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Original Article

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Coronary Artery Calcium Score: Current Efficacy of Cardiac CT in Patients at Hail Region, Saudi Arabia

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ABSTRACT

Calcium levels in the Coronary Artery are an indicative marker of the presence and extent of atherosclerosis. This serves as an additional prognostic indicator in addition to traditional risk factors. Moreover, the coronary calcium test is associated with a descriptor known as the calcium score or calcium score (Cs), which is primarily useful for stratifying the risk of asymptomatic patients, while for patients with acute or chronic chest pain, coronary axial computed tomography is generally required. A retrospective analysis of data was conducted in the radiology department of King Salman Specialist Hospital in Hail City, the kingdom of Saudi Arabia, between January and May 2022. A total of 40 patients were randomly selected, 25 males and 15 females. The study included all patients with or suspected of having a calcium deposit who underwent a CT scan using the Siemens SOMATOM definition MDC scan. Patients underwent a scan with the preparations and laboratory tests required for their coronary artery calcium scores. In this study, males were more likely to be affected by calcium deposits (64%), whereas females were 36%. Approximately 50 percent of the study populations were found to be normal (no identifiable calcium deposits) and 37.5% to have moderate calcium deposits. There is a significant association between CACS and moderate CVD risks based on age and gender in this study. Better control of cardiovascular system (CVS) risks is recommended in all primary care centers in the Kingdom of Saudi Arabia (KSA).

Key words: *Coronary artery disease, CT cardiac, Calcium score, Agatston score, CAC score*

INTRODUCTION

Across the world, cardiovascular disease (CVD) is a major public health concern, including coronary artery disease, strokes, and peripheral vascular diseases [1]. Similarly, cardiovascular disease is becoming a major public

health issue in Gulf Council countries, including Saudi Arabia. It is estimated that over 45% of all deaths are caused by CVD. According to the Saudi Ministry of Health, the prevalence of coronary artery disease is 5.5% in the Kingdom of Saudi Arabia (KSA), with slightly higher rates in urban areas than in rural areas (6 vs. 4.2%, respectively) [2]. As a result of rapid urbanization, lifestyles in Gulf countries have changed dramatically. People eat poorly and are sedentary. As a result, the Gulf population is also at risk of CVD and chronic non-communicable diseases [3].

A significant variation exists between the countries of the world regarding the incidences of cardiovascular disease (CVD), ischemic heart disease, and stroke, with declining rates among developing and poor countries, whereas a corresponding mortality rate and risk prevalence are predicted to be the leading cause of death in developing countries by 2025 [4]. It may be attributed to the fact that smoking habits may be alerted to a change in lifestyle, a change in nitration, and an improvement in medical health care &, an awareness which may be lacking in developing countries. During the early decades of the Saudi Arabian monarchy, the country made significant investments in education, healthcare, and research to combat cardiovascular diseases (CVD) [5].

"A total risk score" is a very useful tool, and should be used as the first method of stratification, even though they are only able to predict 65–80% of the future cardiovascular events that will occur [6]. It is possible to measure coronary artery calcium (CAC) using computed tomography radially and non-invasively as an indicator of an elevated risk of coronary heart disease [7]. Computed tomography can characterize coronary artery calcification as well as the burden of coronary atherosclerosis and the risk of cardiovascular events. The purpose of the present study was to evaluate the Coronary Artery Calcium Score to predict Coronary Heart Disease Events in Saudi Arabia using computed tomography cardiac scoring.

MATERIALS AND METHODS

Following the principles of the Declaration of Helsinki, this study was conducted at King Salman Specialist Hospital, Hail, Saudi Arabia, from December 2020 to December 2021. Written informed consent was obtained after the human research and ethics committees at the University of Hail and King Salman Specialist Hospital (H-2022-188) approved the study.

A total of 40 subjects with suspected symptomatic coronary artery disease underwent conventional coronary angiography, ranging in age from 20 to 90 years. Subjects with a history of cardiac surgery, allergy to iodinated contrast dye or contrast dye–induced nephropathy, multiple myeloma, organ transplantation, elevated serum creatinine level (>1.5 mg per decilitre [133 μmol per liter]), or creatinine clearance less than 60 ml per minute, atrial fibrillation, heart failure (New York Heart Association class III or IV), aortic stenosis, percutaneous coronary intervention within the past 6 months, intolerance to beta-blockers, or a body-mass index of more than 40 were excluded from the study.

Procedure

Subjects underwent 64-row scanners with a slice thickness of 0.5 mm (SOMATOM Definition, Siemens Medical Solution, Forchhemi, Germany, Toshiba) for multidetector CT tests (coronary calcium scoring and angiography). The participants were scanned twice with radiographic phantoms containing identical concentrations of calcium underneath the thorax of certified technologists. During a CT scan at a King Salman Specialist Hospital, a radiologist or cardiologist read the scan and used an interactive scoring system to evaluate it.

Based on the estimated attenuation of the calcium phantom, the reader-workstation interface calibrated each tomographic image before identifying and quantifying coronary calcium in each image. In all analyses, the mean of the two scans was used to calculate the coronary calcium score (Agatston score).

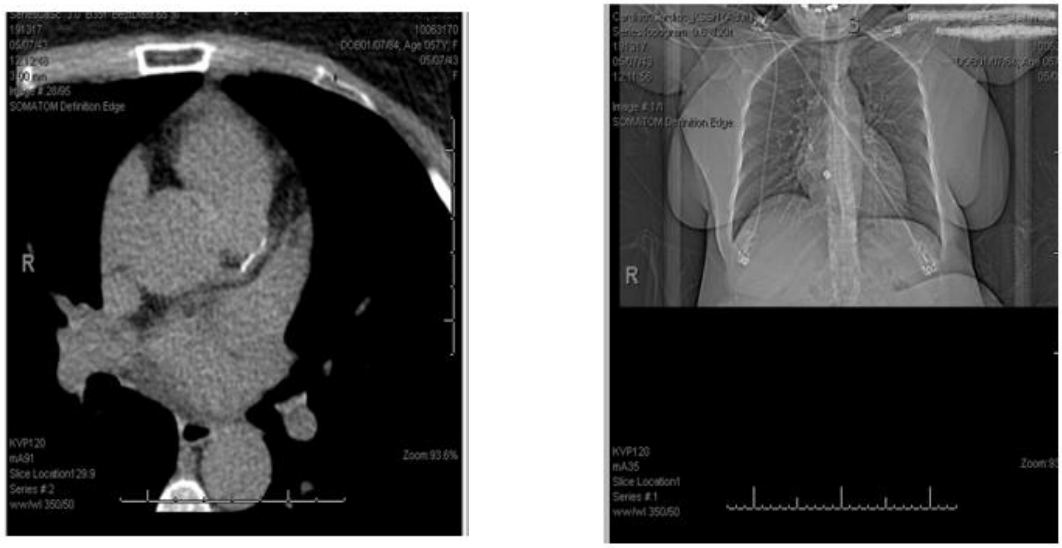
Calcium scoring was performed using prospective electrocardiographic (ECG) gating with a gantry rotation of 400 milliseconds, tube voltage of 120 kV, and tube current of 300 mA. Adaptive multisegmented CT angiography was performed using retrospective ECG gating and heart rate-adjusted gantry rotations between 350 and 500 msec. An effective radiation dose of 12 to 15 mSv was determined by the pitch and tube currents of the multidetector CT calcium scoring based on the patient's weight. This dose was a maximum effective dose of 20 mSv. Women were subjected to a cap of 270 mA, while men were subjected to a cap of 400 mA. The patient received intravenous iopamidol (Isovue 370, Bracco Diagnostics) as well as sublingual nitrates before multidetector CT angiography. If the resting heart rate was greater than 70 beats per minute, beta-blockers were administered. A patient's data were excluded from analysis if their heart rate during acquisition exceeded 80 beats per minute.

The raw image data sets from all acquisitions have been analyzed by an independent reader. We performed multisegmented reconstruction using 0.5 mm slice thickness, 0.3 mm overlap, multiple phases, and editing of the ECG signals.

Measurement of calcium score

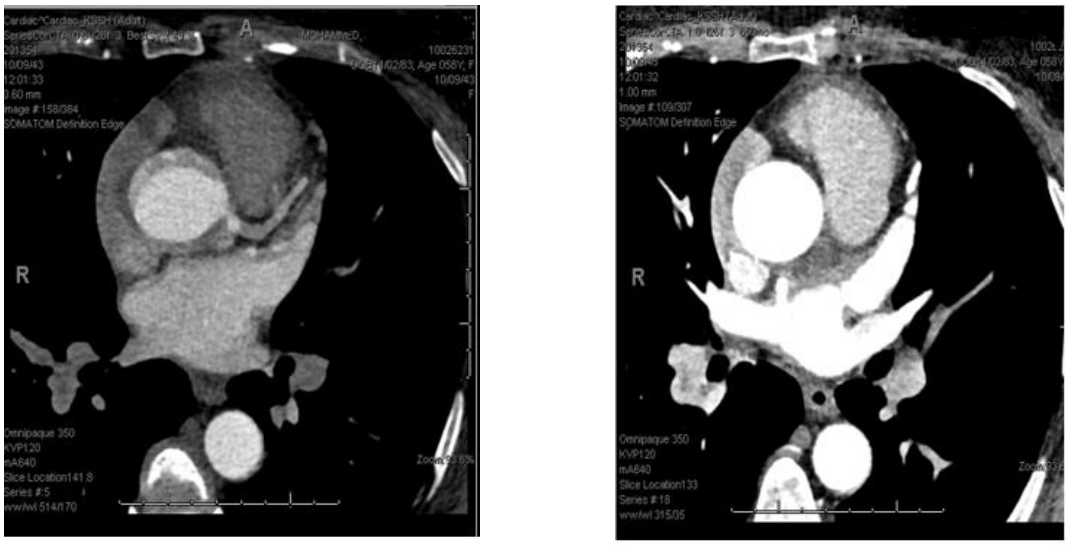
A subject lying supine on the CT scanner table with feet first is scanned with the center of the scanner at approximately 1 cm above the diaphragm. This is between the symphysis pubis and the diaphragm. This image is scanned with the following parameters: slice thickness of 5 millimeters, an interval of 0.2 millimeters, limited to the cardiac region. A small, sticky disc of electrodes will be attached to the patient's chest and to the electrocardiograph, which will be used to record heart electrical activity. As a result, it is possible to obtain CT scans when the heart is not actively contracting.

A calcified area is defined as an area with a hyperattenuating gradient of at least 1 mm2 and having > 130 Hounsfield units (HU) or three adjacent pixels. Once the CT scan has been completed, the table will move slowly through the machine as it is scanned. It may be necessary for the machine to make several passes depending on the type of CT scan. While images are being captured, patients are asked to hold their breath for a period of 10 to 20 seconds. CT scanning usually takes about 10 minutes to complete **(Figures 1 and 2)**.



a) b)

Figure 1. Imaging of mild calcium score in LAD



a) b)

Figure 2. Imaging with zero calcium score

Table 1. Clinical characteristics of the subjects

	Frequency	Percentage
Female	15	35.5
male	25	62.5
from 51-70 years	20	50.0
less than 50 years	17	42.5
More than 70 years	3	7.5
Atherosclerotic heart disease	1	2.5
Chest pain	25	62.5
Chest pain Hyperlipidemia	1	2.5
chest pain varicose veins in lower extremities	1	2.5
COVID19	1	2.5
Dilated cardiomyopathy	3	7.5
Dyspnea	4	10.0
ischemic cardiopathy	2	5.0
Other allergic, rhinitis	1	2.5
Palpitations	1	2.5

Table 2. Percentage of calcium deposits in coronary artery

		Frequency	Percentage
left main coronary artery calcium deposit	indeterminate patency	1	2.5
	low Risk	1	2.5
	Mild Calcium Deposits	2	5.0
	Moderate	1	2.5
	No identifiable calcium deposits	33	82.5
	non calcifed plaque with severe stenosis	1	2.5
left anterior descending artery calcium deposit	calcified plaque with minimal stenosis	1	2.5
	Calcified plaque no stenosis	1	2.5
	indeterminate patency	1	2.5
	Low Risk	1	2.5
	Mild Calcium Deposits	5	12.5
	mild nonobstructive LAD stenosis	1	2.5
	Moderate Calcium Deposits	3	7.5
	No identifiable calcium deposits	25	62.5
	proximal total occlusion	1	2.5
	severe stenosis	1	2.5
left circumflex artery calcium deposit	calcified plaque no stenosis	1	2.5
	indeterminate patency	1	2.5
	low Risk	1	2.5
	mixed plaque with severe stenosis	1	2.5
	moderate Calcium Deposits	1	2.5
	No identifiable calcium deposits	32	80.0
	no significant disease	1	2.5
	stenosis	1	2.5
right coronary artery calcium deposit	calcified plaque no stenosis	1	2.5
	indeterminate patency	1	2.5
	Low Risk	1	2.5
	No identifiable calcium deposits	33	82.5
	non-calcified plaque with severe stenosis	1	2.5

	normal	1	2.5
	occluded	1	2.5

Table 3. The total coronary artery calcium deposit (score)

	CAC score	Frequency	Percentage
Normal	0	22	55.0
Minimal	1-10	0	0
Indeterminate CAD	11-100	1	2.5
moderate	101-400	15	37.5
severe native CAD	Over 400	2	5.0

Table 4. Correlation between gender and calcification

		TOTAL CA					Total
		Normal	Minimal	intermediate	Moderate	severe	
Gender	Male	0	1	7	16	2	25
	Female	1	0	7	6	0	14
	Total	1	1	14	22	2	40
				Value 0.025			

Table 5. Correlation between age and calcification

		TOTAL CA					Total
		Normal	Minimal	intermediate	Moderate	severe	
Age	From 51-70 years	1	0	9	8	2	20
	Less than 50 years	0	1	2	14	0	17
	More than 70 years	0	0	3	0	0	3
	Total	1	1	14	22	2	40
				P.Value 0.030			

RESULTS AND DISCUSSION

Based on the results of the study, 64% of males are affected by calcium deposits, compared with 36% of females. The majority of the subjects were males (62.5%), while the majority of the females (35.5%) were between the ages of 51 and 70, and 42.5% were younger than 50. The results indicate that 62.5% of the subjects had a history of chest pain, with dyspnea occurring in 10% of them **(Table 1)**. A total of 5% of the subjects had severe calcium deposits, 37.5% showed moderate deposits, 2.5% had intermediate deposits, and 55% had no calcium deposits. As shown in **Tables 2 and 3**, male subjects had a significantly higher correlation in calcification than female subjects, and subjects aged 51 to 70 years had a significantly higher correlation in calcification (0.030) **(Tables 2 and 3)**. **Tables 4 and 5** summarizes the correlation between the calcification and gender and age, respectively **(Tables 4 and 5)**.

The Coronary Artery Calcification Scoring technique provides an inexpensive and reproducible method for determining the presence and extent of calcified coronary artery plaque in the arteries. The procedure does not require contrast, and it can be performed on any patient who is capable of holding their breath for five to ten seconds [6].

Image acquisition guidelines for CAC testing have been previously published [8, 9]. The examination requires no intravenous (IV) access, and there is no need for patients to prepare in any way other than practicing holding their breath and remaining still during the examination. CAC scanning is not preceded by the administration of any medications in most centers. However, beta-blockers may be administered to patients with elevated heart rates if they are deemed to be at risk.

[10] During diastole, axial mode scanning should be used with prospective electrocardiogram triggering. To achieve a sufficient balance between radiation dose and image noise, the scan settings include a tube voltage of 120 kV and a tube current based on the size of the patient [11].

An Agatston score is used to quantify the calcium content of plaques. This score is calculated by multiplying the CT density of each plaque area by the amount of calcium within it. It has been demonstrated that CAC scoring is capable of predicting cardiovascular events independently as well as improving traditional risk prediction models [12, 13]. According to several large observational studies, CAC significantly improves the accuracy of risk prediction when added to standard risk prediction models compared to other novel biomarkers or a combination of biomarkers [14-16]. It is important to note that CAC scoring has superior predictive capabilities because it can correctly classify patients into high- and low-risk categories [17]. The risk of coronary artery disease is extremely low for individuals without coronary artery calcifications (CAC = 0). According to the present study, 55% of the subjects had a CAC score of 0, which indicates an extremely low risk of cardiovascular disease. This is similar to that found by Mouden *et al*., In the majority of cases, the results of the study were normal (50 percent of the total CAs were normal, and no calcium deposits were observed) [18].

The utility of CAC scoring for enhancing risk prediction for individuals at intermediate risk has received considerable attention. A total of 37.5% of the subjects in this study were at moderate risk for coronary artery disease with CAC scores between 101 and 400. In addition, 5% were at severe risk for coronary artery disease. According to estimates of all-CHD event rates over 10 years, high CAC scores (over 100) are associated with nearly 10% of all-CHD events among individuals traditionally considered low risk, regardless of their risk factor burden or calculated risk score [19]. In contrast, CAC scores of zero are associated with an all-CHD event rate of roughly 3% among individuals traditionally identified as high risk by the FRS or risk factor burden [20]. It has been found that individuals with no risk factors and an elevated CAC score have nearly three times the event rate as those with multiple risk factors and a zero CAC score. The CAC is an analysis of data drawn from several large observational cohorts that offer the potential for producing a refined, and personalized risk estimate for the primary prevention of cardiovascular disease [21-23].

However, it is important to note that CAC has a significant prognostic value across a wide spectrum of age groups and risk factors. A moderate calcification risk was observed in the present study among male subjects with an age greater than 50 years. Even though studies have shown that coronary artery calcification is age and gender-dependent and that it occurs in 90% of men and 67% of women over the age of 70. Similarly, a population-based study, documented that age and male sex are the most important risk factors for coronary calcification [24]. There is a strong association between cardiovascular risk factors and the amount of coronary calcification in asymptomatic individuals; almost 30 percent of men and 15 percent of women without cardiovascular risk factors have extensive coronary calcification [25]. The prevalence is higher in men than in women as a result of a variety of precipitating factors such as smoking, lifestyle choices, and associated health conditions such as diabetes mellitus and hypertension. It is imperative to consider the entire clinical scenario in such patients and not just the score. If a patient presents with an elevated calcium score but has no symptoms and falls into the intermediate or moderate-risk group, there is evidence to suggest that he or she should be started on statin or aspirin therapy or both [26].

CONCLUSION

This study confirms the significant association between the CACS and CACS (101-400), which was also associated with both age and gender. In symptomatic patients with CAD, calcium screening may provide an additional filter before coronary angiography; however, a zero CACS might not exclude the presence of significant CAD. It is recommended that all primary care centers in the Kingdom of Saudi Arabia (KSA) must manage cardiovascular system (CVS) risks more effectively. A randomized controlled trial is necessary to assess the true impact of CT risk stratification on long-term prognosis.

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CONFLICT OF INTEREST : None

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ETHICS STATEMENT : Ethical approval is obtained from University ethical committee, University of Hail.

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