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Computed Tomography Angiography: Zero Coronary Artery Calcium score in Atherosclerotic plaque patients

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Coronary Artery Calcium (CAC) levels are an important marker of the presence and extent of Athersclerotic Cardio vascular Disease (ASCVD). The purpose of the present study was to assess the Coronary Artery Calcium (CAC) Score in low-intermediate risk volunteers with chest pain to predict the frequent of zero CAC in patients with Coronary atherosclerotic plaques by Computed Tomography technique. In this retrospective cohort study, a total of 50 patients, 25 males and 25 females, with stable chest pain were randomly selected and underwent a CT scan using the Siemens SOMATOM definition MDC scan as a part of routine clinical care. All patients were included in this study with or suspected of having a calcium deposit. .Volunteers underwent CT scan with the preparations and laboratory tests required for their CAC scores. Mean age was51±11 yrs. In this study, a zero CAC score was correlated with a low rate of CAD, with frequency of atherosclerotic plaque in the coronary arteries, Chest pain, Chest pain Hyperlipidemia and chest pain varicose veins of lower extremities was 12 (24%), 28 (56%), 4 (8%), and 6 (12%), respectively. The percent of 48% had an obstruction disease event (>50%)with involvement of two or more segments. There is a significant association between zero CAC score and CVD risks with high higher frequency of atherosclerotic plaque .It is recommended that control of cardiovascular system risks would be integrated in the primary care centers

Keywords: Coronary artery disease; CT cardiac; calcium score; Agatston score; CAC score

INTRODUCTION

Globally, cardiovascular disease (CVD) is a leading public health Issue, that are cause death including in Saudi Arabia. It covering conditions such as coronary artery disease (CAD), strokes, and peripheral vascular diseases. (Roth et al.2020). It is estimated that CVD leading about 45% of all deaths. According to Ministry of Health in Saudi, the prevalence of CAD is 5.5% (Najlaa , 2015; Alhabib et al.2020).

The detection of Subclinical of CAD is remaining the major concern in daily clinical radiology and cardiology practice (Abdulla et al.2007; Schroeder et al.2004).

"A total risk score" is a very valuable technique and should be utilized as a first procedure of stratification. It could beable to predict 65–80% of the occurrence of future cardiovascular events (6)It is possible to quantify coronary artery calcium (CAC) using Computed Tomography (CT)Imaging technique radially and non-invasively as a marker of an elevated risk of CAD.(7)Computed tomography has been shown to be able to measure coronary artery calcification as well as the burden of coronary atherosclerosis and then risk of

cardiovascular events. Also, patients with a zero Calcium Score may have atherosclerotic plaques (Abdulla et al.2007; Schroeder et al.2004) and may need more assessment to predict the future cardiovascular events. The purpose of the present study was to assess the frequency of atherosclerotic plaque in low-intermediate risk volunteers with chest pain by Coronary Artery Calcium (CAC) Score Computed Tomography technique.

MATERIALS AND METHODS

This study was operated at King Salman Specialist Hospital, Saudi Arabia, from January 2021 to December 2021.

A total of 50 Volunteers with suspected symptomatic CAD underwent conventional coronary angiography, and aged from 20 to 70 years. Volunteers were excluded if there is a history of cardiac surgery, allergy to iodinated contrast dye or contrast dye–induced nephropathy, multiple myeloma, higher serum creatinine level (>1.5 mg per deciliter [133 μ mol 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 recently, intolerance to beta-blockers, or a body-mass index of more than 40.

Procedure

Volunteers examined with 64-row scanners and a slice thickness of 0.5 mm (SOMATOM Definition, Siemens Medical Solution, Forchhemi, Germany, Toshiba) for multi-detector CT exams (coronary calcium scoring and angiography). The volunteers were scanned double with radiographic phantoms containing exactly concentrations of calcium underneath the thorax. The scoring system was evaluated by a radiologist and cardiologist during CT exam.

According to attenuation estimation of the calcium in phantom, the reader-workstation interface adjusted each CT images before identifying and calculating coronary calcium values in each image. The mean of the two scans was used then to estimate the coronary calcium score in all measurements (Agatston score).

A prospective electrocardiographic (ECG) gating with a gantry rotation of 400 milliseconds was used for calcium scoring with tube voltage of 120 kV and tube current of 300 mA. Adaptive multi-segmented CTA was achieved using retrospective ECG gating and heart rate-adjusted gantry rotations between 350 and 500 msec. According to volunteer weight, an effective radiation dose of 12 to 15 mSv was defined by the pitch and tube currents of the multidetector CT calcium scoring. This dose was 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 Iopamidol (Isovue 370, Bracco Diagnostics) was injected intravenously into volunteers as well as sublingual nitrates before multidetector CTA. beta-blockers were given once the resting heart rate of volunteers higher than 70 beats per minute.

Measurement of calcium score

A volunteer lying in supine position with feet first on the CT and scanned with the center of the scanner at approximately 1 cm above the diaphragm. The image parameters was: 5 mm slice thickness, 0.2 mm slice interval, limited to the cardiac region.

A calcified area is marked as an area with a hyper attenuating gradient of at least 1 -2 mm and having > 130 Hounsfield units (HU) or has three adjacent pixels. Volunteers are asked to hold their breath for a period of 10 to 20 seconds during the image acquisition. CT scanning usually takes about 10 minutes to be completed. (Figure 1)

Data analysis:

Using SPSS, the data will be analyzed (v23). If relevant, data are reported as percentages or standard deviations with a confidence level of 95%. (CI). p-values less than 0.05 were deemed statistically significant.

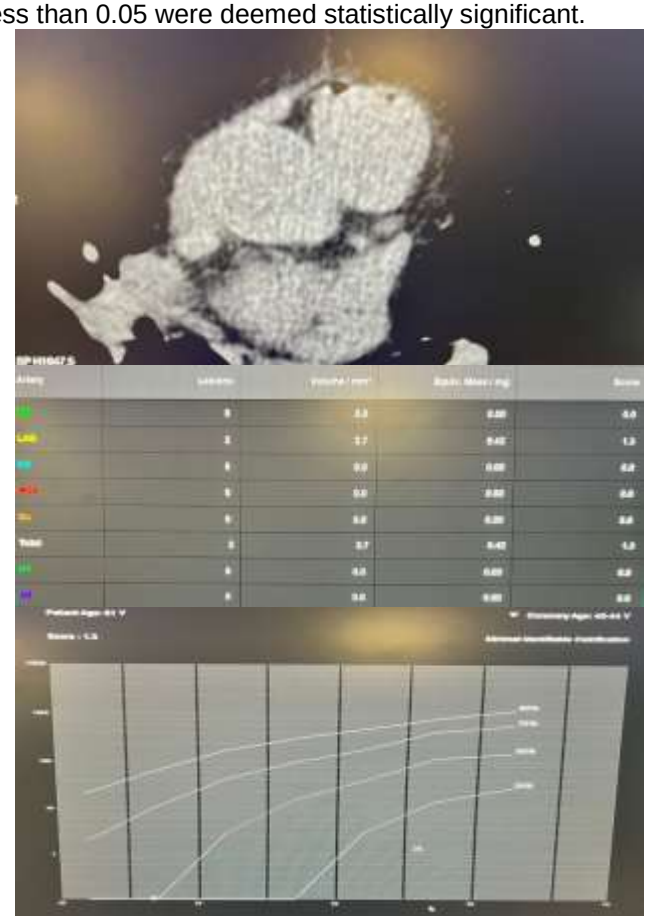

Figure 1: Imaging with zero calcium score

RESULTS

In current study, 50 volunteers, mean age was 51±11 yrs, were subjected to Coronary CTA with 29 of volunteers

had zero CS. Patients were referred to Coronary CTA for atherosclerotic plaque in the coronary arteries, Chest pain, Chest pain Hyperlipidemia and chest pain varicose veins of lower extremities was 12 (24%), 28 (56%), 4 (8%), and 6 (12%), respectively.

A total of 2% of the subjects showed severe calcium deposits, 6% showed moderate deposits, and 26% had intermediate deposits, while 66% had no or minimal calcium deposits.

The incidence of obstructive lesions in the patients (larger than 50% of vessel lumen) in 48% (11/24) of cases, distributed as follows: a) in one segment - 6 patients; b) in two segments - 2 patients; and c) in more than two segments - 3 patient (Figure 1). In the volunteers with non-obstructive lesions (13/24), 10, 2 and 1 patients had one, two and two or more vessels affected, respectively (Table 3).

Table 1: Clinical characteristics of the subjects

	Frequency	Percentage
Mean age	51±11 yrs	-
Body Mass Index	26±3	-
Female	25	50
Chest pain	28	56
Atherosclerotic heart disease	12	24
Chest pain Hyper-lipidemia	4	8
chest pain varicose veins of lower extremities	6	12

Table 2: The total coronary artery calcium deposit (score)

	CAC score	Frequency	Percentage
Normal	0	29	58
Minimal	1-10	4	8
Indeterminate CAD	11-100	13	26
moderate	101-400	3	6
severe native CAD	Over 400	1	2

Table 3: Distribution of atherosclerotic lesions at coronary CTA in patients with zero calcium score

Variable	One Vessel affected	Two Vessels affected	Two or more vessels affected	Total n = 24
Obstructive lesion > 50%	6 (54%)	2 (18%)	3 (27%)	11 (48%)
Non-obstructive lesion	10 (76%)	2 (15%)	1 (7%)	13 (52%)

DISCUSSION

The main finding of this study was the notable correlation of a zero CAC score with atherosclerotic plaque in the coronary arteries. The Coronary Artery Calcification Scoring method provides an inexpensive and reproducible technique for assessing the presence and extent of calcified plaque in the coronary arteries. The technique could be done in any volunteer.

who is capable of holding their breath for few seconds without require contrast injection (Neves et al.2017).

CAC exam guidelines have been previously published. (Mahmood et al.2020; Dorbala et al.2013;Azour L et al.2017) There is no require for intravenous (IV) contrast administration, or need for patients preparation other than holding their breath for five to ten seconds during the Image acquisition. In addition, CAC scanning is not performed by the administration of any medications in most centers except Beta blockers in case of high risk patients with elevated heart rates (Sabarudin A et al.2013). Our result was confirmed with other previous studies which shown a prevalence atherosclerotic plaque in the patients with zero calcium score. They concluded that of 385 patients with a zero calcium score, 4.2% had atherosclerotic plaque with 1.6 of them had a significantly >50% coronary stenosis (Moradi et al.2016).

The calcium content of plaques could be measured by an Agatston score. This score is identified by multiplying the CT density of area of each plaque by the calcium amount within it. It has been confirmed that CAC scoring is capable of predicting cardiovascular events independently (Greenland et al.2018; Zaid et al.2017).According to several large observational studies, CAC meaning fully enhance the accuracy of risk prediction especially when added to standard risk prediction models in compare with other novel biomarkers. (Ge et al.2012; Wang 2011; Manson et al.2015)It is important to note that CAC scoring model has superior ability to categorize the patients into high and low risk grade. (Blankstein et al.2017; Alshammari et al.2022; Qurain et al.2023)The risk of coronary artery disease is significantly low for patients without coronary artery calcifications (ie. CAC = 0)(21). According to our current result, 58% of the subjects had a CAC score of 0, which shows an extremely low risk of cardiovascular events).

Data on the literature have concluded that involving patients with symptomatic and asymptomatic, only symptomatic subjects with zero calcium score had atherosclerotic plaque (8.4%) (Mouden et al.2013; Akram et al.2009).

In addition, the utility of CAC scoring for improving risk prediction for patients at intermediate risk has received significant attention. A total of 40% of the individuals in current data were at moderate risk for coronary artery disease with CAC scores between 101 and 400. However, only 5% were of the subjects at severe risk for coronary artery disease.

CONCLUSION

There is a significant association between zero CAC score

and CVD risks with high higher frequency of atherosclerotic plaque which indicates the absence of calcification does not exclude the presence of plaques in this study. It is recommended that control of cardiovascular system risks would be integrated in the primary care centers. A randomized controlled trial is necessary in order to assess the true impact of CT risk stratification on long-term prognosis.

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Institutional Review Board Statement
The study was approved by the Bioethical Committee of the King Salman Hospital.

Informed Consent Statement
Not applicable.

Data Availability Statement
All of the data is included in the article/Supplementary Material.

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AUTHOR CONTRIBUTIONS
Conceptualization, Q.T.A. and R.A.A.; methodology, A.S.A., A.G.N., and K.A.A.; formal analysis, A.J.A.; M.J.A., and M.M.M.; Data Collection, S.A.A. and M.J.A.; writing-original draft, Q.T.A and F.O.A.; supervision, QTA. All authors read and approved the final version.

Conflict of interest
The authors declare no conflict of interest.

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