

CORONARY ARTERY CALCIUM DATA AND REPORTING SYSTEM: A REVIEW

Pradnya Brijmohan Bhattad, MD^{*1} & Rekha Jain, MD²

^{*1}Resident, Department of Internal Medicine, East Tennessee State University, TN, USA

²Professor, Department of Radiology, James H. Quillen Veterans Affairs Medical Center, Mountain Home, TN, USA

Abstract

Keywords: Coronary artery calcium; Agatston score; Coronary Artery Calcium Data and Reporting System.

Coronary artery disease develops mainly from atherosclerosis. Coronary artery calcium denotes the atherosclerotic coronary calcification burden. A uniform reporting system described as Coronary Artery Calcium Data and Reporting System (CAC-DRS) introduced recently in 2018 to predict coronary artery disease, especially in asymptomatic patient population. The CAC-DRS reporting guidelines have been recommended by the Society of Cardiovascular Computed Tomography and Society of Thoracic Radiology. Coronary artery calcification is computed as a coronary artery calcium (CAC) score. The Agatston score is computer generated, obtained by multiplication of the calcium plaque area by the calcium plaque density.

A higher CAC score indicates high atherosclerotic burden and links to greater morbidity and mortality from cardiovascular events. CAC scoring by CT scan, currently is best used in the intermediate risk patient population.

Coronary calcium parallels the existence of atherosclerotic burden. A CAC score of zero has been noted to have a strong negative predictive value for coronary events. A higher CAC score indicates increased risk of cardiovascular events.

Introduction

Coronary artery calcium data and reporting system: a review

Coronary artery disease is asymptomatic in a vast majority of patients and with increasing severity, it may result in significant morbidity and mortality from acute coronary syndrome, sudden cardiac death, heart failure. Coronary artery disease is a leading cause of mortality and morbidity. Coronary artery disease is known to have a longer latent period of pathogenesis. It is possible to curtail and decrease the mortality and morbidity from coronary artery disease by early detection and preventative management (1,3). Coronary artery disease develops mainly from atherosclerosis. Coronary artery calcium denotes the atherosclerotic coronary calcification burden. Coronary calcium scoring uses the fact that coronary calcium is a marker for coronary atherosclerotic plaque (1,7). Complete absence of coronary artery calcium suggests a very low risk of future coronary events. Males, people with diabetes and renal insufficiency tend to have a higher coronary calcium score. Non-contrast electron-beam CT scan or MD CT commonly with 3mm slice thickness may be used. Administration of contrast is not required as calcium is easily identified because of its extremely high x-ray attenuation coefficient/high HU score (3,6,8). A standardized reporting system CAC-DRS introduced recently in 2018 to predict coronary artery disease, especially in asymptomatic patient population. The CAC-DRS reporting guidelines have been recommended by the Society of Cardiovascular Computed Tomography and Society of Thoracic Radiology. This system can be applied to all non-contrast chest CT scans, CAC scans for evaluation of coronary artery disease (1,2,4,5).

Agatston CAC volume score:

It is the most commonly used scoring system. It is obtained by measuring the area of each calcified coronary lesion and multiplying it by a coefficient of 1 to 4, based on the maximum CT attenuation within that lesion. The score of every calcified lesion is added up to obtain the total coronary calcium score. The limitation of Agatston scoring system is that it not useful for assessment of soft noncalcified plaques (2,5,12).

Agatston score calculation: **Ref (3,5,9,12,15).**

Density in Hounsfield units	Coefficient/density score
A. 130-199 HU	1
B. 200-299 HU	2
C. 300-399 HU	3
D. 400 and above HU	4

Five risk categories of coronary artery disease have been classified based on the Agatston CAC score:

1. no coronary calcification/no evidence of coronary artery disease- CAC score of 0.
2. Mild coronary calcification- CAC score of 100
3. moderate coronary calcification – CAC score of greater than 100 to 399
4. Severe coronary calcification – CAC score of greater than 400 to 999
5. extensive coronary calcification – CAC score of greater than 1000

Visual assessment of coronary artery calcification is an easy, faster method to evaluate for coronary artery calcification in nongated chest CT. With the visual method, coronary artery calcification is categorized as none, mild, moderate, heavy coronary calcification. It is comparable to Agatston method, though it is applicable only for nongated chest CT scans. Advantage of visual assessment is that it is the fastest method with no software requirements (3,5,9,12,15).

Modifiers:

The first modifier in the CAC-DRS indicates the method of CAC score which could be either Agatston or visual assessment. The second modifier in the CAC-DRS indicates the number of coronary vessels affected from 1 to 4, which includes right coronary artery, left main coronary artery, left circumflex artery, left anterior descending coronary artery; wherein N4 suggests involvement of all the 4 coronary vessels. These two modifiers are separated by symbol slash (5,10,12,13,16).

Interpretation categories and recommendations

1. Agatston score: (Ref: 1,2,3,4,5,12,15)

Category	CAC Score	Risk	Recommendations
CAC-DRS A0	0	Very low	Statin not recommended
CAC-DRS A1	1-99	Mild	Moderate intensity statin
CAC-DRS A2	100-299	Moderate	Moderate to high intensity statin and low dose Aspirin
CAC-DRS A3	More than 300	Severe	High intensity statin and Low dose Aspirin

2. Visual CAC score: (Ref: 1,2,3,4,5,12,15)

Category	CAC visual score	Risk	Recommendations
CAC-DRS V0	0	Very low	Statin not recommended
CAC-DRS V1	1	Mild	Moderate intensity statin
CAC-DRS V2	2	Moderate	Moderate to high intensity statin and low dose Aspirin
CAC-DRS V3	3	Severe	High intensity statin and Low dose Aspirin

Miscellaneous features

The coronary artery calcium data reporting system describes reporting of extra cardiac findings; reporting of pericardial, valvular and aortic calcifications with severity classification. These additional findings have not been assigned to CAC-DRS categories (3,11,14,17).

Limitations and Conclusion

The coronary artery calcium score is age and gender specific. Hence, there should be a comparison of the individual data with a “normal cohort” to provide meaningful information. Generally, coronary artery calcification occurs 10 to 15 years later in life in females as compared to males. Also, coronary artery calcification is usually 5 to 7 times lower at any age in females compared to males (12,13,17).

Statins have no documented effect on progression of coronary artery calcium. In patient population with an initial CAC score more than 100 or at the 75th percentile, there appears no discrete advantage of repeat coronary artery calcium score.

It should be noted that not all atherosclerotic plaques are calcified, the detection of a large amount of coronary calcium does not suggest the existing significant coronary stenosis. Coronary artery calcium scoring may be helpful for traditional risk assessment and not for isolated risk assessment (15,17,18).

Cardiac CT image quality will be reduced if a patient has irregular heart rhythm such as atrial fibrillation or flutter, frequent premature atrial/ ventricular contractions with improper ECG triggering leading to slice misregistration or errors in radiation dose modulation. CT scan image quality will be suboptimal in the setting of high regular heart rates, greater than 70 bpm refractory to rate lowering agents, leading to motion artifacts. Metallic objects such as mechanical heart valves, surgical clips, pacemaker wires, automated implanted cardiac defibrillator can produce streaking artifacts as these objects are prone to radiation scatter. Morbid obesity with a BMI more than 40 can contribute to poor CT image quality secondary to reduction in signal to noise ratio from excessive radiation attenuation (16,19,20).

Coronary artery calcium scoring is likely to be more useful in the intermediate risk patient populations wherein a higher or lower CAC score may help to identify individuals to higher or lower risk category for coronary events (14, 18, 20).

Discussion

Literature review suggests the fact that the non-obstructive atherosclerotic plaques are at risk to rupture and promote thrombosis which denotes that a majority of myocardial infarctions arise from nonobstructive plaques. Overall atherosclerotic burden is a more important predictor of long-term cardiovascular events compared to a specific stenosis.

Coronary artery calcification is computed as a CAC score. The Agatston score is computer generated, obtained by multiplication of the calcium plaque area by the calcium plaque density. A higher CAC score indicates high atherosclerotic burden and links to greater morbidity and mortality from cardiovascular events. A higher CAC score may not correlate with a severely stenotic lesion. CAC scoring system can categorize patients to coronary artery disease risk groups without any use of medications, contrast, exercise, is unaffected by resting ECG abnormalities, utilizes a limited amount of radiation.

When compared with the coronary artery calcification score of zero, the presence of any coronary artery calcification has a four times elevated risk of coronary events in 3 to 5 years. In patients with intermediate risk for coronary events such as that by Framingham score, the CAC score may be helpful to categorize patients to a higher or lower risk group. For example, coronary artery calcium score of zero suggests low risk of coronary events whereas coronary artery calcium score of more than 400 suggests a significant cardiac event rate in patients who otherwise appear to be at intermediate risk per Framingham score.

Current literature review suggests that coronary artery calcium scoring is an important aspect for risk stratification of asymptomatic populations, especially with an intermediate Framingham risk score (10-20% risk of cardiovascular events at 10 years) and is important for risk stratification of symptomatic patients before an invasive diagnostic procedure.

Coronary artery disease risk stratification can be performed in individuals based on absolute coronary artery calcification score, as well as by expected coronary artery calcification score for their age.

Coronary calcium parallels the existence of atherosclerotic burden. A higher CAC score indicates increased risk of cardiovascular events. CAC scoring by CT scan, currently is best used in the intermediate risk patient population. Coronary calcium screening appears to be a critical aspect of risk stratification for primary prevention of coronary artery disease.

Abbreviations and Acronyms:

CAD- Coronary Artery Disease

CAC- Coronary Artery Calcium

CAC-DRS- Coronary Artery Calcium Data and Reporting System

CT- Computed Tomography

MDCT- Multiple Detector Computed Tomography

HU- Hounsfield Unit

ECG- Electrocardiogram.

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Tables

Table 1: Ref (3,5,9,12,15). Title: Agatston score calculation:

Density in Hounsfield units	Coefficient/density score
A. 130-199 HU	1
B. 200-299 HU	2
C. 300-399 HU	3
D. 400 and above HU	4

Table 2: (Ref: 1,2,3,4,5,12,15) Title: Agatston score category:

Category	CAC Score	Risk	Recommendations
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CAC-DRS A1	1-99	Mild	Moderate intensity statin
CAC-DRS A2	100-299	Moderate	Moderate to high intensity statin and low dose Aspirin
CAC-DRS A3	More than 300	Severe	High intensity statin and Low dose Aspirin

Table 3: (Ref: 1,2,3,4,5,12,15) Title: Visual CAC score:

Category	CAC visual score	Risk	Recommendations
CAC-DRS V0	0	Very low	Statin not recommended
CAC-DRS V1	1	Mild	Moderate intensity statin
CAC-DRS V2	2	Moderate	Moderate to high intensity statin and low dose Aspirin
CAC-DRS V3	3	Severe	High intensity statin and Low dose Aspirin