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Radiology Section

Role of 64- Slice MDCT-Coronary Angiography in the Evaluation of Various Coronary Artery Pathologies: Comparison with Catheter Coronary Angiography

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ABSTRACT

Introduction: MDCT-Coronary angiography is one of the common investigative modality used for evaluation for coronary artery pathologies like coronary artery diseases, coronary artery anomalies and postoperative cases like coronary artery bypass graft. In this study we compared the findings of MDCT coronary angiography with the gold standard catheter angiography in evaluation of various coronary artery pathologies.

Aim: To evaluate the role of 64- slice MDCT-Coronary angiography in the evaluation of various pathologies involving coronary arteries and to compare the findings with catheter coronary angiography.

Materials and Methods: This was a prospective study and 40 patients were randomly selected for CT- coronary angiography who also underwent catheter coronary angiography within 7 days. The results of CT-coronary angiography were compared with that of catheter coronary angiography. CT studies were done on 64- slice CT scanner.

Results: There were 28 cases of coronary artery disease, 4 cases of abnormalities of origin and course of coronary arteries, 1 case of coronary artery aneurysm, 2 cases of post coronary bypass surgery, 1 case of coronary stenting and 4 cases were completely normal. The overall sensitivity, specificity, positive predictive value and negative predictive value for detection of more than 50 % stenosis by coronary CT angiography were found to be 88 %, 92 %, 91% and 88% respectively.

Conclusion: Non invasive 64-slice CT coronary angiography as a vascular imaging technique can be performed rapidly and safely for the assessment of many different pathologies involving coronary arteries. There are only few studies available in literature using 128-Slice CT which says 128-Slice CT has only slightly increased sensitivity and specificity values when compared to 64- Slice CT. The results obtained with 64 slice CT are comparable to that of 128-Slice CT-scan.

Keywords: Atherosclerosis, Coronary artery, Noninvasive cardiac imaging

INTRODUCTION

Cardiac imaging has undergone significant technological advances over the past decade. Technical developments in CT and MR have made imaging of beating heart a reality. Advances in CT technology have made it possible to display coronary artery anatomy for routine clinical diagnosis. CT imaging of the heart is a demanding task as the heart is under constant motion and we need submillimeter isotropic spatial resolution and high temporal resolution [1-3]. Spectacular advances in CT technology over the last decade has enabled faster scanning times, with sections as thin as 0.5mm and temporal resolution as low as 105 milliseconds can be obtained using multidetector CT. These developments have enabled acquisition of high quality angiographic images of heart in a single breath hold. Potential applications of coronary angiography with multi-detector row CT (MDCT) are diagnosis of coronary artery disease, coronary artery anomalies in origin, course and detection of myocardial bridging. Additional applications include follow up after bypass therapy, myocardial perfusion, scarring and contractility [3]. The key advantages are the non invasiveness of the study and the ability to evaluate both the coronary artery lumen

and vessel wall in contrast to catheter angiography [3]. In this study we want to evaluate the diagnostic accuracy of 64 slice MDCT coronary CT angiography in detection of various pathologies involving coronary arteries by comparing the findings with catheter coronary angiography.

MATERIALS AND METHODS

This study was prospective comparative study conducted in the Department of Radiodiagnosis, SRM Medical College Hospital and Research Centre, Kattangulathur, Kancheepuram, Tamilnadu between January 2014 to July 2015. The study was conducted after obtaining clearance from Institutional Ethics Committee. Total 40 patients were enrolled in the study. The indications for CT coronary angiography included atypical chest pain, proven cases of ischemic heart diseases, suspected coronary artery anomalies and post bypass therapy cases. After coronary CT angiography all these patients underwent catheter coronary angiography within 7 days. The exclusion criteria were heart rate more than 80 beats per minute, arrhythmias, heart failure or left ventricular ejection fraction less than 30 percent, acute myocardial infarction, classical angina and renal failure. The patients fulfilling the inclusion criteria were kept nil orally for atleast six hours before the procedure. All necessary blood investigations like blood sugar, lipid profile and blood pressure were recorded. All studies were performed using 64 slice CT, Siemens medical systems, Germany. A single oral dose of 50 -100 mg metoprolol was administered 1 hour before the scan if the heart rate was more than 70 beats/minute. Written informed consent was taken from all the patients. The patient was cannulated with 18 G venflon in an antecubital vein. A preliminary ECG recording was done after placing the leads, to ensure normal sinus rhythm. A total dose of 100 ml of non-ionic contrast was administered through antecubital vein using a power injector at a rate of 5ml/sec. All data were acquired during a single breath-hold and images were reconstructed using retrospective ECG gating. To obtain motion free images, standard reconstruction windows were explored selectively during the mid-to-end diastolic phase. Additional image reconstruction was explored selectively for patients having higher heart rates. Multiplanar reconstructed images were used to visualize the entire artery in a single plane so that reconstructed images were similar to catheter coronary angiography. The arteries were assessed in terms of course, caliber, outline, presence of any plaque in the walls, mural calcification, stenosis of lumen. Image quality of all segments was classified as good, adequate or poor. Catheter coronary angiography was done within seven days in all patients in PHILIPS allura centron interventional cardiology suite. Only segments with 2mm or more in diameter was considered for comparison with MDCT coronary angiography. The coronary artery stenosis was graded as recommended by the Society of Cardiovascular Computed Tomography [Table/Fig-1] [4]. The sensitivity, specificity, positive and negative predictive value for detection of equal to more than 50 % stenosis in 64- slice MDCT coronary angiography was compared with that of catheter coronary angiography.

Descriptive Lumen Obstruction	Quantitative Stenosis Grading
Normal	Absence of plaque/ No luminal stenosis
Minimal	Plaque with <25% stenosis
Mild	25% to 49% Stenosis
Moderate	50% to 69% Stenosis
Severe	70-99% stenosis
Occluded	

[Table/Fig-1]: Quantitative stenosis grading on CT [4].

RESULTS

The mean interval between CT and catheter coronary angiography was 4.5 plus or minus 2 days. Sixty percent of patients received a beta blocker before CT examination. The mean heart rate was 61 ±7 during the scan procedure. The mean age group was 55 years and out of 40 patients 24 were male patients. [Table/Fig-2] shows distribution of types of cases and the maximum number of cases were of coronary artery diseases contributing to 70% of cases.

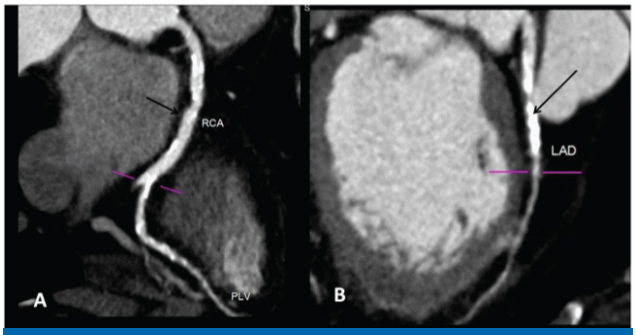
The incidence of risk factors in the study population was 21 out of 40 were hypertensive, 23 of them had diabetes and 15 of them had both diabetes and hypertension. Altered lipid

Types of Cases	Number
Coronary artery disease	28
Abnormalities of origin and course of coronary arteries	4
Coronary artery aneurysm	1
Post coronary artery bypass surgery	2
Status post coronary artery stenting	1
Normal coronary CT angiography	4

[Table/Fig-2]: Distribution of types of cases.

Degree of Stenosis	Right Coronary	Left Main Trunk	Left Anterior Descending	Left Circumflex
Normal	13	17	10	17
Minimal	3	5	2	3
Mild	5	2	7	2
Moderate	4	3	6	6
Severe	3	1	3	0
Occluded	0	0	0	0

[Table/Fig-3]: MDCT-Coronary angiography finding of coronary arteries for detection of degree of stenosis.



[Table/Fig-4a,b]: Multiplanar reformatted images showing calcific and mixed plaques involving right coronary artery and proximal left anterior descending artery causing significant stenosis of left anterior descending artery (black arrows).

Degree of Stenosis	Right Coronary	Left Main Trunk	Left Anterior Descending	Left Circumflex
Normal	13	17	10	16
Minimal	5	5	3	4
Mild	3	2	6	3
Moderate	5	3	7	5
Severe	2	1	2	0
Occluded	0	0	0	0

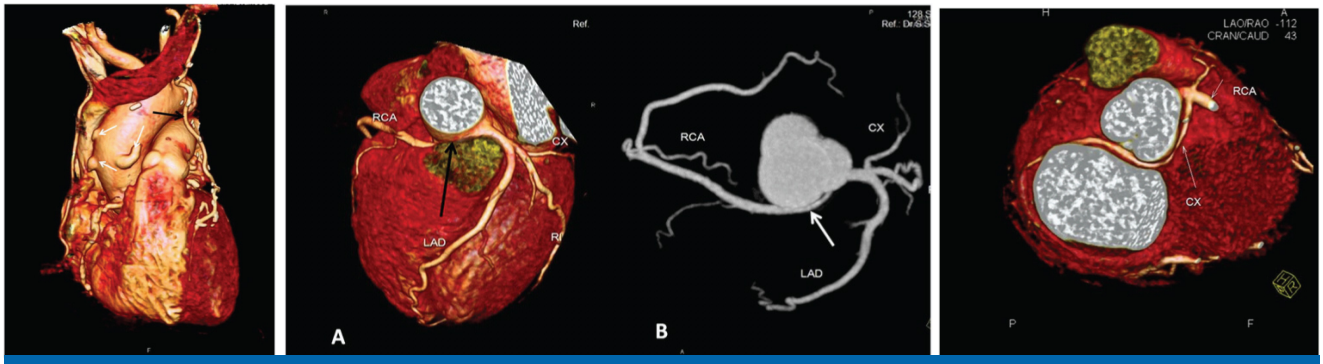
[Table/Fig-5]: Catheter Coronary angiography finding of coronary arteries for detection of degree of stenosis.

Test result	Stenosis Absent	Stenosis Present	Total
Test positive	2	22	24
Test negative	23	3	26
Totals	25	25	50

[Table/Fig-6]: Calculation of sensitivity, specificity, PPV and NPV for detection of more than 50% stenosis by CT-Coronary angiography.

profile with hypercholesterolemia was present in 16 patients. Nine patients all male were smokers. Five patients had history of coronary artery disease in their first order relatives. [Table/Fig-3] shows. MDCT-CA findings of coronary arteries for detection of degree of stenosis. The degree of stenosis was classified as six different categories as according to society of cardiovascular computed tomography [4]. Left anterior descending artery was the most common artery involved by disease [Table/Fig-4a-4b]. [Table/Fig-5] shows, catheter coronary angiography findings of coronary arteries for detection of degree of stenosis. The overall sensitivity, specificity, positive predictive value and negative predictive value for detection of equal to more than 50 % stenosis by coronary CT angiography were found to be 88 %, 92 %, 91% and 88% respectively [Table/Fig-6].

One patient with right coronary artery aneurysm was correctly diagnosed by both CT and Catheter coronary angiography. One patient with stenting and two patients with bypass surgery [Table/Fig-7] were accurately evaluated with CT rather than catheter coronary angiography. Four patients had anomalous course and origin of coronary artery. One patient had an anomalous right coronary artery originating from the left coronary sinus and coursing between the aortic root and main pulmonary artery [Table/Fig-8A,8B], another patient showed common origin of left and right coronary artery from right sinus of valsalva, another patient showed origin of left coronary artery from main pulmonary artery and last patient showed left circumflex artery arising from right coronary artery [Table/Fig-9]. All the patients with anomalous origin and course of coronary arteries were accurately evaluated using CT-Coronary angiography than catheter coronary angiography.



[Table/Fig-7]: Coronal 3-D volume rendered CT coronary angiography image showing patent left internal mammary to left anterior descending artery graft (black arrow) and occluded saphenous venous grafts to obtuse marginal, posterior descending and posterolateral left ventricular branches (white arrows). **[Table/Fig-8a,8b]:** Coronal 3-D volume rendered and maximum intensity projection CT coronary angiography image showing an anomalous right coronary artery originating from the left coronary sinus and coursing between the aortic root and main pulmonary artery (black arrow) with narrowing as it passed between the aorta and the right ventricular outflow tract (white arrow) suggestive of malignant right coronary artery. **[Table/Fig-9]:** 3-D volume rendered CT coronary angiography image showing left circumflex artery arising from right coronary artery (white arrows).

DISCUSSION

Multidetector computed tomography (MDCT) coronary angiography has been emerged as one of an important tool in the evaluation and diagnosis of coronary artery diseases and anomalies due to recent advances in non invasive cardiac imaging [1, 4]. Technical improvement has led to fast ECG-Synchronized CT image acquisition of the heart with combination of speed and spatial resolution. The diagnostic accuracy of non invasive CT Coronary angiography is largely dependent on the overall diagnostic quality of the study. Most studies have suggested that image quality is inversely related to patient heart rate at coronary CT-angiography. It has been recommended that the heart rate of patients undergoing CT coronary angiography be slowed pharmacologically to less than 70 beats per minute with oral administration of beta blockers if contraindications to such a regimen have been ruled out [2,3]. In our study 24 patients had heart rates of above 70 beats per minute and had to be given 50 -100 mg metaprolol.

In our study, the overall sensitivity, specificity, positive predictive value and negative predictive value for detection of equal to more than 50% stenosis by coronary CT angiography were found to be 88%, 92%, 91% and 88% respectively. This correlated with the previous studies done on 64- slice CT scanner by Budoff MJ et al., [5] by which showed sensitivity, specificity, PPV, and NPV for detecting ≥50% stenosis as 85%, 90%, 91%, and 83%, respectively [4- 10].

Coronary artery anomalies and course were better detected using CT-coronary angiography than catheter coronary angiography in our study although the cases were less [11-13]. Multi– detector computed tomography (MDCT) allows accurate and noninvasive depiction of coronary artery anomalies of origin, course, and termination. Multi– detector row CT is superior to conventional angiography in delineating the ostial origin and proximal path of an anomalous coronary [11-13].

Potential applications of CT-Coronary angiography include diagnosis of calcified and non-calcified plaques, detection and quantification of coronary artery stenosis and follow up after surgical by-pass therapy [3]. Additional applications include evaluation of myocardial perfusion, scarring, evaluation of myocardial bridging and detection of anomalous course, origin of coronary arteries. The key advantages are the non invasiveness of the study and the ability to evaluate both the coronary artery lumen and the vessel wall in contrast to catheter angiography which fails to detect mural changes before significant narrowing has occurred [3]. With introduction of volume CT and flat panel detectors, even fifth generation of coronary arteries can be visualized. Even radiation exposure can be minimized using ECG- gated tube current flow modulation techniques. Multi–detector computed tomography (MDCT) allows accurate and noninvasive depiction of coronary artery anomalies of origin, course, and termination [11]. Multi– detector row CT is superior to conventional angiography in delineating the ostial origin and proximal path of an anomalous coronary [12]. The limitations of CT-coronary angiography is that to obtain a diagnostic quality of study patients heart rate should be less, cannot be done in patients with arrhythmias, heart failure or left ventricular ejection fraction less than 30 percent, acute myocardial infarction and renal failure [3,14]. Other limitations include the presence of coronary artery calcifications can reduce the diagnostic accuracy in estimation of coronary artery stenosis [3,15]. The advent of 128, 320 slice CT and dual Source CT have revolutionized the technique of CT coronary angiography and has provided slightly increased sensitivity and specificity values when compared with 64- slice CT [16]. The limitations of this study include smaller sample size and use of 64- slice CT instead of 128 slice CT.

CONCLUSION

A review of current literature supports the use of noninvasive 64-slice CT coronary angiography as a vascular imaging technique that can be performed rapidly and safely for the assessment of many different pathologies involving coronary arteries and not alone coronary artery diseases. Our study re establishes this fact although our study group is less.

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