Section: Radiodiagnosis

Original Research Article

ROLE OF MDCT CORONARY ANGIOGRAPHY IN DETECTION OF CORONARY ARTERY DISEASE IN COMPARISON WITH CONVENTIONAL CORONARY ANGIOGRAPHY

Ahammed Munawar Nanakkal[1], Swapna Chouhan[2], Mamatha Reddy[3], Shaik Ameenulla Hafeezudhin[4], T.Sreedevi[5]

[1]Senior Resident, Department of Radiodiagnosis: Government Medical College, Mahbubnagar, Telangana, India.
[2]Associate Professor, Department of Radiodiagnosis: Government Medical College, Bhupalpally, Telangana, India.
[3]Associate professor, Department of Cardiology: Kakatiya Medical College, Warangal, Telangana, India.
[4]Associate Professor, Department of Radiodiagnosis: Government Medical College, Narsampet, Telangana, India.
[5]Professor and HOD, Department of Radiodiagnosis, Kakatiya Medical College, Warangal, Telangana, India.

Received : *03/02/2025*
Received in revised form : *01/04/2025*
Accepted : *16/04/2025*

Keywords: Coronary heart disease (CHD), Multi-detector computed tomography coronary angiography (MDCTA), conventional coronary angiography (CCA),

Corresponding Author:
Dr. Swapna Chouhan,
Email: drswapnachouhan12@gmail.com

DOI: 10.47009/jamp.2025.7.2.200

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (2); 995-1003

Abstract

Background: The objective of this study was to evaluate the diagnostic performance of 128 slice MDCT coronary angiography with retrospective ECG-gating for the detection of coronary artery stenoses. This was achieved by comparing the method to a gold standard set by catheter based conventional coronary angiography. **Materials and Methods:** A total of 60 patients scheduled for CCA were examined with 128 slice MDCT coronary angiography 1– 2 days prior to conventional coronary angiography. All patients were examined with a MDCT scanner capable of acquiring 128 slices per gantry rotation. These images were used to determine the scan volume and for quantification of coronary calcification. After intravenous injection of non-ionic contrast media the entire heart volume could be scanned within a single breath hold with a slice with of 0.9mm (64x0.25 Collimation). Each coronary segment was analyzed for the presence or absence of coronary stenoses and the location and extent of each lesion was recorded. **Result:** There is potentially interfering influence of variations in lesion size, heart rate, coronary calcification and lesion location within the coronary tree. A total of 900 coronary segments (segment 1 to 15 were evaluated with conventional coronary angiography. Of these segments 882 (98%) could be evaluated with MDCT angiography. The remaining 18 segments could not be adequately depicted due to image artifacts. The statistical analysis to determine 128 slice MDCT coronary angiography performance for the detection of coronary lesions in coronary segments yielded high values for sensitivity (0.90) and specificity (0.95). Positive and negative predictive values were 0.79 and 0.98 respectively. **Conclusion:** The present study has high negative predictive value (98.08%) suggests that 128- Slice MDCT coronary angiography is a good screening modality for evaluation of patients with mild to intermediate risk factors who might otherwise require invasive angiography.

INTRODUCTION

Coronary heart disease (CHD) is an epidemic in India and one of the major causes of disease burden and deaths, Among Indians the risk of coronary artery disease is 3-4 times higher than white Americans. The adult prevalence in the last 60 years has increased in urban areas from about 2% to 10.5%, while in rural areas it increased from 1% to 5%. Indians are facing this disease before 40 years of age and showing the higher incidence of hospitalization due to chest pain and other cardiac symptoms. World Health Organization (WHO) has reported that, cardiovascular diseases are the number one cause of death globally, more people die annually from cardiovascular diseases than from any other cause. Over 80% of cardiovascular diseases deaths take place in low- and middle-income countries and occur almost equally in men and women. WHO report stated that coronary disease accounted for more than

7.3 million deaths worldwide. In industrialized countries CAD is responsible for 1/3rdof total deaths.[1,2]

The drawbacks of CCA, like its advantages, are inherent to the invasive nature of the procedure. Catheterization involves considerable discomfort for the patient and complications ranging from hemorrhage at the site of catheter insertion to coronary rupture may occur. Although severe complications are rare, the risk involved with CCA usually requires a short hospitalization of the patient. These drawbacks of CCA must be considered when defining the indication for the procedure, limiting the procedure to high-risk patients and patients who already show symptoms of CAD Multi-detector computed tomography coronary angiography (MDCTA) is currently considered as a promising alternative to conventional coronary angiography (CCA). The technique is relatively non-invasive. Images can be obtained quickly, there are few complications and the preliminary studies show that it may be cost effective but this has to be determined. Nevertheless, the available equipment suffers from several limitations compared with CCA. The diagnostic accuracy of MDCTA has improved after introduction of newer generations of scanners with high temporal and spatial resolution.[3,4]

MATERIALS AND METHODS

This is a prospective comparative analytic study done at Department of Radio diagnosis Kakatiya medical college, Warangal, Telangana, India. Patients attending the cardiology Department of MGM hospital, Warangal with complaints of chest pain or exertional dyspnea, suspected of having CAD and scheduled for conventional coronary angiography.

A prospective study was conducted over a period of sixteen months (September 2022 to June 2024) on 60 patients with clinically suspected coronary artery disease. They were evaluated with 128 Slice CT Scanner (GE) and conventional coronary angiography.

Inclusion Criteria

Patients of all age groups scheduled for CCA.

Exclusion Criteria

Renal insufficiency (Creatinine >1.7mg/dl), Acute MI patients, with known allergy to contrast media and pregnant women.

The study protocol was approved by the hospitals ethics committee and all patients gave informed consent. Initially the CTA examination was performed, and the reconstructed images were evaluated by a radiologist. The scheduled CCA examination took place. The evaluation of the CCA examination was performed by a physician blinded to the results of CTA.). The location and extent of each diagnosed coronary lesion was recorded separately for each modality. Finally, a comparative analysis of CCA and CTA results was performed, yielding sensitivity, specificity, positive and negative predictive value of CTA compared with CCA. The influence of potentially interfering factors such as heart rate, coronary calcification, was demonstrated in a separate evaluation.

MDCT Angiography Patient preparation: Patient consent was taken. Risks and benefits of the procedure were explained to the patient clearly. Patients were asked not to consume coffee or tea 24 hours prior to study and fast for 4-6 hours prior to study. Patients were also asked to avoid metformin 1 day prior to study. Detailed patient history was taken, medications, routine investigations and non-invasive stress test results were recorded. Whenever necessary, in subjects with heart rate>65/min, beta blockers such as metoprolol 50-100mg are administered with consent of the patient to achieve a target HR of 50- 60beats/min to minimize motion artifacts.

MDCT-CA protocol: All patients were examined with a GE128 slice MDCT scanner using standard cardiac CT protocol. Gantry rotation time was 400 ms with a half sector acquisition protocol and multi-sector reconstruction permitting an effective temporal resolution between 50 and 200 ms depending on patient heart rate. Patient positioning was supine with leg towards the gantry. Initially Calcium scoring was performed by scanning the patient from from the bifurcation of the trachea to the diaphragm.

Table 1: MDCT Scan parameters used for Ca scoring and contrast study

Parameter	Ca scoring	MDCT angiography
Contrast agent	None	75ml; 350 mg /ml; 5 ml/sec
Collimation	40x0.625	64x0.625 mm
Gantry rotation time	400 ms	400 ms
kV	120	140
mA	55	800
Slice width	2.5mm	0.9 mm

The Calcium score was then generated automatically by the software, according to the algorithm introduced by Agatston et al.[5] Later a region of interest at the origin of the descending aorta was marked to permit subsequent use of automated contrast bolus tracking. Iodinated contrast media (Omnipaque 350 mg/ml) was injected via 18 Gauge cannula in antecubital vein, preferably on right side. Contrast volume and rate of injection varied with patient weight from 75 to 90 ml and 5.0 to 6.0 ml/second respectively. The contrast injection was immediately followed by a 40 ml saline “chaser bolus” at a rate of 5 ml/second. Scanning was automatically triggered when contrast media in the pre-defined area of the descending aorta reached a density of 160 Hounsfield units. A single automated breath-hold command was given and helical scan acquisition commenced 3 seconds thereafter to minimise respiratory related fluctuation in heart rate. Overall scan time was between 7 and 10 seconds depending on cardiac size.

Post processing and reconstruction. Data was reconstructed using either a mono- or multi-segmental algorithm depending on patient heart rate automatically and displayed by GE Workspace. Retrospective ECG gating permitted reconstruction of images at 45%, 50%, 60%, 75% and 80% of the transferred data to a dedicated Image analysis workstation.[6]

CCA protocol and quantitative coronary analysis: All 60 patients underwent conventional coronary angiography 1 - 2 days after CTCA using catheter via radial artery into the ostium of each of the two coronary arteries. A contrast agent (Omnipaque Iohexol 350mg Iodine/ml) was injected and a series of images were recorded using Digital Subtraction Angiography. Multiple projections of coronary arteries were acquired and analyzed by experienced cardiologist.

Data Evaluation and Statistics: The analysis of the data is based on the comparison of each single coronary segment seen in CTA with conventional coronary angiography representing the gold standard. For this purpose each coronary segment is classified as either Positive = Stenosis, or negative = no stenosis. The stenosed segments are divided into 3 categories according to the extent of lumen narrowing (high grade stenosis: >70% of vessel lumen, significant stenosis :50-70% of vessel lumen, non-significant stenosis :<50% of vessel lumen). Each coronary segment is thus categorized with both conventional and CT angiography, making it possible to define the CTA results for each segment as either true positive, false positive, true negative or false negative. Separate evaluations for high grade and intermediate stenoses can be performed.

15 segments of coronary tree analyzed with both CCA and MDCT –CA and results were compared with CTA.

Separate statistical evaluations were performed for:

- Lesions > 70% and >50% of the coronary lumen
- Lesions within each of the separate coronary arteries (LAD, RCA and LCX)
- Studies performed at heart rates above and below 65 beats/min
- Studies with calcium scores above and below 100 Agatston

RESULTS

Total 60 patients including male and female (38male and 22 female) were evaluated. The youngest patient was 30 years old and oldest was 72 years old. The mean age of the study group was 55.16 years. The highest numbers of patients were in the age group of 40-60 years. Of the total stenoses seen in CCA 4 (4.8%) was located in the LM, 26 (22.85%) in the RCA, 66(54%) in the LAD and 18 (18.57%) in the LCX. Majority of patient ie,24 out of 60 patients (40%) had calcium score of zero. Only 6 patients had a calcium score of more than 400. The mean CT coronary calcium score was 120 Agatston units.

Table 2: Artery wise distribution of lesions detected on CT Coronary angiography and CCA.

Artery	stenosis on CTA	stenosis on CCA	False Positive	False Negative
RCA	34	26	8	0
PDA/PLV	04	8	0	4
LM	04	04	0	0
LAD	80	66	14	0
LCX	28	18	10	0
Diagonal	04	08	0	4
OMs	04	10	0	6
Total	158	140	32	14

Table 3: Sensitivity, specificity, positive and negative predictive value for MDCT detection of coronary stenoses in comparison with CCA.

		CCA	
		Positive	**Negative**
	Positive	126 (a)	32 (b)
	Negative	14(c)	710(d)
Sensitivity 0.90			
Specificity 0.95			
Positive predictive value 0.79			
Negative predictive value 0.98			

The statistical evaluation of the data to determine sensitivity, specificity, positive and negative predictive value for CTA detection of coronary lesions showed a sensitivity of 0.90 and a specificity of 0.95. Positive and negative predictive values were 0.79 and 0.98 respectively.

Table 4: Sensitivity, specificity, positive and negative predictive value for MDCT detection of coronary stenoses.

		CCA	
		Positive	**negative**
coronary stenoses in LAD	Positive	70	14
	Negative	4	208
Sensitivity: 0.94			
Specificity: 0.93			
Pos. pred. Value: 0.83			
Neg. pred. Value: 0.98			
Coronary stenoses in LAD	Positive	30	08
	Negative	04	192
Sensitivity: 0.88			
Specificity: 0.96			
Pos. pred. Value: 0.78			
Neg. pred. Value: 0.98			
Coronary stenoses in LCX.	Positive	22	12
	Negative	06	254
Sensitivity: 0.78			
Specificity: 0.96			
Pos. Pred. Value: 0.68			
Neg. Pred. Value: 0.97			

Table 5: Sensitivity, specificity, positive and negative predictive value for MDCT detection of coronary stenoses in a group of patients with heart rates.

Below 65 beats per minute	**Positive**	**Negative**
Positive	54	08
Negative	04	294
Sensitivity: 0.93		
Specificity: 0.97		
Pos. pred. Value: 0.87		
Neg. pred. Value: 0.98		
Above 65 beats per minute		
positive	72	24
negative	10	336
Sensitivity: 0.87		
Specificity: 0.93		
Pos. pred. Value: 0.75		
Neg. pred. Value: 0.97		

More motion artefacts seen in patient with high heart rate. In the patient group with heart rates below 65 beats per minute higher values for sensitivity (0.93) and specificity (0.97) were observed, compared to sensitivity (0.87) and specificity (0.93) of the patient group with heart rates above 65 beats per minute. The same pattern was seen for the positive predictive value, which was 0.87 for the group with heart rates below, and 0.75 for that with heart rates above 65 beats per minute. The negative predictive value of 0.97 in the group with high heart rates was slightly lower compared to 0.98 in the group with lower heart rates.

Table 6: Sensitivity, specificity, positive and negative predictive value for MDCT detection of coronary stenoses in a group of patients with Ca.

Scores below 100 Agatston		**CCA**	
		Positive	**Negative**
	Positive	86	28
	Negative	12	550
Sensitivity: 0.87			
Specificity: 0.95			
Pos. pred. Value: 0.75			
Neg. pred. Value: 0.97			
Scores above 100 Agatston	positive	40	04
	negative	02	180
Sensitivity: 0.95			
Specificity: 0.97			
Pos. pred. Value: 0.90			
Neg. pred. Value: 0.98			

The high density of calcifications within coronary vessels makes calcium well visible in CT, but also may result in misinterpretation caused by artifacts. The effect of coronary calcification on CTA detection of coronary stenoses was determined by performing separate evaluations of the data for patients with Agatston scores above and below 100 Agatston. When comparing the statistical results of coronary CTA of patients with calcium scores above and below 100, an increase in sensitivity form 0.87 for patients with scores below 100 to 0.95 for those patients with scores above 100 can be observed. The specificity rose slightly from 0.98 to 0.99

Table 7: Evaluation of all Stenoses with a threshold of 50% and 70% diameter of the coronary lumen.

	Sensitivity	Specificity	Pos. Predictive Value	Neg. Predictive Value
All Stenoses above 50%	0.9	0.95	0.79	0.98
All Stenoses above 70%	0.88	0.97	0.80	0.96

When raising the threshold for stenosis from 50% to 70% of the vessel lumen, so that only hemodynamic relevant stenoses enter the evaluation, the sensitivity decreases from 0.9 to 0.88 while an increase of specificity from 0.95 to 0.97 is observed. Positive and negative predictive values remain practically unchanged (0.79 to 0.8 and 0.98 to 0.98 respectively).

Table 8: Separate evaluation of sensitivity, specificity, positive and negative predictive value for MDCT detection of coronary stenoses in LAD, RCA, LCX respectively are

Artery	Sensitivity	Specificity	Pos. Predictive Value	Neg. Predictive Value
LAD	0.94	0.93	0.83	0.98
LCX	0.84	0.96	0.68	0.98
RCA	0.88	0.96	0.78	0.97

Table 9: Separate Evaluation for Patients with heart rates above and below 65 beats per min.

HR	Sensitivity	Specificity	Pos. Predictive Value	Neg. Predictive Value
Heart rate ≤65/min	0.93	0.97	0.87	0.98
>65/min	0.87	0.93	0.75	0.97

Table 10: Separate evaluations for patients with coronary calcium burden above and below 100 Agatston., (Coronary segments 1 to 15)

Agatston	Sensitivity	Specificity	Pos. Predictive Value	Neg. PredictiveValue
Ca.-Score ≤100	0.87	0.95	0.75	0.97
Ca.-Score >100	0.95	0.97	0.90	0.99

The positive predictive value for the patient group with calcium scores below 100 was very low (0.75) compared to the patient group with scores above 100 (0.90). The negative predictive value shows a slight decrease from 0.97 for patients with scores below, to 0.99 for those with scores above 100.

DISCUSSION

The present study included both gender male and female (38male and 22 female) were evaluated. The youngest patient was 30 years old and oldest was 72 years old. The mean age of the study group was 55.16 years. The highest numbers of patients were in the age group 40-60 years. With CCA, The 900 coronary segments included in the study were found to contain a total number of 140 stenoses, of these stenoses 70 (50%) were hemodynamic significant. (≥ 50% of vessel lumen). CTA was able to detect 158 of all stenoses, among them 79 segments were found to have significant stenosis. Among the total stenosis 32 were false positives and 14 were false negatives (14 stenotic lesions were missed on CT coronary angiography).

Many authors have compared the diagnostic accuracy between MDCT Coronary angiography and invasive coronary angiography. Raff et al,[6] reported sensitivity, specificity, positive predictive value, negative predictive value of 64-slice CT as 86%, 95%, 66% and 98% respectively. Nikolaou et al,[7] reported in their study, sensitivity, specificity, positive predictive value, negative predictive values are 82%, 95%, 72% and 97%. respectively. Ronny R Buechel et al,[8] conducted a longitudinal follow-up study in tertiary referral cardiac imaging centre on 434 consecutive patients who were referred for evaluation of CAD by CCTA Completely normal coronary arteries were documented in 171 patients (47%), while exclusively non-obstructive lesions were found in 66 (18%), and obstructive coronary lesions were diagnosed in 130 patients (35%). A mean follow-up of 47±16 weeks was obtained. The first-year event rate was 0% in patients with normal coronary arteries on CCTA but increased to 3% and 26% in patients with non-obstructive and obstructive coronary artery lesions, respectively. Mean effective radiation dose was 1.8±0.6 mSv. They demonstrate the excellent prognostic value of prospectively ECG-triggered CCTA with a mean effective radiation dose <2 mSv. Absence of atherosclerotic findings in CCTA was an excellent predictor of event-free survival.

Kim JS, Choo KS et al,[9] study per-segment analysis, stated that two low-radiation dose CCTA techniques using 128-slice MDCT yields comparable diagnostic performance for coronary artery disease in symptomatic patients with low heart rates. Sensitivity, specificity, positive predictive value, and negative predictive value were 91/96%, 95/94%, 75/73%, and 98/99% for step-and-shoot prospectively ECG-gated and retrospectively ECG gated with TCM CCTA, respectively, relative to conventional coronary angiography. Effective radiation dose were low (1.75 ± 0.83 mSv,) in the step-and-shoot prospectively ECG-gated technique compared to retrospectively ECG-gated with TCM CCTA (4.91 ± 1.71 mSv).

Hong, C et al,[10] Optimal image quality was achieved with a 50% trigger delay for the right coronary artery and 60% for the left circumflex coronary artery. And same at 50% and 60% triggering for the left anterior descending coronary artery. Concluded that selection of appropriate trigger delays reduce cardiac motion artifacts and a decreasing heart rate improves image quality.

A.F. Kopp et al,[11] conducted a study on102 patients who underwent both conventional and MDCT coronary angiography .Two blinded independent reviewers analyzed image quality for segments 1–4 (right coronary artery), 5–8 (left main, left anterior descending), and 11, 12 (left circumflex). These segments were evaluated for the presence or absence of significant (≥50%) stenoses. The results were compared with those of invasive coronary angiography in a blinded fashion .The overall sensitivity for the detection of significant stenoses (≥50%) were 0·86 (reader 1) and 0·93 (reader 2), specificity 0·96 (reader 1) and 0·97 (reader 2), negative predictive value 0·98 (reader 1) and 0·99 (reader 2).High resolution MDCT angiography with retrospective gating permits the non-invasive detection of coronary artery stenoses with high accuracy if image quality is optimized for each of the three major coronary arteries.

Gorenoi V, Schönermark MP, Hagen A,[12] had a sensitivity of 96 % (95 % CI: 93 % to 98 %), specificity of 86 % (95 % CI: 83 % to 89 %), positive likelihood ratio of 6.38 (95 % CI: 5.18 to 7.87) and negative likelihood ratio of 0.06 (95 % CI: 0.03 to 0.10). They proposed that CT coronary angiography using scanners with at least 64 slices should be recommended as a test to rule out obstructive coronary stenoses in order to avoid inappropriate invasive coronary angiography in patients with an intermediate pretest probability of CHD.

Duarte R, Miranda D, Fernández- Pérez G, Costa JC,[13] effective dose of radiation was also calculated. The clinical characteristics of the patients in the two groups were similar. The image quality obtained with dual source CT was significantly better than that obtained with single source CT (P=0.006). The mean effective dose of radiation in the group undergoing dual source CT was 36% lower than in the group undergoing single source CT (1.4±0.6 mSv vs. 2.2±0.9 mSv; P<0.01). The results of the study showed both provide good image quality and low effective doses of radiation, 128-slice dual source helical CT with prospective acquisition provides better image quality and results in a lower effective dose of radiation.

Chen BX et al,[14] study fifty-eight out of 879 segments (7%) from CTA were not assessable because of irregular rhythm, vessel calcification or tachycardia. Compared with invasive coronary angiography, segment-based analysis from the 821 segments showed the sensitivity by CTA was 87%, specificity 97%, PPV 83% and NPV 97%. Four out of 22 stents implanted in 15 patients were not assessable by CTA because of poor image quality. Compared with invasive coronary angiography, the sensitivity of diagnosing in-stent re-stenosis by CTA was 100%, specificity 77%, PPV 63% and NPV 100% for the remaining 18 stents.

The results of the study shows One hundred and twenty-eight-slice CTA has a high accuracy for detecting coronary artery disease and in-stent re-stenosis after coronary stenting and could be considered as a valuable noninvasive technique for screening coronary artery disease in suspected patients. The present study with128- Slice MDCT angiography had an overall sensitivity of 90.00%, specificity of 95.12%, and positive predictive value of 79%and negative predictive value of 98.08% with invasive catheter angiography as the gold standard. Among 60 patients included in the present study, 8 patients (13.3 %) had normal angiograms, 10 (16.6%) had non-significant disease and 42 patients (63%, 36 male and 6 female) had significant disease, on CT coronary angiography, which was also proved on invasive angiography. The incidence of significant coronary artery stenoses detected was highest in age group of 41-60 years.

Sensitivity, specificity, positive and negative predictive value for MDCT detection of coronary stenoses, in a group of patients with heart rates below 65 beats per minute and above 65 beats per min are 93.10%/87.80%, 97.35%/93.33%, 87.09%/75.00% and 98.65%/97.10% respectively.

In the patient group with heart rates below 65 beats per minute, higher values for sensitivity (0.93) and specificity (0.97) were observed, compared to sensitivity (0.87) and specificity (0.93) of the patient group with heart rates above 65 beats per minute. The same pattern was seen for the positive predictive value, which was 0.87 for the group with heart rates below, and 0.75 for that with heart rates above 65 beats per minute. The negative predictive value of 0.97 in the group with high heart rates was slightly lower compared to 0.98 in the group with lower heart rates.

An approach has been made to combine the data of 2 subsequent cardiac cycles into one Image, thereby reducing the temporal resolution by half. With a gantry rotation time of 0.4sec, a reduction from 200ms to 100 ms can be achieved. The drawback to this method is that the motion of the heart within the two given cardiac cycles must be identical for the data to match perfectly. This makes the approach very sensitive to any kind of variations in cardiac rhythm. By choosing the right interval for image reconstruction within the cardiac cycle and applying dedicated spiral algorithms, motion artifacts can be reduced significantly.

Despite the attempts to minimize the effects of cardiac motion, high heart rates still do affect the outcome of coronary CTA. This becomes evident when observing the number of coronary segments that could not be adequately depicted due to poor

ISSN (O): 2687-5365; ISSN (P): 2753-6556

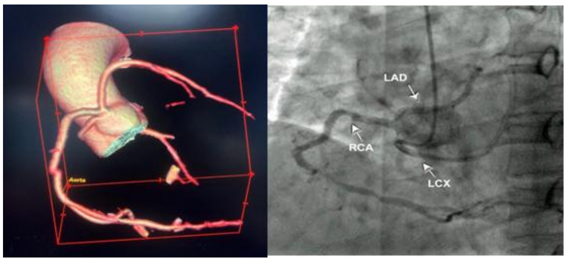
image quality. The number of such segments is greater in studies performed at high heart rates. In the sub-group of patients with heart rates ≤ 65 beats/min (n=24), 14% of all coronary segments could not be adequately depicted with CTA. This number increases to 23% in the sub-group of patients (n=36) with heart rates above 65 beats/min. The effect of increased heart rate is not as clearly reflected in the statistical evaluation of CTA performance in patients with heart rates above and below 65 beats per min. CTA showed slightly higher values for sensitivity and specificity (0.89 and 0.92) for patients with heart rates below 65/min, compared to values of 0.88 and 0.88 for patients with higher heart rates. These statistical values show such slight variation because good image quality attained with current generation MDCT Scanners with short image acquisition time.

It seems logical that larger coronary lesions are more easily detected in CTA that smaller ones. To determine the influence of this factor, a separate statistical evaluation including only stenoses greater than 70% of the vessel lumen and greater than 50% was performed and compared. Sensitivity, specificity, positive and negative predictive value for MDCT detection of coronary stenoses > 50% diameter of vessel lumen, and >70%diameter of vessel lumen are 90%/88%, 95%/97%, 79%/80% and 98%/98% respectively. The decrease of sensitivity for detection of larger stenoses from 0.9 to 0.88 is initially surprising, since a greater sensitivity for larger lesions would be expected. The explanation for the, seemingly, lower detection rate of high grade stenoses is found in the underestimation of stenoses by CTA. Since the threshold for high grade stenoses was set at 70%, all high grade stenoses that were estimated to be below 70% with CTA were counted a false negative, accounting for the decrease of sensitivity.

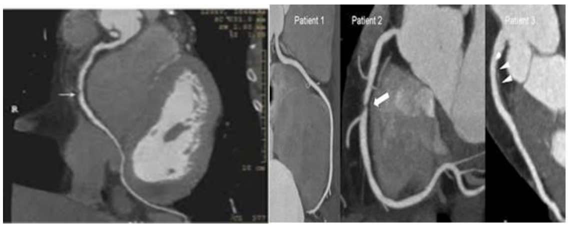
The increase of specificity for high grade stenoses from 0.95 to 0.97 reflects the decrease of false positive segments. To understand this phenomenon, one must consider what causes a segment to be read as false positive. If the CTA image of a coronary segment contains artifacts or is simply of poor quality, the reader may believe to see a stenosis where there is none, thereby, creating a false positive result. The higher specificity observed for high grade stenoses reflects the lower number of false positive segments in this group. It can be concluded that most false positive findings were read as low grade stenoses.

When analyzing the results of coronary CTA for each coronary branch separately, differences in outcome become evident. A number of factors can be held responsible for this phenomenon. Naturally, the size of the vessel contributes to the clear depiction in angiography, but vessel size alone is not the sole contributing factor.

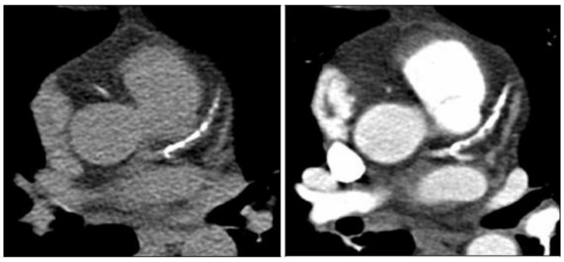
The velocity and the pattern of motion of each coronary segment are responsible for motion artifacts and hinder the clear depiction of the vessels. Each segment of the coronary tree has a different motion pattern during the cardiac cycle, depending on the location of the vessel. Because of their position within the coronary groove, the RCA and LCX are subjected to more rapid motion during diastole than the LAD. This is caused mainly by atrial contraction during end diastole.



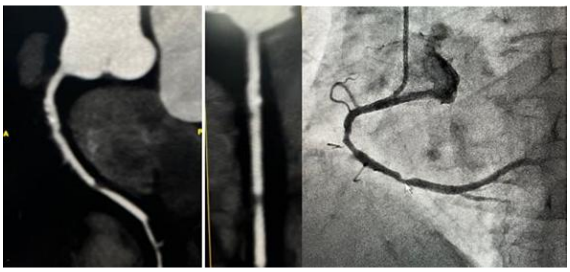
Volume rendering image and CCA showing separate origin of RCA,LAD &LCX from Right coronary cusp



Contrast enhanced multi-row CT coronary angiography Multi-planar reconstruction studies showing normal coronary arteries in patient 1,soft plaque in RCA(arrows)in patient 2 and soft atheromatous plaque and calcifications in patient3.

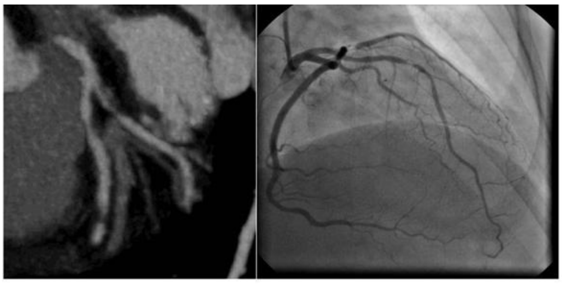


Axial CT images from a contrast enhanced multi-row CT coronary angiography study showing calcifications of the LAD before (left image) and after (right image) application of contrast media. Assessment of the vessel lumen is hindered by the extensive vascular calcifications.

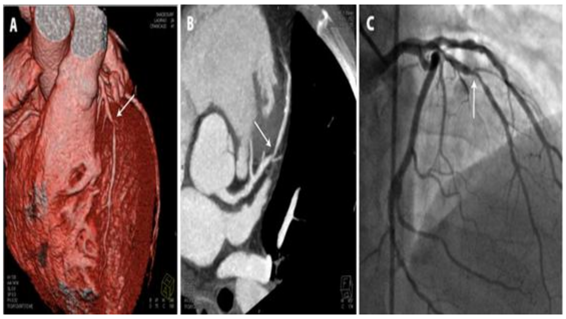


MDCT showing curved and lumen image showing stenosis in RCA which was confirmed by CCA

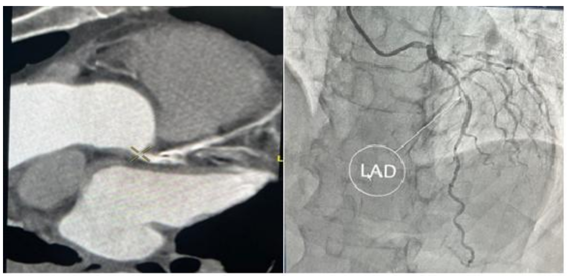
Recent studies have shown that performance of EBCT and MDCT angiography is reduced by coronary motion, and that this factor is most evident in those coronary segments in which velocity of motion is greatest, namely the LCX and the RCA. Since rapid coronary motion causes a reduction of image quality, we expect to see better results for detection of coronary stenoses in those braches which experience less motion during diastole. The separate evaluation of the data for each coronary branch yielded the highest sensitivity (0.95) for detection of coronary lesions within the LAD compared to the RCA and LCX with values of sensitivity of 0.88 and 0.78, respectively. This result in accordance with the fact that the LAD experiences less rapid motion than the RCA and the LCX during the diastole phase of the cardiac cycle. Only slight variations of specificity were observed between the three coronary branches, suggesting that the different motion patterns do not induce a large difference in false positive findings.[15] Among 60 patients included in the study, congenital anomalies detected in two patients where separate origin of RCA, LAD &LCX from right coronary cusp is seen in one patient and myocardial bridging of left anterior descending artery (LAD) seen in another patient.



A) MDCT CA with retrospective ECG gating. MIP image showing stenosis in LAD and D1. B) CCA image shows stenosis LAD (mid segment)

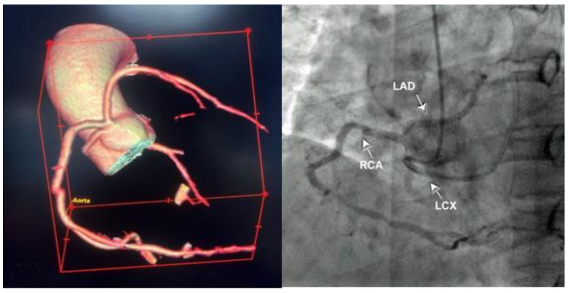


a) volume rendering image. b). MIP Axial image shows significant stenosis in proximal LAD. Which is confirmed by CCA (c).



a) curved MPR showing calcified plaque in proximal LAD causing stenosis b) CCA image showing stenosis in proximal LAD.

Picture showing semi-automated method to calculate calcium score



Volume rendering image showing separate origin of RCA, LAD & LCX from Rt coronary cusp. CCA also showing the same findings with no evidence of stenosis.

Soft plaques are coronary lesions that show no calcification and contain a lipid core covered by a thin fibrous cap. These lesions are less stable than calcified plaque and are more likely to rupture causing an acute coronary event.[16] Soft plaques cannot be differentiated from other coronary lesions with CCA since only the vessel lumen and not the tissue of the lesion itself is depicted with this modality. Intravascular ultrasound may be performed CCA in order to determine plaque morphology but is an expensive during procedure which is not performed on a standard basis. Ideally, soft plaques may be identified with CTA since coronary calcium is evident in CT angiograms. The potential of assessing plaque morphology is a strong advantage of CTA, but the small size of coronary lesions and the rapid cardiac motion demand an increase in spatial and temporal resolution for the reliable depiction of plaque morphology.

CONCLUSION

The present study has high negative predictive value (98.08%) suggests that 128- Slice MDCT coronary angiography is a good screening modality for evaluation of patients with mild to intermediate risk factors who might otherwise require invasive angiography. It may be used to evaluate the coronary artery anomalies and also in coronary evaluation in patients undergoing major non- cardiac surgery.

REFERENCES

1. Gupta R, Mohan I, Narula J. Trends in Coronary Heart Disease Epidemiology in India. Ann Glob Health. 2016 Mar-Apr;82(2):307-15.
2. Ashraf S, Brener SJ. Risks and complications of coronary angiography: a comprehensive review. Glob J Health Sci. 2012 Jan 1;4(1):65-93.

3. Budoff MJ, Achenbach S, Blumenthal RS, Carr JJ, Goldin JG, Greenland P, et al. Assessment of coronary artery disease by cardiac computed tomography: a scientific statement from the American Heart Association Committee on Cardiovascular Imaging and Intervention, Council on Cardiovascular Radiology and Intervention, and Committee on Cardiac Imaging, Council on Clinical Cardiology. Circulation. 2006; 114:1761–1791
4. Clemente A, Seitun S, Mantini C, Gentile G, Federici D, Barison A, Rossi A, Cuman M, Pizzuto A, Ait-Ali L, Bossone E, Cademartiri F, Chiappino D. Cardiac CT angiography: normal and pathological anatomical features-a narrative review. Cardiovasc Diagn Ther. 2020 Dec;10(6):1918-1945.
5. Nieman K, Rensing BJ, van Geuns RJ, Vos J, PattynamaPM,KrestinGP, et al. Non-invasive coronary angiography with multislicespiral computed tomography: impact of heart rate.Heart.2002;88:470-474.
6. Raff GL, Gallagher MJ, O’Neill WW, Goldstein JA. Diagnostic Accuracy of Noninvasive Coronary Angiography Using 64-Slice Spiral Computed Tomography. J Am.CollCardiol.2005; 46:552-57.
7. Nikolaou K, Knez A, Rist C, Wintersperger BJ, Leber A, Johnson T. Accuracy of 64-MDCT in the Diagnosis of Ischemic heart Disease. AJR. 2006; 187:111-17.
8. Ronny R Buechel, Aju P Pazhenkottil, Bernhard A Herzog, Michael Brueckner, Rene Nkoulou, Jelena R Ghadri et al. Prognostic Performance of Low-dose CoronaryCT Angiography with Prospective ECG Triggering. Disclosures Heart. 2011; 97(17):1385-1390.
9. Kim JS, Choo KS, Jeong DW, Chun KJ, Park YH, Song SG, Park JH, Kim JH, Kim J, Han D, Lim SJ. Step-and-shoot prospectively ECG-gated vs. retrospectively ECG-gated with tube current modulation coronary CT angiography using 128-slice MDCT patients with chest pain: diagnostic performance and radiation dose. Acta Radiol. 2011 Oct 1;52(8):860-5.
10. Hong C, Becker CR, Huber A, Schoepf UJ, OhnesorgeB, Knez A et al. ECG-gated reconstructed multi-detector row CT coronary angiography: effect of varying trigger delay on image quality. Radiology.2001;220:712- 717.
11. A.F. Kopp, S. Schroeder , A. Kuettner , A. Baumbach, C. Georg , R.Kuzoet al.Non-invasive coronary angiography with high resolution multidetector-row computed tomography. Results in 102 patients. Eur Heart J. 2002 Nov; 23 (21):1714-25.
12. Gorenoi V, Schönermark MP, Hagen A.CT coronary angiography vs. invasive coronary angiography in CHD.GMS Health TechnolAssess. 2012; 8:Doc02.
13. Duarte R, Miranda D, Fernández-Pérez G, Costa JC. Coronariografía mediante tomografía computarizada con sincronización prospectiva. Comparación de la calidad de imagen y dosis de radiación con equipos de 128 detectores de fuente única y doble fuente [Coronary CT angiography using a prospective protocol. Comparison of image quality and radiation dose between dual source CT and single source CT]. Radiologia. 2013 Jul-Aug;55(4):315-22.
14. Chen BX, Ma FY, Wen ZY, Luo W, Zhao XZ et al..[Diagnostic value of 128- slice CT coronary angiography in comparison with invasive coronary angiography].ZhonghuaXinXue Guan Bing ZaZhi[Article in Chinese] 2008 Mar;36(3):223-8.
15. Ngam PI, Ong CC, Chai P, Wong SS, Liang CR, Teo LLS. Computed tomography coronary angiography - past, present and future. Singapore Med J. 2020 Mar;61(3):109-115.
16. Huang H, Virmani R, YounisH, Burke AP, Kamm RD, Lee RT. The impact of calcification on the biomechanical stability of atherosclerotic plaques. Circulation.2001; 103:1051-1056.

ISSN (O): 2687-5365; ISSN (P): 2753-6556