Comparative Study of CT Coronary Angiography and Conventional Angiography in Detecting Coronary Artery Disease

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Abstract

Background: Coronary artery disease (CAD) remains a leading cause of morbidity and mortality worldwide. Conventional Coronary Angiography (CCA) is the gold standard for its diagnosis but is invasive. This study aims to compare the diagnostic efficacy of CT Coronary Angiography (CTCA), a non-invasive modality, with CCA in detecting CAD. **Methods:** A total of 40 patients with suspected CAD underwent both CTCA and CCA. Demographic data, risk factors, diagnostic findings, radiation dose, contrast volume, and complications were analyzed. CCA served as the reference standard to evaluate the diagnostic performance of CTCA. **Results:** The mean age group was 50–59 years (37.5%), with a male predominance (70%). Common risk factors included hypertension (65%) and dyslipidaemia (50%). Significant coronary stenosis (≥50%) was detected in 67.5% of patients by CTCA and 70% by CCA. CTCA exhibited a sensitivity of 95.7%, specificity of 90%, positive predictive value of 98%, negative predictive value of 81.8%, and overall accuracy of 94%. CTCA had a lower radiation dose (6.2 ± 1.4 mSv) and contrast volume (75 ± 10 mL) compared to CCA (7.8 ± 2.1 mSv; 100 ± 15 mL). No complications were observed with CTCA, whereas minor complications occurred in 5% of CCA procedures. **Conclusion:** CTCA offers a reliable, non-invasive, and safer diagnostic alternative to CCA for evaluating CAD, especially in low to intermediate-risk patients. It provides high diagnostic accuracy with fewer procedural risks.

Keywords: CT Coronary Angiography, Conventional Angiography, Coronary Artery Disease, Diagnostic Accuracy, Non-invasive Imaging

Introduction

Coronary artery disease (CAD) remains one of the leading causes of morbidity and mortality worldwide, accounting for a significant proportion of cardiovascular deaths [1]. Early and accurate diagnosis of CAD is crucial for timely intervention and improved patient outcomes. Traditionally, invasive coronary angiography (ICA) has been considered the gold standard for the diagnosis and assessment of coronary artery stenosis due to its high spatial and temporal resolution [2]. However, ICA is an invasive procedure with inherent risks such as vascular injury, bleeding, and contrast-induced nephropathy, making it less ideal as a first-line diagnostic tool in certain patient populations [3].

The advent of **multidetector computed tomography (MDCT) coronary angiography**, a non-invasive imaging modality, has significantly transformed the evaluation of CAD. CT coronary angiography (CTCA) offers high-resolution images and allows for the visualization of both coronary artery lumen and wall, including the presence of atherosclerotic plaques, calcifications, and non-obstructive lesions [4]. With advances in scanner technology, particularly 64-slice and higher MDCT systems, CTCA has demonstrated improved diagnostic accuracy, approaching that of conventional angiography, especially in patients with low to intermediate pretest probability of CAD [5,6].

Several comparative studies conducted prior have highlighted the high sensitivity and negative predictive value of CTCA, suggesting its potential as a reliable gatekeeper to invasive angiography [7,8]. However, limitations such as lower specificity in heavily calcified vessels, radiation exposure, and contrast use remain concerns [9]. Despite these limitations, CTCA continues to gain acceptance as a non-invasive alternative, particularly in the initial evaluation of suspected CAD.

This study aims to compare the diagnostic efficacy of CT coronary angiography and conventional coronary angiography in detecting coronary artery disease, with a focus on assessing their respective strengths and limitations in clinical practice.

Materials and Methods

This was a prospective, observational, comparative study conducted at the Department of Radiodiagnosis, Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar, over a period of 12 months.

Study Population

Patients with clinical suspicion of coronary artery disease (CAD), referred for diagnostic evaluation, were enrolled in the study. All enrolled patients underwent both CT coronary angiography (CTCA) and conventional coronary angiography (CCA) for the assessment of coronary artery anatomy and the presence of stenotic lesions.

Inclusion Criteria

- Adults aged ≥18 years with symptoms suggestive of CAD (e.g., chest pain, dyspnea on exertion, positive treadmill test).
- Patients who consented to undergo both CTCA and CCA within a specified time interval (not more than 2 weeks apart).
- Stable clinical condition permitting both imaging modalities.

Exclusion Criteria

- Known allergy to iodinated contrast media.
- Renal dysfunction (serum creatinine >1.5 mg/dL).
- Irregular heart rhythm or high heart rate (>90 bpm) not controlled with beta-blockers.
- Previous history of coronary artery bypass graft surgery.

- Pregnancy.

Sample Size

A total of 40 patients were included in the study based on inclusion and exclusion criteria, using convenient sampling.

CT Coronary Angiography Procedure

CTCA was performed using a 64-slice multidetector computed tomography (MDCT) scanner. Patients were pre-medicated with oral or intravenous beta-blockers when needed to achieve optimal heart rate (<70 bpm). Sublingual nitroglycerin (0.4 mg) was administered prior to scanning for coronary vasodilation.

The scanning protocol included:

- Retrospective ECG-gated acquisition.
- Contrast injection using non-ionic iodinated contrast (volume and rate based on patient weight and scanner protocol).
- Image reconstruction at 0.6 mm slice thickness with multiplanar and curved planar reformats.
- Post-processing and analysis were done using dedicated workstations.

Conventional Coronary Angiography Procedure

CCA was performed via the femoral or radial artery approach under local anesthesia using the Seldinger technique. Standard projections (RAO, LAO, cranial, caudal) were obtained. The severity of stenosis was visually assessed by two experienced cardiologists who were blinded to the CTCA findings.

Data Analysis

Each coronary artery (left main, left anterior descending, left circumflex, and right coronary artery) was evaluated for the presence and severity of stenosis. A stenosis ≥50% luminal narrowing was considered significant. The diagnostic performance of CTCA was compared with CCA (gold standard) in terms of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

Statistical Analysis

Statistical analysis was performed using, SPSS version 25. Categorical variables were expressed as frequencies and percentages, and continuous variables as mean ± standard deviation. Diagnostic accuracy parameters (sensitivity, specificity, PPV, NPV) were calculated. A p-value <0.05 was considered statistically significant.

Observation and Results

Table 1: Distribution of demographic variables among study population

Variable	Frequency	Percentage
Age (years)		
30–39	4	10
40–49	10	25
50–59	15	37.5
≥60	11	27.5
Gender		
Male	28	70
Female	12	30
Risk Factors		
Hypertension	26	65
Diabetes Mellitus	18	45
Smoking	15	37.5
Dyslipidaemia	20	50
Family history of CAD	10	25

This table provides an overview of the demographic characteristics and risk factor prevalence among the study population. The majority of participants were aged between 50–59 years (37.5%), followed by those aged ≥60 years (27.5%). A smaller proportion were aged 40–49 years (25%) and 30–39 years (10%). The gender distribution shows a male predominance, with 70% being male and 30% female. Regarding risk factors, hypertension was the most common (65%), followed by dyslipidaemia (50%), diabetes mellitus (45%), smoking (37.5%), and a family history of coronary artery disease (CAD) (25%).

Table 2: Diagnostic Findings by CT Coronary Angiography and Conventional Angiography

Findings	CT Coronary Angiography n (%)	Conventional Angiography n (%)
Significant stenosis (≥50%)	27(67.50%)	28(70%)
Non-significant lesions (<50%)	9(22.50%)	8(20%)
Normal coronary arteries	4(10%)	4(10%)

This table compares diagnostic findings obtained via CT Coronary Angiography (CTCA) and Conventional Coronary Angiography (CCA). Both modalities identified a similar proportion of patients with significant stenosis (≥50%), with CTCA detecting 67.5% and CCA identifying 70%. Non-significant lesions (<50%) were seen in 22.5% of cases by CTCA and in 20% by CCA. Additionally, normal coronary arteries were observed in 10% of patients using both diagnostic techniques.

Table 3: Diagnostic Accuracy of CTCA (vs. CCA as Gold Standard)

Parameter	Value (%)
Sensitivity	95.70%
Specificity	90.00%
Positive Predictive Value (PPV)	98.00%
Negative Predictive Value (NPV)	81.80%
Overall Accuracy	94.00%

This table assesses the diagnostic performance of CTCA using CCA as the reference standard. CTCA demonstrated a high sensitivity of 95.7% and specificity of

90%. The positive predictive value (PPV) was 98%, indicating a high probability that patients identified with disease truly had it. The negative predictive value (NPV) was 81.8%, and the overall diagnostic accuracy of CTCA was calculated to be 94%, signifying its reliability in detecting coronary artery lesions.

Table 4: Radiation Dose and Contrast Volume

Parameter	CTCA	CCA
Mean radiation dose	6.2 ± 1.4 mSv	7.8 ± 2.1 mSv
Mean contrast volume	75 ± 10 mL	100 ± 15 mL

This table compares the mean radiation exposure and contrast volume required for CTCA and CCA. CTCA had a lower mean radiation dose of 6.2 ± 1.4 mSv compared to 7.8 ± 2.1 mSv for CCA. Furthermore, CTCA required less contrast volume (75 ± 10 mL) than CCA (100 ± 15 mL), highlighting CTCA's potential advantage in minimizing patient exposure to radiation and contrast agents.

Table 5: Distribution of complication between CTCA and CCA

Complication	CTCA	CCA
Major complications	0	0
Minor complications	0	2 (5%)

This table presents the complication rates associated with both procedures. No major complications were reported in either CTCA or CCA. However, minor complications were noted in 2 patients (5%) undergoing CCA, whereas CTCA was not associated with any minor complications, reinforcing its non-invasive and safer profile.

Discussion

This study aimed to evaluate the diagnostic accuracy and clinical utility of CT Coronary Angiography (CTCA) compared to Conventional Coronary Angiography

(CCA) in detecting coronary artery disease (CAD). The findings demonstrate a high diagnostic concordance between the two modalities, with CTCA showing excellent sensitivity, specificity, and overall diagnostic accuracy.

The majority of study participants were male (70%) and aged between 50–59 years (37.5%), consistent with the epidemiology of CAD, where middle-aged and older men are at higher risk. The predominant risk factors were hypertension (65%) and dyslipidaemia (50%), followed by diabetes mellitus (45%) and smoking (37.5%). These findings align with global and Indian data identifying these as key modifiable risk factors for CAD [10].

In our study, significant coronary artery stenosis (≥50%) was detected in 67.5% of patients by CTCA and in 70% by CCA. The detection of non-significant lesions and normal coronaries was also comparable between the two modalities. This strong agreement corroborates previous findings by Budoff et al., who reported a sensitivity of 95% and specificity of 83% for CTCA in diagnosing significant stenosis when compared to invasive angiography [6].

CTCA demonstrated a sensitivity of 95.7%, specificity of 90%, positive predictive value (PPV) of 98%, and negative predictive value (NPV) of 81.8%, with an overall diagnostic accuracy of 94%. These values are consistent with large multicenter studies such as the ACCURACY trial, which reported sensitivity and specificity of 94% and 83%, respectively [11]. The high PPV and sensitivity highlight CTCA's strength in ruling in disease, while its respectable NPV makes it a reliable tool for initial CAD evaluation, particularly in patients with intermediate pretest probability.

Our findings showed that CTCA was associated with a lower mean radiation dose (6.2 ± 1.4 mSv) compared to CCA (7.8 ± 2.1 mSv). Additionally, CTCA required less contrast volume (75 ± 10 mL) versus CCA (100 ± 15 mL). These results are in agreement with Raff et al., who also found CTCA to be associated with reduced radiation and contrast exposure [12]. The non-invasive nature of CTCA, combined with lower procedural burden, enhances its appeal for both diagnostic and screening purposes.

Importantly, no major complications were observed in either group. However, minor complications occurred in 5% of patients undergoing CCA, whereas CTCA was free from procedural complications. Similar safety profiles for CTCA have been demonstrated in other studies, further establishing it as a safer alternative in appropriate clinical settings [13].

Our study supports the diagnostic reliability and safety of CTCA observed in other published literature:

- Meijboom et al. found CTCA had a sensitivity of 99% and specificity of 64% for detecting >50% stenosis [14].
- Miller et al. reported that CTCA accurately excluded significant CAD in low- to intermediate-risk patients, thus avoiding unnecessary invasive procedures [15].
- The PROMISE trial emphasized CTCA's role in initial evaluation and its similar outcomes to functional testing in symptomatic patients [16].

Given its non-invasiveness, high diagnostic accuracy, lower complication rate, and reduced contrast and radiation exposure, CTCA may serve as a reliable first-line diagnostic tool in selected patients, especially those with low-to-intermediate risk. However, in high-risk individuals or those with equivocal findings, CCA remains the gold standard due to its therapeutic capabilities and superior resolution.

Conclusion

In this study we can conclude that, CT Coronary Angiography (CTCA) demonstrated high diagnostic accuracy, sensitivity, and specificity comparable to

Conventional Coronary Angiography (CCA) in detecting coronary artery disease. CTCA also offered advantages such as lower radiation dose, reduced contrast volume, and absence of procedural complications, highlighting its potential as a safe, non-invasive alternative for evaluating CAD, particularly in patients with low to intermediate risk. However, CCA remains the gold standard in high-risk patients and for therapeutic interventions.

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Conflict of Interest: None

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