

Review Article

Coronary artery calcium in hypertension: a review



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Abstract

Coronary artery calcium (CAC) is a powerful independent predictor of future cardiovascular events. However, the clinical utility of calcium score testing specifically among patients with hypertension is not well defined. We performed a review of studies involving both high blood pressure (BP) and CAC to assess several aspects of the interrelationship. Among four specific topics evaluated, the main objective was to assess the independent association of CAC with cardiovascular risk among patients with hypertension. From 6822 identified publications, 21 studies met criteria for inclusion. All studies ($n = 14$) that reported the relationship between BP values and the presence or extent of coronary calcium found positive associations. The results from two studies linking coronary calcium with the risk for developing hypertension were mixed. Each of the five studies that evaluated the relationships between CAC score in regard to future cardiovascular events and/or all-cause mortality in patients with high BP reported independent positive associations. The inclusion of calcium score results into prediction models improved risk stratification when statistically evaluated. The findings of this review demonstrate that CAC testing is likely to be of clinical utility for tailoring the medical management of patients with high BP, particularly among individuals with mild or prehypertension. Future trials testing the clinical effectiveness of a calcium score-based treatment algorithm should be considered. *J Am Soc Hypertens* 2015;9(12):993–1000. © 2015 American Society of Hypertension. All rights reserved.

Keywords: Coronary calcium; prehypertension; blood pressure.

Introduction

Cardiovascular disease (CVD) is the leading cause of death worldwide, impacting over a third of the population in the United States (US).¹ Hypertension is the most important modifiable risk factor accounting for nearly half of all CVD events globally.² Unfortunately, the prevalence of high blood pressure (BP) is increasing and now affects roughly 30% of adults in the US or nearly 80 million people.³ Given the aging population and epidemic of obesity, the prevalence is projected to further increase

over the next decade.^{1,3} Although control rates in the US have improved, recent data demonstrate that nearly half of all hypertensive individuals still have BP levels above goals.³

Medical treatment of severe and Stage 2 hypertension is well established to reduce CVD events and universally recommended.^{4–6} Despite decades of trials, numerous uncertainties remain including the management of milder forms of hypertension (eg, Stage 1 and prehypertension), treatment thresholds in the elderly (>60 years),⁴ and optimal BP targets. An additional critically important unanswered question is how to best assess overall CVD risk, including the evaluation of target organ damage, in patients with hypertension to optimally tailor treatment decisions. Guidelines recommend several routine tests (eg, electrocardiogram, creatinine, urinalysis) and assessing for other CVD risk factors (eg, diabetes). However, unlike with cholesterol management,⁷ guidance regarding the usage of global risk scores and the incorporation of advanced imaging test results, such as coronary artery calcium (CAC)

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score, into clinical decision making have not been well delineated.^{4–6}

CAC is a marker of subclinical atherosclerosis and ranks among the most robust independent predictors of future CVD events (myocardial infarctions and strokes) as well as all-cause mortality.^{8,9} Several guidelines and expert opinions have been published regarding its usage in clinical practice.^{10–12} However, the role of CAC testing among patients with hypertension has never been specifically addressed.^{4–6} Recent evidence supports that a CAC-based treatment algorithm of hyperlipidemia would likely be highly effective¹³ due to its accuracy in stratifying patients in regard to absolute CVD risk. In a similar fashion, meta-analyses demonstrate that overall CVD risk (rather than just BP level) is the most predictive factor in regard to the treatment benefits derived from antihypertensive therapy.¹⁴ In this context, the overarching purpose of this review was to evaluate the evidence supporting the clinical utility of CAC among patients with high BP (or at risk for hypertension). To meet this purpose, we addressed four topics including: (1) the role of high BP in causing CAC, (2) the ability of CAC to predict hypertension incidence; (3) the association of CAC with cardiovascular outcomes specifically in hypertensive populations, and (4) the potential clinical utility of CAC (eg, enhanced risk stratification) in hypertension management. The main objectives and focus were on topics #3 and #4 which provide the most compelling evidence for the role of CAC in the management of patient with pre-existing high BP.

Methods

Search Strategy

We performed a comprehensive search of the studies in MEDLINE/PUBMED and EMBASE databases (up to February 2015), using following keywords: “coronary artery calcium,” “coronary calcium,” “CAC,” “hypertension,” “cardiovascular events,” “cardiovascular outcomes,” and “mortality” in various combinations. Additional studies were identified through careful screening of the cited references in all the studies. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement was used to carry out this review¹⁵ (Figure 1).

Selection Criteria

Inclusion Criteria

The following inclusion criteria were applied: (1) studies that reported the predictive role of CAC in hypertension and vice versa (topics #1 and #2), (2) studies that examined the role of CAC in predicting cardiovascular and other adverse outcomes in hypertensive populations (topic #3), and (3) studies that evaluated the clinical utility and/or risk stratification capacity of CAC in hypertension (topic #4).

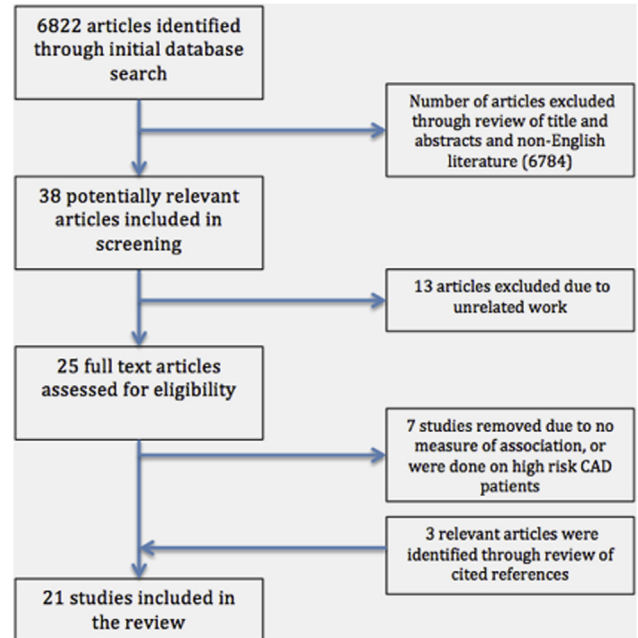


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analysis flow chart of review. CAD, coronary artery disease.

Exclusion Criteria

Studies not reporting either of the aforementioned inclusion criteria were excluded. Studies involving exclusive coronary artery disease patients and reports with the main focus being the effect other risk factors (eg, diabetes) regardless of hypertensive status were not included. Non-English publications were excluded.

Data Extraction

One reviewer (S.M.-R) gathered all the pertinent data using a standardized format. Accuracy of the data was carefully examined by two reviewers (M.R. and R.D.B.). Any disparities were resolved by mutual discussion among authors. The following study characteristics were collected: first author, year published, patient population, information on CAC and BP status, influence on cardiovascular outcomes and mortality, and conclusions.

Results

The methodological approach and results of the systematic search are shown in Figure 1. Of the 6822 studies identified, a total of 21 satisfied all inclusion and exclusion criteria and were included in the review. Fourteen studies investigated topic #1: the association of BP levels with the presence and/or extent of CAC (Online Supplement; Table S1).^{16–29} All studies reported positive associations. Two studies evaluated topic #2: the linkage of CAC with hypertension incidence

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