for 1, 2, 3, and 4 vessels with CAC, the rates were 3.0, 8.0, 16.1, and 24.8, respectively. In multivariate models adjusting for CAC score, the number of vessels with CAC remained predictive of revascularization and mode of revascularization. Independent predictors of CABG versus percutaneous coronary intervention included 3- or 4-vessel CAC, higher CAC burden, and involvement of the left main coronary artery. Risk for CABG was extremely low with <3-vessel baseline CAC. Results were similar when considering only symptom-driven revascularizations.

CONCLUSIONS In this multiethnic cohort of asymptomatic subjects, baseline CAC was highly predictive of future coronary revascularization procedures, with measures of CAC burden and distribution each independently predicting need for percutaneous coronary intervention versus CABG over an 8.5-year follow-up. (J Am Coll Cardiol Img 2014;7:476–86) © 2014 by the American College of Cardiology Foundation

Measurement of the total coronary artery calcium (CAC) score (Agatston score) using noncontrast cardiac gated computed tomography provides an excellent estimation of cardiovascular risk through its strong correlation with total coronary atherosclerotic burden. Moderate to high CAC is a strong independent predictor of hard cardiovascular events, including myocardial infarction and death (1–4). In contrast, absence of CAC among asymptomatic patients identifies a low-risk population with <1% estimated 10-year risk for cardiovascular mortality (5–7) and a low probability of significant coronary artery disease on invasive coronary angiography (5). When added to traditional risk prediction scores, CAC scoring provides significant improvement in risk discrimination and risk reclassification across sex and ethnic groups (2,8–10).

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Although CAC is a strong marker of future cardiovascular risk, the extent to which regional distribution of CAC provides additional risk information beyond the Agatston score has not been fully explored. A prior analysis from a registry of more than 25,000 subjects suggested that left main or multivessel CAC may identify a higher risk group independent of the overall CAC score (11). Further supporting the potential importance of CAC distribution, there is a significant association between the burden of CAC within an individual coronary artery and the severity of angiographic stenosis within the same artery (12).

Revascularization remains an important clinical endpoint, and the need for and chosen method of revascularization are directly influenced by the overall burden and distribution of angiographic coronary artery disease. For example, coronary artery bypass graft (CABG) is commonly associated with more diffusely distributed angiographic coronary atherosclerosis compared with percutaneous coronary intervention (PCI). Thus, mode of revascularization provides an excellent opportunity to test the importance of the anatomic information inherent in measures of regional CAC distribution that is not accounted for in the traditional Agatston score.

We first sought to evaluate whether the distribution of subclinical atherosclerosis, as measured by CAC, was independently and incrementally associated with risk for future revascularization. We then sought to evaluate whether the overall burden and distribution of CAC was associated with a specific mode of revascularization (percutaneous vs. surgical), hypothesizing that increasingly diffuse CAC would be preferentially associated with future surgical revascularization.

METHODS

Study population. Full details of the MESA (Multi-Ethnic Study of Atherosclerosis) study design have been published previously (13). In brief, MESA is a prospective observational cohort of 6,814 men and women aged 45 to 84 years from different ethnic origins (white, black, Hispanic, and Chinese), with no known baseline clinical cardiovascular disease who were asymptomatic at the time or enrollment. Subjects were enrolled between July 2000 and September 2002 at 6 field centers across the United States (Baltimore; Chicago; Forsyth County, North Carolina; Los Angeles; New York City; and St. Paul, Minnesota). The study protocol was approved by the institutional review board at each site, and all participants provided written informed consent.

ABBREVIATIONS AND ACRONYMS

CABG = coronary artery bypass graft

CAC = coronary artery calcium

IQR = interquartile range

PCI = percutaneous coronary intervention

Risk factor measurement. As part of the baseline examination, staff members at each of the 6 centers collected information about cardiovascular risk factors, including medical history, smoking history, blood pressure measurement, anthropometric measurements, and laboratory data, as previously described (13). A central laboratory (University of Vermont, Burlington, Vermont)

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