

Prospective Study on Clinical Outcome of Coronary CT Angiography in Patients with Suspected Coronary Artery Disease: Three-year Follow-up Study

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ABSTRACT

Introduction: Coronary Artery Disease (CAD) is one of the leading causes of morbidity and mortality in India. Coronary Computed Tomography Angiogram (CTA) is a non-invasive imaging modality for evaluation of CAD and has high accuracy in ruling out significant CAD. The prognostic value of CTA is less established.

Aim: To assess the clinical outcome of CTA in patients with suspected CAD.

Materials and Methods: Total of 30 patients with suspected CAD underwent CTA for evaluation of coronary arteries. Patients were categorised as normal, non-significant stenosis (<50% luminal stenosis) and significant stenosis (>50% luminal stenosis) on CTA findings. All patients were followed up for three years for occurrence of adverse cardiac events. Fischer's-exact test was used to see the association between calcium score and occurrence of adverse cardiac events and to see the association between the groups of patients and the adverse event outcome. The p-value <0.05 was considered as statistically significant.

Cumulative adverse cardiac event rates as a function over time (follow-up period) were estimated according to the Kaplan-Meier method and survival curves of the composite end points were compared using the log-rank test.

Results: CTA was normal in 19 (63.3%) patients, 5 (16.7%) patients had non-significant stenosis and remaining 6 (20.0%) had significant stenosis. No adverse cardiac events were reported in patients with normal CTA and non-significant stenosis. Four patients (66.7%) out of six with significant stenosis required revascularisation on follow-up. Cardiac events in patients with calcium score more than zero (36.4%) were significantly higher compared to those with zero calcium score (0.0%) (p<0.05). The event free survival was significantly higher among those with normal and non-significant stenosis compared to those with significant stenosis.

Conclusion: In patients with suspected CAD, patients with normal coronary arteries or non-obstructive CAD on CTA showed excellent prognosis with no adverse cardiac events on follow-up.

Keywords: Adverse cardiac event, Calcium score, Significant stenosis

INTRODUCTION

Prevalence of CAD in India is around 14% in urban population and around 7% in rural population [1,2]. Imaging modalities available for evaluation of suspected CAD are conventional angiography, CTA, magnetic resonance coronary angiography, Single Photon Emission Computed Tomography (SPECT), Positron Emission Tomography (PET) and cardiac MRI [3].

CTA has sensitivity of 93-100% , specificity of 91 to 96% and negative predictive value of 96 to 100% for detecting significant stenosis (>50% stenosis) [4-12]. Prognosis of the patient with CAD is currently done based on SPECT and PET findings. Patients with normal SPECT scan have low mortality rate of 0.6 -1% and patients with abnormal scan have death or infarction rate of 5.9% [13,14].

Role of CTA in prognosis of patients with CAD is not well established with few studies in the literature and most of them have shown no or less than 1% adverse cardiac events in patients with normal CTA or non-significant stenosis [15-19]. In this study, the prognostic value of CTA was assessed in patients with possible CAD.

MATERIALS AND METHODS

It was a prospective observational study done in a tertiary care centre. Ethical approval was taken from the ethical committee of the institute. Informed consent was taken from all the patients.

Patient Selection

All patients referred for CTA between September 2011 to August 2013 were included in the study.

Inclusion criteria: Patients with typical or atypical chest pain, equivocal exercise test.

Exclusion criteria: Patients with known CAD, history of prior coronary angioplasty.

Image Acquisition

All the scans were performed on Philips Brilliance 64 slice Computed Tomography (CT) machine. Patient heart rate was kept below 60 beats per minute by administering metoprolol. Initial scannogram of chest was taken. Unenhanced axial scan from the arch of aorta to diaphragm was done in craniocaudal direction for calcium scoring with following parameter, slice thickness of 2.5 mm, increment of 25.0 mm, kV 120 and mA 80.

Calcium scoring was calculated based on Agatston scoring system [20]. CTA was done after injecting 100 ml non-iodinated contrast and 30ml of saline at 5 ml/sec with retrospective electrocardiography gating by bolus tracking method with locator and tracker at the level of arch of aorta. Image reconstructions were done in 35%, 45%, 70%, 80% and 90% phases of cardiac cycle. Image reconstruction was done on Philips extended brilliance Workspace version 3.5. Axial, multiplanar, curved multiplanar reformation and volume rendered images were used for coronary artery evaluation. Coronary arteries were assessed for calcified plaque, soft plaque and amount of stenosis.

Patients were categorised as normal, non-significant stenosis (< 50% stenosis) and significant stenosis (>50% stenosis). Patients with >50% stenosis were referred for conventional angiography for further management. CT analysis was done by one author with expertise in CTA.

Follow-Up

All the patients were followed up for 36 months. Follow-up data was obtained by either cardiology clinical database or telephonic interview. All the patients were followed for occurrence of cardiac death, chest pain requiring hospital admission and revascularisation (angioplasty or stenting).

STATISTICAL ANALYSIS

Statistical Package for Social Sciences (SPSS) v 20 was used for statistical analysis. Fischer's-exact test was used to see the association between calcium score and occurrence of adverse cardiac events and to see the association between the groups of patients and the adverse event outcome. The p-value <0.05 was considered as statistically significant. Cumulative adverse cardiac event rates as a function over time (follow-up period) were estimated according to the Kaplan-Meier method and survival curves of the composite end points were compared using the log-rank test.

RESULTS

The study included 30 patients with mean age of 55.5 years, ranging from a minimum of 35 years to a maximum of 79 years.

Calcium score of patients is summarised in [Table/Fig-1]. Of six patients with significant stenosis, two patients had calcium score of 11-100, two patients had score of 101-400 and two patients had score of more than 400.

Calcium score	Normal (n=19, 63.3%)	Nonsignificant stenosis (n= 5, 16.6%)	Significant stenosis (n= 6, 20%)
0	19	-	-
1-10	-	-	-
11-100	-	3	2
101-400	-	2	2
>400	-	-	2

[Table/Fig-1]: Showing the calcium score of the study population.

The proportions of events that occurred among patients with calcium score more than zero (36.4%) was significantly higher compared to those with zero calcium score (0.0%) (p<0.05) [Table/Fig-2].

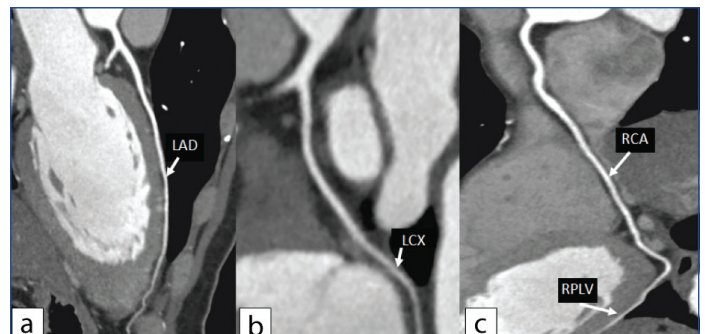
Calcium score	Occurrence of cardiac event		p-value
	Present	Absent	
Zero	00 (0.0%)	19 (100.0%)	0.012
More than zero	04 (36.4%)	07 (63.6%)	

[Table/Fig-2]: Showing association between calcium score and occurrence of event. Fisher's-exact test applied. p-value <0.05 considered as significant statistical association

Follow-up of patients is summarised in [Table/Fig-3]. There were no adverse cardiac events in both the group of patients who had normal CTA (19/30, 63.3%) [Table/Fig-4] and <50% stenosis (5/30, 16.7%) [Table/Fig-5] on CTA. In patients with >50% stenosis (n=6) [Table/Fig-6], four patients (66.7%) had reported adverse cardiac events. This association was statistically significant.

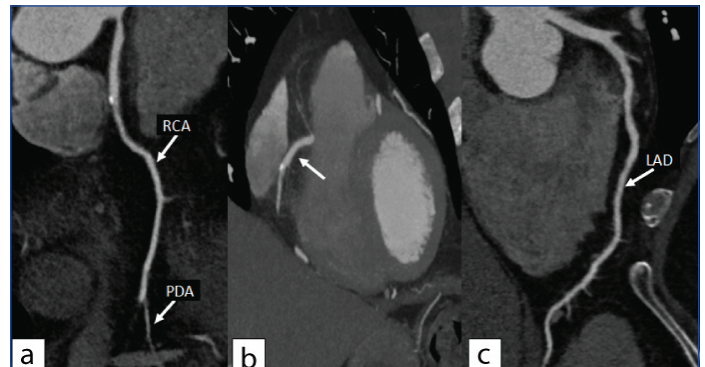
Groups based on CT angiography	No. of patients	Adverse cardiac event		p-value
		No	Yes	
Normal	19	19	0	0.001
<50% stenosis	5	5	0	
>50 stenosis	6	2	4	

[Table/Fig-3]: Showing association between groups and adverse cardiac events. Fisher's-exact test was applied; CT- Computed Tomography



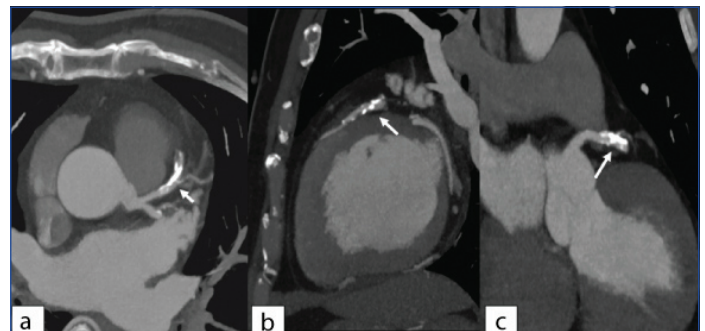
[Table/Fig-4]: Multiplanar reconstruction images of left anterior descending coronary artery (a); left circumflex artery (b); and right coronary artery (c) showing no plaque or stenosis.

LAD: Left anterior descending artery; LCX: Left circumflex artery; RCA: Right coronary artery; RPLV: Posterior left ventricular artery



[Table/Fig-5]: Multiplanar reconstruction image of right coronary artery (a,b) showing small calcified plaque in proximal segment causing no significant stenosis (<50%). Multiplanar reconstruction image of left anterior descending coronary artery; (c) showing no plaque or stenosis.

RCA: Right coronary artery; LAD: Left anterior descending artery; PDA: posterior descending artery



[Table/Fig-6]: Axial (a), oblique sagittal (b) and oblique coronal (c) maximum intensity projection image of left anterior descending coronary artery showing near total occlusion of proximal and mid segment.

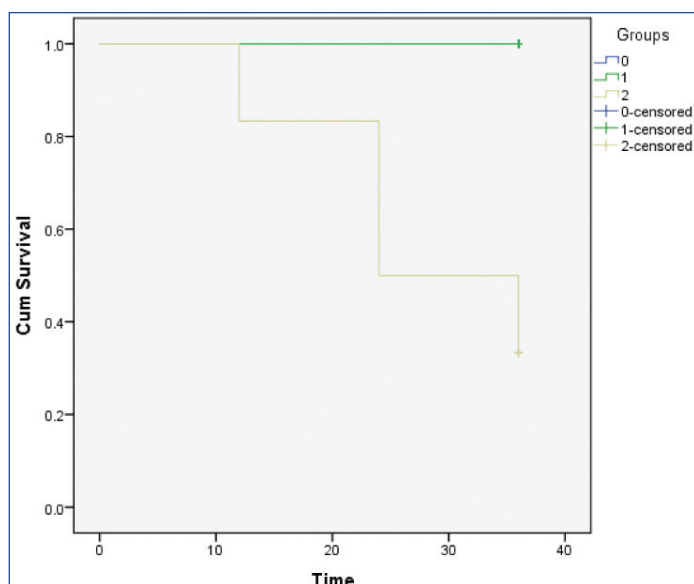
Over the 36 months follow-up period for all the patients, 100% event free survival was seen normal CTA group and non-significant stenosis group whereas only 33.3% reported adverse cardiac event free survival in significant stenosis group. Thus, patients with > 50% stenosis had significantly more adverse cardiac event in the 36 months follow-up (p <0.0001) [Table/Fig-7].

DISCUSSION

In the present study, there was no stenosis in patients with calcium score of zero and adverse cardiac were significantly higher in patients with calcium score more than zero (36.4%) compared to those with zero calcium score (0.0%). Findings of the current study are in concordance with other studies.

Coronary artery calcification is indicator of CAD and absent calcium on CTA rules out CAD with high negative predictive value [21]. Adverse cardiac event rate was less than 1.01% in patients with calcium score of zero and as high as 5.75% in patients with calcium score of more than 400. In 2 to 4% of patients with no calcium can also have significant CAD [3,15].

In the present study, there were no adverse cardiac events in normal CTA and <50% stenosis patients and cardiac events were seen in



[Table/Fig-7]: Kaplan-Meier graph showing adverse cardiac event occurrence for patients with normal (group-0), <50% stenosis (group-1) and > 50% stenosis (group-2).

66.7% of patients with significant stenosis. Event-free survival was 100% in normal CTA group and non-significant stenosis group and 33.3% in significant stenosis group. Findings were consistent with other studies [15-19].

Prognosis of patients with intermediate probability of CAD was assessed by Hay CS et al., showed no adverse cardiac events in patients with normal CTA and non-significant stenosis [16]. Study done by Russo V et al., showed cardiac event rate of 0.88% in patients with normal CTA and 8.09% in patients with obstructive coronary lesions [15]. Clinical outcomes of CTA assessed by Gopal A et al., showed 100% survival free from cardiac events in patients with normal CTA and non-significant stenosis [17]. Pundziute G et al., showed one year event rate of 0% in patients with normal coronary arteries and 30% in patients with CAD on CTA [18]. Study done by Shuman WP et al., showed no adverse cardiac events for one year in patients with stenosis of less than 50% on CTA [19].

LIMITATION(S)

The study is limited by small sample size. There was no risk stratification of patients for CAD.

CONCLUSION(S)

Patients with absent calcium, normal coronary arteries and non-significant stenosis on CTA were associated with no adverse cardiac events and have excellent prognosis.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Mar 07, 2020
- Manual Googling: Apr 23, 2020
- iThenticate Software: Jun 27, 2020 (16%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: Mar 01, 2020
Date of Peer Review: Mar 31, 2020
Date of Acceptance: May 15, 2020
Date of Publishing: Jul 01, 2020