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Original Article

A Clinical Study on Role of Coronary Computed Tomography Angiogram in the Diagnosis of Coronary Artery Disease

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Abstract

Background: In the recent past, cardiac computed tomography (CT) angiography is being performed for the diagnosis and treatment of coronary artery disease (CAD) and congestive heart failure. The differentiation of ischemic from non-ischemic cardiomyopathy, characterization of hypertrophic cardiomyopathy, and delineation of congenital heart defects are its primary diagnostic applications.

Aim of the Study: The aim was to study the clinical applications of coronary CT angiography (CCTA) in patients with suspected CAD and identify factors that affect CCTA findings.

Materials and Methods: Two hundred and fourteen patients diagnosed with CAD were included in the study. Patients aged between 36 and 76 years were included. Patients with chest trauma and prior thoracic surgery (coronary stenting or coronary artery bypass grafts) were excluded. Demographic data of the patients were recorded including age, gender, blood pressure, body mass index, smoking habits, intake of alcohol, previous history of angina, diabetes, and hypertension were recorded. The duration of symptoms was classified into five groups: <1 week, 1 week to 1 month, 1–3 months, 3–6 months, and more than 6 months. All the patients were investigated with lipid profile, serum creatinine, and blood glucose levels. All the patients were subjected to CCTA. The percentage of abnormal CCTA was observed and recorded. Abnormality of coronary arteries was expressed as atherosclerotic changes identified on CCTA scans, which is reflected in either an involvement of the right coronary artery (RCA), or the left coronary artery (LCA), or both of RCA and LCA. Significant coronary stenosis indicates that more than 50% lumen stenosis due to the presence of plaques was considered.

Observations and Results: Two hundred and fourteen patients with diagnosed CAD were included in the study, aged between 36 and 76 years. The mean age was 56 ± 2.10 years. There were 153 (71.49%) males and 61 (28.50%) were female, with a male-to-female ratio of 3.44:1. The youngest patient was aged 37 years and the eldest patient was 75 years with a mean age of 56 ± 2.10 years. There were 114/214 (53.27%) patients with abnormal CCTA scans and among them 84/114 (73.68%) were male and 30/114 (26.31%) were female. The most common symptom of presentation was pain in the chest elicited in 139 (64.95%) of the patients in this study, followed by history of hypertension in 89 (41.58%) patients. It was observed that there was no significant difference in the percentage of abnormal CCTA findings between male and female patients ($P = 0.19$), (with P value taken as statistically significant at <0.05). Similarly, no significant difference was found between the sex (male/female) and duration of symptoms ($P = 0.71$).

Conclusions: CCTA is a non-invasive, outpatient-based procedure suitable in patients without actionable CAD, obviating unnecessary invasive examination of coronary vessels. CT angiography findings are directly related to patient age and duration of symptoms, with increased abnormal findings reported in elderly population with the duration of symptoms more than 6 months. Moreover, there was a direct correlation between the involvement of coronary arteries and the patient age.

Key words: Angiogram, Computed tomography scan, Coronary computed tomography scan and myocardial infarction, Coronary

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INTRODUCTION

In view of rapid technical improvements in coronary computed tomography (CT) imaging, allowing large number of slices at a very rapid rate with high spatial resolution, its use in the recent times in the diagnosis of cardiovascular disease is possible. CT angiography (CTA)

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is being used as the first line of investigative procedure in patients with stable chest pain, first-time angina, and typical and atypical angina patients.[1-3] It is also being used as a first-line modality in the early diagnosis of abdominal aortic aneurysm, aortic dissection, and pulmonary embolism.[4-6] Coronary CTA (CCTA) now is being used as a standard clinical assessment for patients with low-to-intermediate pre-test probability for coronary artery disease (CAD).[7,8] CCTA can also be used as a follow-up in the patients who have undergone endovascular stents and stent grafts with the aim of determining stent and stent-graft patency and stent graft-related complications.[9,10] Prospective Multicenter Imaging Study for Evaluation of Chest Pain with $n = 10{,}003$, Scottish CT of the heart with $n = 4{,}146$, have established that CCTA is at least as effective as strategies that do not utilize CCTA for all studied cardiovascular outcomes.[11,12] In few randomized controlled imaging-guided trials, CCTA has been consistently associated with reduced incident myocardial infarction (MI) in both acute and stable chest pain populations.[13] In another meta-analysis of randomized trials, stable chest pain patients who underwent coronary CCTA were noted to have a 31% lower risk for MI (pooled risk ratio: 0.69; 95% confidence interval: 0.49–0.98).[13] Recently introduced capabilities for CCTA are fractional flow reserve CT and effective dose reduction through iterative reconstruction. In this context, the present study was conducted to study the clinical applications of CCTA in patients with suspected CAD and identify factors that affect CCTA findings.

Type of Study

This was a prospective cross-sectional and analytical study.

Duration of Study

The study was conducted from October 2015 to October 2018.

Institute of Study

The study was conducted at Al Azhar Medical College and Super Speciality Hospital, Thodupuzha, Kerala, India.

MATERIALS AND METHODS

Two hundred and fourteen patients diagnosed with CAD attending the Departments of General Medicine and Radiology of Al Azhar Medical College Hospital were included in the study. Patients aged between 36 and 76 years were included. An ethical committee clearance was obtained before the commencement of the study. An ethical committee approved consent form was used for the study.

Inclusion Criteria

1. Patients aged between 36 and 76 years were included
2. Patients with CAD were included
3. Patients presenting with chest discomfort as an isolated symptom were included
4. Patients with hypertension or diabetes with suspected CAD were included.

Exclusion Criteria

(1) Patients with ages below 36 and above 76 were excluded. (2) Patients with chest trauma, prior thoracic surgery (coronary stenting or coronary artery bypass grafts) were excluded. Demographic data of the patients were recorded including age, gender, blood pressure, body mass index, smoking habits, intake of alcohol, previous history of angina, diabetes, and hypertension were recorded. The duration of symptoms was classified into five groups: <1 week, 1 week–1 month, 1–3 months, 3–6 months, and more than 6 months. All the patients were investigated with lipid profile, serum creatinine, and blood glucose levels. All the patients were subjected to CCTA. All CT scans were performed on a 64-slice CT scanner (GE Medical Systems, Light speed VCT, 64 × 0.625 mm) with the following protocols: beam collimation 0.625 mm, pitch 0.18, reconstruction interval of 0.625 mm, with tube voltage of 120 kV, and tube current ranging from 300 mAs to 650 mAs (tube current modulation). Contrast medium (Iopamiro, 370, 60–80 mL) was injected into the antecubital vein at 5 mL/s, followed by 30 mL of saline chasing at 3 mL/s, and the scan was performed with a bolus tracking technique with a CT attenuation of 250 HU as the triggering threshold at the ascending aorta to initiate the scan. Axial images were reconstructed with a slice thickness of 0.625 mm in 0.625 mm increment resulting in isotropic volume data with a voxel size of 0.625 mm × 0.625 mm × 0.625 mm. A retrospective electrocardiographic-gating protocol was used in all patients to acquire the volume data achieving a temporal resolution of 175 ms in the center of the gantry rotation. Most volume data were reconstructed at 70–80% RR interval to minimize artifacts. In some patients, the volume data were reconstructed at 45% RR interval to acquire better image quality of the right coronary artery (RCA) and at 75% RR interval to better demonstrate the left anterior descending artery. For patients with a heart rate more than 70 beats/min, a beta-blocker was used to slow down the heart rate. The percentage of abnormal CCTA was observed and recorded. Abnormality of coronary arteries was expressed as atherosclerotic changes identified on CCTA scans, which is reflected in either an involvement of the RCA, or the left coronary artery (LCA), or both of RCA and LCA. The involvement of LCA includes abnormal changes to the left main stem, left anterior descending, and left circumflex as well as side branches, whereas the involvement of both RCA and LCA refers to

abnormal changes at both of these arteries including side branches. Significant coronary stenosis indicates more than 50% lumen stenosis due to the presence of plaques.

OBSERVATIONS AND RESULTS

Two hundred and fourteen patients diagnosed with CAD attending the Departments of General Medicine and Radiology of Al Azhar Medical college hospital were included in the study. They were aged between 36 and 76 years. The mean age was 56 ± 2.10 years. There were 153 (71.49%) males and 61 (28.50%) were female, with a male-to-female ratio of 3.44:1. The youngest patient was aged 37 years and the eldest patient was 75 years with a mean age of 56 ± 2.10 years. There were 114/214 (53.27%) patients with abnormal CCTA scans, and among them, 84/114 (73.68%) were male and 30/114 (26.31%) were female. The most common symptom of presentation was pain in the chest elicited in 139 (64.95%) of the patients in this study, followed by history of hypertension in 89 (41.58%), diabetes mellitus in 39 (18.22%), and tachycardia in 28 (13.08%), and 16/214 (07.47%) had dizziness as the initial symptoms. Abnormal CCTA findings corresponding to the age of patients, gender, and duration of symptoms were observed in this study. It was observed that there was no significant difference in the percentage of abnormal CCTA findings between male and female patients ($P = 0.19$), (with P value taken as significant at <0.05). Similarly, no significant difference was found between the sex (male/female) and duration of symptoms ($P = 0.71$), [Table 1].

Out of 204 CCTA investigations done, 114 (53.27%) were found to be abnormal. Out of which, 8 (03.73%) were abnormal in the age group of 36–45 years, followed by 24 (11.21%) in the age group of 46–55 years, 35 (16.35%) in the age group of 56–65 years, and 47 (21.96%) were abnormal for the age group of 66–75 years [Table 2]. Fifty percent or more of the patients in the age groups between 46 and 75 years had abnormal CCTA findings which was statistically significant with $P = 0.013$ [Table 2].

The highest abnormal rates of coronary involvement of LCA, RCA, and RCA/LCA were noticed in the age group over 66 years (47/76, 61.84%), followed by 56–65 years' age group with abnormal CCTA in 35 out of 61 patients (57.37%). In the youngest age groups of 36–45 and 46–55 years, the incidence was 32 out of 77 patients (41.55%). There was a correlation between the involvement of coronary arteries and the increasing age of the patients; the P value was 0.031 ($P < 0 = 0.05$) [Table 2]. The occurrence of significant stenosis was observed in 21/76 (27.63%) of the patients in the age group of 66–76 years, followed by 13/61 (21.31%). Only 9/48(18.75%) and 2 out of 29 (18.75%) patients aged 46–55 years and 36–45 years, respectively, were found to have stenosis changes in their CCTA investigation [Table 2].

DISCUSSION

In the present study, CCTA was undertaken as an investigation in patients with suspected CAD, presenting with complaints of pain in the chest, tachycardia, hypertension, and diabetes mellitus. There were 114/214 (53.27%) patients with abnormal CCTA scans, and among them 84/114 (73.68%) were male and 30/114 (26.31%) were female. The review of literature showed that the majority of studies (with the exception of the coronary evaluation using

Table 1: The incidence of CCTA abnormalities in both genders depending upon the duration of symptoms (*n*=214)

Duration of symptoms	Total	Abnormal number-114	Male/ Female	RCA Abnormal change	LCA Abnormal change	RCA/LCA Abnormal change	No of significant stenosis
< 1 week	06	01	01/0	02	01	03	02
1 week to 1 month	11	06	04/02	01	03	02	04
1-3 months	34	23	14/09	02	11	10	11
3-6 months	68	39	24/15	05	22	12	23
>6 months	95	45	31/26	07	23	15	29

CCTA: Coronary computed tomography angiography, RCA: Right coronary artery, LCA: Left coronary artery

Table 2: The Coronary CT angiography findings in patients with suspected coronary arterial disease (*n*=214)

Age groups	Total	Abnormal number	Male/ Female	RCA Abnormal change	LCA Abnormal change	RCA/LCA Abnormal change	No of significant stenosis
36-45	29	08	22/07	0	06	2	02
46-55	48	24	37/12	05	13	06	09
56-65	61	35	47/14	07	13	15	13
66-76	76	47	59/17	10	21	16	21

CCTA: Coronary computed tomography angiography, RCA: Right coronary artery, LCA: Left coronary artery

multidetector spiral CTA using 64 Detectors [CORE 64] study) indicate that a negative CCTA can effectively rule out obstructive CAD.[14] In a meta-analysis,[15] of similar studies with 64-slice CT scanner, CCTA showed a sensitivity of 99% and negative prediction value (NPV) of 100% for patient-based detection of significant CAD. However, the specificity has been lower than the sensitivity in most studies, and false-positive results are possible, particularly in patients with high calcium scores.[16] Out of 204 CCTA investigations done, 114 (53.27%) were found to be abnormal. Out of which, 8 (03.73%) were abnormal in the age group of 36–45 years, followed by 24 (11.21%) in the age group of 46–55 years, 35 (16.35%) in the age group of 56–65 years, and 47 (21.96%) were abnormal for the age group of 66–75 years [Table 2]. Fifty percent or more of the patients in the age groups between 46 and 75 years had abnormal CCTA findings which was statistically significant with $P = 0.013$ [Table 2]. In the Assessment by Coronary Computed Tomographic Angiography of Individuals Undergoing Invasive Coronary Angiography (ACCURACY) which was a prospective multicenter trial of patients with chest pain without known CAD and intermediate disease prevalence, 64-slice CCTA had a patient-based sensitivity of 94% and a specificity of 83% in detecting stenosis of 70% or greater (comparable values were seen at a 50% stenosis level). Unlike, the previous study patients with high calcium scores were not excluded from this study. Calcium scores (Agatston score) >400 reduced specificity significantly. The net predictive value (NPV) of CCTA was 99%,[17] whereas in a CORE trial, 64 prospective multicenter trial of patients with suspected symptomatic CAD referred for conventional coronary angiography (CCAG), 64-slice CCTA had a patient-based sensitivity of 85% and specificity of 90% (excluding patients with a calcium score greater than Agatston score of 600) for detecting stenosis 50% or greater. However, the NPV of 83% in this study was lower than in other studies.[18] In a 2008 meta-analysis, the sensitivity was highest in the left main artery and lowest (85%) in the circumflex artery.[16] In a systematic review that evaluated the diagnostic accuracy of CCTA for detecting cardiac allograft vasculopathy (CAV) compared with CCAG alone or with intravascular ultrasound, Wever-Pinzon *et al.* found that CCTA had high sensitivity, specificity, and NPV for the detection of any CAV and significant CAV.[19] Three aspects of the present study are worth notable. They are: (1) the abnormal CCTA findings in patients with suspected CAD are directly related to the age group which indicates that CCTA should be selectively recommended for imaging elderly patients presenting with chest discomfort. (2) The abnormal symptoms of patients are closely related to the abnormal CCTA findings, especially in those with complaints for more than 6 months. (3) There was a direct correlation between abnormal CCTA images and patient age group, with patients aged over 65 years found to have abnormal changes, including significant stenosis to the LCA, RCA and RCA/LCA, and higher rates than any other age group.

CONCLUSIONS

CCTA is a non-invasive, outpatient-based procedure suitable in patients without actionable CAD, obviating unnecessary invasive examination of coronary vessels. CTA findings are directly related to patient age and duration of symptoms, with increased abnormal findings reported in the elderly population with the duration of symptoms more than 6 months. Moreover, there was a direct correlation between the involvement of coronary arteries and the patient's age. However, use of CCTA in the diagnosis of patients with suspected CAD needs to be justified clinically, since a low percentage of positive results are reported in younger patients. Further studies with the inclusion of clinical predictive outcomes should be conducted to verify our preliminary results.

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