European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 09, Issue 02, 2022

Original Research Article

Agatston coronary artery calcium score in patients with obstructive and non-obstructive coronary artery disease

[1]Dr. Hemanth Purigali Naganna, [2]Dr. Supriya AS, [3]Dr. Rinu Pious, [4]Dr. Lohit K, [5]Dr. Rashwin Pinto, [6]Dr. Thilak KS

[1]Associate Professor, Department of Radiodiagnosis, Mysore Medical College and Research Centre, Mysore, Karnataka, India
[2,3,5,6]Resident, Department of Radiodiagnosis, Mysore Medical College and Research Centre, Mysore, Karnataka, India
[4]Senior Resident, Department of Radiodiagnosis, Mysore Medical College and Research Centre, Mysore, Karnataka, India

Corresponding author: Dr. Lohit K

Abstract

The total Agatston score (AS) of each individual is calculated by summing the scores of every calcified focus through all of the coronary arteries. 14 Coronary artery calcium scoring has been established as a strong tool for prediction of coronary events, reflecting the burden of coronary artery disease. Calcium scoring is considered the "gatekeeper" for CCTA. Demographic details of the patient with history of risk factors, such as diabetes, hypertension, treatment for hypertension, dyslipidemia, smoking and positive family history was collected using a questionnaire which was part of the clinical research form. Indication for referral was noted. Thus, significant coronary artery disease was present even in patients with calcium score 0 & calcium scoring could not quantify vascular stenosis or assess non-calcified and mixed plaque which may have features that render the plaque as vulnerable or at high risk for rupture due to presence of a lipid core or spotty calcifications.

Keywords: Agatston coronary artery calcium score, obstructive coronary artery disease, non-obstructive coronary artery disease

Introduction

Arthur Agatston and his colleagues introduced the quantitative CACS protocol in 1990. This remains the standard method in calcium scoring. Any structure with densities of 130 Hounsfield units (HU) or more and of an area of 1mm2 or more is segmented as a calcified focus. The calcified foci that overly the anatomic sites of coronary arteries are considered to represent calcified plaques. They are given stratified density scores 1, 2, 3 and 4 which represent the densities 130-199 HU, 200-299 HU, 300-399 HU and ≥ 400 HU, respectively [1].

The total Agatston score (AS) of each individual is calculated by summing the scores of every calcified focus through all of the coronary arteries. Coronary artery calcium scoring has been established as a strong tool for prediction of coronary events, reflecting the burden of coronary artery disease. Calcium scoring is considered the "gatekeeper" for CCTA [2].

Plaques in the coronary arteries due to atherosclerosis are primarily asymmetrical focal areas

of intimal thickening. They result from accumulation of various components such as foamy macrophages, smooth muscle, necrotic debris and calcium. Pathological studies have shown that components of plaque have an important role to play in the pathophysiology of coronary artery disease. Acute coronary syndromes which present with acute chest pain are often result of plaque rupture. Plaque rupture is related to high percentage of intra-plaque lipid core within non-calcified plaques. Therefore, the imaging not only identifies and delineates the plaque boundaries but also helps to identify the various components within the plaque such as lipid, fibrous tissue and calcium [3, 4].

Intravascular ultrasound and optical coherence tomography have been shown to provide most accurate information regarding plaque morphology that matches the findings on catheter angiography. The use of these modalities are however limited due to the invasiveness, limited availability and high cost. Therefore, less invasive modalities like CT and MRI play a more important role in plaque characterization, especially among patients with low or intermediate risk of coronary artery disease where imaging is more of a screening tool. Researchers since the early days of CCTA identified the ability of CT to depict attenuation differences within an atherosclerotic plaque. This therefore helps to differentiate plaques as lipid rich, fibrous and calcific. With rapid development in CT technology, characterization as well as quantification of plaque is now possible. Good correlation between plaque classification on CT as compared to IVUS has been observed [5, 6].

Methodology

The subjects of this study were symptomatic patients who were referred to the hospitals attached.

Sample size: 45 cases.

The sample size is calculated using the formula 4PQ/d2, the calculation is based on the prevalence of coronary artery disease as evaluated by CT coronary angiography which is equal to 7.8%, with 95% confidence interval and power of 80 and precision of 8.

In this study, after obtaining written consent from the patient, a detailed history along with complete clinical examination and laboratory investigations were done before the CT calcium score and coronary angiogram examination.

Sampling technique: Purposive sampling technique.

Type of study: Descriptive study.

Duration of study: 18 months.

Inclusion criteria

The patients included in the study are symptomatic patients with symptoms like chest pain.

Exclusion criteria

- Hypersensitivity to contrast agent Deranged renal function tests.
- Pregnant women.

ISSN 2515-8260 Volume 09, Issue 02, 2022

Data collection

Demographic details of the patient with history of risk factors, such as diabetes, hypertension, treatment for hypertension, dyslipidemia, smoking and positive family history was collected using a questionnaire which was part of the clinical research form. Indication for referral was noted.

Results

Of the 45 patients who underwent a CTCA as part of the study, as shown, on the non-contrast CT, majority of them (53%, n=24) did not have any coronary calcification (calcium score = zero).

Table 1: Distribution of Coronary Artery Calcification in the Study Population

Agaston Score	Frequency	Percentage
Zero	23	51%
Mild (10-99)	14	31%
Moderate (>100-400)	8	18%
Severe (> 400)	0	0%

9 of the 28 patients who had atherosclerotic plaque had Agatston score 0, of whom 66% had severe stenosis of grade 4.

Table 2: Stenosis Stenosis by Atherosclerotic Plaque in Patients with Agatson Score 0

Stenosis	Frequency	Percentage
1.	2	22%
2.	0	0%
3.	1	11%
4.	6	66%
5.	0	0%
Total	9	100%

Table 3: Stenosis by Atherosclerotic Plaque in Patients with Agatson Score < 100

Stenosis	Frequency	Percentage
1	4	33%
2	2	17%
3	4	33%
4	1	8.5%
5	1	8.5%
Total	12	100%

Table 4: Stenosis by atherosclerotic plaque in patients with agatson score 100 to 400

Stenosis	Frequency	Percentage
1	0	0%
2	3	43%
3	1	14%
4	3	43%
5	0	0%
Total	7	100%

Table 5: Stenosis by Atherosclerotic Plaque in Patients with Agatson Score >400

Only 1 patient in our study had a calcium score of more than 400 who had a stenosis of 80%.

Stenosis	Frequency	Percentage
1	0	0%
2	0	0%
3	0	0%
4	1	100%
5	0	0%
Total	1	100%

Table 6: Coronary Artery Calcium Score in Non-Obstructive Coronary Artery Disease (Stenosis < 50%)

CACS	Frequency	Percentage
Zero	2	20%
Mild (10-99)	6	60%
Moderate (100-400)	2	20%
Severe (> 400)	0	0%
Total	10	100%

Table 7: Coronary Artery Calcium Score in Obstructive Coronary Artery Disease (Stenosis > 50%)

CACS	Frequency	Percentage
Zero	7	39%
Mild (10-99)	6	33%
Moderate (100-400)	4	22.5%
Severe (> 400)	1	5.5%
Total	18	100%

Table 8: Coronary Artery Calcium Score in Obstructive and Non-Obstructive Coronary Artery Disease

	Non-obstructive CAD		Obstructive CAD	
CACS	Fr	Per	Fr	Per
Zero	2	20%	7	39%
Mild (10-99)	6	60%	6	33%
Moderate (100-400)	2	20%	4	22.5%
Severe (> 400)	0	0%	1	5.5%
Total	10	100%	18	100%

Discussion

Parsons *et al*. conducted a study on 44 aircrew subjects undergoing regular clinical & occupational assessment. 26/44 (59%) patients were found to have evidence of CAD, with 13/44 (30%) having at least a single vessel stenosis ≥50%. All of these patients had subsequent occupational restrictions. Two patients with a calcium score ≤10 had at least 1 single vessel stenosis ≥50%. They concluded that a CTCA pathway is potentially a better discriminator of CAD burden in aircrew when compared with CACS and may reduce downstream testing, allowing a more efficacious approach to CAD assessment in military aircrew [7, 8].

Cademartiri F *et al*. conducted a study on 118 subjects to compare the coronary artery calcium score (CACS) and computed tomography coronary angiography (CTCA) for the assessment of non-obstructive/obstructive coronary artery disease (CAD) in high-risk

asymptomatic subjects. CACS proved inadequate for the detection of obstructive and non-obstructive CAD compared with CTCA. CTCA has a high diagnostic accuracy for the detection of non-obstructive and obstructive CAD in high-risk asymptomatic patients with inconclusive or unfeasible stress test results [8].
The results of the above studies were similar to the results of our study.

Conclusion

Our study showed a low diagnostic accuracy of using coronary artery calcium score in accessing coronary plaque burden. Also, Agatston score showed no statistical difference to differentiate obstructive and non-obstructive coronary artery disease.
Thus, significant coronary artery disease was present even in patients with calcium score 0 & calcium scoring could not quantify vascular stenosis or assess non-calcified and mixed plaque which may have features that render the plaque as vulnerable or at high risk for rupture due to presence of a lipid core or spotty calcifications. This underestimates the actual plaque burden. Contrast enhanced study of the coronaries gives us this additional information regarding plaque burden and degree of stenosis.

References

1. Khan MA, Hashim MJ, Mustafa H, Baniyas MY, Al Suwaidi SKBM, AlKatheeri R, *et al*. Global Epidemiology of Ischemic Heart Disease: Results from the Global Burden of Disease Study. Cureus. 2020 Jul;12(7):e93-49. Doi: 10.7759/cureus.9349. PMID: 32742886; PMCID: PMC7384703.
2. Lewis Wexler, Bruce Brundage, John Crouse, Robert Detrano, Valentin Fuster, Jamshid Maddahi, *et al*. AHA Staff Coronary Artery Calcification: Pathophysiology, Epidemiology, Imaging Methods, and Clinical Implications. A Statement for Health Professionals from the American Heart Association Originally published1 Sep # Falk E, Shah PK, Fuster V. Coronary plaque disruption circulation. 1995;92:657-671.
3. Beckman JA, Ganz J, Creager MA, Ganz P, Kinlay S. Relationship of clinical presentation and calcification of culprit coronary artery stenoses. Arterioscler Thromb Vasc. Biol. 2001;21(10):1618-1622.
4. Sayols-Baixeras S, Lluís-Ganella C, Lucas G, Elosua R. Pathogenesis of coronary artery disease: focus on genetic risk factors and identification of genetic variants. Appl Clin Genet. 2014 Jan;7:15-32.
5. Peters SAE, Ruijter HM Den, Bots ML, Moons KGM. Improvements in risk stratification for the occurrence of cardiovascular disease by imaging subclinical atherosclerosis: A systematic review. Heart. 2012 Feb;98(3):177-84.
6. Veit Sandfort, Joao AC Lima, David A. Bluemke Noninvasive Imaging of Atherosclerotic Plaque Progression. Status of Coronary Computed Tomography Angiography Originally published, 2015 Jul.
7. Schoepf UJ, Zwerner PL, Savino G, Herzog C, Kerl JM, Costello P. Coronary CT Angiography. Radiology. 2007 Jul;244(1):48-63.

Accepted on 21/05/2022