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ORIGINAL ARTICLE

Comparison Between Coronary Calcium Score by Computed Tomography and Myocardial Perfusion Imaging as Indicators to Significance of Coronary Artery Disease

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ABSTRACT

Background and objective: Non-invasive assessment of coronary artery disease become an important method especially for patients with low to intermediate pretest probability. This work aimed to investigate the correlation between CAC score and SPECT in a group of patients with suspected CAD and its severity.

Methods: The study was conducted at Kobry Alkobba Military hospital, Cairo, Egypt, during the period from January 2018 to March 2019. The study protocol was approved by Department of Cardiology at Zagazig University and Ethical committee of faculty of medicine. An overall 50 patients out of 500 patients who presented with chest pain with low and intermediate pretest probability (PTP) for CAD to outpatient clinic were consecutively included into our study. All study population will undergo coronary artery calcium scoring by computed tomography and myocardial perfusion imaging by SPECT.

Results: The study showed that there is statistically significant data for the relationship between severity of myocardial perfusion imaging and CACS severity. About 37 patients out of 50 had abnormal Ca score (more than 11) found to have abnormal myocardial perfusion imaging from mild to sever affection.

Conclusion: CAC score carries a strong value in predicting adverse events in patients with suspected CAD and myocardial perfusion imaging with mild-moderate perfusion defects and may be useful in risk stratification of these patients and there is statistically significant data for the relationship between severity of myocardial perfusion imaging and CACS severity.

Key words: Coronary Calcium Score, Computed Tomography, Myocardial Perfusion Imaging, Coronary Artery Disease, vessel disease.

INTRODUCTION

Coronary artery disease (CAD) is the develop ed world's single most common cause of deat h, responsible for about one in six deaths[1]. C ardiovascular disease mortality is commonly predicted at 23.4 million in 2030[2]. Every yea r more than four million Europeans die of CA D[3].The American Heart Association (AHA) 2016 Heart Disease and Stroke Statistics Rep ort recently reported that 15.5 million people > 20 years of age in the U.S. have coronary he art disease (CHD). While the recorded prevale nce increases with age for both men and wom en and it has been estimated that about every 42 seconds an American will suffer from a m yocardial infraction (MI)[4].

Acute coronary syndrome (ACS) involves my ocardial infraction with ST segment elevation or new LBBB (STEMI), nonST elevation my ocardial infarction (NSTEMI) diagnosed with enzyme elevation and unstable angina when is chemic symptoms are new or worsening, and ischemic ECG changes with normal biomarke rs[5].Diagnostic tests for myocardial ischemia diagnosis are most effective for patients with an intermediate risk of CAD pre-testing and are recommended for all patients with an intermediate or high probability of CAD. It involves screening for exercise treadmill, stress echocardiography, magnetic resonance imaging, CCT, coronary angiography[6].

Multislice computed tomography (CT) has in creasingly been used to detect calcium of the coronary artery (CAC) and to diagnose stenos is of the coronary artery[7].The risk, cost and time burden associated with coronary catheter angiography (CCA) indicates that patients with suspected coronary artery disease (CAD) need to establish a non-invasive assessment especially for those with low disease probability[8].Quantifying the amount of CAC with non-enhanced CT scans is widely accepted as a successful non-invasive screening technique for patients with a possible risk of developing major heart problems and is typically quantified using the Agatston score[9,10,11].The clinical application of CAC scoring was supported by evidence showing that the absence of calcium consistently prevents obstructive coronary artery stenosis[12] and that the volume of CAC is a strong predictor of myocardial infraction risk assessment and sudden cardiac death, independent of traditional coronary risk factors[13,14].

Myocardial perfusion imaging (MPI) with gat ed single photon emission computed tomogra phy (SPECT) was commonly used in CAD diagno sis and high diagnostic accuracy risk stratifica tion compared to CT angiography[15,16].The presence of ischemia may be used to classify patients with CAD and candidates for aggressive medical therapy and management. A normal MPI does not necessarily exclude significant coronary stenosis, however, while high CAC scores sometimes do not lead to abnormal MPI perfusion[7]. Therefore, it is not very clear the exact relationship between CAC and MPI.

PATIENTS AND METHODS

An overall 50 patients out of 500 patients who presented with chest pain with low and intermediate pretest probability (PTP) as in table 5 for CAD to outpatient clinic were consecutively included into our study. The study was conducted at Kobry Alkobba Military hospital, Cairo, Egypt, during the period from January 2018 to March 2019. The study protocol was approved by Department of Cardiology at Zagazig University and Ethical committee of faculty of medicine. The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Inclusion criteria:

Patients presenting with chest pain with low and intermediate pretest probability for CAD.

Exclusion Criteria:

Myocardial infraction.
Percutaneous coronary intervention.
Atrial fibrillation.
Decompensated heart failure.
Body weight >120 Kg.
Patients refusing consent for enrollment.
ECG changes and LBBB.
High pretest probability for CAD.

Methods:

The following diagnostic work up was carri ed out by all study population:

Informed consent taken from each patient.
Full medical history
Full clinical examination
Blood sample and chemistry
Electrocardiography (ECG)
Transthoracic Echocardiography
Coronary CT scanning protocol
Coronary artery calcium scoring
MPI-SPECT imaging protocol
MPI-SPECT image analysis

Statistical analysis :

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) **(Statistical Package for the**

Social Sciences) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean ± SD, the following tests were used to test differences for significance. Difference and association of qualitative variable by Chi square test (X^2). Agreement by Kappa . P value was set at <0.05 for significant results & <0.001 for high significant result.

ROC curve

A receiver operating characteristic (ROC), or simply ROC curve, is a graphical plot which illustrates the performance of a binary classifier system as its discrimination threshold is varied. It is created by plotting the fraction of true positives out of the positives (TPR = true positive rate) vs. the fraction of false positives out of the negatives (FPR = false positive rate), at various threshold settings. TPR is also known as sensitivity (also called recall in some fields), and FPR is one minus the specificity or true negative rate.ROC analysis provides tools to select possibly optimal models and to discard suboptimal ones independently from (and prior to specifying) the cost context or the class distribution. ROC analysis is related in a direct and natural way to cost/benefit analysis of diagnostic decision making. The ROC curve was first developed by electrical engineers and radar engineers during World War II for detecting enemy objects in battlefields and was soon introduced to psychology to account for perceptual detection of stimuli. ROC analysis since then has been used in medicine, radiology, biometrics, and other areas for many decades and is increasingly used in machine learning and data mining research.

RESULTS

The distribution of co- morbidity among studied group.DM were 44%, HTN 54%, dyslipidemia 42%, smoking 64%, FH 24% and Obesity 20%.(**Table 1**).

The association and agreement between MPI and CA score, there was statistically significant relation between the severity of myocardial perfusion imaging and CAC severity.(**Table 2).**

The validity of MPI regard CA score as a reference, there was highly significant association and agreement with sensitivity 84.1% and specificity 66.7%.(**Table 3**).

The validity of CA score regard MPI as a reference, there was highly significant association and agreement with sensitivity 94.9% and specificity 36.4%.(**Table 4**).

The relation between severity of CA score and risk factors, these show that DM, HTN and dyslipidemia significantly associated with high score.(**Table 5**)

The relation between myocardial perfusion imaging and risk factors, these show that DM and HTN significantly associated with high severity.(**Table 6**).

Table 1: Co-morbidity distribution among studied group :

		N	%
DM	**No**	**28**	**56.0**
	Yes	**22**	**44.0**
HTN	**No**	**23**	**46.0**
	Yes	**27**	**54.0**
Dyslipidemia	**No**	**29**	**58.0**
	Yes	**21**	**42.0**
Smoking	**No**	**18**	**36.0**
	Yes	**32**	**64.0**
FH	**No**	**38**	**76.0**
	Yes	**12**	**24.0**
Obesity	**No**	**40**	**80.0**
	Yes	**10**	**20.0**
	Total	**50**	**100.0**

Table 2: Association and agreement between MPI and CA score :

			MPI Severity				Total	X^2	P	Kappa agreement
			Normal	Mild	Moderate	Sever				
Severity CA	1-10	N	**4**	**2**	**0**	**0**	**6**	**48.2**	**0.001***	**0.58**
		%	**36.4%**	**11.1%**	**0.0%**	**0.0%**	**12.0%**			
	11-100	N	**5**	**12**	**2**	**0**	**19**			
		%	**45.5%**	**66.7%**	**13.3%**	**0.0%**	**38.0%**			
	101-400	N	**1**	**3**	**10**	**0**	**14**			
		%	**9.1%**	**16.7%**	**66.7%**	**0.0%**	**28.0%**			
	>401	N	**1**	**1**	**3**	**6**	**11**			
		%	**9.1%**	**5.6%**	**20.0%**	**100.0%**	**22.0%**			
Total		N	**11**	**18**	**15**	**6**	**50**			
		%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**			

Table 3: Validity of MPI regard CA score as a reference :

			CA SCORE		Total	X^2	P	Kappa agreement
			Normal	Abnormal				
MPI	Normal	N	**4**	**7**	**11**	**7.92**	**0.005****	**0.41**
		%	**66.7%**	**15.9%**	**22.0%**			
	Abnormal	N	**2**	**37**	**39**			
		%	**33.3%**	**84.1%**	**78.0%**			
Total		N	**6**	**44**	**50**			
		%	**100.0%**	**100.0%**	**100.0%**			

Table 4 : Validity of CA score regard MPI as a reference :

			MPI		Total	X^2	P	Kappa agreement
			Normal	**Abnormal**				
CA_SCORE	**Normal <10**	**N**	**4**	**2**	**6**	**7.92**	**0.005****	**0.41**
		%	**36.4%**	**5.1%**	**12.0%**			
	Abnormal >11	**N**	**7**	**37**	**44**			
		%	**63.6%**	**94.9%**	**88.0%**			
Total		**N**	**11**	**39**	**50**			
		%	**100.0%**	**100.0%**	**100.0%**			

Table 5: Relation between severity of calcium scoring and risk factors:

			Severity CA				Total	X^2	P
			1-10	**11-100**	**101-400**	**>401**			
DM	No	N	**5**	**14**	**7**	**2**	**28**		
		%	**83.3%**	**73.7%**	**50.0%**	**18.2%**	**56.0%**		
	Yes	N	**1**	**5**	**7**	**9**	**22**	**10.82**	**0.013***
		%	**16.7%**	**26.3%**	**50.0%**	**81.8%**	**44.0%**		
HTN	No	N	**3**	**11**	**8**	**1**	**23**		
		%	**50.0%**	**57.9%**	**57.1%**	**9.1%**	**46.0%**		
	Yes	N	**3**	**8**	**6**	**10**	**27**	**7.85**	**0.049***
		%	**50.0%**	**42.1%**	**42.9%**	**90.9%**	**54.0%**		
DYSLIP	No	N	**5**	**14**	**8**	**2**	**29**		
		%	**83.3%**	**73.7%**	**57.1%**	**18.2%**	**58.0%**		
	Yes	N	**1**	**5**	**6**	**9**	**21**	**10.66**	**0.014***
		%	**16.7%**	**26.3%**	**42.9%**	**81.8%**	**42.0%**		
Smoking	No	N	**3**	**7**	**5**	**3**	**18**		
		%	**50.0%**	**36.8%**	**35.7%**	**27.3%**	**36.0%**		
	Yes	N	**3**	**12**	**9**	**8**	**32**	**0.88**	**0.83**
		%	**50.0%**	**63.2%**	**64.3%**	**72.7%**	**64.0%**		
FH	No	N	**6**	**12**	**11**	**9**	**38**		
		%	**100.0%**	**63.2%**	**78.6%**	**81.8%**	**76.0%**		
	Yes	N	**0**	**7**	**3**	**2**	**12**	**3.86**	**0.27**
		%	**0.0%**	**36.8%**	**21.4%**	**18.2%**	**24.0%**		
Obesity	No	N	**6**	**14**	**12**	**8**	**40**		
		%	**100.0%**	**73.7%**	**85.7%**	**72.7%**	**80.0%**		
	Yes	N	**0**	**5**	**2**	**3**	**10**	**2.62**	**0.45**
		%	**0.0%**	**26.3%**	**14.3%**	**27.3%**	**20.0%**		
Total		N	**6**	**19**	**14**	**11**	**50**		
		%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**		

Table 6: Relation between myocardial perfusion imaging and risk factors:

			MPI severity				Total	X^2	P
			Normal	Mild	Moderate	Sever			
DM	No	N	**9**	**12**	**6**	**1**	**28**		
		%	**81.8%**	**66.7%**	**40.0%**	**16.7%**	**56.0%**		
	Yes	N	**2**	**6**	**9**	**5**	**22**	**9.13**	**0.028***
		%	**18.2%**	**33.3%**	**60.0%**	**83.3%**	**44.0%**		
HTN	No	N	**4**	**12**	**7**	**0**	**23**		
		%	**36.4%**	**66.7%**	**46.7%**	**0.0%**	**46.0%**		
	Yes	N	**7**	**6**	**8**	**6**	**27**	**8.62**	**0.035***
		%	**63.6%**	**33.3%**	**53.3%**	**100.0%**	**54.0%**		
DYSLIP	No	N	**7**	**13**	**8**	**1**	**29**		
		%	**63.6%**	**72.2%**	**53.3%**	**16.7%**	**58.0%**		
	Yes	N	**4**	**5**	**7**	**5**	**21**	**5.93**	**0.131**
		%	**36.4%**	**27.8%**	**46.7%**	**83.3%**	**42.0%**		
Smoking	No	N	**5**	**7**	**6**	**0**	**18**		
		%	**45.5%**	**38.9%**	**40.0%**	**0.0%**	**36.0%**		
	Yes	N	**6**	**11**	**9**	**6**	**32**	**3.9**	**0.26**
		%	**54.5%**	**61.1%**	**60.0%**	**100.0%**	**64.0%**		

			MPI severity				Total	X^2	P
FH	No	N	**11**	**11**	**11**	**5**	**38**		
		%	**100.0%**	**61.1%**	**73.3%**	**83.3%**	**76.0%**		
	Yes	N	**0**	**7**	**4**	**1**	**12**	**5.84**	**0.11**
		%	**0.0%**	**38.9%**	**26.7%**	**16.7%**	**24.0%**		
Obesity	No	N	**10**	**14**	**12**	**4**	**40**		
		%	**90.9%**	**77.8%**	**80.0%**	**66.7%**	**80.0%**		
	Yes	N	**1**	**4**	**3**	**2**	**10**	**1.54**	**0.67**
		%	**9.1%**	**22.2%**	**20.0%**	**33.3%**	**20.0%**		
Total		N	**11**	**18**	**15**	**6**	**50**		
		%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**		

DISCUSSION

Around 14 percent of all deaths worldwide are caused by ischemic heart disease. Nevertheless, CAD is not diagnosed in about one third of these patients until a heart attack occurs.

Luckily, there are many advantages of treating proven CAD. The morbidity and mortality levels in CAD were significantly reduced by both coronary artery revascularization and clinical therapies. Early diagnosis of the condition is important because CAD is severe and lethal , but treatable when diagnosed early[1].Although based on a relatively small sample size, this study presents important findings which are considered valuable for the clinical diagnosis of patients with suspected CAD. There is a relationship between the CAC scores and MPI-SPECT assessments, with a significant relationship observed between these scoring techniques. Thus, CAC scores can be reliably used as single parameters to predict the prognosis of CAD.

Similarly, our study showed that patients with a high calcium score had abnormal, or probably abnormal MPI-SPECT results, and the correlation between these imaging modalities was significant. However, studies have been reported that patients with a high CAC score did not demonstrate a significantly different percentage of abnormal MPI findings than in patients with a low CAC score[3,4]. A high CAC in patients with normal MPI-SPECT reflects non-obstructive atherosclerosis, which is regarded as a preclinical state with strong predictive value for the development of CAD. Thus, aggressive risk factor modification should be recommended according to the guidelines[7]. A CAC score and MPI should be considered complementary approaches rather than individual parameters in the assessment of patients with suspected CAD.Our results were in agreement with the study published by [9] who stated that CACS allows further risk stratification, indicating very low risk when CACS less than 1 is associated with normal SPECT MPI findings. Conversely, in patients with abnormal SPECT MPI findings, a CACS of 1 or more confers an added value for predicting adverse outcomes, this study included 326 patients aged 55 years or older.

On the contrary the opposite opinion was confirmed in the study done by **Almoudi and Sun,** [17] who proved that there is a lack of correlation between the CAC scores and the MPI-SPECT findings in the assessment of the extent of coronary artery disease. CAC scores and MPI- SPECT should be considered complementary approaches in the evaluation of patients with suspected coronary artery disease[17].The same point of view was discussed in the study done published by **Siqueira, et al.** [18] who stated that the possibility of excluding extensive coronary disease by means of a calcium score zero, or indicating the presence of an extensive disease when it is severely increased, justifies the use of this method in the initial or joint evaluation, in patients with suspected CAD and in cardiovascular risk stratification. Confirmation of the disease with the application of more specific methods and positive predictive value as myocardial perfusion scintigraphy is still fundamental in certain patients.

Our study showed that there is statistically significant relation for the relationship between severity of myocardial perfusion imaging and CACS severity which was not in agreement with the study done by **Ghadri, et al.** [19] that showed that In patients with normal SPECT MPI, a CAC >1000 confers a high diagnostic added value for detecting CAD. This is not solely based on unmasking balanced ischemia due to epicardial3-VD, as it occurred predominantly in patients with 1-VD and 2-VD.

CONCLUSION

CAC score carries a strong value in predicting adverse events in patients with suspected CAD and myocardial perfusion imaging with mild-moderate perfusion defects and may be useful in risk stratification of these patients and there is statistically significant data for the relationship between severity of myocardial perfusion imaging and CACS severity.

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