

Detection of Coronary Artery Anomalies using 64 Slice MDCT Angiography

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ABSTRACT

Introduction: Coronary artery anomalies are uncommon conditions of congenital origin with an incidence ranging from 0.17% in autopsy cases to 1.2% in cases undergoing conventional angiography. Coronary artery anomalies were evaluated by using catheter-based angiography and transesophageal echocardiography which are invasive methods. Multidetector row-computed tomography (MDCT) angiography is a recent non-invasive imaging technique and its importance is well established in the field of cardiac imaging. The purpose of this study was to evaluate the prevalence of coronary artery anomalies in patients using 64 slice multi detector CT coronary angiography.

Materials and Methods: Retrospective study of 974 patients who underwent MDCT coronary angiography using 64 slice MDCT scanner for detection of coronary anomalies was done.

Results: 14 (1.43%) patients had coronary anomalies with most commonly being the origin and course anomaly of the proximal coronary segments seen in 8(57%) patients. Left coronary anomalies (64%) were more common than the right coronary anomalies (36%).

Conclusion: 64 slice ECG gated MDCT coronary angiography is an accurate non-invasive imaging modality which suitable to evaluate patients that have an anomalous coronary artery, especially when they have symptoms relating to anomalous vessels. Radiologists must be able to identify and characterize such anomalies and be aware of their clinical significance.

Keywords: MDCT Coronary Angiography, Coronary Anomalies

INTRODUCTION

Coronary artery anomalies are uncommon congenital conditions with incidence ranging from 0.17% in autopsy cases¹ to 1.2% in cases evaluated through conventional angiography.² Most of these anomalous conditions are clinically asymptomatic. However, severe chest pain or sudden death can occur in such patients³, most notably among young athletes or after vigorous exercise.^{5,6} If the aberrant vessel traverses in between the aorta and the main pulmonary artery, it can cause sudden death, especially if the aberrant vessel supplies the left coronary artery distribution⁷ Previously Coronary artery anomalies were diagnosed by using conventional angiography, which is the gold standard for imaging coronary anomalies. Transoesophageal echocardiography done endoscopically can also aid in detection of coronary anomalies, but the disadvantage of this method is invasiveness and cost can be prohibitive.⁸⁻¹⁰ Multidetector row-computed tomography (MDCT) is the newer imaging modality and its usefulness in coronary imaging is gradually increasing.

Regardless of the complexity of the vascular anatomy, coronary vessel opacification is always possible by MDCT after injection of systemic contrast agent and the relation of the anomalous coronary vessel to the great vessels of the thorax can be clearly described.¹¹ Hence it is of utmost importance to identify and describe the coronary anomalies on CT coronary angiography at the first instance of presentation. The purpose of this study was to evaluate the prevalence of coronary artery anomalies in patients using 64 slice multi detector CT coronary angiography.

MATERIALS AND METHODS

974 patients with exertional chest pain, changes of ischaemia on ECG and suspected coronary artery disease underwent MDCT coronary angiography in Department of Radiodiagnosis, ESI Hospital, Rajajinagar, Bangalore, during the period from January 2012 and May 2017. Retrospective evaluation was performed at our department from the CT data files of these patients. Medical ethics

committee clearance was obtained for this retrospective study.

Imaging equipment used was Philips Brilliance 64 slice Multidetector CT.

The following imaging protocol was followed:

- MDCT coronary angiography with retrospective ECG gating technique after injection of 80 ml non-ionic contrast media Contrapaque 350 followed by saline chase using pressure injector.
- Beam collimation 10mm, Detector configuration 64 x 0.625
- Pitch 0.16, Tube current 350-600 mAs
- Voltage 120kv, Total exposure time 6.5s, Mean effective radiation dose 17mSv.

Minimum Intensity Projection (MIP), Multi Planar Reconstruction (MPR) and Volume Rendered (VR) images were obtained from the axial source images. The MDCT images were viewed on clinical workstation – Philips 4.0 version. According to the study of Schmitt et al., the anomalies of the coronary arteries are classified into four groups. Group A = central coronary segments showing anomalies of both the origins and courses, Group B = anomalies of the origins only, Group C = origin and course anomalies of the peripheral coronary vessels and Group D = arterio-venous anomalies of the coronary arteries.

STATISTICAL ANALYSIS

Microsoft office 2007 was used for analysis. Descriptive statistics like mean and percentages were used for the analysis.

RESULTS

A review of the previous CT coronary angiograms was carried out and patients with anomalous coronary arteries were included in the study. 14 patients were found to have coronary artery anomalies, with patients belonging to the age group ranging from 36-69yrs. Among this study group there were 11 males and 3 female patients. Males were most often found to have coronary anomalies, comprising 78% of total patients.

Among 14 patients, the origin and course anomalies of the central coronary artery segments were found in 8 (57%) patients, anomalies of only coronary artery origin in 5 (40%) patients, the peripheral coronary segments showing origin and course anomalies in 1(10%) patients and coronary arterio-venous fistula was however not detected in our study. Left coronary anomalies were seen in 9(64%) patients and right coronary anomalies in 5 (36%) patients. Among the origin and course anomalies of the central coronary segments 5 patients had left circumflex artery originating from right coronary sinus with retro aortic course (Figure 1) and 3 patients showed right coronary artery having its origin from left coronary sinus and its course between the aorta and main pulmonary artery (Figure 2).

Among the anomalies of only coronary artery origins 1 patient had absent left main coronary artery with direct origin of left anterior descending and left circumflex artery from left coronary sinus (Figure 3), 1 patient had anomalous left main coronary artery from right coronary sinus, 1 patient had single right coronary artery with separate origins of left anterior descending and left circumflex arteries arising from RCA, 1 patient had only left anterior descending artery arising from the right coronary artery (Figure 4) and 1 patient had single coronary ostium (Figure 5). Among the origin and course anomalies of the peripheral coronary segments, absent left circumflex artery was found in 1 patient.

DISCUSSION

Approximately 20% of coronary anomalies have been implicated in chest pain, sudden death, cardiomyopathy, syncope, dyspnoea, ventricular fibrillation, and ischaemic heart disease.¹² Among the intrinsic heart diseases, Coronary artery anomalies are the second leading cause of death especially due to structural heart disease in young athletes.¹³

Minimally invasive imaging methods are the mainstay in the diagnosis of congenital coronary anomalies, as it is practically impossible to make the correct diagnosis by means of clinical examination and electrocardiography, or

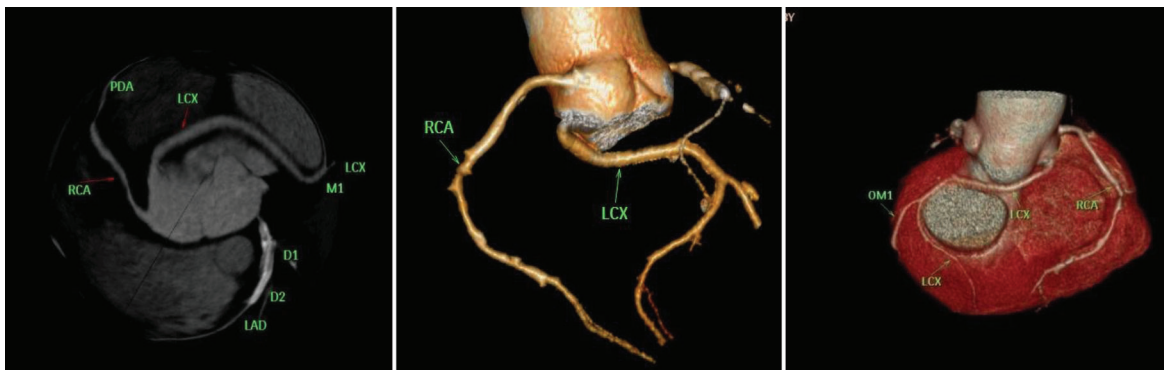


Figure-1: Left circumflex artery (LCX) anomalous origin. MIP and 3D volume-rendered image shows the LCX arising separately from the right coronary sinus with retroaortic course.

even functional echocardiography tests.

Transoesophageal echocardiography done endoscopically may be helpful only in the characterization of origin of coronary arteries and their proximal course¹⁴, but the disadvantages are it is a semi-invasive method and not capable of demonstrating the entire course of such anomalous vessels.^{15,16}

Conventional coronary angiography (CCA) has been the technique of choice for visualization of the coronary arteries for several decades. In addition to being invasive CCA has disadvantages in detecting coronary artery anomalies because of limited number of 2D projection images obtained during catheterization and the absence of soft tissue details.¹⁷

Conventional angiography is already established to be the gold standard method in such patients^{14,18}, but it cannot identify the proximal course and the relation of the anomalous vessel to the other great vessels of the thorax and is less accurate in comparison to computed tomography coronary angiography (55% accuracy demonstrated in a study developed by Schmitt et al¹⁹⁻²¹). Over the last decade substantial advances have been made in non-invasive cardiac imaging. MDCT Coronary angiography had an increasingly important role in the diagnosis of coronary artery disease. Currently, Multidetector computed tomography coronary

angiography is considered as being the gold standard to demonstrate the coronary anatomy.¹⁹

Depiction of origin and course of anomalous vessels along with the complex anatomic relations with adjacent structures is excellent with MDCT.^{22,23}

This study demonstrated prevalence of 1.43% with respected to detection of coronary artery anomalies which is consistent with findings in the study conducted by Yang et al.²⁴

In this study, the most common anomaly was seen in origin and course of central coronary segments constituting 57% of the cases. This is concordant with results of Schmitt et al.²⁵

In this study, the cardiac and vascular anatomy is clearly depicted using MIP and 3D volume-rendered images obtained from 3D CT data sets. The coronary ostial origin, proximal path and relation of the anomalous coronary artery were well delineated.

The left coronary artery anomalies were more common than right coronary artery anomalies. This is in agreement with the results of study conducted by Datta J et al.²⁶ However in studies conducted by Yang et al²⁴ and Knickelbine et al²⁷ left coronary anomalies had lower prevalence than the right possibly due more lethality of left coronary anomalies than the right coronary artery anomalies in paediatric age group.

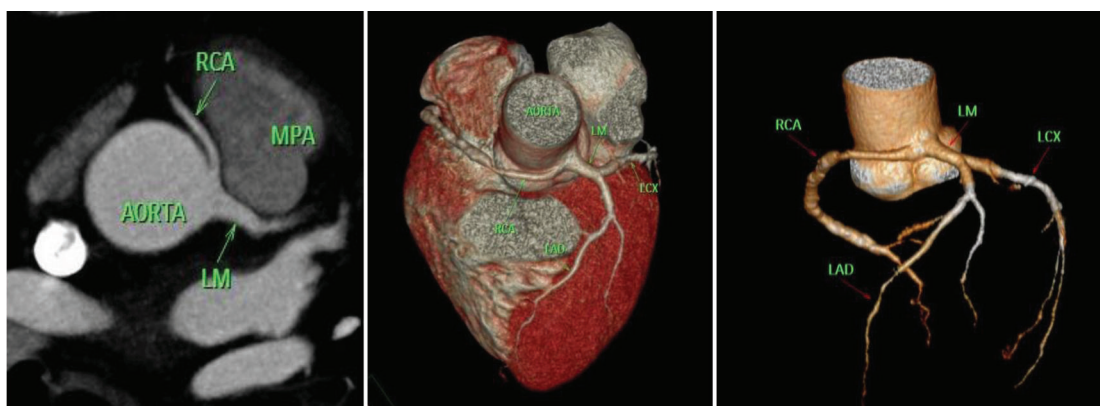


Figure-2: MIP and Three-dimensional volume-rendered image showing the RCA arising from the left coronary sinus very close to the origin of LMCA and demonstrating a malignant course between the aorta and the right ventricular outflow tract (MPA)

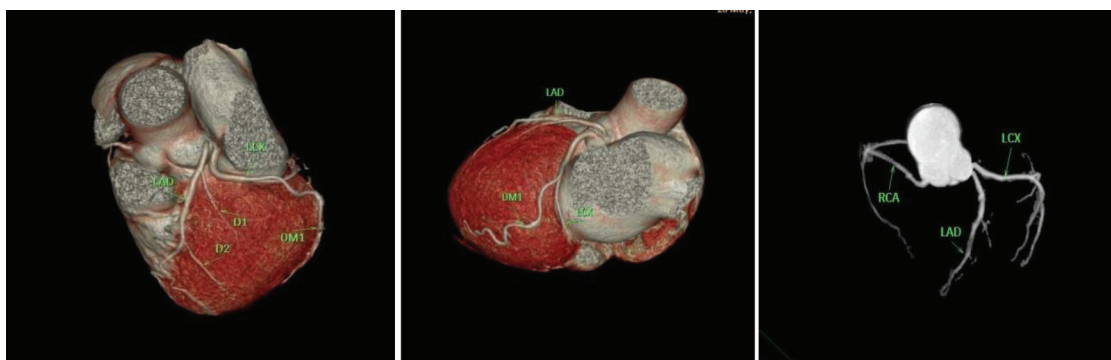


Figure-3: Three dimensional Volume rendered and MIP images showing Absent left main trunk with the separate origin of the left anterior descending artery (LAD) and circumflex artery (LCX) from left coronary sinus in 3D volume-rendered and MIP arterial tree images.

“Malignant course” refers to the course of the anomalous coronary artery located in between the aorta and the pulmonary arterial trunk as it has an increased risk for sudden death.^{14,18} It is the most frequent type of hemodynamically significant anomaly.¹⁴ Many hypotheses are suggested to explain the increased incidence of sudden death in people with ‘malignant course’ anomaly. Some authors suggest that the anomalous vessel with this course can be obstructed during exercise by compression between the aorta and the pulmonary artery; but this hypothesis is rejected by others.¹⁴ Other commonly associated factors include: 1) ostial stenosis/ slit-like ostium; 2) acute angle take-off; 3) intramural aortic segment.²⁸ In our study right coronary artery originating from left coronary sinus with its course between the aorta and main pulmonary artery was seen.

No vascular structure is found in the region of posterior region of the aorta and the interatrial septum. Although not associated with any hemodynamic repercussion, the retro aortic course plays a significant role in cases of cardiac valvular surgery. It is usually related to anomalous origin of the left coronary trunk and of the circumflex artery.¹⁴

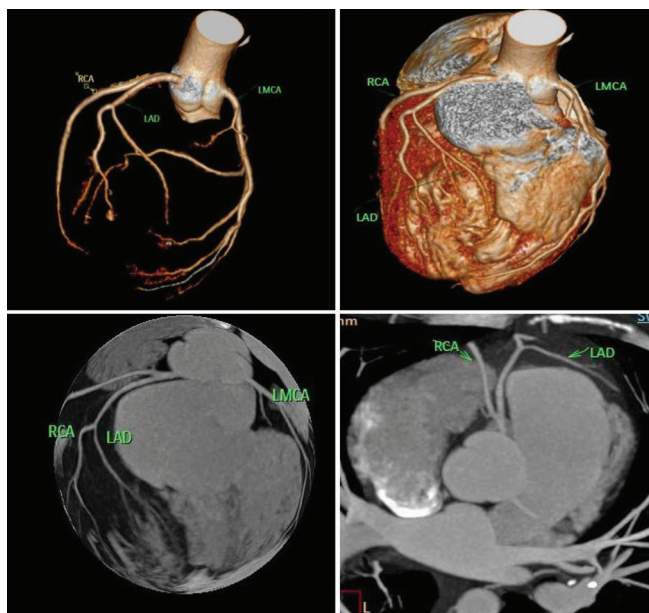


Figure-4 Three-dimensional VR and MIP cardiac images of the coronary arterial tree showing a left anterior descending artery (LAD) arising from proximal right coronary artery (RCA) close to right coronary sinus.

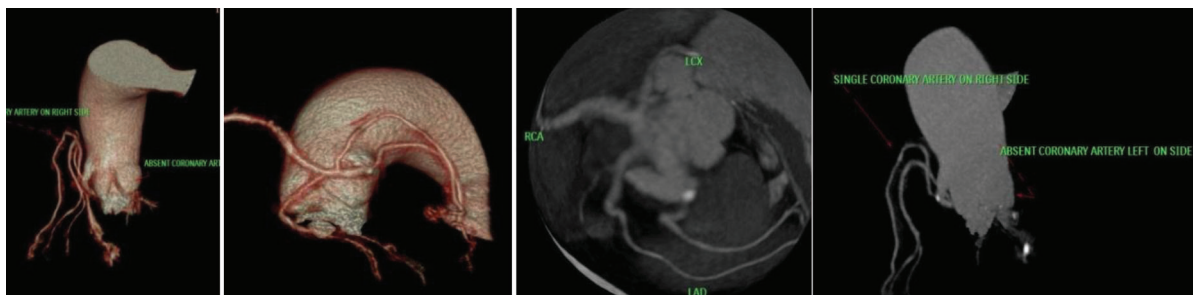


Figure-5: Three-dimensional reconstruction and MIP cardiac MDCT images of the coronary arterial tree depicting a single coronary arterial origin from the right sinus of Valsalva.

In our study left circumflex artery originating from right coronary sinus with retro aortic course was seen.

Separated origins of the left anterior descending (LAD) and left circumflex (LCX) arteries are infrequently found (0.4%). They may cause catheterization difficulties during angiography, but they allow for the development of new collateral vessels if there is proximal obstruction in one of those vessels.²⁹ It is associated with a higher incidence of myocardial bridging and left dominance.³⁰ In our study 1 patient had direct origins of LAD and LCX with absent left main coronary artery.

Left coronary trunk arising from the right coronary sinus or as a branch of a single coronary artery occurs in 0.09% to 0.11% of the individuals undergoing angiography. Proximal interarterial course occurs in 75% of such patients.²⁹ One patient had these findings in our study.

The circumflex artery is the one that most commonly presents anomalous origin from the right coronary sinus, occurring in 0.32% to 0.67% of the population. Retroaortic pathway is its most common course, and there is no association with sudden death.²⁹ Five patients in our study had this finding.

A single coronary artery originating from a single aortic root ostium is an extremely rare anomaly (0.0024% to 0.044% of the population). This may present with the following pattern- one main trunk dividing into right coronary and left coronary trunk, one coronary artery originating as a branch from another having normal origin, or not following the usual distribution of the coronary anatomy.²⁹ One of the patients had similar findings in our study.

MDCT image quality is often suboptimal in patients with irregular heart rates. Scanning patients during atrial fibrillation and ventricular ectopic beats should be avoided. MDCT angiography is contraindicated in some subjects with severe contrast material allergy. MDCT image quality can compromise diagnostic accuracy in patients with irregular or fast heart rates, morbid obesity, severe calcifications, or coronary stents.

CONCLUSION

Contrast enhanced ECG-gated 64-row MDCT coronary angiography is a non-invasive imaging modality and an

accurate diagnostic tool that can precisely depict the origin and course coronary artery anomalies. It has become the reference method in the evaluation of coronary artery anomalies. MDCT should be done in patients for the evaluation of any coronary artery anomaly, especially when the patients have symptoms relating to anomalous vessels, as MDCT is able to demonstrate the relationship between the anomalous vessel with arteries and other cardiac structures. It is paramount for the radiologists to identify and characterize such anomalies and their clinical significance.

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