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Research paper

Prognostic value of segment involvement score compared to other measures of coronary atherosclerosis by computed tomography: A systematic review and meta-analysis☆

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ABSTRACT

Background: The segment involvement score (SIS) is a semiquantitative measure of the extent of atherosclerosis burden by coronary computed tomography angiography (CTA). We sought to evaluate by meta-analysis the prognostic value of SIS, and to compare it with other CTA measures of coronary artery disease (CAD).

Methods: Electronic databases from 1946 to January 2016 were searched. Studies reporting SIS, or an equivalent measure by coronary CTA, and clinical outcomes were included. Maximally adjusted hazard ratios (HR), predominantly for clinical variables, were extracted for SIS, obstructive CAD, Agatston coronary artery calcium score, and plaque composition. These were pooled using DerSimonian-Laird random effects models.

Results: Eleven nonrandomized studies with good methodological quality enrolling 9777 subjects (mean age 61 ± 11 years, 57% male, mean follow up 3.3 years) who had 472 (4.8%) MACE (cardiac or all cause death, non-fatal myocardial infarction or late revascularization), were included. SIS (per segment increase) had pooled HR of 1.25 (95% CI: 1.16,1.35; $I^2 = 71.4\%$, $p < 0.001$) for MACE. HR for MACE was 1.37 (95% CI: 1.32,1.42; $I^2 = 95.6\%$, $p < 0.001$) for number of segments with stenosis (per segment increase), 3.39 (95% CI: 1.65,6.99; $I^2 = 87.8\%$, $p = 0.001$) for obstructive CAD (binary variable) and 1.00 (95% CI: 1.00,1.01; $I^2 = 75.0\%$, $p = 0.490$) for Agatston score (per unit increase). HRs by plaque composition (calcified, non-calcified and mixed; per segment change) were 1.24 (95% CI: 1.10,1.39; $I^2 = 81.6\%$, $p = 0.001$), 1.20 (95% CI: 0.97,1.48; $I^2 = 92.9\%$, $p = 0.093$) and 1.27 (95% CI: 1.03,1.58; $I^2 = 89.8\%$, $p = 0.029$), respectively.

Conclusion: Despite heterogeneity in endpoints, extent of CAD as quantified by SIS on coronary CTA is a strong, independent predictor of cardiovascular events.

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List all abbreviations

SIS	Segment involvement score
CTA	Computed tomography angiography
CAD	Coronary artery disease
MACE	Major adverse cardiac events
MI	Myocardial infarction
NCEP	National Cholesterol Education Program

1. Introduction

Coronary computed tomography angiography (CTA) is recommended for the detection and quantification of coronary artery disease (CAD) in low-intermediate risk symptomatic patients, and has had increasing clinical indications as evidence accrues for its utility.[1] In addition to its diagnostic role, several coronary CTA derived measures of atherosclerosis yield important prognostic information.[2–4] Such measures include the Agatston coronary artery calcium score, obstructive CAD, extent of coronary atherosclerosis and plaque characteristics.[2,3,5,6]

Segment involvement score (SIS) represents the total number of coronary segments with atherosclerotic plaque (Fig. 1), and is a semi-quantitative score of disease burden that can be easily calculated from clinical coronary CTA data. As such, SIS as measure is consistent with the move from qualitative to quantitative CTA reporting as articulated in the CAD-RADS guideline, which standardizes communication of CTA findings to better facilitate decision making and management.[7]

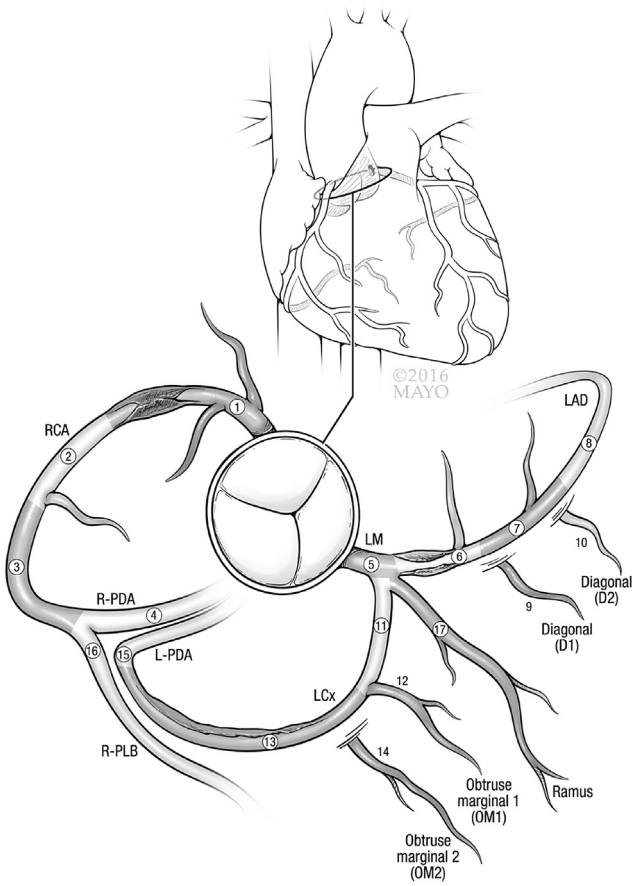

Fig. 1. Coronary artery tree and application of SIS. Depicted here is the 17 segment model of the coronary artery tree. Three segments here have plaque (segments 1, 6 and 13), resulting in an SIS score of 3.

Although SIS is often reported in scientific studies, it is not reported routinely in clinical coronary CTA studies. Therefore, a systematic review and meta-analysis to pool data was conducted to clarify potential clinical utility of CTA derived measures of atherosclerotic burden. Specifically, we sought to evaluate the prognostic value of SIS, and to compare its ability to predict events with routine coronary CTA measures of atherosclerosis, including obstructive CAD, plaque composition and Agatston score. We also sought to identify a potential SIS threshold that would portend increased risk of events.

2. Methods

This systematic review is reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement,[8] and followed an a priori established protocol. The study protocol was designed by CA, and reviewed and approved by experts in coronary CTA (BC), coronary atherosclerosis (LK, GH), and meta-analysis methodology (MM, ZW).

2.1. Search strategy

The database search was conducted by a senior medical librarian experienced in systematic reviews (PE). Electronic databases were interrogated from 1946 to Jan 8, 2016, including Ovid Medline, Ovid EMBASE, Web of Science, Scopus, and Ovid Cochrane Central Register of Controlled Trials. Index terms, controlled vocabulary as well as text words were used for the search as per the strategy shown in Supplemental Table 1. The search was limited to English and human studies. Multiple publications of retrieved articles were acquired in order to include the most complete or recent study results. Reference lists of retrieved original papers and of review articles were hand-searched to further identify studies for possible inclusion.

2.2. Inclusion and exclusion criteria

Inclusion criteria were published studies that were population-based, single or multicenter studies; used CT evaluation; reported quantification of number of coronary segments affected (either as SIS, or equivalent measure, such as total plaque score [TPS]) and reported outcomes (all-cause mortality, cardiac mortality, MI, late revascularization or a composite of these such as MACE) as hazard ratio (HR) or equivalent. Studies included in the search included randomized control trials, cohort studies, and observational studies, and both symptomatic and asymptomatic patients.

In the case of multiple studies from the same cohort, data from the larger report were included. Most study designs were anticipated to be similar, primarily cohort or observational studies. However heterogeneity was anticipated in study outcomes and composites of MACE used.

Exclusion criteria were non-English language, abstracts without a published peer-reviewed manuscript, unpublished results, case reports, studies without SIS (or the equivalent TPS score, or 'number of segments affected by disease'), or inadequate information regarding number of coronary segments involved. Studies where the outcome of interest was not reported or could not be calculated from the results, even after contact of the principal investigator, were excluded. We also excluded all analyses from the CONFIRM multinational registry, due to potential overlap with other single center studies.

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