DIAGNOSTIC ACCURACY OF CORONARY COMPUTED TOMOGRAPHY ANGIOGRAPHY FOR DETECTING ISCHEMIC HEART DISEASE IN ADULTS AGED OVER 40 YEARS WITH CARDIOVASCULAR RISK FACTORS

Abdel Raouf Fouad
MD, FRCGP, PHD, MSC, Professor Interal Medicine & Diabetes, Eton university, US & UAE

Corresponding Author: Abdel Raouf Fouad, **Email Id:** abdelraouf555@yahoo.com

Abstract

Background: Ischemic heart disease (IHD) remains the main reason for cardiovascular mortality worldwide, accounting for approximately 16% of global mortality. In participants over 40 years of age, the incidence of cardiovascular risk factors significantly elevated the likelihood of coronary artery disease (CAD). The objective was to assess the diagnostic accuracy of CCTA for detecting ischemia-relevant CAD in adults aged >40 years with one or more cardiovascular risk factors.

Methods: This prospective single-center study was done on 150 cases aged >40 years presenting with suspected stable IHD and at least one cardiovascular risk factor. All patients underwent CCTA followed by ICA ± invasive FFR (≤0.80).

Results: Ischemia-relevant CAD was confirmed in 62 patients (41.3%). CCTA established a sensitivity of 96.8%, specificity of 80.5%, positive predictive value (PPV) of 77.2%, negative predictive value (NPV) of 97.7%, and overall diagnostic accuracy of 88.7%.

Conclusions: CCTA provides excellent diagnostic performance with very high negative predictive value, supporting its role as the gold-standard non-invasive diagnostic test for IHD in adults over 40 years with cardiovascular risk factors.

Keywords: Coronary computed tomography angiography, Ischemic heart disease, Coronary artery disease, Invasive Coronary Angiography, Fractional flow reserve

Introduction:

Ischemic heart disease (IHD) is the main reason for mortality globally and constitutes a significant public health challenge [1]. The incidence of coronary artery disease (CAD) rises markedly after the age of 40, especially in individuals possessing conventional cardiovascular risk factors involving hypertension, dyslipidaemia, obesity, smoking, diabetes mellitus and a premature CAD family history [2].

Invasive coronary angiography (ICA) has traditionally been regarded as the definitive standard for detecting CAD; nevertheless, it is an invasive procedure that carries procedural risks, such as vascular complications and contrast-induced nephropathy [3]. Furthermore, angiographic evaluation of luminal stenosis demonstrates limited correlation with lesion-specific ischemia, potentially resulting in over- or under-treatment [4].

Coronary computed tomography angiography (CCTA) provides high-resolution, non-invasive imaging of coronary anatomy, allowing precise determination of both obstructive and non-obstructive atherosclerotic disorder [5]. Extensive randomized trials have decumented that CCTA has superior negative predictive value and sensitivity in comparison to functional testing, rendering it particularly effective for excluding CAD [6, 7].

CCTA is now recommended as a primary evaluation test in cases with suspected stable CAD based on this expanding body of evidence [8-10]. Fractional flow reserve (FFR), assessed throughout

invasive angiography, has established itself as the gold standard for identifying lesion-specific ischemia and informing revascularization strategies [4].

This study prospectively evaluates the diagnostic accuracy of CCTA in adults aged >40 years with cardiovascular risk factors, using ICA with invasive FFR as the reference standard.

Patients and Methods:

This prospective single-center study was performed at DM Health care (Medcare & Aster), Dubai and included 150 cases aged >40 years presenting with suspected stable IHD and at least one cardiovascular risk factor.

An informed written consent was secured from the case.

Inclusion Criteria

- Age >40 years
- ≥1 cardiovascular risk factor
- Stable chest pain or anginal equivalent
- Written informed consent

Exclusion Criteria

- Known CAD (prior myocardial infarction, PCI, or CABG)
- Acute coronary syndrome
- Severe renal impairment (eGFR <30 mL/min/1.73 m²)
- Known contrast allergy
- Pregnancy
- Persistent arrhythmias preventing adequate CCTA

CCTA was conducted by a ≥128-slice CT scanner with ECG-gated acquisition, following Society of Cardiovascular Computed Tomography (SCCT) recommendations [10]. Heart rate control and sublingual nitrates were administered as appropriate.

ICA was performed in patients with obstructive or equivocal CCTA findings. Invasive FFR was measured for intermediate lesions (40–70%). An FFR value ≤0.80 defined ischemia-relevant disease [4].

Sample Size Calculation

Sample size was evaluated to estimate the sensitivity of CCTA for detecting ischemia-relevant CAD, based on previously published diagnostic studies [5, 11]. The following assumptions were applied: expected sensitivity of 95%, prevalence of ischemia-relevant CAD of 40%, margin of error of ±7%, and a confidence level of 95%. Using Buderer's formula for diagnostic accuracy studies $n = (Z^2 \times S \times (1 - S))/(d^2 \times P)$, the minimum required sample size was calculated to be 131 cases. To compensate for potential dropouts or incomplete invasive assessment, a total of 150 cases were enrolled in the study.

Statistical analysis

Statistical analysis was performed by SPSS v26 (IBM Inc., Armonk, NY, USA). Shapiro-Wilks test and histograms were used to assess the normality of the distribution of data. Quantitative data were presented as mean and standard deviation (SD) or median and interquartile range (IQR) according to data distribution, while qualitative data were expressed as frequency and percentage (%). The

diagnostic performance of CCTA was assessed by measuring sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy using ICA with FFR as the reference standard. A two tailed P value ≤ 0.05 was considered statistically significant.

Results:

The study pupulation had a mean age of 59.1 ± 9.6 years and was predominantly male (62.7%). Hypertension was present in 69.3% of patients, while dyslipidemia and diabetes mellitus were observed in 58.0% and 34.7%, respectively. Current smoking was reported in 29.3% of the cohort. Notably, 65.3% of patients had two or more cardiovascular risk factors **(Table 1)**.

Table 1: Baseline demographic and clinical characteristics

	n=150
Age (years), mean ± SD	59.1 ± 9.6
Male sex, n (%)	94 (62.7)
Hypertension, n (%)	104 (69.3)
Diabetes mellitus, n (%)	52 (34.7)
Dyslipidemia, n (%)	87 (58.0)
Current smoking, n (%)	44 (29.3)
≥2 risk factors, n (%)	98 (65.3)

ICA with FFR identified ischemia-relevant CAD in 62 patients (41.3%). Obstructive CAD with ≥50% stenosis was present in 46 patients (30.7%), while an additional 16 patients (10.6%) had physiologically significant lesions with FFR ≤0.80 despite the absence of ≥50% angiographic stenosis. No significant CAD was found in 88 patients (58.7%) **(Table 2)**.

Table 2: Invasive coronary angiography and fractional flow reserve findings

	n=150
No significant CAD	88 (58.7)
Obstructive CAD ≥50%	46 (30.7)
FFR ≤0.80 without ≥50% stenosis	16 (10.6)
Total ischemia-relevant CAD	62 (41.3)

CAD: coronary artery disease, FFR: fractional flow reserve

CCTA showed a sensitivity of 96.8% and a specificity of 80.5% for detecting ischemia-relevant CAD. The PPV was 77.2%, while the NPV reached 97.7%. The overall diagnostic accuracy of the examination was 88.7% **(Table 3)**.

Table 3: Diagnostic accuracy of CCTA

	Value (%)
Sensitivity	96.8
Specificity	80.5
PPV	77.2
NPV	97.7
Overall accuracy	88.7

NPV: negative predictive value, PPV: positive predictive value, CCTA: coronary computed tomography angiography.

Discussion

The current study demonstrates that CCTA offers outstanding diagnostic accuracy in detecting ischemia-relevant CAD among adults over 40 years of age with cardiovascular risk factors, exhibiting a sensitivity of 96.8% and a specificity of 80.5%. The most clinically significant finding is the exceptionally high negative predictive value (97.7%), which affirms the reliability of CCTA as an effective rule-out test for IHD within this population.

Our observed sensitivity of 96.8% is consistent with Miller et al. [12] who determined the diagnostic performance of CCTA. They demonstrated that 64-slice CCTA attained sensitivities exceeding 90% for the identification of significant coronary stenosis as comparing with ICA. Follow-up analysis of the same trial indicated that diagnostic accuracy was affected by the extent of coronary calcium, resulting in decreased specificity among patients with elevated Agatston scores [13]. These outcomes are concordant with our results, in which false-positive CCTA findings were primarily related to heavily calcified coronary segments.

Several meta-analyses have further established the high sensitivity of CCTA. Danad et al. [14] reported that CCTA exhibited an overall sensitivity of approximately 97% for identifying anatomically significant CAD when compared with ICA and FFR, with specificity varying between 75% and 82% depending on disease prevalence and the reference standard. Similar diagnostic performance was reported in a study by Budoff et al. [15], which consistently documented high sensitivity and NPV across different scanner generations and patient populations.

Douglas et al. [6] compared anatomical and functional assessments for coronary artery disease and showed that CCTA detected more cases of CAD than functional stress testing, leading to an elevated rate of initiation of preventive medical treatments. Although short-term clinical outcomes were comparable, they underscored the enhanced diagnostic efficacy of anatomical imaging.

Newby et al. [7] further reinforced the importance of CCTA by showing a substantial decrease in coronary mortality and non-fatal myocardial infarction at follow-up for five-year when CCTA was integrated into standard clinical practice. Importantly, this advantage was ascribed not only to the detection of obstructive lesions but also to the recognition of non-obstructive atherosclerosis, highlighting the prognostic significance of the overall plaque burden. Our study population, comprising adults over 40 years of age with cardiovascular risk factors, closely parallels their study, thereby underscoring the clinical significance of our results.

A key benefit of the current study is the incorporation of invasive FFR as a component of the reference standard. Numerous studies have shown that the severity of angiographic stenosis alone correlates inadequately with lesion-specific ischemia. Meijboom et al. [16] demonstrated that while CCTA precisely identifies anatomical stenosis, the physiological significance evaluated by FFR may vary, especially for intermediate lesions.

Tonino et al. [4] identified invasive FFR as the definitive standard for guiding revascularisation decisions, showing enhanced outcomes with FFR-guided approaches relative to angiography-guided procedures. Our results are consistent with these data, as a subset of lesions identified as obstructive on CCTA were not ischemia-producing on FFR, thereby contributing to decreased specificity.

The moderate degree of specificity observed in our study (80.5%) aligns with previous research and reflects the inherent limitations of CCTA. Coronary calcification, which is more common in elderly cases and individuals with multiple risk factors, produces blooming artifacts that can overestimate the extent of luminal narrowing [17].

False-negative results were infrequent within our cohort, indicating the high sensitivity of modern CCTA systems. When present, false negatives were predominantly associated with motion artefacts or diminutive distal vessels, which are acknowledged limitations of CT spatial resolution.

In addition to identifying flow-limiting stenosis, CCTA offers valuable prognostic insights. Even non-obstructive CAD found by CCTA is linked to higher long-term mortality than normal coronary arteries, as demonstrated by Min et al. [18] Furthermore, subsequent analyses demonstrated that statin therapy initiated according to CCTA findings markedly decreased adverse cardiovascular events [19].

These observations emphasize that the clinical value of CCTA extends beyond ruling out obstructive disease.

The 2019 guidelines of European Society of Cardiology (ESC) and the 2021 ACC/AHA chest pain guidelines advocate the use of CCTA as a primary evaluation test in cases had suspected stable CAD and intermediate pre-test probability [8, 9]. Our findings provide real-world evidence supporting these recommendations in a higher-risk, older population.

The limitations of this study comprise its single-center design and relatively limited sample size. Additionally, long-term clinical outcomes were not assessed. Future studies incorporating CT-derived FFR or myocardial CT perfusion imaging may further enhance the specificity of CCTA and reduce the need for invasive testing.

Conclusions:

When compared to ICA with FFR, CCTA showed superior diagnostic accuracy and a very high NPV for the detection of ischemia-related CAD in adults over 40 years of age with cardiovascular risk factors. These findings reaffirm the status of CCTA as the gold-standard non-invasive diagnostic modality in this population, enabling the safe exclusion of significant disease, facilitating the appropriate selection of patients for invasive assessment, and allowing for early detection of atherosclerosis to inform preventive strategies.

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Conflict of Interest: Nil

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