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Original Article

A study of coronary artery variants and anomalies observed at a tertiary care armed forces hospital using 64-slice MDCT

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ABSTRACT

Background: Isolated coronary artery anomalies are usually clinically silent and mostly detected incidentally during angiography or autopsy. However, few of them may be implicated in cases of sudden cardiac death even in the absence of additional heart abnormalities. Prior knowledge of such variants and anomalies is necessary for planning various interventional procedures. Multiple detector computed tomography coronary angiography has proved a very useful non-invasive modality in this direction given its superiority over conventional coronary angiography in providing detailed coronary artery anatomy.

Methods: A retrospective review of the coronary CT angiography studies carried out at our center between August 2014 and December 2015 with the purpose of describing the coronary artery variants and anomalies that we came across in our cohort.

Results: In our cohort, about 77% ($n = 391$) of the patients had a right dominant system while left dominant and co-dominant systems were seen in 12% ($n = 61$) and 11% ($n = 56$) respectively. Coronary CT angiography was successful in visualizing smaller branches, such as the conus artery (96.25%, $n = 489$), the sinus node artery (83.07%, $n = 422$), and the septal branches (95.27%, $n = 484$). Coronary anomalies were observed in the 10.04% of our population ($n = 51$). Eleven anomalies of origin and course were found.

Conclusion: Coronary CT angiography gives us a good understanding of the variations and anomalies of the anatomy of the coronary arteries. This can be of immense help to the clinician planning interventional procedures.

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1. Introduction

It has been a constant endeavor in coronary artery imaging to find a variety of non-invasive techniques that may successfully replace invasive conventional coronary angiography. Some of these techniques like electron-beam computed tomography (CT) and magnetic resonance have shown promising results; however, they are limited by their inadequacy for large-scale clinical implementation and limited availability.^{1–3} The introduction of multiple detector computed tomography coronary angiography has been a significant step forward in this direction. For improved isotropic spatial resolution and faster temporal resolution of the latest 64-slice and above, computed tomography equipment is a

viable alternative to conventional coronary angiography in select patient populations.^{4,5}

While there is still no consensus regarding the differentiation between coronary artery variants and anomalies, Angelini et al.⁶ have proposed that any variation from the normal anatomy that is found in more than >1% of the general population be considered a variant, while those occurring in <1% of the population may be designated as anomalies.

The most cited study describing the various coronary variants and anomalies based on catheter angiography by Angelini et al.⁶ described and classified various anomalies based on origin, course, branching pattern, and termination of coronary arteries. They reported an incidence of anomalies in about 1% of the general population.

Following the establishment of coronary CT angiography as an alternative to catheter angiography, a few articles have also been published on the variations and anomalies detected using coronary CT angiography. The incidence of coronary anomalies is purportedly higher using coronary CT angiography compared to conventional angiography. According to Cademartiri et al.,⁷ catheter angiography

Abbreviations: RCA, right coronary artery; LCX, left circumflex artery; LAD, left anterior descending artery; CAD, coronary artery disease; CT, computed tomography.

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cannot detect ectopic openings of coronary arteries being a two-dimensional study. They have reported 100 (18%) anomalies from 543 consecutive coronary CT angiography done using a 64-slice CT scanner. On coronary CT angiography, 14 (16.5%) coronary anomalies were detected among the 85 patients without any associated coronary artery disease in their study, while 86 coronary anomalies (18.8%) were detected among the 458 patients with significant coronary artery disease.

Not only do variations in coronary anatomy have a known association with structural forms of congenital heart,⁸ but an anomalous coronary artery with an oblique origin, intramural course (within the wall of the aorta), or positioning between the great arteries puts the coronary arteries at risk for compression and may significantly limit the reservoir capacity of the epicardial coronary system. Myocardial ischemia is thus the commonest manifestation of these anomalies. Coronary artery anomalies are clinically significant as a cause of sudden death in asymptomatic individual. Taylor et al. found a significantly higher risk of exercise related sudden death in a retrospective review of clinicopathologic records of 242 patients with isolated coronary artery anomalies.⁹ Prior knowledge of such variants and anomalies is necessary for planning various interventional procedures.

In this study, we propose to describe the various coronary artery variants and anomalies discovered in an Indian subset with symptomatology suggestive of coronary artery disease (CAD).

The aim of this study is to increase awareness about the various coronary artery variants and anomalies in a symptomatic subset of Indian population.

2. Materials and methods

This is a retrospective review of the coronary CT angiography study carried out at our center. The study period was from August 2014 to December 2015.

The aim of this study is to describe the coronary artery variants and anomalies that we have come across in our cohort.

2.1. Inclusion criteria

All patients undergoing coronary CT angiography for suspected/diagnosed coronary artery disease.

2.2. Exclusion criteria

Nil.

2.3. Imaging

All examinations were performed using a GE Discovery PET/CT 610 64-Slice PET/CT scanner with the following parameters: tube voltage 120 kV, tube current 250 mAs effective, collimation 64 mm × 0.6 mm, effective slice thickness 0.6 mm, reconstruction increment 0.3 mm, and rotation time 330 ms. Images were acquired from the level of carina to the base of the heart.

Patients with heart rate >70 beats per minute received 50 mg of metoprolol twice daily for three days prior to the examination. A bolus of 1.5 mL/kg of iso-osmolar non-ionic iodinated contrast medium (290 mg/mL of iodine) was injected into the antecubital vein at the rate of 5 mL/s using a pressure injector. Image acquisition was triggered manually using bolus tracking keeping the ROI cursor in left ventricle.

Data were reconstructed by retrospective gating in end-diastolic phase (from –300 to –450 ms before the peak of the subsequent R wave). Retrospective gating was used in our study since our cohort comprised symptomatic patients, in whom it was desirable to provide functional analysis which is not available in

prospective gating in spite of its benefit of lower exposure to ionizing radiation.

2.4. Definitions

Normal coronary artery anatomy was defined as falling under the criteria laid down by Angelini et al. for normal features of the coronary anatomy in humans.⁶ According to these criteria, the coronary arteries may arise only from the upper midsection of right and left coronary sinuses respectively with an orientation of 45–90° off the aortic wall. A common trunk is seen exclusively on the left side. The course of the coronary arteries should be subepicardial with termination into the capillary bed. The right coronary artery (RCA) supplies the free wall of the right ventricle and the left anterior descending artery (LAD) supplies the antero-septal wall while the left circumflex artery (LCX) supplies the left ventricular free wall.

2.5. Image and data analysis

All coronary CT angiography examinations were loaded into a dedicated workstation (Brilliance, Phillips, USA). All data were analyzed with post-processing tools such as multiplanar reconstructions, curved multiplanar reconstructions, maximum intensity projections, and volume rendering to three-dimensionally image the complex anatomy of the coronary artery tree. Segments were classified according to the American Heart Association scheme.¹⁰

Variants considered were:

1. Coronary dominance (right, left, balanced)
2. Variable origin of the conus branch and sinus node artery
3. Presence of the ramus intermedius branch

Anomalies considered were:

1. Anomalies of origin and course
2. Intrinsic coronary anomalies
 - i) Myocardial bridging
 - ii) Aneurysms >1.5 mm
3. Anomalies of termination (fistulas)

Prevalence data of coronary artery variants and anomalies were collated in a tabulated form.

2.6. Ethical issues

This study conforms to widely accepted ethical principles guiding human based research.

As this is a retrospective observational study not involving any additional risk to the patients, we received approval for the study from the institutional ethics committee with a waiver of consent.

3. Results

A total of 508 patients underwent CT coronary angiography at our center between August 2014 and December 2015.

The mean age of the patients in our cohort was 54.2 ± 13.7 years and the majority of these were in the age group of 51–60 years. Male patients formed the majority 78% of the cohort while female patients formed the rest 22%.

3.1. Coronary artery variants

We have enumerated the coronary variants as well as the number of smaller branches observed in our study, to reiterate the superiority of coronary CT angiography in depicting even the

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