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COMPARISON OF HIGH RESOLUTION COMPUTED TOMOGRAPHY CORONARY ANGIOGRAPHY WITH CONVENTIONAL CORONARY ANGIOGRAPHY

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Contribution
All the authors contributed significantly to the research that resulted in the submitted manuscript.

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ABSTRACT

Objective: To compare high resolution computed tomography coronary angiography with conventional coronary angiography.

Methodology: This comparative study was carried outon 55 patients fulfilling the inclusion criteria.They had already done CT angiography, then they underwent invasive coronaryangiography at catheterization lab of Cardiology department, Lady Reading Hospital Peshawar for segmental analysis of all four vessels i.e. left main stem(LMS), left anterior descending artery (LAD), left circumflex(LCX) and right coronary artery (RCA).

Results: Mean age was 53 ±10.168 (46-80), most 39(72%) were males while 16(28%) were females. In this study,sensitivity for the left main stem was 60%, specificity 100%, PPV 100% and NPV 91%. For Proximal LAD, sensitivity was 100%, specificity 78 %, PPV 90 % and NPV was100%. For Mid LAD sensitivity was 100%, specificity 93%, PPV75% and NPV 100%. For distal LAD, sensitivity was 100%, specificity 92%, PPV55% and NPV 100%. In Proximal LCX, sensitivity was 100% , specificity 87% , PPV 85% and NPV was 100%. For the Mid LCX the sensitivity was 100%, specificity 95%, PPV 75% and NPV was 100%. For distal LCX, the sensitivity was 100%, specificity 94%, PPV 62% and NPV 100 % . In Proximal RCA, sensitivity was 100%,specificity 71%, PPV 66% and NPV 100%. For Mid RCA sensitivity was 100%, specificity 92 %, PPV 94 % and NPV 100 %.For distal RCA, sensitivity was 75%, specificity 100%, PPV 100% and NPV 96%.

Conclusion: MDCTA angiography has potential diagnostic accuracy in the detection of CAD as compared to conventional angiography.

Key Words: Significant stenosis, Computerized Tomography (CT) angiography, Conventional invasive angiography

INTRODUCTION

Coronary artery disease represents the major cause of morbidity and mortality in Western populations.[1]The prime diagnostic tool that allowed the development of rational treatment techniques for this disease is invasive conventional coronary angiography (CCA), which is associated with a small rate of life-threatening complications.[2]More than 40% of the invasive coronary angiography studies are not followed up by subsequent interventional or surgical therapy but are conducted only for the purpose of ruling out coronary artery disease.[3] This initiated research on noninvasive imaging of the coronary arteries relying on various methods including MRI[4], electron beam CT[5], and multi slice detector computerized tomography angiography (MDCTA).[6] In the past couple of years, considerable progress has been achieved in the field of noninvasive coronary angiography. Recent advances in CT technology with the development of MDCTA allow a more robust and reliable application of the technique in coronary artery disease.[7] Initial results indicate high sensitivity ratings, although specificity is still compromised by overestimation of stenotic lesions. The technique is non-invasive, images can be obtained quickly, therefore complications are less here and the preliminary studies show that it may be cost effective but this has to be determined.[8,9]The diagnostic accuracy of MDCTA has improved after introduction of newer generations of scanners with high temporal and spatial resolution. Many studies have addressed the accuracy of evolving generations of MDCTA in a variety of patient groups using CCA as standard reference.[10]

The high radiation dose is probably the most undesirable disadvantage concerning the safety of 64-SCTA. The estimated mean effective radiation dose per patient in some studies was about 15 and 20 mSv and with modulated protocols 7 and 14 mSV for males and females, respectively.[11] This dose is markedly higher compared with the dose associated with an uncomplicated CCA which is about 5-7 mSv,[12,13] but is almost similar to the patient dose administered when using nuclear cardiac stress scanning (with technetium it is about 6-8 mSv and up to 27 mSV with thalium).[11-14]Modulated radiation protocols with dose-saving algorithms are therefore important in daily practice to reduce the risk of radiation and at the same time maintain relevant image quality.[15] Nevertheless, it should be noticed that the estimated overall risk associated with 64-SCTA is still considered lower than CCA.[13,16]The aim of this study was to compare findings of coronary artery disease of noninvasive CTstudies with conventional invasive images.

METHODOLOGY

This comparative study on 50 patients fulfilling the inclusion criteria, who had already done CT angiography was carried out at the cardiology department of Lady Reading Hospital,Peshawar.The patients then underwent invasive coronary angiography at catheterization lab of cardiology department, Lady Reading Hospital Peshawar, and segmental analysis of all four vessels i.e. right coronary, left coronary circumflex and left anterior descending artery was done.Patient with history of allergy to contrast agent, renalinsufficiency, previous CABG,previous stents were excluded from the study. Each CT and invasive angiography was divided into Left mian stem(LMS), Left anterior descending artery(LAD),Left Circumflex (LCX) and Right coronary artery(RCA).Each artery was further divided into proximal,mid and distal segments.We selected stenosis of 70% or greater in diameter forcomparison.In this study, we evaluated all arteries being >1.5 mm in diameter, and no segment had to be excluded from analysis.

Protocol of CT angiography: The 64-SCTA technique scanning required patients to be in sinus rhythm without tachycardia, to be able to hold theirbreath for 10-15 s during scanning, be without contrast allergy, and have normal renal function. Patients not fulfilling these criteria were precluded. Scanning protocols were almost the same in the included studies that used a 64-slice scanner. The mean volume of the injected intravenous contrast agents was 85 mL with a range of 65-100 mL. The contrast agents used was Ultravista 370 (Iopromide370 mg I/mL). Assessment of stenosis diameter was done by visual estimation.

Conventional Coronary Angiography: The conventional coronary angiography was performed by experienced cardiologists according to the standard procedure of using the transfemoral or transradial Judkins technique at our hospital. To visualize the right coronary artery, at least two projections were obtained; for the left coronary artery, at least six projections were obtained. The severity of stenosis was evaluated, by a single observer who was blinded to the CT results. Segmental disease was analyzed in each vessel , that was employed for the CT analysis. The severity of stenosis was classified on the projection according to the maximal luminal diameter stenosis. We selected stenosis of 70% or greater in diameter for comparison.

Data analysis: The main analyses were performed using the traditional methods for combining data for diagnostic accuracy tests. The analyses that were performed to compare accuracy of 64-SCTA vs. CCA as reference incorporated all accuracy tests: sensitivity, specificity, negative predictive value, positive predictive value. Accordingly, the absolute numbers of true positive, false positive, true negative, and false negative findings were analyzed to provide sensitivity and specificity. P-values$\leq$ 0.05were considered significant.

RESULTS

In our study,Age distribution was 46-80 years, 08(14.54%) patients in age group 35-40 years,18(32.27%) patients in age group 41-50 years, 13(23.63%) patients in age group 51-60 years,10(18.18%)patients were in age group 61-70 years and 6(10.90 %) patients in age group 71-80 years. Mean age was 53±10.168. Gender distribution was analyzed as most 39(72%) were male while 16(28%) were female. Patients risk factors are shown in Table 1.

In this study, we evaluated all arteries being >1.5 mm in diameter, and no segment had to be excluded from analysis. We selected arterial narrowing more than 70% for

Table 1: Demographic variables

Total number of patients	55
Males	39
Females	16
Mean Age	53±10.17
No Risk Factors	5
Hypetension	13
Diabetics	9
Smokers	6
Hyperlipedimics	5
Family hx for premature CAD	5
Hypertension +Diabetics	5
Hypertension +Diabetics+Hyperlipedimics	4
Hypertension+Diabetics+Hyperlipedimics+Smokers	3

Table 2: Left main stem artery (n=55)

	CT Finding	Invasive Angiography Findings
Disease present	9	10
Disease absent	46	45
Total	55	55
True Positive (a)	9	
True Negative (d)	45	
False Positive (b)	0	
False Negative (c)	1	
Sensitivity(a/a+c)	90%	
Specificity(d/b+d)	100%	
Postive Predictive Value=a/a+b	100%	
Negative Predictive Value = d/c+d	97.67%	

Table 3: Left anterior descending artery

Left anterior descending						
	Proximal		Mid		Distal	
modality /Disease	CT angiography	Invasive angiography	CT angiography	Invasive angiography	CT angiography	Invasive angiography
Present	40	36	12	9	9	5
Absent	15	19	44	46	46	50
Total	55	55	55	55	55	55

	Proximal LAD	Mid LAD	Distal LAD
True Positive (a)	36	9	5
True Negative (d)	15	44	46
False Positive (b)	4	3	4
False Negative (c)	0	0	0
Sensitivity(a/a+c)	100%	100%	100%
Specificity(d/b+d)	78%	93%	92%
PPV(a/a+b)	90 %	75%	55%
NPP (d/c+d)	100%	100%	100%

Table 4: Left circumflex artery (n=55)

Circumflex artery						
	Proximal		Mid		Distal	
modality /Disease	CT angiography	Invasive angiography	CT angiography	Invasive angiography	CT angiography	Invasive angiography
Present	28	24	8	6	8	5
Absent	27	31	47	49	47	50
Total	55	55	55	55	55	55

Variables	Proximal CX	Mid CX	Distal CX
True Positive (a)	24	6	5
True Negative (d)	27	47	47
False Positive (b)	4	2	3
False Negative (c)	0	0	0
Sensitivity(a/a+c)	100%	100%	100%
Specificity(d/b+d)	87%	95%	94%
PPV(a/a+b)	85%	75%	62%
NPP (d/c+d)	100%	100%	100%

Table 5: Right coronary artery (n=55)

Circumflex artery						
	Proximal		Mid		Distal	
modality /Disease	CT angiography	Invasive angiography	CT angiography	Invasive angiography	CT angiography	Invasive angiography
Present	30	20	20	17	8	6
Absent	25	35	35	38	47	49
Total	55	55	55	55	55	55

Variables	Proximal RCA	Mid RCA	Distal RCA
True Positive (a)	20	17	6
True Negative (d)	25	35	47
False Positive (b)	10	3	0
False Negative (c)	0	0	2
Sensitivity(a/a+c)	100%	100%	75%
Specificity(d/b+d)	71%	92%	100%
PPV(a/a+b)	66%	94%	100%
NPP (d/c+d)	100%	100%	96%

comparison. Diagnostic accuracy of CT Angiography in left main stem artery was analyzed. (Table 2). Diagnostic accuracy of CT Angiography, in left Anterior Descending Artery in proximal, mid and distal segments was analyzed. (Table 3). Diagnostic accuracy of CT Angiography in left circumflex artery(LCX) in proximal and distal segments was analyzed (Table 4).Diagnostic accuracy of CT Angiography in right coronary artery(RCA) in proximal,mid and distal segmentswas analyzed (Table 5).

DISCUSSION

To become a clinically accepted tool for the examination of patients with suspected CAD, the main requisite for CT coronary angiography includes complete visualization of all therapeutic relevant coronary arteries without excluding segments.[17] With four-slice CT, a sensitivity of 58–86% for the detection of coronary stenosis has been reported,[6-18] but up to 32% of the vessels had to be excluded from analysis because of a decreased image quality.[18]Using 16-slice CT, overall sensitivity including all segments was reported to be between 73 and 95%, depending on the diameter of the segment, the modality of analysis, and the patient selection criteria.[19,20,21] However, in some studies evaluation was limited to branches having a diameter >2 mm.[17,21] In this study, we evaluated all arteries being >1.5 mm in diameter, and no segment had to be excluded from analysis, thereby finding a high sensitivity and specificity similar to gold standard invasive angiography, for the detection of significant coronary stenoses. Because of different patient populations and imaging protocols compared with the earlier mentioned studies, a direct comparison of study results is not permitted. Nevertheless, the data reported herein using a 64-slice CT scanner suggest a certain improvement regarding diagnostic accuracy. The high negative predictive value of CT angiography, furthermore suggests an important future role of CT coronary angiography for reliably excluding CAD in patients with an equivocal clinical presentation, who may currently undergo a cost-extensive ICA.[22]

As compared with cardiac 16-slice CT, improved spatial and temporal resolution of the new scanner generation increases image quality and facilitates the assessment of CAD. We also know from literature, that with 64 MDCTA, the scanning time is shortened to <12 s, allowing a decreased breath-hold time, a better exploitation of contrast-media with less enhancement of adjacent structures, and a lower dose of applied contrast media. While comparing high resolution 64 slice to 16 slice CT angiography, we get following information from literature.(Table 6)

Author	Year	Patients	Sensitivity (%)	Specificity(%)	PPV (%)	NPV (%)	
16 slice studies							
Neimen [6]	2002	58	95	86	90	97	16-SLICE
Schuijf[10]	2005	45	85	89	71	95	16-SLICE
Martuscelli[17]	2004	93	97	100	-	-	16-SLICE
Kopp [18]	2002	102	93	97	81	99	16-SLICE
Mollet[24]	2004	128	92	95	79	98	16-SLICE
64slice studies							
LEBER[25]	2005	55	73	97		99	64 SLICE
LESCHKA[26]	2005	67	94	97	87	98	64 SLICE
RAFF[27]	2005	70	86	95	66	99	64 SLICE
PUGLIESE[28]	2006	35	99	96	78	99	64 SLICE
Mean*** for 64 slice		227	87	96	77	99	

*** Adjusted for number of patients studied.

In our study, the sensitivity and specificity for different segments were comparable to that reported in ACCURACY[23] study. In ACCURACY trial[23] for stenosis of 70% or more patient, sensitivity, specificity, PPV, NPV were,91% ,84%, 49% ,and 98% respectively, which match our data to a greater extent except for the very low PPV i.e 62% and 42%,which the author, explained that the low PPV in this study was because of the low prevalence of CAD in their study group.

Overall when we compare our results to the following studies done on 64slice CT angiography, we get comparable results (Table-6).

Our study was not powered to include the Calcium score, obesity and heart rate which would be other wise considered as confounding variables. Keeping in view the above results, which go hand in hand with many studies quoted above and many found in the literature, we can conclude that CT angiography can be considered as good alternative in the evaluation of patients suspected of having CAD, especially those with low likelihood of disease, who may otherwise be subjected to catheter angiography.

CONCLUSION

MDCTA angiography has potential diagnostic accuracy in the detection of CAD.

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