CAN COMPUTERIZED TOMOGRAPHIC ANGIOGRAPHY BE USED TO TRIAGE PATIENTS WITH CHEST PAIN PRESENTING TO THE EMERGENCY DEPARTMENT?

Zahoor Ahmad Khan[1], Shahsawar[2], Zahid Aslam Awan[3]

ABSTRACT

Objective: *To confirm the findings of Computerized Tomography Angiography by invasive angiography.*

Methodology: *This comparative study on 50 patients fulfilling the inclusion criteria were admitted in cardiology ward. Then they were shifted to catheterization lab of Lady Reading Hospital Peshawar for invasive angiography and segmental analysis of all four vessels i.e. right coronary, left coronary circumflex and left anterior descending artery was done.*

Results: *A total of 50 patients were studied both with CT angio and invasive angio and 750 segments were analyzed for the 4 main arteries that is LMS, LAD, RCA and Circumflex. The sensitivity of CT angiography for the LMS was 87.5%, Specificity 100%, PPV 100% and NPV 97.6%, PPV was 100% and NPV was also 100%. Similarly the diagnostic accuracy of CT angiography for the circumflex was sensitivity 100%,PPV 100% and NPV 97.91 to 100%. For RCA the sensitivity was from 60 to 100%, specificity 100%, PPV 100% and NPV 95 to 100%.*

Conclusion: *Coronary CT angio with the highest resolution scanners could be a suitable means for rapid triage of patients presenting to emergency departments with chest pain and for evaluation of patients with equivocal stress test results who might otherwise need invasive angiography.*

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

INTRODUCTION

In asymptomatic patients, diagnosis of the presence and severity of coronary artery disease is very important for determining appropriate clinical management.[4,5] Indirect evalution of coronary stenosis, such as through stress testing, has limited diagnostic ability as compared with direct conventional coronary angiography[6,7]. Conventional coronary angiography reveals the extent, location and severity Of coronary obstructive lesion, which are potent predictors of outcome[8,9] and identifies high risk patients who may benefit from revascularization[10-12].

Thus, Invasive coronary angiography remains the gold standard for the diagnosis of obstructive coronary artery disease, however the procedure is associated with non-negligible morbidity[10]. Because of the invasive nature of the procedure only few patients undergo direct coronary artery lumen assessment[10]. Recently, 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 II a recommendation for this specific indication was proposed in a recent scientific statement of the American Heart Association[13,14].

In comparison to invasive angiography, which is restricted to vessle lumen assessment, MSCT can also depict the coronary artery wall, thereby providing additional information regarding the presence of coronary Atherosclerosis[15].

In this regard this study was designed to asses the diagnostic accuracy of CT angiography considering invasive angiography as gold standard.

[1-3]Department of Cardiology, Hayatabad Medical Complex, Peshawar - Pakistan

Address for Correspondence:
Dr. Zahoor Ahmad Khan,
Registrar,
Department of Cardiology,
Hayatabad Medical Complex, Peshawar - Pakistan
E-mail: drzahoorcd_79@yahoo.com

METHODOLOGY

This comparative study was conducted on 50 patients fulfilling the inclusion criteria and were admitted in cardiology ward. Then they were shifted to catheterization lab Lady Reading Hospital Peshawar for invasive angiography and segmental analysis of all four vessels i.e. right coronary, left coronary circumflex and left anterior descending artery was done. All these information was gathered through a proforma indicating name, age, sex, CT, angiography and invasive angiography findings.

Patients with CT- Angiography done on their own and not willing for further interventions via invasive angiography were excluded from the study because these were the confounders and lead to make the study results biased.

RESULTS

In our study which was a single center, included 50 patients who underwent both CT angio and conventional coronary angio. We used 15 segments American Heart Association modal for evaluating both angiography and CT examination. So a total of 750 segments were studied for the four main coronary arteries i.e. the left main stem, LAD, Circumflex and right coronary artery.

Age distribution was analyzed as most of the patients 19(38%) were in the age group 51-60 years, followed by 10(20%) patients in age group 46-50 years, 9(18%) patients in age group 35-40 years, 7(14%) patients in age group 61-70 years, 4(8%) patients in age group 41-45 years and 1(2%) patient in age group 71-80 years. Mean age was 53 years while standard deviation was computed as S.D± 10.168.

Gender distribution was analyzed as most of the patients 36(72%) were male while 14(28%) patients were female.

Diagnostic accuracy of CT Angio in left main stem artery was analyzed as in CT finding group only 7(14%) patients had disease while in Invasive Angio Finding group 8(16%) patients had disease. The overall sensitivity for the left main stem was 87.5%, specificity was 100%, PPV was 100% and NPV was 97.67%. P value was 0.894 (Table 1).

Diagnostic accuracy of CT Angio in left Anterior Descending Artery was analyzed as in Proximal LAD 34(68%) patients had disease in CT Findings group while 33(66%) patients had disease in Invasive Angio findings group. In Mid LAD 7(14%) patients had disease in CT Findings group while 7(14%) patients had disease in Invasive Angio findings group and in Distal LAD 3(6%) patients had disease in CT Findings group while 3(6%) patients had disease in Invasive Angio findings group. The results of CT angio and invasive angio were insignificant with p-value=0.894.

More over for the Proximal LAD, The sensitivity was 100%, specificity was 94.12%, PPV was 97.05% and NPV was100%. For the Mid LAD, the sensitivity was 100%, specificity was 94.12%, PPV was 100% and NPV was 100%. Similarly for the distal LAD, the sensitivity, specificity, PPV, NPV were all 100% and P Value for proximal, mid and distal was 0.000 (Table 2).

Table 1: Diagnostic accuracy of Computerized Tomography Angiography in Left Main Stem Artery (n=50)

Left Main Stem Artery		
	CT Findings	**Invasive Angio Finding**
Disease	7	8
Normal	43	42
Total	50	50

Left Main Stem Artery	
True Positive	7
True Negatives	42
False Positive	0
False Negative	1
Sensitivity	87.5%
Specificity	100%
PPV	100%
NPV	97.67%

Table 2: Diagnostic accuracy of Computerized Tomography Angiography in Left Anterior Descending Artery (n=50)

Left Anterior Descending Artery								
Proximal			Mid			Distal		
	CT Findings	Invasive Angio Finding		CT Findings	Invasive Angio Finding		CT Findings	Invasive Angio Finding
Disease	34	33	Disease	7	7	Disease	3	3
Normal	16	17	Normal	43	43	Normal	47	47
Total	50	50	Total	50	50	Total	50	50

Left Anterior Descending Artery					
Proximal		Mid		Distal	
True Positive	33	True Positive	7	True Positive	3
True Negatives	16	True Negatives	43	True Negatives	47
False Positive	1	False Positive	0	False Positive	0
False Negative	0	False Negative	0	False Negative	0
Sensitivity	100%	Sensitivity	100%	Sensitivity	100%
Specificity	94.12%	Specificity	100%	Specificity	100%
PPV	97.05%	PPV	100%	PPV	100%
NPV	100%	NPV	100%	NPV	100%

Diagnostic accuracy of CT Angio in Circumflex Artery was analyzed as in Proximal LAD 22(44%) patients had disease in CT Findings group while 22(44%) patients had disease in Invasive Angio findings group. In Mid LAD 4(8%) patients had disease in CT Findings group while 4(8%) patients had disease in Invasive Angio findings group and in Distal LAD 2(4%) patients had disease in CT Findings group while 3(6%) patients had disease in Invasive Angio findings group. More over for the proximal circumflex, the sensitivity, specificity, PPV, NPV were also 100%. For the mid circumflex, the sensitivity, specificity, PPV and NPV were all 100%. For the distal circumflex, the sensitivity fell down to 66.67%,

specificity 100%, PPV 100% and the NPV was 97.91% which correlate with the notion quoted in the literature about the shortcomings of CT angio in visualizing the distal part of coronaries especially circumflex. P Value for proximal was 0.440, mid was 0.539 and Distal was 0.670 (Table 3).

Diagnostic accuracy of CT Angio in Right Coronary Artery was analyzed as in Proximal LAD 18(36%) patients had disease in CT Findings group while 18(36%) patients had disease in Invasive Angio findings group. In Mid LAD 14(28%) patients had disease in CT Findings group while 15(30%) patients had disease in Invasive Angio findings group and in Distal LAD 2(4%) patients

had disease in CT Findings group while 4(8%) patients had disease in Invasive Angio findings group. More over for the Proximal RCA sensitivity of 100%, specificity 100%, PPV 100% and NPV of 100%. In the mid RCA, the sensitivity was 93.33%. Specificity 100%, PPV 100%, while the NPV 97.22%. However as in circumflex, for the distal RCA, the sensitivity was low i.e. 50%, Specificity 100%, PPV 100% and NPV 95.83%. P Value for Proximal, Mid and for distal was 0.000.

Diagnostic accuracy of CT Angio in diagonals was analyzed as in Diagonal 1 n=8(16%) patients had disease in CT Findings group while n=10(20%) patients had disease in Invasive Angio findings group. In Diagonal II n=1(2%) patient had disease in CT Findings group and n=3(6%) patients had disease in Invasive Angio findings group. Similarly the sensitivity was much lower for the diagonal branches of LAD I .e 70% for diagonal 1 and 33.33% for the diagonal 2.Howerever the NPV for both these branches remained sill high i.e. above 90%. P Value for diagonal I was 0.563 and 0.799 for Diagonal II.

Diagnostic accuracy of CT Angio in Obtuse Marginal arteries was analyzed as in OM-1

6(12%) patients had disease in CT Findings group while 6(12%) patients had disease in Invasive Angio findings group. In OM-2 1(2%) patient had disease in CT Findings group and 2(4%) patients had disease in Invasive Angio findings group. More over the CT angio was also found very accurate in the obtuse marginal branches of circumflex artery and the sensitivity and NPV for both obtuse marginal 1 and 2 were 100% and 50% and 100% and 97.95% respectively. P Value for OM 1 and OM 2 were 0.000.

Diagnostic accuracy of CT Angio in Posterior descending artery was analyzed as in CT Findings group 3(9%) patients had disease while in Invasive Angio findings group 4(8%) patients had disease. More over for the PDA branch of RCA, the sensitivity, Specificity. PPV and NPV were 75%, 100%, 100% and 97.87%respectively. The posterior left ventricular branch of RCA did not show any significant lesion in all patients both on CT angio and conventional angiography. P value was 0.598.

Our study was not powered to include the Calcium score, obesity and heart rate which would be other wise considered as confounding variables.

Table 3: Diagnostic accuracy of Computerized Tomogrphy Angiography in Circumflex Artery (n=50)

Circumflex Artery								
Proximal			**Mid**			**Distal**		
	CT Findings	**Invasive Angio Finding**		**CT Findings**	**Invasive Angio Finding**		**CT Findings**	**Invasive Angio Finding**
Disease	22	22	**Disease**	4	4	**Disease**	2	3
Normal	28	28	**Normal**	46	46	**Normal**	48	47
Total	50	50	**Total**	50	50	**Total**	50	50

Circumflex Artery					
Proximal		**Mid**		**Distal**	
True Positives	22	True Positives	4	True Positives	2
True Negatives	28	True Negatives	46	True Negatives	47
False Positive	0	False Positive	0	False Positive	0
False Negative	0	False Negative	0	False Negative	1
Sensitivity	100%	Sensitivity	100%	Sensitivity	66.67%
Specificity	100%	Specificity	100%	Specificity	100%
PPV	100%	PPV	100%	PPV	100%
NPV	100%	NPV	100%	NPV	97.91%

Keeping in view the above results, which go hand in hand with many studies quoted above and many more quoted in the literature, we can conclude tat CT angiography can be considered as good alternative in the evaluation of patients suspected of having CAD, especially those with low to intermediate likelihood of disease, who may otherwise be subjected to catheter angiography. However since, at present, there is no system with CT angio available for any intervention if needed in some patients, so it can not replace invasive angiography which is still the gold standard.

DISCUSSION

In our study in a group of 50 patients, we found that MSCT angiogram is fairly accurate in detecting the exact diameter stenosis.In previous studies on 4 slice CT angiography 32% of the segments could not be analysed 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 vessles.

Our results are comparable in terms of overall diagnostic accuracy of CT angio in detecting significant coronary artery stenosis and no segments were excluded due to poor image quality.

Dr James Min in presenting the ACCURACY trial at the radiological society of North America 2007 meeting stated that 232patients 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 hyperlipedemia,55%were smokers and 25%were diabetic, so they expected a high prevalence of CAD but it was not the case[16].

In our study, the PPV was around 95 to 100% for almost all the segments which can be explained by the fact that all the patients were referred for diagnostic catheterization and all of them had either a very high pretest likelihood of the disease or they were known CAD.

Despite substantial improvement in spatial resolution,64 slice CT appear somewhat limited for accurate assessment of entire coronary artery tree including small peripheral segments[17].

In our study ,it is also evident from the results that the sensitivity and NPV, for the smaller branches like Obtuse Marginals of circumflex, Diagonals of LAD, 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 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 more quoted in the literature, we can conclude tat CT angiography can be considered as good alternative in the evaluation of patients suspected of having CAD, especially those with low to intermediate likelihood of disease, who may otherwise be subjected to catheter angiography. However since, at present, there is no system with CT angio available for any intervention if needed in some patients, so it can not replace invasive angiography which is still the gold standard.

CONCLUSION

This study may have an important clinical implication. The very high negative predictive value in the range of 99-100%, as observed in this study and in many more quoted in the literature, suggest that coronary CT angio with the highest resolution scanners could be a suitable means for rapid triage of patients presenting to emergency departments with chest pain and for evaluation of patients with equivocal stress test results who might otherwise need invasive angiography.

REFERENCES

1. Rosamond W, Flegal K, Friday G, Furie K, Go A, Greenlund K, Haase N, et al. Heart disease and stroke statistics--2007 update: a report from the American Heart Association Statistics Committee and Stroke Statistics Sub-committee. Circulation 2007;115:69-171.

2. Finance Division. Economic survey of pakistan 1998-1999. Islamabad: Network publications science; 1998.

3. Pakistan Medical Research Council. National health survey of Pakistan, 1990-94: health profile of people of Pakistan. Islamabad: Network publications science; 1998.

4. Mark DB, Nelson CL, Califf RM. Continuing evolution of Therapy for coronary Artery disease. Initial results from the ear of coronary Angioplasty. Circulation 1994;89:2015-25.

5. Yusuf S, Zucker D, Peduzzi P. Effect of coronary artery bypass surgery on survival overview of 10 years survival from randomized trials by the coronary artery bypass graft surgery trialist collaboration. Lancet 1994;344:563-70.

6. Fleisch KE, Hunink MG, Kuntz KM, Douglas PS. Exercise echocardcogryphy or exercise spect imaging? A metaanalysis of diagnostic test performance. JAMA 1998;280:913-20.

7. Paetsh I, Jahnke C, Wahl A, Gebker R, Neuss M, Fleck E, et al. Comparison of donbutamine stress magnetic resonance, of adenosine stress magnetic resonance perfusion. Circulation 2004;110:835-42.

8. Ringquist I, Fisher LD, Mock M. Prognostic value of angiographic indices of coronary artery disease from the Coronary Artery Surgery Study (CASS). J Clin Invest 1983;71:1854-66.

9. Ellis S, Alderman E, Cain K, Fisher L, Sanders W, Bourassa M. Prediction of risk of anterior myocardial infarction by lesion severity and measurement. Method of stenosis in the left anterior descending coronary artery distribution. A cases registry study. J Am Coll Cardiol 1988;11:908-16.

10. Scanlon PJ, Faxon DP, Audelt AM, Carabello B, Dehmer GJ, Eagle KA, et al. ACC/AHA guidelines for coronary angiography: executive summary and recommendations. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Coronary Angiography) developed in collaboration with the Society for Cardiac Angiography and Interventions. Circulation 1999;99:2345-57.

11. Smith SC, Feldman TE, Hirshfeld JW Jr, Jacobs AK, Kern MJ, King SB, et al. ACC/AHA/SCAI 2005 Guideline Update for Percutaneous Coronary Intervention--summary article: a report of the American College of Cardiology/American Heart Association Task

Force on Practice Guidelines (ACC/AHA/SCAI Writing Committee to Update the 2001 Guidelines for Percutaneous Coronary Intervention).Circulation 2006;133:156-75.

12. Boden WE, O'Rourke RA, Teo KK, Hartigan PM, Maron DJ, Kostuk WJ, et al. Optimal medical therapy with or without PCI for stable coronary artery disease. N Eng J Med 2007;3561:1503-16.

13. Achenbach S, Daniel WG. Computed tomography of coronary arteries: more than meets the (angiographic) eye. J Am Coll Cardiol 2005;155-7.

14. Budoff MJ, Chenboch S, Blumenthal RS, Carr JJ, Goldin JG, Greenland P, et al. Prediction of risk of anterior myocardial infarction by lesion severity and measurement. Circulation 2006;114:1761-91.

15. Redberg RF, Vogel RA, Criqui MH. What is the spectrum of current & emergency technique for the invasive measurement of atherosclerosis? J Am Coll Cardiol 2003;41:1886-98.

16. Budoff JM, Dow D, Jollis GM, Glitter M, Sutherland J, Halamert E, et al. Diagnostic performance of 64-multidetector row coronary computed tomography for evaluation of coronary artery stenosis in individuals with out known coronary artery disease. J Am Coll Cardiol 2008;52:1724-32.

17. Herzog C, Zwerner PL, Doll JR, Nielsen CD, Nguyen SA, Savino G, et al. Significant coronary artery stenosis comparison on per patient and per vasscle or per segment basis at 64-section CT angiography. Radiology 2007;244:112-20.