

## ORIGINAL ARTICLE

# Comparison of Severity of Coronary Lesion with Segmental Calcium Score using Multislice CT Coronary Angiography

Rehab Mohamed Elnagar <sup>1</sup>, Rokia Hesham Abdelrahman <sup>2</sup>, Ahmed Hamdy Mhsb <sup>2</sup>, Wesam Emam Elmozy <sup>3</sup>, Soha Abd El Hamid Romieh <sup>4</sup>, Hala Maher Ahmed <sup>2</sup>

<sup>1</sup> Department of diagnostic radiology and medical imaging, Faculty of Medicine, Tanta University

<sup>2</sup> Department of diagnostic radiology and medical imaging, Faculty of Medicine, Aswan University.

<sup>3</sup> Department of diagnostic radiology and medical imaging, Faculty of Medicine, Cairo University.

<sup>4</sup> Department of cardiology, Faculty of Medicine, Tanta University.

### ABSTRACT

**Keyword:** CTCA, CAC, CAD

**\*Corresponding author:** Rokia Hesham Abdelrahman

Email:  
[roki.hesham0424@gmail.com](mailto:roki.hesham0424@gmail.com)

**Phone No.:** 01149814836

**Background** Determining the clinical management of coronary heart disease requires careful consideration of risk stratification. Atherosclerosis's constituent calcium in the coronary arteries (CAC) is nearly exclusively present in atherosclerotic arteries. The CAC score from a non-contrast cardiac CT scan can be used to evaluate the overall amount of coronary atherosclerotic burden. The purpose of this research is to determine the significance of the segmental coronary artery calcium score in predicting the degree of calcified coronary stenosis. **Objectives:** to determine the risk of C50% coronary stenosis using the segmental calcium score (SCS) from computed tomography (CT). **Methodology:** CT coronary angiography and CT calcium scoring were performed on a sample of 52 patients. **Results:** Out of these 52 patients, there were 25 significantly stenotic segments with calcium score above 50 and 15 significantly stenotic segments with calcium score below 50. **Conclusion:** According to recent findings, there was a strong statistically significant relationship between severe coronary stenosis and the segmental calcium score.

### INTRODUCTION

Worldwide, one of the main causes of death and disability is coronary atherosclerotic heart disease or CHD. A slow and cumulative build-up of cholesterol-based atheromatous plaques along the coronary artery tree is the cause of coronary artery disease (CAD), which eventually leads to myocardial ischemia or necrosis (also known as ischemic heart disease) and lumen stenosis [1].

Clinical management of cardiovascular disease is determined in large part by risk stratification. Atherosclerosis's constituent calcium in the coronary arteries (CAC) is nearly exclusively present in atherosclerotic arteries. The CAC is a subclinical predictor of incident

cardiovascular disease that is determined by non-contrast cardiac gated computed tomography (CT). Its score is regarded as one of the most effective subclinical measures for risk prediction of cardiovascular events.[2].

The likelihood of angiographic substantial (C50% diameter reduction) stenosis is correlated with the total amount of calcification in the coronary arteries as measured by CT. The sensitivity of the CAC score in predicting stenosis is noticeably higher. [3].

An individual coronary segment or lesion's chance of having stenosis is not shown by the total calcium score. Moreover, the intermediate calcium score values (e.g., between 1 and 399) and associated stenosis do not correlate well.[4].

## AIM OF WORK

The significance of the segmental coronary artery calcium score as a marker of the degree of calcified coronary stenosis is to be assessed in this study.

## SUBJECT AND METHODS

This prospective cross-sectional study was carried out on fifty-two patients with atypical chest pain referred to the diagnostic radiology department at Aswan Heart Center between August 2023 and January 2024.

The inclusion criteria included patients who have atypical chest pain and a low to intermediate risk of having ischemic heart disease

Chest pain with a low to intermediate probability of ischemic heart disease. No age or gender restrictions.

Pregnant women, prior CABG and percutaneous coronary intervention, contraindications to iodinated contrast media, renal insufficiency (estimated GFR < 45 ml/min/1.73 m<sup>2</sup>), and noncompliance with protocol requirements were among the exclusion criteria.

A detailed history was taken regarding the history of systemic hypertension, DM, hyperlipidemia, and smoking. Revision of previous laboratory and cardiac investigations.

Before the exam, patients were told to fast for four to six hours while continuing to take their medications as usual. Every patient received reassurance, and each phase of the study was well described to them. Patients who had heart rates higher than 60 beats per minute were given beta-blockers 45 minutes before the examination (those who were contraindicated for B blockers were not included). All means of study cleared up for every patient.

### **The examination protocols are as follows:**

All patients were scanned using a Siemens dual-source 128 multidetector CT machine (MSCT SOMATOM, Siemens, Erlang, Germany)

A preliminary scout study was obtained, followed by non-enhanced coronary calcium scans utilizing ECG-gating in a typical low-dose protocol.

Depending on the kV utilized and the patient's BMI, a tight bolus of non-ionic contrast material (50–90 ml) was injected, followed by 50 ml of saline chaser at an injection flow rate of 4.5–6.5 ml/sec. This resulted in a scan range that extended from the carina to the cardiac apex. Using a pre-defined ROI and a trigger threshold set at 230 HU, we use the bolus

tracking method to initiate CTA capture when contrast media reaches the descending aorta at mid-heart level.

Data sets were reconstructed using retrospective ECG gating and a mono-segmental reconstruction algorithm. An offline workstation (Intelli Space Portal Philips workstation) was used to analyze CT datasets.

Dedicated software was used on non-enhanced scans to measure calcium scores.

### ETHICAL CONSIDERATIONS

1. The study was conducted according to the stipulations of the Aswan University Ethical and Scientific Committee keeping the privacy of participants and confidentiality of data.
2. The consent, all data, and investigations of subjects were obtained from saved files on the database. Each patient enrolled in the study will have a code number, will be confidential with a private file for each subject, all given data will be used for the current medical research only, and the names of the subjects will be hidden from the photos used in the study or published at the research paper.

### RESULTS

This was a prospective study that was carried out at the MSCT unit of the Radiology department at Aswan Heart Center on 52 patients complaining of atypical chest pain who have an intermediate to low risk of developing ischemic heart disease. There were 32 cases were males and 20 were females and the ages ranged from 28 to 79 years (mean 59.58 years).55.8% of cases were hypertensive, 44.2% were obese, 44.2% were diabetic, 38.5% were smokers, 77% were dyslipidemic and 1.9% with ESRD.

**Table (1):** Distribution of the studied cases according to Segmental Calcium Score

	No. = 52		
	Mean ± SD	Median (IQR)	Range
Proximal RCA	82.17 ± 158.50	42.00 (12 – 74)	2 – 731
Mid RCA	18.60 ± 21.88	10.00 (4 – 21.5)	1 – 85
Distal RCA	19.17 ± 18.43	13.50 (6 – 27)	3 – 52
Right PDA	21.33 ± 5.69	23.00 (15 – 26)	15 – 26
LM	12.38 ± 15.35	7.50 (4 – 12.5)	2 – 49
Proximal LAD	51.08 ± 53.68	38.50 (7 – 75)	1 – 207
Mid LAD	42.17 ± 52.58	20.00 (3 – 60.5)	1 – 187
Distal LAD	15.00 ± 18.60	11.00 (3 – 13)	1 – 47
D1	15.96 ± 17.03	9.00 (2 – 30.5)	1 – 53
D2	48.75 ± 63.52	26.00 (5.5 – 92)	3 – 140
Proximal Cx	31.17 ± 41.53	11.50 (4.5 – 44.5)	1 – 165
OM	24.20 ± 33.79	10.50 (6 – 21)	2 – 110
Distal Cx	25.00 ± 16.51	28.50 (12.5 – 37.5)	3 – 40
PL	43.00 ± 0.00	43.00 (43 – 43)	43 – 43
Left PDA	86.00 ± 0.00	86.00 (86 – 86)	86 – 86
<b>Total Calcium Score</b>	<b>138.29 ± 194.06</b>	<b>75.50 (15 – 181)</b>	<b>1 – 970</b>

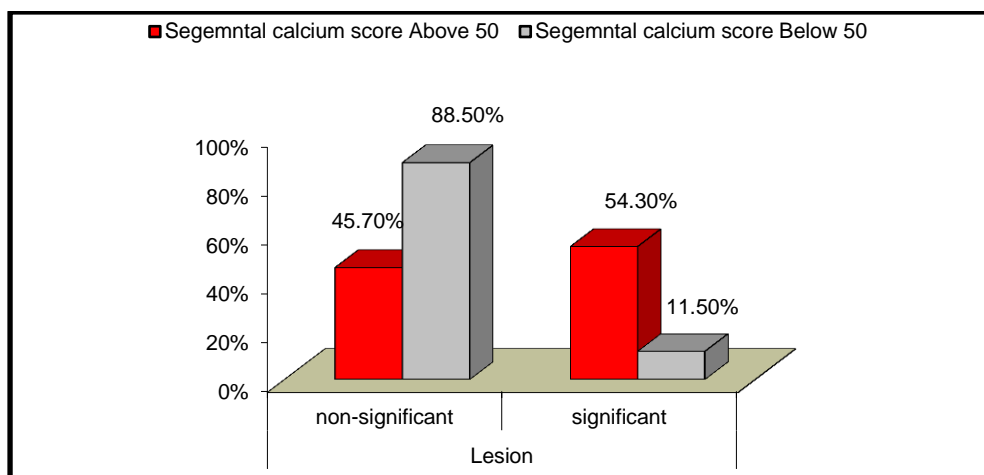
There were 25 significantly stenotic coronary lesions with a segmental calcium score above 50 and 15 significantly stenotic coronary lesions with a segmental calcium score below 50. There were 21 non-significantly stenotic coronary lesions with segmental calcium scores above 50 and 115 non-significantly stenotic coronary lesions with segmental calcium scores below 50.

**Table (2):** Relation between Segmental calcium score and significant stenotic Lesion

Lesion	Segmental calcium score Above 50		Segmental calcium score Below 50		Test value	P-value	Sig.
	No.	%	No.	%			
non-significant	21	45.7%	115	88.5%	35.456	0.000	HS
Significant	25	54.3%	15	11.5%			

**P-value >0.05: Non-significant (NS); P-value <0.05: Significant(S); P-value < 0.01: highly significant (HS)**

There was a highly Statistically significant difference between a Segmental calcium score above 50 and a significant stenotic Lesion.



**Figure (1):** shows the relation between Segmental Calcium Score and Significant stenotic coronary lesion.

The total calcium score ranged from 1 to 970 with a mean of 138.29 and a median of 75. There was a non-statistically significant correlation between total calcium score and age. The median total calcium score for females was 65 (11–137) and it was 75.50 (17.5 – 198) for males, and this was statistically insignificant. The median total calcium score for cases with hypertension was 77.00 (15 – 138), while it was 39.00 (13 – 136) for cases with obesity, while it was 39.00 (15 – 187) for cases with DM, while it was 105.00 (59 – 209.5) for cases with smoking, while it was 63.00 (41 – 101) for cases with dyslipidemia, while it was 318.00 (318 – 318) for cases with ESRD, and this was statistically insignificant.

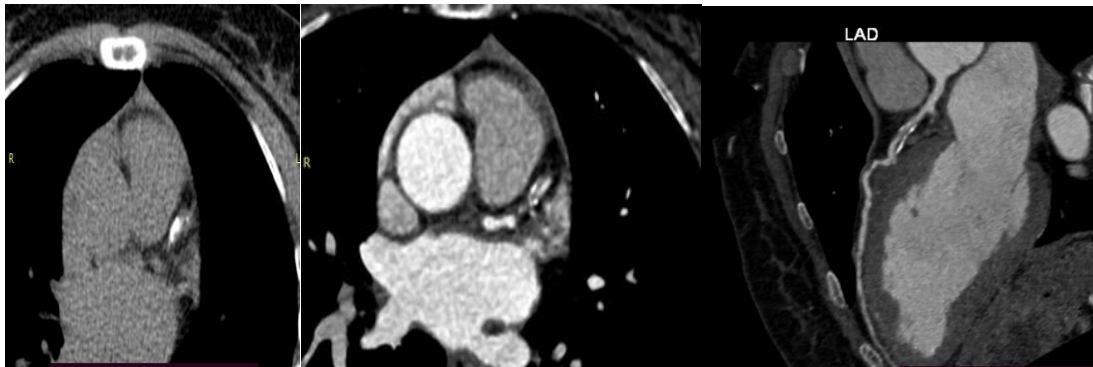
## Case Presentation

### Case no (1)



A 57-year-old diabetic male, smoker, complaining of chest pain. The calcium score of proximal RCA calcium score is 52. Coronary angiography shows proximal RCA plaque causing moderate stenosis

### Case no (2)



A 28-year-old female patient hypertensive, ESRD on regular dialysis complaining of chest pain. The calcium score of proximal LAD is 146. Coronary angiography shows proximal LAD plaque causing moderate stenosis.

### Case no (3)



A 58-year-old male, smoker and obese presented with chest pain. Calcium score of ramus intermedius 140. Coronary angiography shows moderate to severe stenosis at ramus intermedius

### Case no (4)



A male smoker, age 36, complained of chest pain. . calcium score of mid-LAD is 106. coronary angiography shows mid-LAD subtotal occlusion.

### DISCUSSION

Heart disease, including coronary artery disease (CAD), is one of the main causes of death in the elderly. The World Health Organization (WHO) estimates that heart attacks claim the lives of around 18 million people globally each year. The lifetime risk of developing CAD is estimated to be 49% for men and 32% for women. Therefore, it is critical to identify those who are at risk and to receive an early diagnosis.[5].

The most widely recognized risk factors for cardiovascular diseases are age, gender, dyslipidemia, obesity, smoking, high blood pressure, diabetes, and insufficient physical activity. Recent studies have shown that coronary artery calcium, or CAC, is a strong independent predictor of coronary artery disease (CAD). The calcification of the coronary arteries is a crucial step in the pathophysiology of atherosclerosis. The measurement of CAC is made easy by noninvasive imaging methods including electron-beam tomography (EBT) and multidetector computed tomography (CT).[6].

The non-contrast cardiac CT scan, which calculates the CAC score (CACS), is a reasonably priced, low-radiation test that provides an objective measure of the overall burden of coronary atherosclerosis. An increasing amount of data suggests that CACS is a helpful test for risk assessment of people with and without symptoms. It has been demonstrated that greater CACSs are linked to an increased risk of severe cardiovascular events and death from all causes.[2].

According to many studies, there might be a connection between cardiac risk factors and CACS. However, there were notable variations within the results that were released. [7,8].

This study aimed to evaluate the significance of segmental coronary artery calcium score as a predictor of the severity of calcified coronary lesions.

This was a prospective study that was carried out at the radiology department at Aswan Heart Center on 52 patients complaining of atypical chest pain with a low to intermediate probability of ischemic heart disease.

In our study, there were 25 significantly stenotic segments with a calcium score above 50 and 15 significantly stenotic segments with a calcium score below 50.

In our study, there were 21 non-significantly stenotic segments with calcium scores above 50 and 115 non-significantly stenotic segments with calcium scores below 50.

In our study, 32 cases were males and 20 were females and the ages ranged from 28 to 79 years (mean 59.58 years).

In our study, 55.8% of cases were hypertensive, 44.2% were obese, 44.2% were diabetic, 38.5% were smokers, 77% with dyslipidemia, and 1.9% with ESRD.

In agreement, Elkhoraiby et al. [9] comprised 100 patients who had MSCT-CA but had no definitive indications or symptoms of CAD. Of them, 62 had hypertension, 39 had diabetes, 28 were smokers, and 63 were men. There was a 56.6 mean age.

In harmony, Lo-Kioeng-Shioe et al. [2] attempted to ascertain the independent relationships between significant adverse cardiac events and the Agatston score, CAC volume, CAC area, CAC mass, and CAC density score in individuals with suspected coronary artery disease. Per their assessment, 34% of the population was female and the median age was 62 years old (interquartile range: 56–68 years).

In our study, the total calcium score ranged from 1 to 970 with a mean of 138.29 and a Median of 75.

Li et al. [10] showed that proximal lesions had a higher frequency of severe calcification. This observation could be explained by the fact that the hemodynamic impact causes the proximal section to have a higher shearing force, which leads to more atherosclerosis developing there. Although calcification is frequently seen in the coronary segments with localized high stenosis, prior research revealed no significant correlation between the amount of calcification and the stenotic extent of plaque. They discovered that compared to the mild and moderate calcification groups, the stenotic extent of lesions in the severe calcification group was significantly smaller. They discovered that the group with severe calcification had more nubbly and nodular lesions and that the morphology of these lesions likewise showed nubbly and nodular calcification. According to the consistency of stenosis assessment by conventional coronary angiography and CTA, the matching degree declined as the quantity of calcification increased, possibly as a result of calcium's shielding effect.

Erciyes et al. [11] reported that the proximal segment of the LAD showed the most calcium deposition in the coronary arteries when the segment-by-segment analysis was performed.

There was no statistically significant relationship found in our investigation between total calcium score and age. The median total calcium score for females was 65 (11 – 137) and it was 75.50 (17.5 – 198) for males, and this was statistically insignificant. The median total calcium score for cases with hypertension was 77.00 (15 – 138), while it was 39.00 (13 – 136) for cases with obesity, while it was 39.00 (15 – 187) for cases with DM, while it was 105.00 (59 – 209.5) for cases with smoking, while it was 63.00 (41 – 101) for cases with dyslipidemia, while it was 318.00 (318 – 318) for cases with ESRD, and this was statistically insignificant.

In accordance, Ueda et al. [12] found no evidence of a significant correlation between smoking, diabetes, dyslipidemia, hypertension, or male gender with CACS.

On the other hand, Kiani et al. [7] discovered that patients with higher CACs (>100) tended to be older and had a higher incidence of obstructive CAD. Upon comparing the features of individuals undergoing CT angiography with and without obstructive CAD, the researchers discovered that the latter group had advanced in age. They discovered that the existence of obstructive CAD in CT angiography can be independently and significantly

predicted by older age and CACS >100. They discovered that patients with CACS >100 had a higher prevalence of obstructive CAD (67.0% vs. 28.1%) than individuals with lower CAC levels. CACS >100 was associated with a 4.31-fold increased incidence of obstructive CAD.

Ho et al. [13] revealed that older patients had higher CACS and that they also had higher rates of substantial CT angiographic stenosis, hypertension, and male gender preponderance.

Likewise, Ueda et al. [12] observed a strong correlation between older age, being a man, having diabetes, hypertension, or high cholesterol, and higher CACs in individuals with suspected CAD. They also discovered that the CACS led to an increase in the prevalence of obstructive CAD.

These findings also are contrary to previous research showing a clear correlation between age and CAC.

Shaw et al., [14] These discrepancies could be explained by changes to the sample size, analytical methods, CACS cut-off points, and study design.

A previous study by Bielak et al. [3] reported that patients of either sex had obstructive CAD if their calcium scores were  $\geq 200$  for those over 50 and  $\geq 100$  for those under 50. Patients  $\geq 50$  years old did not have obstructive CAD, as demonstrated by a calcium score of 0.

Erciyas et al. [11] reported that, compared to normolipidemic patients, those with elevated total and LDL cholesterol levels had higher total calcium scores. Individuals with hypertension had higher total calcium scores than individuals without hypertension. Smokers' and non-smokers' calcium scores did not differ substantially. Compared to non-diabetic patients, diabetic patients scored higher on calcium. Patients with and without a positive family history of coronary artery disease did not differ significantly. Individuals with hyperlipidemia and elderly individuals had higher total calcium scores.

In our study, the median total calcium score for cases with CAD RADs 1 was 33.00 (8.5 – 79.5), while it was 28.00 (10 – 91) for cases with CAD RADs 2, while it was 65.00 (34.5 – 139) for cases with CAD RADs 3, while it was 138.00 (73 – 315) for cases with CAD RADs 4A, while it was 318.00 (318 – 318) for cases with CAD RADs 4A/V, while it was 195.50 (153 – 238) for cases with CAD RADs 4B, while it was 238.50 (119 – 358) for cases with CAD RADs 5, and this was statistically insignificant.

This suggests an increasing trend in the median total calcium score as the severity of coronary artery disease (CAD RADs category) increases. This aligns with the general understanding that higher calcium scores are associated with more advanced and severe coronary artery disease.

The CONFIRM (Coronary CT Angiography Evaluation for Clinical Outcomes: An International Multicenter) Registry included 10,037 symptomatic patients who underwent simultaneous coronary CTA and CAC scoring. The results of the analyses revealed that although the absence of CAC significantly lowers the incidence of obstructive CAD, it does not completely eliminate it. Of these individuals, 84% had no CAD, 13% had non-obstructive stenosis, 3.5% had  $\geq 50\%$  stenosis, and 1.4% had  $\geq 70\%$  stenosis on coronary CTA [15].

Li et al. [10] concluded that segmental coronary calcium score (SCCS) is a more useful tool for assessing CAC lesions than global coronary calcium score (GCCS) and can be used as a guide for choosing an interventional therapy device. SCCS is a useful reference indicator for clinical diagnosis and treatment as a result.

Pugliese et al. [4] reported that Intermediate calcium scores (such as those between 100 and 399) and related stenosis have a limited correlation.



## CONCLUSION

In light of current discoveries, there were high Statistically significant between Segmental calcium score and significant stenotic coronary lesions.

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