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CORONARY CALCIUM SCORE AS A PREDICTOR OF SEVERITY OF CORONARY ARTERY DISEASE

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ABSTRACT

Background: Cardiac diseases, particularly myocardial infarctions, are a major global health issue, often found in asymptomatic individuals. Identifying high-risk patients is crucial, with coronary calcium as a key marker for early atherosclerosis. **Patients and Methods:** This study examined 60 patients with significant chest pain across three Iraqi cardiac centers from June 2022 to March 2023. The patients underwent ECG, echocardiography, and CT scans to assess calcium scores, focusing on those at low to intermediate ischemic heart disease risk and excluding individuals with prior major cardiac events. Demographic data were collected for 10-year ASCVD risk assessment, and statistical analysis was performed using Microsoft Excel and SPSS. **Results:** The study assessed 60 patients suspected of coronary artery diseases, with an average age of 56.7 years. Demographic distribution showed 38.3% aged 50-59. Health conditions included hypertension (46.7%), diabetes (23.3%), dyslipidemia (10%), and smoking (16.7%). ASVCD scores revealed 35% low risk, 48.3% intermediate, and 16.7% high risk, while calcium scores for the LAD, LCX, and RCA averaged 71.6, 29.4, and 22.2, respectively. Agatston classifications showed 36.6% very mild CAC, 20% mild, 26.7% moderate, and 16.7% severe. Severe CAD correlated significantly with age, male gender, and diabetes. A CAC score of 34.7 predicted severe CAD with 100% sensitivity and 85% accuracy. **Conclusions:** The coronary artery calcium score is an important predictor of severe coronary artery diseases. A score of 34.7 predicts severe disease accurately. Key risk factors include advanced age, male gender, and diabetes mellitus.

KEYWORDS: Coronary Artery Disease, Coronary Calcium Score, Predictor, Severity.

INTRODUCTION

Cardiac diseases persist to be the major obstacle among the world, much of the patients who attained cardiac death or fatal myocardial infarction didn't had previous symptoms: in addition to about half of myocardial infarction patients having no history of ischemic heart diseases, so it is notable to knowing the persons at high risk of heart attacks prior to its occurring.[1]

calcium of the coronaries is a marker for atherosclerotic plaque formation and can start in a patient with 10-20 years old. calcium phosphate is referred to calcification by its name, which is like that of bone.[2]

Both American college of cardiology (ACC) and American heart associations (AHA) conference meetings advice that coronary calcium is found in atherosclerotic plaque and are not present in healthy vessel walls. Coronary calcium is the main component of atherosclerosis and presented in both non calcific and calcific plaques,[3] and had a role in plaque size increment, progression and stabilization.[4] the CAC burden had a high association with cardiovascular events.[5]

A modern risk scores had been devised by 2013 guidelines to investigate the 10-year risk for having the

first ASCVD attack clarified by developing non-fatal MI, ischemic heart disease death or stroke.[6] A Framingham score is the tool which is mostly used to pick up the 10-year risk assessment for cardiovascular diseases[7] Although many standard screening tools had been evaluated for predicting a new cardiac event, but it fails to obtaining many persons who have a heart attack later on[8], so noninvasive radiological tests had been elaborated like coronary computed tomographic angiography (CCTA) and coronary artery calcium scoring for their ability to defining a coronary artery disease lesions.[9]

The CT is now the tool of choice to clarify and quantitatively count the calcified plaques of coronary vessels and aortic plaques.[10-11] the application of coronary calcification scoring by multi-detector CT angiography has been used as a noninvasive technique for identifying of coronary lesions.[14] Brazilian society of cardiology and the Brazilian college of radiology had recommended to apply the coronary calcium score in non-symptomatic persons who had intermediate risk for future cardiac events as manifested by Framingham risk score as an evidenced method.[12-14]

The Total Agatston score is used to estimate the coronary artery calcium score extension, and the calcium volume burden in the vessel, calcium score is not done in high risk people because it adds non valuable markers to the estimation score.[15]

The current study aimed to clarify the correlation between coronary artery calcium score and the severity of coronary artery disease.

PATIENTS AND METHODS

Study population

This study was conducted in three Iraqi cardiac centers (Ibn Al-bittar center for cardiac surgery, Baghdad heart center, Nasiriyah heart center) from June 2022 to march 2023. We plan to involve 60 patients who attend outpatient clinics complaining from significant chest pain evaluated by ECG, Echocardiography then referred to CT scan department looking for calcium score. Consent have been taken from all patients before enrollment.

Inclusion criteria

1- Patients with had low to intermediate IHD probability.
2-patients attend CT scan with suspected IHD.

Exclusion criteria

1-prior history of ACS
2-prior history of PCI or CABG
3-known case of IHD by Coronary angiography.

Patients demographic criteria

Full history taken from each patients including age, gender, main compliant, past medical history of diabetes, hypertension, dyslipidemia, smoking history, family history of IHD, we estimate 10 year ASCVD risk at initial visit to establish reference point in order to classify patients into low, intermediate or high risk.

Multidetector CT scan examination (MDCT)

A 64 slice MDCT scanner was used to assess coronary artery calcium. Area from the tracheal carina to the diaphragm was imaged with native CT scan with slice depth of 3mm, tube voltage 100 kv, and tube current 300 mA.

Coronary artery calcium score assessed by using Agatston score examine left main, left anterior descending artery, left circumflex and right coronary artery, calcium score in each artery and total calcium have been assessed by radiologist and expert cardiologist (software base). patients with zero calcium score with low probability for IHD have been excluded from study while those with zero calcium score with intermediate probability have been referred to coronary angiography. Categorized results as zero=no CAC score;1-99=mild CAC score; 100-299=moderate CAC score; more than 300=severe CAC score.

Statistical analysis

Applications of Microsoft Excel and the statistical package for social science (SPSS) version 23 were used to examine the study's data. The analysis's results were organized into category variables and scale variables (means and standard deviation). For categorical variables, Fisher's exact test and the chi square test were employed. Two means were compared using the independent samples t-test, and more than two means were compared using a one-way ANOVA analysis. The predictability of the CAC score with respect to the severity of CAD was evaluated using the ROC curve. A P value of less than 0.05 was considered significant.

RESULTS

The study involved 60 patients with suspected coronary artery diseases (CADs) presented with mean age of 56.7±10.6 years; 6.7% of patients was in age group <40 year, 13.3% was in 40-49 year group, 38.3% was in 50-59 year group, 25% of them was in 60-69 year group and 16.7% of them was in age 70 year group and more. Male patients were equal to female patients with male to female ratio as 1:1.

The hypertension was observed in 46.7% of patients, diabetes mellitus in 23.3% of them, dyslipidemia in 10% of them, while smoking was active for 16.7% of patients and ex-smoking was observed in 3.3% of them. The serum calcium was abnormal among 6.7% of patients.

Mean ASVCD score for patients was 5.9±1.6 %; 35% of them had low risk, 48.3% intermediate and 16.7% of them had high risk (≥7.5%). (***Table 1***)

Table 1: ASCVD risk score.

ASCVD risk score	Frequency	Percentage
Low (<5%)	21	35.0
Intermediate (5-7.5%)	29	48.3
High (>7.5%)	10	16.7
Total	60	100.0

The mean LAD calcium score was (71.6), mean LCX calcium score was (29.4) and mean RCA calcium score was (22.2). Mean total coronary artery calcium score (CAC) was (123.2). (***Table 2***)

Table 2: Total and coronary calcium scores of patients with CADs.

Variable	Mean± SD
LAD calcium score	71.6±102.7
LCX calcium score	29.4±64.6
RCA calcium score	22.2±48.5
Coronary Artery Calcium score	123.2±171.2
Total	60

According to Agastone classification; 36.6% of patients had very mild CAC score (Zero), 20% of them had mild CAC score (1-99), 26.7% of them had moderate CAC score (100-299) and 16.7% of them had severe CAC score (≥300). The study present a significant correlation among patients increased age and severe CADs (p=0.005). Also a significant association was identified between male gender patients and severe CADs (p=0.02). (***Table 3***)

Table 3: Distributions of patients' demographic characteristic according to CAD severity.

Variables		Less severity		Severe		P-value
		No.	%	No.	%	
Age	<40 years	4	10.0	0	0.0	**0.005***
	40-49 years	6	15.0	2	10.0	
	50-59 years	19	47.5	4	20.0	
	60-69 years	9	22.5	6	30.0	
	≥70 years	2	5.0	8	40.0	
Gender	Male	16	40.0	14	70.0	**0.02****
	Female	24	60.0	6	30.0	

** Fishers exact test, **Chi square test*

No significant difference was observed between patients with less severe CADs and severe CADs regarding hypertension (p=0.4), dyslipidemia (p=0.06), smoking (p=0.1) and serum calcium (p=4). There was a good association between diabetes mellitus and severe CADs (p=0.03). (***Table 4***)

Table (4): Distribution of patient's risk factors in relation to CAD severity.

Variable		Less severity		Severe		P-value
		No.	%	No.	%	
Hypertension	Yes	20	50.0	8	40.0	0.4*
	No	20	50.0	12	60.0	
Diabetes Mellitus	Yes	6	15.0	8	40.0	**0.03****
	No	34	85.0	12	60.0	
Dyslipidemia	Yes	6	15.0	0	0.0	0.06**
	No	34	85.0	20	100.0	
Smoking	No	34	85.0	14	70.0	0.1**
	Active	6	15.0	4	20.0	
	Ex	0	0.0	2	10.0	
Serum calcium	Normal	38	95.0	18	90.0	0.4**
	High	2	5.0	2	10.0	

** Chi square test, ** Fishers exact test.*

Patients with severe CAD had a considerably higher mean CAC score than those with less severe CAD. (***Figure 1***)

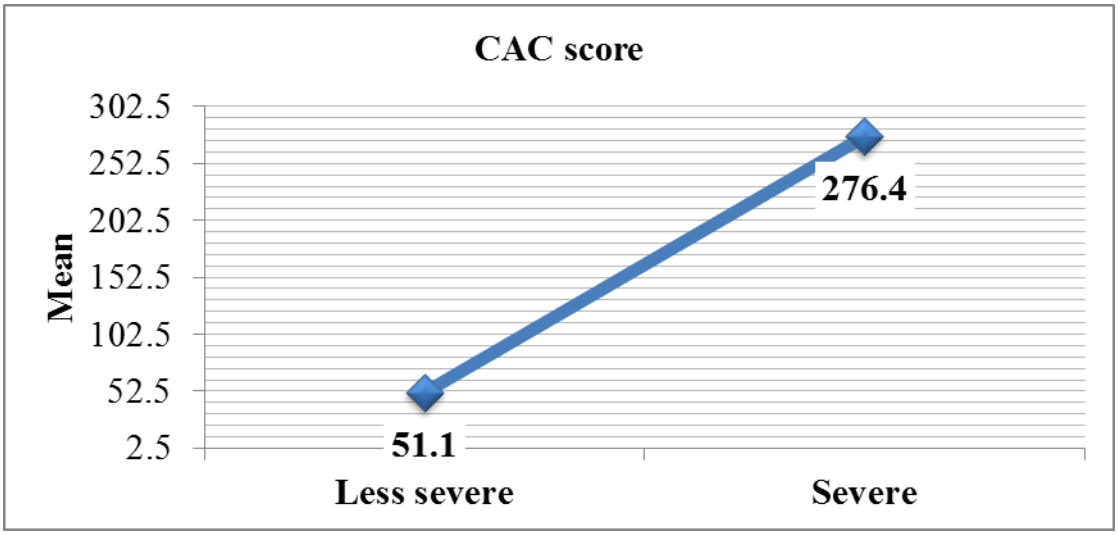

Figure (1): CAC score mean distribution according to CAD severity.

Mean CAC score of patients with CADs was significantly increased with increased number of vessels with lesions (p<0.001). (***Figure 2***)

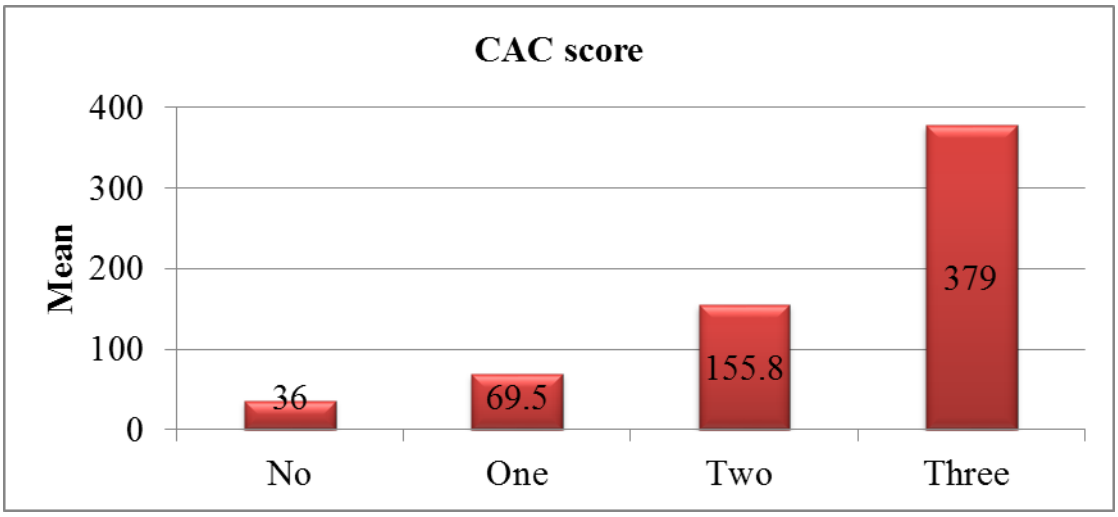

Figure (2): CAC score distribution according to number of vessels with lesions.

Accepted cut off point and the correspond validity value for CAC score in predictions of severe CAD was 34.7 which had acceptable validity result (100% sensitivity, 70% specificity, 100% PPV, 68.5% NPV and accuracy 85%). (***Table 5***)

Table (5): ROC coordinates for prediction of severe coronary artery disease by CAC score.

Cutoff point	Sensitivity	Specificity	PPV	NPV	Accuracy
15	100%	60%	100%	58%	65%
17.5	100%	65.5%	100%	73.5%	76%
34.7	**100%**	**70%**	**100%**	**68.5%**	**85%**
108	70%	75.5%	68.8%	73%	71.3%
90.2	70%	70%	68%	72%	70%
108	70%	77.5%	67%	75%	68%

DISCUSSION

Patients with severe coronary artery disease had a considerably higher mean CAC score in the current research (p<0.001). The results are in line with a study conducted in Canada by Youness et al.[12] on 2659 patients to determine the incidence of CAD severity in the presence of a high agatstone score. The study found that a higher CAC score in patients with stable symptoms and normal myocardial perfusion imaging is a significant indicator of severe coronary artery disease. Higher CAC scores were significantly associated with severe coronary artery disease, according to a different research

conducted by Choi et al.[16] in China on 2658 patients to evaluate the occurrence of concurrent asymptomatic CAD in ischemic stroke.

The results of our investigation showed that 36.6% of patients had a zero CAC score. Gulati et al.[17] consistently showed that coronary artery stenosis was not excluded by a zero CAC score in their study on the importance of coronary calcification for prediction of coronary artery disease and cardiac events, which was conducted in a Taiwanese hospital on 100 patients with suspected CAD. In a research conducted on 175 patients in Iraq, Al-Naffi et al.[18] discovered that while a higher CAC score is linked to severe coronary artery disease, the lack of coronary artery calcification does not always mean that coronary artery disease is not present.

In the current investigation, individuals with CADs had a considerably higher mean CAC score and more arteries with lesions ($p<0.001$). According to a cross-sectional study conducted in Iran on 748 patients with suspected CADs, the mean coronary artery calcium score (CAC) increased significantly as the number of vessels with lesions increased. These results are consistent with the findings of Moradi et al.[19] (prognostic value of coronary artery calcium score for determination of presence and severity of CAD). Increasing the number of vessels with lesions improved the accuracy of both Agaston and CAC scores in predicting severe CADs, according to a study conducted in the USA on 3262 CAD patients by Blaha et al.[20]

According to the current study, the CAC score had an appropriate cut-off point of 34.7 and the associated validity values for predicting severe CAD, with 100% sensitivity, 70% specificity, 100% PPV, 68.5% NPV, and 85% accuracy as validity outcomes. A research conducted in Albania by Beka et al.[21] found that a cutoff value of 21.4 for the CAC score in the prediction of severe CADs had sufficient validity findings (80% sensitivity, 67% specificity, 70.8% PPV, 77% NPV, and 74% accuracy). These findings are similar to those of that study. According to ROC curves in several publications, a rise in CAC score is associated with an increase in its accuracy in identifying severe CADs.[22]

The current investigation discovered a strong correlation ($p=0.005$) between patients' increasing ages and severe CADs. This conclusion is in line with the findings of a Japanese research by Nakazato et al.[23] that showed that a patient's age affects their risk of coronary artery disease.

The current investigation discovered a strong correlation ($p=0.02$) between severe CADs and male patients. In a similar vein, a study conducted in Australia by Chiha et al.[24], titled "Gender Difference in the Severity and Extent of Coronary Artery Disease," found that there is a clear disparity in the severity and burden of coronary artery diseases between males and females, with women having significantly lower severity of coronary artery diseases than age-matched men. Inconsistently, a research conducted in the Netherlands by Maas et al.[25] found that coronary artery disorders continue to be the leading cause of death for women, despite the fact that women tend to present with these conditions later than males do. Diabetes mellitus and severe CADs were significantly correlated in this research ($p=0.03$). This finding is consistent with a research conducted in France by Larifla et al.[26] that found diabetes mellitus to be the most prevalent modifiable risk factor for the severity of coronary artery disease in the Afro-Caribbean.

CONCLUSIONS

The coronary artery calcium score is a valuable predictor of severe coronary artery diseases and is closely associated with the atherosclerotic cardiovascular disease score. This score is influenced by the number of coronary artery vessels that have lesions. A calcium score of 34.7 has been shown to accurately predict severe coronary artery disease, supported by strong validity findings. Conversely, a score of zero does not rule out the presence of coronary artery stenosis. Key risk factors contributing to the severity of coronary artery disease include advanced age, male gender, and the presence of diabetes mellitus.

Recommendations

- Encouraging physicians to adopt the non-invasive coronary artery calcium score for diagnosis and risk stratification of coronary artery diseases.
- Increasing number of vessels assessed will increase accuracy of the coronary artery calcium score.
- More attention about accurate site of calcification and involved vessel.
- More researches on importance of the coronary artery calcium score in assessing severity of coronary artery diseases must be supported.

Limitations of Study

- Small sample size.
- In this study we use 64 slice MDCT with slice thickness 3mm which may be missed low calcium score.
- In our study we used agatstone method for calcium calculation, other methods like relative calcium mass score and calcium volume score did not used.

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