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DIAGNOSTIC ACCURACY OF COMPUTED TOMOGRAPHIC ANGIOGRAPHY FOR THE DETECTION OF STENOTIC LESIONS OF THE DISTAL SEGMENTS OF MAIN CORONARY ARTERIES

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ABSTRACT

Objective: It was to find out the diagnostic accuracy of CT angiography for the detection of stenotic atherosclerotic lesions in the distal segments of 4 main coronary arteries using invasive angiography as gold standard.

Methodology: This observational study was carried out at Department of Cardiology, Hayatabad Medical Complex, Peshawar. It included 50 patients from June to September 2011. CT and invasive angiography was performed for each patient and data was analyzed in SPSS software version 10.0 to analyze the findings of distal segments of the 4 main arteries.

Results: The sensitivity for detection of stenotic atherosclerotic lesions in left main stem, left anterior descending, circumflex and right coronary arteries was 87.5%, 100%, 66.67% and 50% respectively. Specificity for detection of stenotic atherosclerotic lesions in left main stem, left anterior descending, circumflex and right coronary artery was 100% for all. Positive predictive value for detection of stenotic atherosclerotic lesions in left main stem, left anterior descending, circumflex and right coronary arteries was also 100% for all and negative predictive value was 97.6%, 100%, 97.91% and 95.83% for the left main stem, left anterior descending, circumflex and right coronary arteries respectively.

Conclusion: Invasive angiography is more sensitive than CT angiography but has equal specificity to invasive angiography for the detection of stenotic lesions in the distal segments of 4 main coronary arteries.

Key Words: CT angiography; Invasive angiography, Distal segment of coronary arteries.

INTRODUCTION

Coronary artery disease is the leading cause of death worldwide.[1] Located in South Asia, Pakistan has a population of 140 millions, survey in Pakistan indicate very high prevalence rates of cardiovascular disease risk factors, with over 30% of population over 45 years of age affected.[2]

Indirect evaluation of coronary stenosis, such as through stress testing, has limited diagnostic ability as compared with Computed Tomographic (CT) angiography and direct conventional coronary angiography.[3] Conventional coronary angiography reveals the extent, location and severity Of coronary obstructive lesion, which are potent predictors of outcome[4]and identifies high risk patients who may benefit from revascularization.[5,6]

Because of the invasive nature of the procedure only few patients undergo direct coronary artery lumen assessment. Moreover although catheter angiography is the gold standard for coronary lumen assessment, this procedure offers little information on coronary artery wall associated with early or even chronic stages of coronary atherosclerosis.[7]

Recently, Multi Slice Computed Tomography (MSCT) has emerged as a non invasive technique that allows to reliable detect coronary stenosis and is going acceptance as a tool to rule out coronary artery stenosis in patients with low to intermediate pretest likelihood and class IIa recommendation for this specific indication was proposed in a recent scientific statement of the American Heart Association.[8]

In comparison to invasive angiography, which is restricted to vessel lumen assessment, MSCT can also depict the coronary artery wall, thereby providing additional information regarding the presence of coronary atherosclerosis.[9]

CT angiography used as filter to select symptomatic patients for invasive angiography may reduce the number of diagnostic angiography by more than one third without increasing risk to the patients. With accurate definition of coronary artery calcification, MSCT allows the non invasive assessment of sub clinical Atherosclerosis.[10]

Several studies have compared the accuracy of invasive angiography to MSCT for the detection of coronary artery lumen narrowing but the reliable and unbiased estimate of diagnostic accuracy of MSCT with invasive angiography is still lacking and needed to be elucidated.[11,12] Moreover the diagnostic accuracy of MSCT and conventional angiography is different in different segments of coronary arteries.[13]

In this regard this study was designed to assess the diagnostic accuracy of CT angiography considering invasive angiography as gold standard in distal segments of coronary arteries.

METHODOLOGY

This descriptive prospective study was conducted in Department of Cardiology comprising of 50 patients from June to September, 2011 who underwent both CT and invasive angiography for the detection of stenotic lesions in the distal segments of 4 main coronary arteries i.e. left main stem artery, left anterior descending artery, circumflex artery and right coronary artery. Patients who had CT angiography by 64 slice CT scanner and undergoing for invasive angiography were included while patients who had CT angiography and not willing/needing for invasive angiography were excluded from study.

Patients fulfilling the inclusion criteria were admitted in cardiology ward. Then they were shifted to catheterization lab for invasive angiography and distal segment analysis of stenotic lesions of all four vessels. All these information was gathered through a proforma indicating name, age, sex, CT, angiography and invasive angiography findings.

Diagnostic accuracy of CT angiography was measured in term of sensitivity, specificity, positive and negative predictive values. The four possible outcomes include True Positive (TP), False Positive (FP), False Negative (FN), and True Negative (TN). True positive and true negative patients were those who were and were not having lesions on both invasive and CT angiography respectively. False positive patients were those who were having lesions on CT angiography but not on invasive angiography and false negative patients were those who were not having lesions on CT angiography but having lesions on invasive angiography.

Sensitivity was proportion of people who have the disease who test was positive [TP / (TP + FN)] while specificity was the proportion of people who do not have the disease [TN / (FP + TN)] who test was negative. Positive Predictive Value (PPV) was the proportion of people who test was positive and who have the disease [TP / (TP + FP)] while Negative Predictive Value (NPV) was the proportion of people who test was negative and who do not have the disease [TN / (FN + TN)]. Accuracy was the proportion of true results (both true positives and true negatives) in the = [(Number of TP + Number of TN) / (Number of TP + FP + FN)].

Data was analyzed with the help of SPSS software version 10.0. P value was generated using T-test for comparison of CT and invasive angiography findings. P value of <0.05 was considered significant.

RESULTS

The total number of patients was 50 with mean age±SD of 50 ± 9.43.Maximum number of patients 42 (84%) and 7 (14%) with stenotic lesions on invasive and CT angiography were in the distal part of left main stem artery respectively

Table 1: Findings on CT and Invasive Angiography

Coronary artery	CT Angiography		Invasive Angiography	
	Normal	Diseased	Normal	Diseased
Left main stem artery	43 (86%)	7 (14%)	8 (16%)	42 (84%)
Left anterior descending artery	47 (94%)	3 (6%)	47 (94%)	3 (6%)
Circumflex artery	48 (96%)	2 (4%)	47 (94%)	3 (6%)
Right coronary artery	48 (96%)	2 (4%)	46 (92%)	4 (8%)

Table 2: Diagnostic Accuracy of CT Angiography in Distal Segments of Coronary Arteries

	Left main Stem artery	Left anterior descending artery	Circumflex artery	Right coronary artery
True positive	7 (14%)	3 (6%)	2 (4%)	2 (4%)
True Negative	42 (84%)	47 (94%)	47 (94%)	46 (92%)
False Positive	0 (%)	0	0	0
False Negative	1 (2%)	0	1 (2%)	2 (4%)
Sensitivity	87.5%	100%	66.67%	50%
Specificity	100%	100%	100%	100%
Positive predictive value	100%	100%	100%	100%
Negative predictive value	97.67%	100%	97.91%	95.83%

and minimum were in the circumflex artery i.e. 2 (4%) and 3 (6%) on CT and invasive angiography respectively. Full detail is shown in Table1.

On CT angiography, the maximum number of true positive were in the left main stem artery; 7 (14%), true negative were in the Left anterior descending and circumflex artery; 47 (94%). The sensitivity of CT angiography for the Left main stem was 87.5%, Specificity 100%, PPV 100% and NPV 97.6%. The sensitivity, specificity PPV and NPV for the LAD in distal segment were 100% for each while specificity and positive predictive value of CT angiography was 100% for all 4 main coronary arteries (Table 2).

DISCUSSION

More than 1 million inpatient diagnostic cardiac catheterizations are performed annually in the United States.[14] Approximately 40% are estimated to be solely for diagnostic purposes.[15]

Because of the higher cost and invasive nature of coronary angiogram, patients with suspected coronary artery disease with low risk characteristics were investigated by non invasive methods before invasive angiography. But presently available non invasive tests are neither sensitive nor specific enough to replace the invasive angiogram.

Multislice CT (MSCT) coronary angiogram has emerged as a reliable substitute for invasive angiogram in selected group of low risk patients. The available studies on 64 slice CT angiogram have shown sensitivity close to 99% and specificity up to 98%.[16,17]

In our study in a group of 50 patients, we found that MSCT angiogram is fairly accurate in detecting the stenosis. In previous studies on 4 slice CT angiography 32% of the segments could not be analyzed due to poor image quality. With the 64 slice CT scanner, better temporal resolution helps to decrease the breath holding time, hence avoiding motion artifact and better spatial resolution helps visualizing smaller branches and distal vessels.

Dr James Min in presenting the ACCURACY trial at the radiological society of North America 2007 meeting stated that 232 patients with typical or atypical chest pain underwent invasive coronary angiography and 64 slice CT. For stenosis of 50% or more per patient, the sensitivity, specificity, PPV and NPV were 93%, 82%, 62%, and 97% respectively. While for stenosis of 70% or more per patient those were, 91%,84%,49%, and 98%, which match our data to a greater extent except for the very low PPV i.e. 62% and 42%, which he explained that the low PPV in this study was because of the low prevalence of CAD in their study group, despite the fact that the researchers were taken by surprise as roughly 70% patients had a family history of CAD, hypertension and hyperlipidemia, 55% were smokers and 25% were diabetic, so they expected a high prevalence of CAD but it was not the case.[18]

Leschka et al, investigated the accuracy of 64 slice CT for assessing hemodynamically significant stenosis of coronary arteries. They found that there is 98% sensitivity and specificity for the distal LAD segment while PPV was 88% and NPV 97% for the same territory. Similarly for distal circumflex the sensitivity and specificity was 96%, PPV 87% and NPV 100%. They concluded that 64-slice CT allows a non-invasive assessment of hemodynamically significant CAD with a high diagnostic accuracy. Extensive arterial wall calcifications still impair vessel assessment, but no segment had to be excluded from analysis.[19]

Despite substantial improvement in spatial resolution, 64 slice CT appears somewhat limited for accurate assessment of entire coronary artery tree including small peripheral segments.[20]

In our study, it is also evident from the results that the sensitivity and NPV, for the distal segments of circumflex, and especially the distal segments of RCA, was very low which could be explained on the basis of increased motion artifacts and heavy calcification impairing image quality.

Our study was single center, having small number of patients. All patients had noninvasive tests like exercise ECG, echocardiography, cardiac enzymes and troponin etc before CT angiography so the pretest probability of disease was very high, thus increasing the sensitivity. Since our study was not powered to assess the effect of calcium score/obesity on the interpretation of the results, the positive predictive value might have been lower. Other limitations include radiation exposure, the use of contrast and the use of beta blockers to reduce the heart rate.

CONCLUSION

CT angiography has equal specificity and positive predictive value as compared to invasive angiography but lower sensitivity for detecting stenotic lesions in the distal coronary arteries. The negative predictive value of CT angiography is nearly equal to invasive angiography for ruling out distal stenotic lesions.

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