

Evaluation of Prevalence and Features of Coronary Artery Anomalies using Multidetector-row Computed Tomography

FARAH KALSOOM¹, MUHAMMAD TAHA KHALIL², MUSTAFA ALI SIDDIQI³, SEHRISH KHALID⁴

¹Assistant Professor.

²Senior Registrar.

³Associate Professor

⁴MO

Department of Radiology, Ch. Pervaiz Elahi Institute of Cardiology Multan

Correspondence to Dr. Farah Kalsoom, Email: drfarah1232@yahoo.com

ABSTRACT

Aim: To evaluate the course, origin and termination of coronary artery anomalies in subjects demonstrating various symptoms and undergoing multidetector CT coronary angiography for evaluation of coronary disease.

Study Design: Retrospective study

Place and duration: Ch.Pervaiz Elahi Institute of Cardiology Multan from January 2021 to January 2022.

Methodology: The study included patients who were referred to the radiology department because of suspicion of coronary artery disease. The data of these patients were reviewed for the course and origin of coronary artery anomalies. A 64-slice scanner was used for MDCT coronary angiography. At the start of acquisition contrast arriving coronary arteries were synchronised using the bolus tracking technique. The whole heart was imaged during apnea using 80-90ml iodinated contrast material administered intravenously. Coronary arteries were evaluated using 3-D and multiplanar reformatted images

Results: Total of 600 patients who were referred for MDCT coronary angiography. The subjects underwent screening because of various risk factors, chest pain, or similar symptoms. Coronary artery anomalies were diagnosed in 21 out of 600 (3.5%) patients, whose mean age was 52.6±10.8 years and 504 (84%) were male. 3(14%) patients had high take-off of RCA (right coronary artery) and 4(19%) of LMCA (left main coronary artery). In 5(24%) patients left circumflex artery (LCx) and left anterior descending artery (LAD) originated separately from the left sinus of Valsalva (LSV). In 3(14%) patients RCA originated from the opposite sinus of Valsalva. RCA anomaly in 1 patient had a malignant course.

Conclusion: The study shows that evaluation of coronary artery anomalies can viably be done using CT. Right diagnosis and treatment planning are based upon an understanding of the clinical significance and CT characteristics of different CAAs.

Keywords: Coronary artery angiography, MDCT, prevalence

INTRODUCTION

The coronary artery anomaly is a rare condition with an incidence of 0.17% -1.2%¹.

Almost 20% of these anomalies result in life-threatening conditions like myocardial infarction, syncope or arrhythmias². Among the reasons for sudden cardiac arrest, coronary artery anomalies (CAAs) are accounted as the second most common cause³. Most of the studies conducted on coronary artery anomalies and their variants are based upon a study conducted by Angelini et al. in which different anomalies were classified and described on the basis, of course, origin, termination and branching pattern of coronary arteries⁴. The course of coronary arteries is not ideally defined by conventional coronary artery angiography. Coronary artery imaging is being tried to improve by finding non-invasive ways for replacing conventional invasive coronary angiography. Techniques like magnetic resonance and computed tomography have shown good results⁵. Multidetector coronary CT (MDCT) results in flexible processing in form of 3D volume rendering, maximum intensity projections (MIP) and curved multiplanar reformations (c-MPR) techniques. Recent studies have shown that computer tomography coronary angiography has better diagnostic value for anomalies of coronary artery than invasive coronary angiography.

In this study, the course, origin and termination of coronary artery anomalies in subjects demonstrating various symptoms are studied. These subjects underwent multidetector CT coronary angiography for evaluation of coronary disease.

METHODOLOGY

After IRB permission a retrospective study was conducted Ch.Pervaiz Elahi Institute of Cardiology Multan from January 2021 to January 2022. The study included patients who were referred to the radiology department because of suspicion of coronary artery disease. The data of these patients were reviewed for the course and origin of coronary artery anomalies. The standard patient procedure

Received on 05-02-2022

Accepted on 26-06-2022

consisted of administering beta blocker before scan for stabilizing heart rate < 65 beats/min if needed (HR more than 70bpm). Moreover, patients were also given nitroglycerin sublingually prior to a contrast-enhanced scan for widening coronary arteries. Electrocardiography was used to monitor heart rhythm. A 64-slice scanner was used for MDCT coronary angiography. At the start of acquisition contrast arriving coronary arteries were synchronised using the bolus tracking technique. The whole heart was imaged during apnea using 80-90ml iodinated contrast material administered intravenously. After the administration of contrast material, 30ml normal saline was administered for decreasing artefacts due to contrast material. Coronary arteries were evaluated using 3-D and multiplanar reformatted images. In all subjects, images were recaptured during end-diastole. Dedicated workstations were used to perform the analysis. An experienced radiologist assessed all MDCT coronary angiography images

RESULTS

The study was conducted on a total of 600 patients who were referred for MDCT coronary angiography. The subjects underwent screening because of various risk factors, chest pain, or similar symptoms. Coronary artery anomalies were diagnosed in 21 out of 600 (3.5%) patients, whose mean age was 52.6±10.8 years and 504(84%) were male (Table 2). 3(14%) patients had high take-off of RCA (right coronary artery) and 4(19%) of LMCA (left main coronary artery). In 5(24%) patients left circumflex artery (LCx) and left anterior descending artery (LAD) originated separately from the left sinus of Valsalva (LSV). In 3(14%) patients RCA originated from the opposite sinus of Valsalva. RCA anomaly in 1 patient had a malignant course. LCx terminated normally in all patients. 2(9.5%) had a single coronary artery. LMCA originated from RCA and its course was between the right ventricular outflow tract and aorta. In a 48-year-old, a single coronary artery arose from the left sinus of Valsalva. Right coronary artery ostium was not present. LCx continued in the atrioventricular groove and gave branches to the right atrium and ventricle. In 1 patient RSV lead to the left coronary trunk. In a 61-year-old female, the right sinus of Valsalva gave rise to the whole coronary system. The LCx passed between the aortic root and left atrium for resuming the normal route in

the left atrioventricular groove. In a 48-year-old male with chest pain left coronary system originated from the right coronary cusp. In 1 patient LMCA originated from the pulmonary artery. Evaluation of a 43-year-old male having symptoms of myocardial infarction showed LMCA originated from the pulmonary artery and RCA had a dominant origin from the right aortic sinus and provided branches to the left coronary system.

Table 1: Prevalence and Features of Coronary Artery Anomalies using Multidetector-row Computed Tomography

Anomaly	n	Incidence%	Anomalies%
LCA from PA	1	0.2	4.5
LCA from RSoV	1	0.2	4.5
Single coronary artery	2	0.3	9.5
Cx arising from RCA or right SoV	2	0.3	9.5
RCA from LSV	3	0.5	14
Separate Ostia for left Cx and LAD	5	0.8	24
High take-off	7	1.2	33
Total	21		

DISCUSSION

The anomalous structure of the heart is much different from a normal one. The anomalies are present at birth and incidentally detected during angiography and autopsy. Their incidence varies from 0.6% - 1.3 % Varied genetic background is the reason for the varying frequency of congenital abnormalities^{6,7}. A large scale study reported the incidence of coronary artery anomalies to be 1.3%⁸.

In this study, 21(3.5%) patients were identified as having coronary artery anomalies through MDCT coronary angiography. Nevertheless, the prevalence of these anomalies has been seen to vary widely⁹. A study reported a 7.9% prevalence of the anomalies of course and origin of coronary artery¹⁰. Another study showed better diagnostic performance of CTA as compared to invasive angiography for evaluating the origin and anatomic root of anomalous coronary arteries¹¹. A recent study found the prevalence of anomalies to be 0.8% through evaluation using MDCT coronary angiography¹². The absence of clear diagnostic criteria and referral bias can be the cause of discrepancies in prevalence. Some patients with these anomalies are referred specifically for CAA rather than other unrelated factors. In our study more men had CAA as compared to women, such findings may depict referral bias for MDCTA.

In our study, the most common CAA was high take-off coronary artery. "High Takeoff" means either LMCA or RCA artery originated abnormally high from as ending aorta. Most commonly RCA originates high above the sinotubular junction. It is rare for the coronary artery to arise from the brachiocephalic artery, bronchial artery, aortic arch, subclavian artery, internal mammary or descending aorta. High takeoffs are asymptomatic and do not have haemodynamic significance, but can cause unexpected angiographic issues during localizing orifices. Angiographic and reformatted images better represent high take off¹⁴. Cardiac should have knowledge of this anomaly as during cross-clamping or aorta during cardiac bypass, high cannulation is required for the accidental transaction of RCA.

The separate origin of LCX and LAD from the left sinus of Valsalva was the second most common anomaly found in our study. Multiple Ostia are clinically insignificant but may pose difficulty during vessel cannulation. Origin of the coronary artery from the opposite sinus of Valsalva (ACAOS) is the most common reason for sudden cardiac arrest in people doing strenuous exercise¹⁵. A proximal course of coronary artery and ostium were identified using MDCTA, additionally high and low-risk ACAOS was also differentiated. The anomalous origin of RCA from the opposite sinus of Valsalva was one of the most common anomalies found in our study. Intraarterial anomalous course of RCA from the left sinus of Valsalva is most common and leads to sudden cardiac arrest in 30% of individuals.

In our study, the course of anomalous LCX was posterior to the aorta reaching normal distribution. It is a benign anomaly as it did not lead to functional disturbance of myocardium¹⁵. A single coronary artery means that a single aortic ostium gives rise to both rights and left coronary arteries. In our study, 2 patients had a single left coronary artery. One of the most fatal CAAs is the coronary artery originating from the pulmonary artery. It may be presented alone or in association with cardiac abnormalities like VSD, aortic coarctation, patent ductus

arteriosus and tetralogy of fallot¹⁶. This anomaly usually needs surgical treatment.

An unusual connection between another structure mostly the right chamber of the heart or venous structure and coronary arteries is called coronary artery fistula. A study has shown its prevalence to be .002%¹⁷.

CONCLUSION

The study shows that evaluation of coronary artery anomalies can viably be done using CT. Right diagnosis and treatment planning are based upon an understanding of the clinical significance and CT characteristics of different CAAs.

Authors Contribution: Farah, Sehrish, conceived, designed and did statistical analysis & editing of manuscript, Taha, farah, did data collection and manuscript writing, Ali, Farah, did review and final approval of manuscript

Grant Support & Financial Disclosures: None

REFERENCES

- Kastellanos S, Aznaouridis K, Vlachopoulos C, Tsiamis E, Oikonomou E, Tousoulis D. Overview of coronary artery variants, aberrations and anomalies. *World journal of cardiology*. 2018 Oct 26;10(10):127. <https://doi.org/10.4330/wjwc.v10.i10.127>
- Pandey NN, Sinha M, Sharma A, Rajagopal R, Bhamri K, Kumar S. Anomalies of coronary artery origin: evaluation on multidetector CT angiography. *Clinical Imaging*. 2019 Sep 1;57:87-98. <https://doi.org/10.1016/j.clinimag.2019.05.010>
- Harris KM, Mackey-Bojack S, Bennett M, Nwaudu D, Duncanson E, Maron BJ. Sudden unexpected death due to myocarditis in young people, including athletes. *The American Journal of Cardiology*. 2021 Mar 15;143:131-4.
- Angelini P, Velasco JA, Flamm S. Coronary anomalies: incidence, pathophysiology, and clinical relevance. *Circulation*. 2002 May 21;105(20):2449-54. Angelini P, Velasco JA, Flamm S. Coronary anomalies: incidence, pathophysiology, and clinical relevance. *Circulation*. 2002 May 21;105(20):2449-54. <https://doi.org/10.1161/01.CIR.0000016175.49835.57>
- Rao A, Pimpalwar Y, Yadu N, Yadav RK. A study of coronary artery variants and anomalies observed at a tertiary care armed forces hospital using 64-slice MDCT. *Indian Heart Journal*. 2017 Jan 1;69(1):81-6. <https://doi.org/10.1016/j.ihj.2016.05.018>
- Nawale JM, Chaurasia AS, Nalawade DD, Choudalwar P, Borikar N, Tiwari D. Study of clinical profile, incidence, pattern, and atherosclerotic involvement of congenital coronary artery anomalies in adults undergoing coronary angiography: a study from a tertiary care institute in western part of India. *Heart India*. 2018 Oct 1;6(4):133.
- Sirasapalli CN, Christopher J, Ravilla V. Prevalence and spectrum of coronary artery anomalies in 8021 patients: A single center study in South India. *Indian Heart Journal*. 2018 Nov 1;70(6):852-6. <https://doi.org/10.1016/j.ihj.2018.01.035>
- Yamanaka O, Hobbs RE. Coronary artery anomalies in 126,595 patients undergoing coronary arteriography. *Catheterization and cardiovascular diagnosis*. 1990 Sep;21(1):28-40. <https://doi.org/10.1002/ccd.1810210110>
- Javaid I, Akram M, Amjad S, Riaz R, Ehsan A, Tariq A. Frequency of Coronary Artery Anomalies in patients undergoing Coronary Angiography. *The Professional Medical Journal*. 2020 Feb 10;27(02):377-80.
- Sirasapalli CN, Christopher J, Ravilla V. Prevalence and spectrum of coronary artery anomalies in 8021 patients: A single center study in South India. *Indian Heart Journal*. 2018 Nov 1;70(6):852-6. <https://dx.doi.org/10.18203/2320-6012.ijrms20200240>
- Al-Umairi RS, Al-Kindi F, Al-Tai S. Prevalence and spectrum of coronary anomalies detected on coronary computed tomography angiography: A single centre experience in Oman. *Sultan Qaboos University Medical Journal*. 2019 May;19(2):e108.
- Srinivasan KG, Gaikwad A, Kannan BR, Ritesh K, Ushanandini KP. Congenital coronary artery anomalies: Diagnosis with 64 slice multidetector row computed tomography coronary angiography: A single-centre study. *Journal of medical imaging and radiation oncology*. 2008 Apr;52(2):148-54. <https://doi.org/10.1111/j.1440-1673.2008.01933.x>
- Goel A, Reddy BN, Gaduputi J, Reddy P, Viswamitra S. Computed tomography evaluation of coronary artery variants and anomalies. *European Congress of Radiology-ECR 2020*.
- Pandey NN, Sinha M, Sharma A, Rajagopal R, Bhamri K, Kumar S. Anomalies of coronary artery origin: evaluation on multidetector CT angiography. *Clinical Imaging*. 2019 Sep 1;57:87-98.
- Imieri V, Gervasi S, Bianco M, Cogliari R, Poscolieri B, Cuccaro F, Marano R, Mazzari M, Basso C, Zeppilli P. Anomalous origin of coronary arteries from the "wrong" sinus in athletes: diagnosis and management strategies. *International journal of cardiology*. 2018 Feb 1;252:13-20. <https://doi.org/10.1016/j.ijcard.2017.10.117>
- Montaudon M, Latrabe V, Iriart X, Caix P, Laurent F. Congenital coronary arteries anomalies: review of the literature and multidetector computed tomography (MDCT)-appearance. *Surgical and Radiologic Anatomy*. 2007 Jun;29(5):343-55.
- Dodge-Khatami A, Mavroudis C, Backer CL. Anomalous origin of the left coronary artery from the pulmonary artery: collective review of surgical therapy. *The Annals of Thoracic Surgery*. 2002 Sep 1;74(3):946-55.