Original Article

Assessing the Diagnostic Efficacy of Multi-detector CT Angiography *versus* Digital Subtraction Angiography in Coronary Artery Disease : A Tertiary Care Centre Study

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Background : Coronary Artery Disease (CAD) represents a significant global health challenge, leading to high mortality rates. Traditional diagnostic approaches, primarily invasive, have limitations, necessitating the exploration of alternative, non-invasive diagnostic modalities like MDCT angiography.

Aims and Objectives : The study aims to evaluate the diagnostic performance of MDCT angiography in assessing CAD, comparing its effectiveness with traditional catheter angiography and examining its potential as a primary diagnostic tool.

Design : This research is a diagnostic accuracy study, employing a prospective cohort design to assess the efficacy of MDCT angiography.

Setting : The study was conducted in the Department of Radiodiagnosis at a tertiary care center, ensuring access to advanced diagnostic technology and a diverse patient population.

Materials and Methods : A cohort of 30 patients presenting with symptoms indicative of CAD underwent MDCT angiography followed by catheter angiography. The study utilized a 128-slice Philips CT machine for imaging and images were analyzed for stenosis level, plaque characterization, and other findings.

Main Outcome Measures : The primary outcome measures included the sensitivity, specificity, positive predictive value (PPV) and Negative Predictive Value (NPV) of MDCT angiography in diagnosing CAD, alongside a comparison of diagnostic accuracy between MDCT and traditional angiography.

Sample Size : The study sample consisted of 30 patients, selected based on presenting symptoms and preliminary tests suggestive of CAD.

Results : MDCT angiography demonstrated high diagnostic accuracy, with overall sensitivity and specificity rates comparable to catheter angiography. It was particularly effective in identifying the degree of stenosis, with accuracy rates exceeding 96% for various stenosis levels. Calcium scoring provided additional prognostic information, correlating with the severity of CAD.

Conclusions : MDCT angiography is a reliable, non-invasive diagnostic tool for CAD, offering comparable accuracy to catheter angiography. Its ability to assess stenosis level, along with additional insights into plaque composition and coronary anatomy, supports its use as an alternative diagnostic approach.

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Key words : **Coronary Artery Disease, Multidetector Computed Tomography (MDCT), Stenosis Grading, Anatomical Variants, Calcium Scoring.**

Coronary Artery Disease (CAD) poses a significant Worldwide health threat, characterized by compromised blood flow through coronary arteries due to atheromas[1]. Its impact is profound, constituting a leading cause of mortality worldwide, with over 75% of deaths occurring in developing nations. In 2016, CAD-related diseases claimed 17.5 million lives globally, reflecting a stark contrast between developed and developing countries due to epidemiological transitions.

India mirrors this trend, grappling with a rising cardiovascular disease burden, notably CAD, with an estimated 54.5 million cases[2]. The urgency for effective diagnostic and therapeutic strategies is evident.

Editor's Comment :

- This study demonstrates that MDCT angiography is highly accurate for diagnosing Coronary Artery Disease (CAD), comparable to traditional catheter angiography.
- It offers detailed insights into stenosis severity, plaque characteristics and coronary anatomy, highlighting its potential as a primary diagnostic tool in CAD assessment.

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Traditionally, invasive techniques like catheter coronary angiography were the gold standard for CAD diagnosis but offered limited insights[3]. The advent of non-invasive imaging, notably multi-detector Computed Tomography (CT) angiography, revolutionized CAD diagnosis. With high-resolution imaging and minimal radiation exposure, CT angiography provides precise anatomical detail and plaque characterization.

The evolution of CT technology, from single-row to multi-row detectors, has enhanced diagnostic accuracy[4]. This shift underscores a transformative era in CAD diagnosis, with CT angiography offering unprecedented clarity in visualizing coronary plaques and assessing calcification.

This research aims to measure the diagnostic performance of MDCT angiography in evaluating CAD in a tertiary care centre. It aims to prove that it can be utilized as an alternative diagnostic modality in the evaluation of CAD.

This discourse traces the evolution of CAD diagnosis, emphasizing the transition from invasive to non-invasive modalities. Through historical milestones and technological advancements, it highlights the journey towards improved patient outcomes and cardiovascular health. Ultimately, the narrative underscores the pivotal role of CT angiography in reshaping CAD diagnosis and management paradigms, promising a future of enhanced precision and clinical efficacy.

Materials and Methods

The study was commenced after receiving approval from the Institutional Ethical Committee. A cohort of 30 patients presenting with chest pain symptoms was enrolled for CT coronary angiography prior to undergoing a Catheter angiogram.

All patients exhibiting clinical, ECG, or preliminary imaging indicating CAD have been involved in the research. Patients with Chronic Kidney Disease, pregnant women, those having a history of contrast allergy, and individuals unwilling to consent to the study were excluded from the study.

The study involved both male and female patients across various age groups referred to the Department of Radiodiagnosis at our hospital. Prior radiological and blood investigation reports were collected and informed consent was attained from each patient after explaining the investigation procedure.

Using a 128-slice Philips CT machine, patients were positioned supine on the table and ECG leads were connected to monitor heart rate. Prospective ECG gating was employed to ensure a desirable heart rate of 60-65 bpm before initiating the study. The procedure included obtaining the calcium score and placing the tracker in the descending aorta. A non-ionic contrast of approximately 80 ml was injected at 6ml/sec, followed by a saline rush of 50ml at 5ml/sec via a double-barrel injector.

Images were saved and reconstructed, and then subjected to post-processing using Maximum Intensity Projection (MIP), Volume Rendering Technique (VRT), and Multiplanar Reconstruction (MPR). Subsequently, images were meticulously assessed on the console, and the level and percentage of stenosis were noted. Additionally, other cardiac along non-cardiac findings were documented.

The gold standard technique for confirmation was invasive catheter angiography, performed by cardiologists in the cardiac catheterization lab under C-arm guidance[5]. A comparative analysis of images from both studies was conducted and charts were prepared accordingly.

A 57 y/o male presented with chest pain clinically diagnosed as recent Non-ST elevated MI and underwent a CT angiogram before a conventional coronary angiogram. It showed LAD narrowing, while VR and cMPR images display diffuse LAD narrowing (Fig 1). The MIP and VR images also illustrated the diseased LAD (Fig 2). A coronary angiogram revealed proximal LAD showing a diffuse eccentric lesion with 80-90% stenosis at its narrowest part (Fig 3). Subsequently the patient underwent stenting.

Calculation of positive predictive value (PPV), sensitivity, specificity, and Negative Predictive Value (NPV) was performed based on patients diagnosed with CAD.

Result

The research encompassed 30 patients presenting with the symptoms suggestive of CAD. The age distribution revealed a predominant involvement in the 51-60 years age group, comprising 36% of the cases, followed by the 41-50 years age group at 23.33% (Fig 4). Males were more frequently affected than females, constituting 63.33% of the patient cohort (Table 1).

Anatomical variants observed in the study included myocardial bridging (10%), ramus intermedius (6.67%), and anomalous origin of the left primary coronary artery (3.33%) (Fig 5). Coronary dominance analysis revealed that 80% of cases exhibited right dominance, followed by left dominance and co-dominance (Fig 6).

Agatston calcium scoring demonstrated that 70% of patients had scores ranging between 100 and 400, indicating a significant calcification burden in the studied population (Table 2). There exists a progressive increase in calcium stores with advancing age,

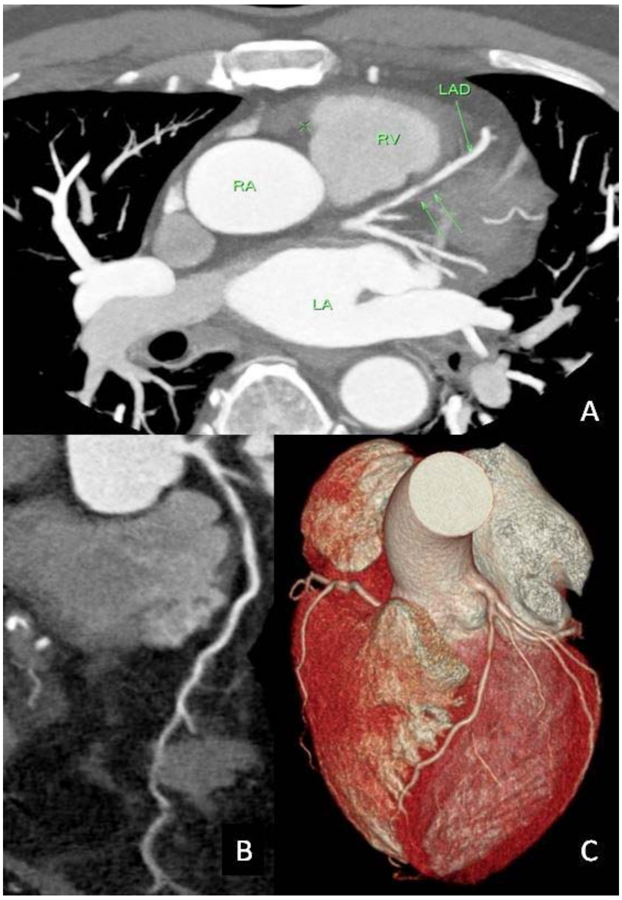

Fig 1 — (A) axial section annotated image (green arrows) shows LAD narrowing, (B) cMPR, (C) VR images

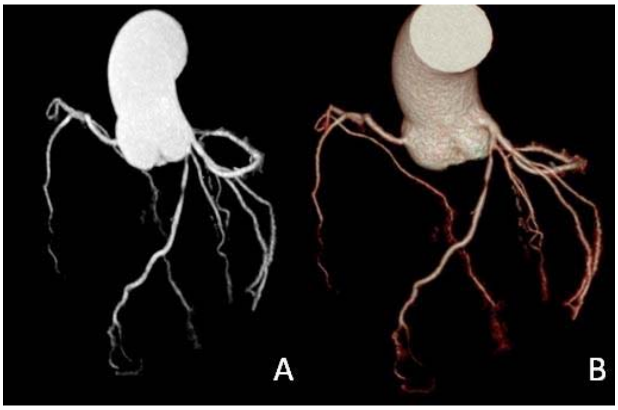

Fig 2 — (A) MIP and (B) VR images showing the diseased LAD

indicating a correlation between age and coronary artery calcification (Fig 7).

Assessment of coronary artery segments revealed the middle, proximal and distal segments of the LAD (left anterior descending) artery to be the most commonly involved (70%) followed by similar right coronary artery segments (37%) (Fig 8).

The overall accuracy of CT coronary angiogram in assessing stenosis of <50%, 50-70%, and >70% were 96.55, 96.58% and 98.28% respectively (Fig 9). For mild 50-70% (p=0.316) and severe (p=0.85) stenosis, the demonstrative accuracy of traditional coronary angiography and 128-slice Computed Tomography was equivalent, with no significant variations among the 2 techniques (p >0.05).

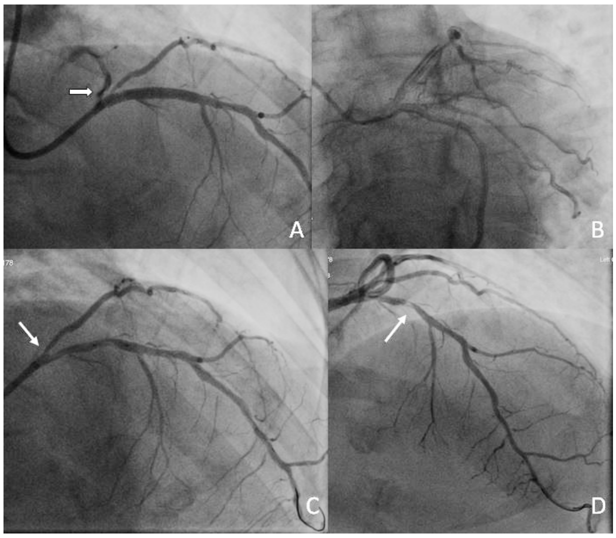

Fig 3 — (A,B) LAD – Type III, Proximal LAD shows diffuse eccentric lesion with 80 – 90% stenosis

Table 1 — *Showing illustrates the distribution of age groups categorized by gender among patients*

Age in years	Male		Female	
	N	%	N	%
≤40 years	1	5.26	1	9.09
41-50 years	5	26.32	2	18.18
51-60 years	8	42.11	3	27.27
61-70 years	3	15.79	4	36.36
71-80 years	1	5.26	1	9.09
>80 years	1	5.26	0	0
Total	19	100	11	100

Evaluation of the level of stenosis demonstrated high sensitivity and specificity of CT coronary angiogram in detecting stenosis levels, with sensitivity ranging from 92% to 98.25% and specificity ranging from 95% to 100% across different stenosis levels. Positive Predictive Values (PPV) ranged from 94.92% to 100%, while Negative Predictive Values (NPV) ranging from 97.8% to 100%. Total accuracy ranged from 96.55% to 98.28%, indicating the robust diagnostic performance of CT coronary angiogram in detecting and characterizing coronary artery stenosis when in comparison to catheter angiography, the gold standard (Table 3).

In summary, the study underscores the efficacy of CT coronary angiography in diagnosing CAD and assessing coronary artery stenosis levels with high

Table 2 — *Agatston calcium scoring, 70% patients have score of 100-400*

Agatston Calcium	N	%
0	6	20
1-100	3	10
100-400	21	70
>400	0	0
Total	30	100

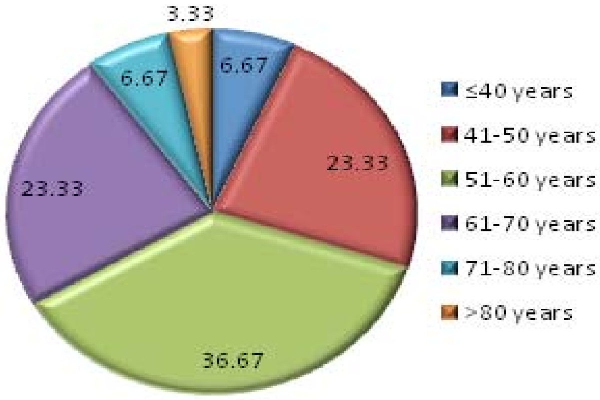

Fig 4 — Graphic representation of age group involvement, 36% patients are from 51-60 years age

accuracy and reliability, offering valuable insights into patient management and treatment planning.

Discussion

Our study focused on evaluating the diagnostic performance of 128-slice MDCT in assessing CAD among 30 patients presenting with cardiac complaints. Our findings provide valuable insights into the efficacy of MDCT in diagnosing CAD, assessing stenosis grading and identifying anatomical variants.

Age and gender distribution within our study cohort revealed a predominant representation of patients aged 60 to 70 years, with males exhibiting a higher prevalence, particularly in the 50-60 years age group. These demographic trends reflect the well-established

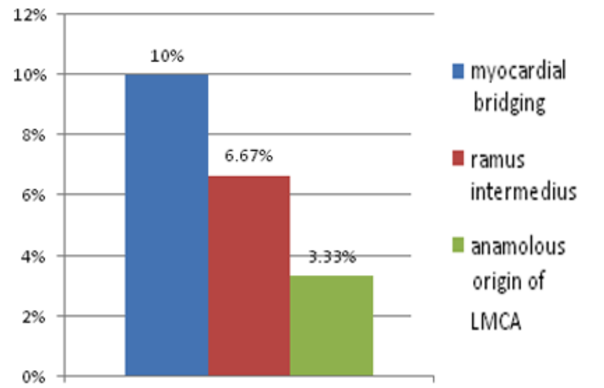

Fig 5 — Graphical representation of anatomical variants found in the study

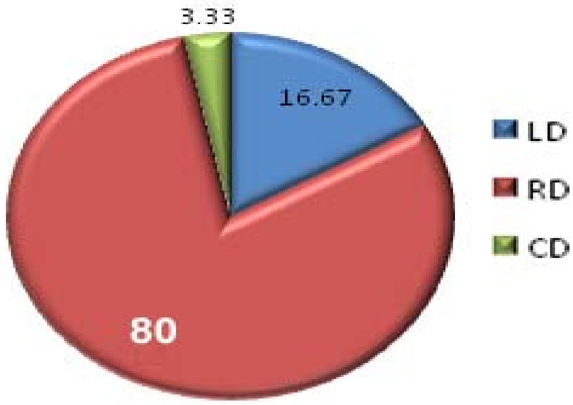

Fig 6 — Graphical representation of coronary dominance

association between advancing age, male gender and increased susceptibility to CAD, emphasizing the need for targeted screening and diagnostic interventions in at-risk populations.

Assessment of stenosis grading using MDCT demonstrated high sensitivity and specificity across different severity categories, with notable values for stenosis <50% (92%), 50-70% (98.25%) and >70% (94.12%). These findings corroborate previous research by Doris, *et al* and Antonio Moscariello, *et al* highlighting the consistent diagnostic accuracy of MDCT in CAD assessment[6,7].

Moreover, our study revealed an overall accuracy of 128-slice MDCT in assessing stenosis (<50%, 50-70%, and >70%) ranging from 96.55% to 98.28%. Importantly, comparative analysis with conventional coronary angiography demonstrated comparable diagnostic precision, with no significant differences observed for moderate (50-70%) and severe stenosis. However precision of 128-slice MDCT was better than

Table 3 — *Catheter angiogram findings are taken as control and the diagnostic performance of CT coron*

Characteristics	<50% stenosis	50-70% stenosis	>70% stenosis
True Positive	23(19.83%)	56(47.86%)	32(27.59%)
False Positive	2(1.72%)	3(2.56%)	0(0%)
False Negative	2(1.72%)	1(0.85%)	2(1.72%)
True Negative	89(76.72%)	57(48.72%)	82(70.69%)
Sensitivity (95% C.I)	92% (73.97% to 99.02%)	98.25% (90.61% to 99.96%)	94.12% (80.32% to 99.28%)
Specificity (95% C.I)	97.8%(92.29% to 99.73%)	95% (86.08% to 98.96%)	100%(95.60% to 100.00%)
PPV (95% C.I)	95% (94.40% to 97.85%)	94.92% (86.10% to 98.25%)	100%
NPV (95% C.I)	97.8% (92.17% to 99.41%)	98.28% (89.09% to 99.75%)	100%
Overall accuracy (95% C.I)	96.55% (91.41% to 99.05%)	96.58% (91.48% to 99.06%)	98.28% (93.91% to 99.79%)

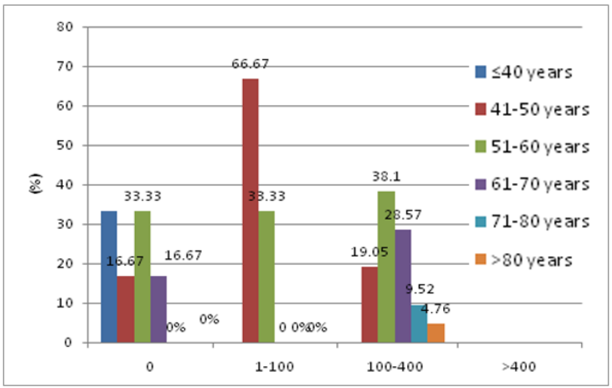

Fig 7 — Age and calcium scoring comparison according to age in a graphical representation

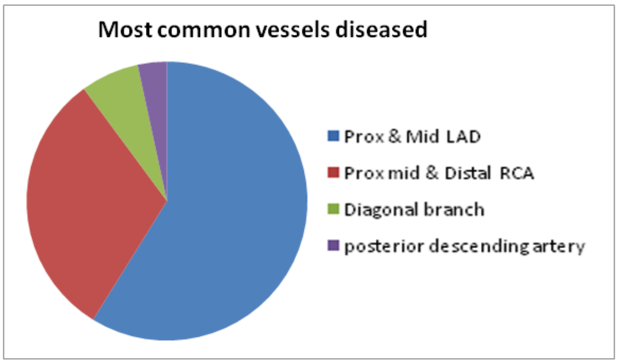

Fig 8 — Among all segments of coronary arteries proximal and mid segments are commonly involved

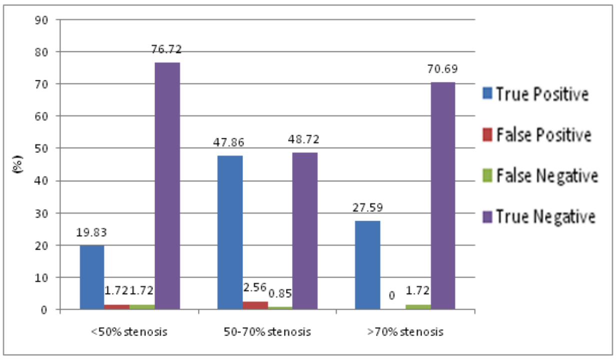

Fig 9 — Graphical representation of the predictability of CT angiogram

that of 64-slice MDCT as proved in Bayar SN, *et al*[8].

As per Miller, *et al* (2008)'s research, patients who underwent coronary calcium scoring and CT angiography before undergoing conventional invasive coronary angiography demonstrated that coronary CTA had a diagnostic accuracy of 85% at ruling out or detecting coronary stenoses, 90% at specificity and 91 percent at positive predictive negative predictive values for coronary CTA[9].

Gorenoi, Schonermark Hagen, *et al* (2012) says CT coronary angiography had a greater sensitivity in comparison to invasive coronary angiography (80% *versus* 67%), and the specificity of coronary CTA was 67%, compared to 75% in invasive coronary angiography[10].

Notably, MDCT tends to overestimate moderate (50-70%) stenosis, particularly in regions with heavily calcified plaques. This emphasizes the importance of comprehensive interpretation and integration of MDCT findings with clinical and angiographic assessments to optimize diagnostic accuracy and guide therapeutic decision-making[11,12].

Anatomical variants such as myocardial bridging and ramus intermedius were observed in our study cohort, albeit at lower frequencies compared to prior literature likely due to genetic and geographic disturbances[13]. These variations underscore the diverse anatomical manifestations of CAD and highlight the importance of individualized patient evaluation and management strategies[14].

Assessment of plaque characteristics using MDCT enabled the differentiation of calcified, non-calcified, and mixed plaques, providing valuable insights into plaque vulnerability and potential prognostic implications[15]. Additionally, the evaluation of coronary artery dominance and the presence of stents facilitated comprehensive anatomical assessment and therapeutic planning.

Our study also investigated the prognostic value of MDCT through calcium scoring, revealing predominant calcium scores between 100 and 400, particularly among patients aged above 60 years. These findings underscore the prognostic importance of coronary artery calcification burden in CAD risk stratification and management[16].

Importantly, MDCT demonstrated favorable radiation measurements, albeit higher than conventional angiography, with no observed contrast-related complications in our study cohort. This highlights the safety and feasibility of MDCT as a non-invasive imaging modality for CAD assessment[17].

In summary, our study underscores the diagnostic efficacy and prognostic value of 128-slice MDCT in CAD assessment, with high sensitivity, specificity, and overall accuracy in detecting coronary vessel stenosis. Despite some limitations, including overestimation of moderate stenosis and variations in anatomical findings, MDCT remains a valuable tool in CAD diagnosis and management.

Conclusion

MDCT coronary angiogram is an invasive, cheaper, faster modality that can be utilized as an alternative diagnostic modality to evaluate the degree of stenosis in a CAD patient. The overall accuracy of CT angiogram in finding true negative cases (no plaque/narrowing) is 100%. The CT coronary angiogram diagnostic performance in detecting the percentage of stenosis in coronary arteries was found to be comparable with a catheter angiogram. In addition, we also found that a CT angiogram provides more information about calcium load, anatomical variants, nature of the plaque, and non-coronary findings like chamber anatomy.

Limitations of the study : Smaller study population and a shorter duration of follow-up of cases were the two limitations of the study.

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Ethics approval : Not applicable.

Declaration of consent : The authors at test that they have all the necessary permissions in place to publish this case study and any related photos.

Competing interests : The authors claim they have no competing interests, either financial or non-financial.

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Declaration of generative AI and AI-assisted technologies in the writing process : During the preparation of this work, Open AI was used in order to improve language and readability. After using this tool/ service, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the publication.

Conflict of Interest : The authors declare no conflict of interest.

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