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Reliability of CAC Scoring on Nongated Compared With Gated Cardiac CT Scans From MESA

Shone O. Almeida, MD*, **Lily Honoris, MD**, **Anthony Defranco, MD**, **Steven Port, MD**, **Dong Li, MD, PhD**, **Khurram Nasir, MD**, **Richard Kronmal, PhD**, **R. Graham Barr, MD**, **Matthew Budoff, MD**

Los Angeles Biomedical Research Institute, 1124 W. Carson Street, CT Lab Torrance, California 90502

Coronary artery calcification (CAC) identifies atherosclerotic disease on electrocardiogram-gated computed tomography (CT) studies. However, nongated chest CTs may also have the capacity to accurately quantify coronary calcification. Although vascular calcification may be noted on formal reports, quantification of CAC is typically not undertaken. This study aims to correlate CAC from gated and nongated CT studies to determine whether nongated CT adequately classifies patients into appropriate risk tiers.

Participants for this study were selected from a substudy of the MESA (Multi-Ethnic Study of Atherosclerosis) study in which participants (N = 2,750) completed same-day gated and nongated CTs (1). CAC quantification was completed on a random subset of 516. The scans were acquired using 64-slice multidetector row CTs from Siemens Healthcare (Erlangen, Germany) and GE Healthcare (Waukesha, Wisconsin) following predefined parameters (0.984 pitch, 0.5 s, 120-kV peak). The milliampere level was based on body mass index.

Using a threshold of 130 Hounsfield units, semiautomated software (TeraRecon 4.4.13, TeraRecon, Foster City, California) was used to compute an Agatston score for gated and nongated scans. Participants were then assigned to Agatston CAC tiers (0, 1 to 100, 101 to 400, and >400) (2). Simple linear regression of log-transformed CAC scores and weighted kappa statistic were used to summarize the degree of reliability between scores using SAS version 9.4 (SAS Institute, Cary, North Carolina).

Of 516 participants, 281 (54.5%) were women, with a mean age of 68.5 ± 8.7 years. A total of 135 (26%) participants had CAC of 0 and 381 (74%) had CAC >0. Nongated chest CT scans correctly classified 442 (86%) participants into appropriate Agatston score tiers; 74 (14%) were reclassified using gated studies as the reference standard (Table 1). Mild CAC, defined as an Agatston score of 1 to 100, was misread as “0” in 11 (2%) nongated scans. Overestimation of CAC on nongated scans is uncommon (n = 37, 6.6%). With nongated CAC of 101 to 400, misclassification is uncommon, but is more likely to

*Los Angeles Biomedical Research Institute, 1124 W. Carson Street, CT Lab Torrance, California 90502, shonealmeida@gmail.com.

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occur due to underreading (n = 18, 3.4%), rather than over-reading (n = 9, 1.7%). A CAC >400 is rarely interpreted as mild (n = 2, 0.4%) or intermediate calcification (n = 6, 1.2%). Linear regression yielded an r statistic of 0.95 and a weighted Cohen's kappa of 0.86 (95% confidence interval: 0.84 to 0.89).

CAC measured from nongated chest CTs strongly correlates with electrocardiogram-gated cardiac CT scans. Nongated CTs correctly classify 86% of participants into the appropriate CAC tier and even when misclassified, the error appears to favor underestimation of the calcium score. Potential mechanisms for misclassification include thicker slices and motion artifact in nongated studies which alter calcium quantification.

These findings have many practical applications. First, insurance coverage for calcium scans is still uncommon, however many individuals have indications for nongated chest CT (i.e., lung cancer screening). The presence and the tier of coronary calcification can be determined from these studies. Second, many centers do not report clinically on the presence of coronary calcification when interpreting nongated scans (3). The extent of coronary artery disease may be the most critical information that an otherwise unremarkable scan may provide. Third, the 2018 ACC Guidelines on the Management of Blood Cholesterol recommends incorporating the CAC score for select patients in deciding need for lipid-lowering therapy. Many such patients have had a nongated chest CT in the past, obviating the need to have a dedicated scan. Finally, if subsequent studies confirm that CAC tier from nongated scans correlates with prognosis, quantification and reporting of CAC would be elevated to a Radiological Society of North America standard.

Several limitations exist in this study. CAC quantification uses semiautomated software, introducing possible user error in measurement. Additional bias may be introduced by utilization of the Agatston score which uses a 4-point density weighting factor rather than a continuous Hounsfield unit scale. Further study is needed to determine if potential early recognition of coronary artery disease on nongated CTs results in reduction of subsequent cardiovascular events and downstream savings.

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TABLE 1

Agatston Calcium Score Tiers for Gated and Nongated Scans

	Gated Agatston Score				
	0	**1-100**	**101-400**	**>400**	**Total**
Nongated Agatston Score					
0	135	12	0	0	147 (28.5)
1-100	11	125	15	1	152 (29.5)
101-400	0	18	134	9	161 (31.2)
>400	0	2	6	48	56 (10.8)
Total	146 (28.3)	157 (30.4)	155 (30.0)	58 (11.2)	516 (100.0)

Values are n (%) unless otherwise indicated.