Indian Journal of
Applied Radiology

Volume 9, Issue 1 - 2023

www.opensciencepublications.com

MDCT Evaluation of Coronary Artery Variants: Pictorial Essay

Pictorial Essay

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Article Information: Submission: 02/01/2023; Accepted: 07/03/2023; Published: 13/03/2023

Abstract

Objective: The purpose of this pictorial essay is to review the multi detector computed tomography (MDCT) coronary angiography appearance of coronary artery variants [CAV]. Although CAV are relatively uncommon, familiarity with atypical anatomy and their clinical presentation may facilitate appropriate diagnosis and management. This will be of immense help to the clinician planning interventional procedures like stenting, balloon dilatation, or graft surgery particularly when there are secondary changes of calcification, plaque formation and stenosis.

Conclusion: Increasing the employment of MDCT in cardiac imaging may yield diagnostic information on congenital coronary artery variants not obtained with invasive coronary angiography. Axial sections, multiplanar reconstructions, virtual angioscopy, and 3D volume-rendered images should aid within the detection and improve the interpretation of such coronary variants, which might be of immense help to the clinician planning interventional procedures.

Keywords: Computed tomography coronary angiography; Coronary artery variants

Introduction

Coronary artery variants (CAV) are uncommon and most of them are diagnosed incidentally during conventional coronary angiography or MDCT coronary angiography performed for other reasons and do not require any diagnostic workup, further investigation or treatment..Although catheter angiography is an efficient tool, it's invasive and related to procedural morbidity (1.5%) and mortality (0.15%) [1]. Because of its two dimensional nature, catheter angiography has protectional limitations and it cannot show the link of aberrant vessels with the underlying cardiac structures [2]. Recent development of ECG gated MDCT coronary angiography allows accurate and noninvasive depiction of coronary artery variants of their origin, course, and termination.

Coronary Artery Variants

Illustrative Cases

Case 1: 56 years old male with dominant Right coronary arterial (RCA) system (Figure 1).

Case 2: 49year's old male with dominant Left coronary arterial (LCA) system (Figure 2).

Case 3: 36 years old male with Co-dominant coronary arterial system (Figure 3).

Case 4: 38 years old male with trifurcation of LMCA into LAD, LCX & Ramus intermedius (Figure 4).

Case 5: 36 years old man with early branching of Posterior descending artery (Figure 5).

Case 6: 58 years old man with Sinoatrial (SA) node branch from LMCA (Figure 6).

Case 7: 50 year old man with SA node branch arising from LCX (Figure 7).

ISSN: 2581-3919

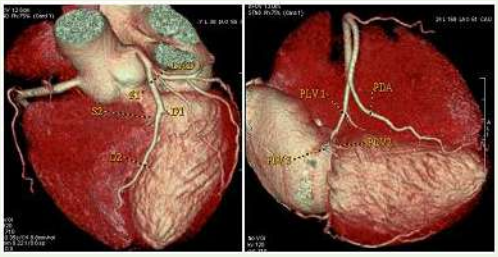

Figure 1: (A,B) Computed tomography coronary angiography (CTCA) 3D volume rendered images shows dominant right coronary arterial system, posterior descending artery (PDA) and posterior left ventricular (PLV) branches arising from RCA.

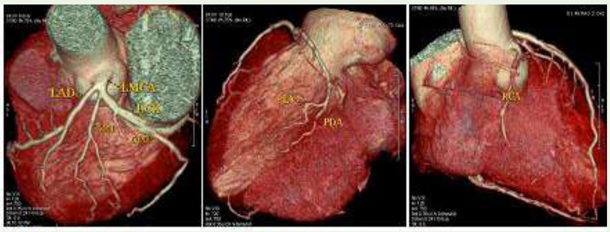

Figure 2: (A-C): CTCA 3D volume rendered images shows dominant left coronary arterial system, posterior descending artery (PDA) and posterior left ventricular (PLV) branches arising from LCA.

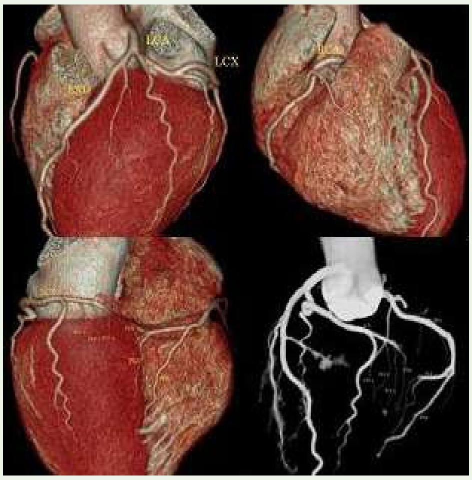

Figure 3: (A-D) CTCA 3D volume rendered (A-C) and coronary tree images show co-dominant coronary arterial system, PDA and PLV branches arising from both LCA& RCA.

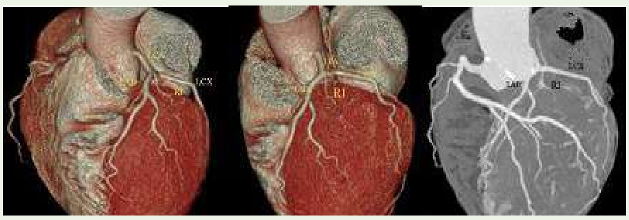

Figure 4: (A-C): CTCA 3D volume rendered (A,B) and MIP coronary tree (C) images shows trifurcation of LMCA into LAD, LCX & Ramus Intermedius (RI).

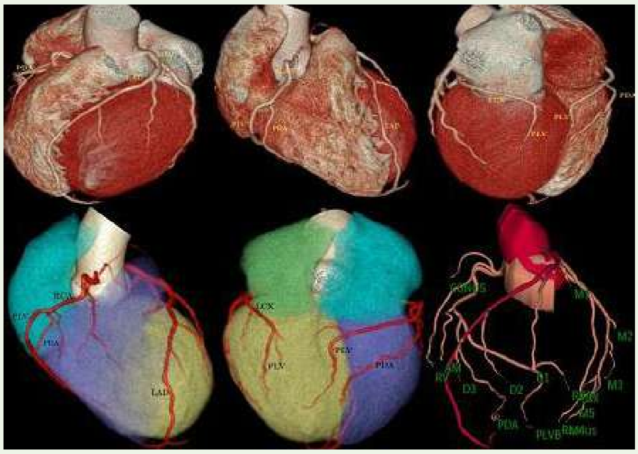

Figure 5: (A-F): CTCA3D volume rendered (A-E) and coronary tree(F) images reveal early branching of PDA.

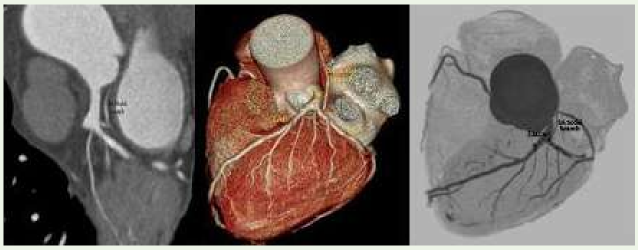

Figure 6: (A-C): CTCA 2D curved vessel (A) 3D volume rendered (B) positive coronary tree(C) images reveal origin of SA nodal branch from LMCA.

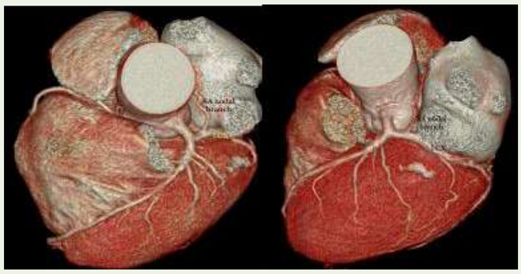

Figure 7: (A,B): CTCA 3D volume rendered images reveal origin of SA nodal branch from proximal LCX.

Case 8: 45 year old woman with SA node branch arising from Right coronary sinus (Figure 8).

Case 9: 52 year old male with Conus branch from Right coronary sinus (Figure 9).

Case 10: 42 year old man with conus branch fromRight coronary sinus (Figure 10).

Case 11: 35 old woman with left atrial posterior branch from distal RCA (Figure 11).

Case 12: 57 years old woman with Right ventricular branch from LAD (Figure 12).

Case 13: 50 years old man with Type 1 LAD (Figure 13).

Case 14: 39 years old woman with Type2 LAD (Figure 14).

Case 15: 36 years old male with type3 LAD (Figure 15).

Case 16: 82 years old male with type 4 LAD (Figure 16).

Figure 8: CTCA 3D volume rendered coronary tree image reveal anomalous origin of SAnodal branch from RCS.

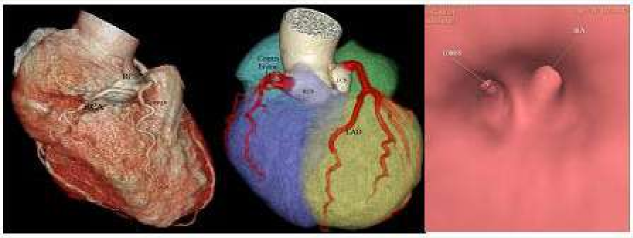

Figure 9: (A-C): CTCA 3D volume rendered (A,B) and virtual angioscopy (C) images reveal anomalous origin of Conus branch from RCS.

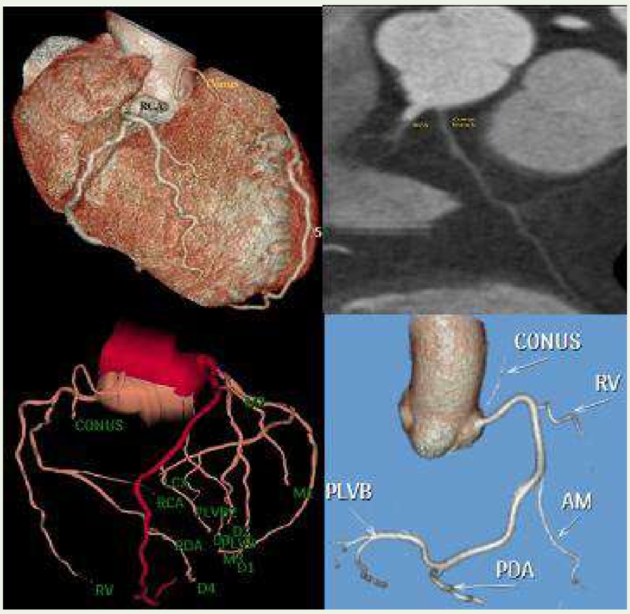

Figure 10: CTCA3D volume rendered (A), 2D curved view (B) and coronary tree (C,D) images reveal anomalous origin of Conus branch from RCS.

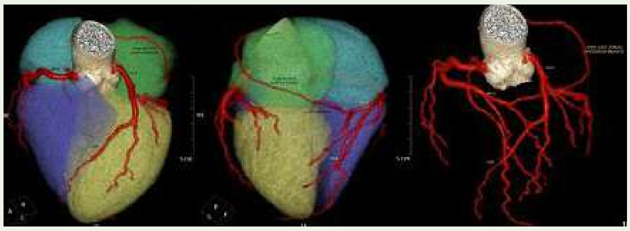

Figure 11: (A-C): CTCA3D volume rendered (A,B) and coronary tree (C) images reveal origin of long left atrial posterior branch from distal RCAin the posterior atrio-ventricular (AV) groove.

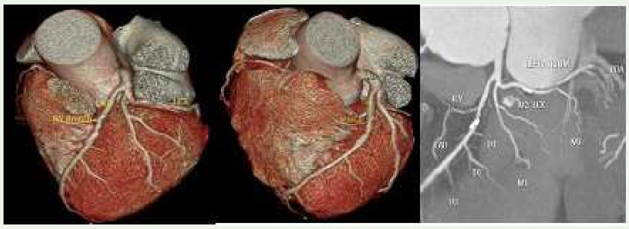

Figure 12: (A-C): CTCA 3D volume rendered(A,B) and MIP coronary tree (C) images reveal origin of RV branch from proximal LAD in left dominent coronary arterial system.

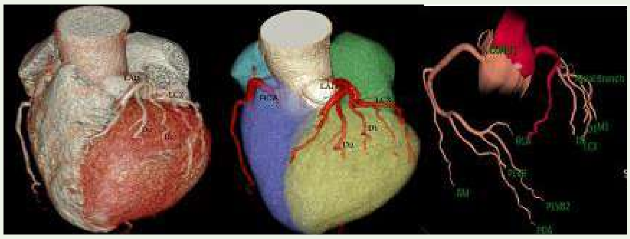

Figure 13: (A-C): CTCA 3D volume rendered (A,B) and coronary tree (C) images reveal Type1 LAD.

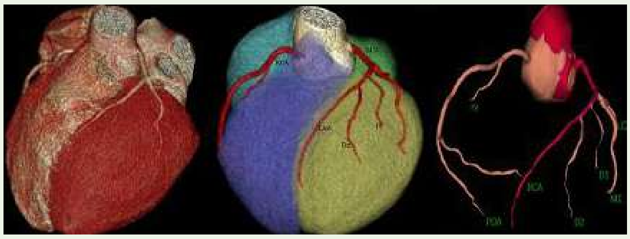

Figure 14: (A-C): CTCA3D volume rendered (A,B) and coronary tree(C) images reveal Type 2 LAD.

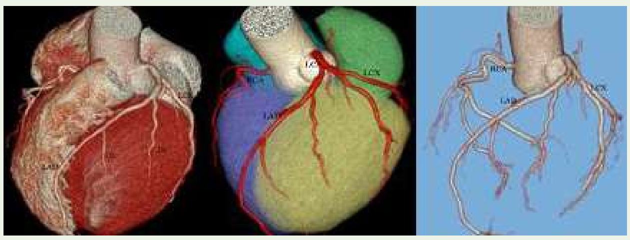

Figure 15: (A-C): CTCA 3D volume rendered (A,B) and coronary tree(C) images reveal Type 3 LAD.

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Figure 16: (A-C): CTCA MIP coronary tree (A,B) and curved vessel analysis (C) images reveal Type 4 LAD.

Discussion

The coronary arteries arise from the aortic sinuses, clustering towards the apex of the heart. Normally, there are three main coronary arteries, the right coronary artery (RCA)which generally arises from the right sinus of Valsalva (RSV) of the ascending aorta and supplies the right side of the heart, left circumflex artery (LCX) and left anterior descending (LAD), artery arising from a common stem, the left main coronary artery (LMCA) which arises from left sinus of Valsalva (LSV). Among these, the origin of the posterior descending coronary artery (PDA) from either the right (70%) (Figure 1) or the left (10%) (Figure 2) coronary artery defines the coronary dominance, co-dominance (Figure 3) in 20% of cases, with the dominant artery usually providing blood supply to the sino-atrial (SA) and atrio-ventricular (AV) nodes, albeit with some exceptions.Other common possible findings include trifurcation of the LMCA, with a Ramus intermedius (in ≈20% of the cases) (Figure 4), distributing across a variable portion of the lateral wall of the left ventricle [3].

Arteries supplying the left atrium (LA) are among the earliest branches of the Left coronary artery, usually from the LCX, and originate along the AV groove. Arteries supplying the right atrium (RA) are among the foremost branches of the RCA after the conus artery and originate along the right atrio-ventricular (AV) groove. Arteries supplying the left & right atriumare generally classified into the anterior, intermediate/marginal and posterior atrial branches [4].

Congenital coronary anomalies (CCA)may be defined as a coronary pattern or feature that's encountered in lower than 1% of the general population.

In summary, we are able to divide the coronary feature in two groups:

(1) Normal coronary anatomy, defined as any morphological characteristics seen in > 1% of unselected sample. This group also includes normal anatomical variants, defined as alternative and comparatively unusual morphological feature observed in > 1% of the population; and

(2) Anomalous coronary anatomy, defined as morphological features found in < 1% of the population [5-7].

For several decades, these anomalous coronary arteries were identified by conventional catheter coronary angiography. MDCT coronary angiography has been accepted as the ideal system for evaluation of patients with atypical chest pain due to its excellent temporal and spatial resolution [1,8].

Magnetic resonance coronary angiography could be a non-invasive method that doesn't require the utilization of contrast agents or ionizing radiation, and thus is superior compared to cardiac CT angiography and conventional coronary angiography. Its disadvantages are lengthy acquisition time and lower spatial resolution [9].

Congenital coronary variants (CCV) refer to simple variations within the structural anatomy. Some of the variants include

1. Left coronary dominance (10%) (Figure 2), Co-Dominance (20%) (Figure 3), LMCA trifurcates (20%) into Ramus intermedius (RI) (Figure 4), LAD & LCX [7],

2. Early branching of the PDA (early take off) from the RCA (Figure 5) before the crux of the heart.

3. Duplication of branches, e.g., two PDAs getting in the septum.

4. Shepherd's crook RCA-In this variant, the RCA has a normal origin, but takes a tortuous and high course, immediately after the origin. The prevalence of this variant is estimated of roughly 5%.The shepherd's crook isn't clinically significant, but its presence may complicate percutaneous interventions within the RCA [10].

5. Presence of a descending septal branch originating from the RCA that supplies part of the basal interventricular septum [10].

6. SA nodal artery from LMCA (Figure 6), proximal LCX (Figure 7), distal LCX, distal RCA [11], or right coronary sinus (Figure 8). In 55% of human hearts, the RCA supplies the SA nodal artery within 2 cm of the coronary ostium and corresponds to the right anterior atrial branch [12]. In 45% of cases, it originates within the first few mm of the LMCA (Figure 6), and usually corresponds to the left anterior atrial branch [13].

7. Origin of Conus branch from aorta or directly from the right sinus of Valsalva (Figures 9,10) [13, 14].

8. Left posterior atrial branch from Distal RCA (Figure 11).

9.Right ventricular branch from LAD (Figure 12).

10. Depending upon the length of the LAD, the LAD is classed into four types:

Type-I – does not supply the left ventricular (LV) apex (Figure 13),

Type-2 – supplies a part of the apex (Figure 14) the remainder being supplied by the right coronary

Type-3 – supplies the entire apex (Figure 15), and

Type-4 – wrap around apex, supplies the apex and >25% of the inferior wall (wrap around LAD)(10) (Figure 16).

Variations in coronary anatomy are frequently seen in association with structural styles of congenital cardiovascular disease like Fallot's tetralogy, transposition of the great vessels, Taussig-Bing heart (double-outlet right ventricle), or common arterial trunk [14].

All forenamed variants are clinically benign and pose no threat

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to patients. At utmost, some of them, like the shepherd's crook RCA, may present technical challenges during coronary intervention for other issues, due to difficulty in engaging angiographic catheters and guides. In addition, a descending septal branch, which originates from the RCA and supplies part of the interventricular septum, may be used as a target for alcohol septal ablation in symptomatic patients with hypertrophic obstructive cardiomyopathy whose basal septum is supplied by this branch of the RCA. In addition, a descending septal branch from the RCA may be an important source of collateral retrograde filling of a proximally occluded LAD [15].

Conclusion

Increasing the employment of MDCT in cardiac imaging may yield diagnostic information on congenital coronary artery variants not obtained with invasive coronary angiography. Axial sections, multi planar reconstructions, virtual angioscopy, and 3D volume-rendered images should aid in the detection and ameliorate the interpretation of such coronary variants, which can be of immense help to the clinician planning interventional procedures.

References

1. Pannu HK, Flohr TG, Corl FM, Fishman EK (2003) Current concepts in multi-detector row CT evaluation of the coronary arteries: Principles, techniques, and anatomy. Radiographics 23: S111-125.
2. Shi H, Aschoff AJ, Brambs HJ, Hoffmann MH (2004) Multislice CT imaging of anomalous coronary arteries.Eur Radiol 14: 2172-2181.
3. McConnell MV, Ganz P, Se.lwyn AP, Li W, Edelman RR, et al. (1995) Identification of anomalous coronary arteries and their anatomic course by magnetic resonance coronary angiography. Circulation 92: 3158-3162.
4. Greenberg MA, Fish BG, Spindola-Franco H (1989) Congenital anomalies of coronary artery: classification and significance. Radiol Clin North Am 27: 1127-1146.
5. Angelini P, Velasco JA, Flamm S (2002) Coronary anomalies: incidence, pathophysiology, and clinical relevance. Circulation 105: 2449-2454.
6. Angelini P (2007) Coronary artery anomalies: an entity in search of an identity. Circulation 115: 1296-1305.
7. Boppana VS, Castaño A, Avula UMR (2011) Atrial Coronary Arteries: Anatomy And Atrial Perfusion Territories. J Atr Fibrillation 4: 375.
8. Kim SY, Seo JB, Do KH, Heo JN, Lee JS, et al. (2006) Coronary artery anomalies: Classification and ECG-gated multi-dedector row CT findings with angiographic correlation. Radiographics 26: 317-333.
9. Desmet W, Vanhaecke J, Vrolix M, Piessens J, Willems J, et al. (1992) Isolated single coronary artery: a review of 50,000 consecutive coronary angiographies. Eur Heart J 13: 1637-1640.
10. Shriki JE, Shinbane JS, Rashid MA, Hindoyan A, Withey JG et al. (2012) Identifying, characterizing and classifying congenital anomalies of the coronary arteries. Radiographics 32: 453-468.
11. Romhilt DW, Hackel DB, Estes EH, Jr. (1968) Origin of blood supply to sinoauricular and atrioventricular node. Am Heart J 75: 279-280.
12. James TN, Burch GE (1958) The atrial coronary arteries in man. Circulation 17: 90-98.
13. Boffano C, Chiribiri A, Cesarani F (2009) Native whole-heart coronary imaging for the identification of anomalous origin of the coronary arteries. Int J Cardiol 137: e27-e28.
14. Shirani (2018) J Isolated coronary artery anomalies.
15. Kastellanos S, Aznaouridis K, Vlachopoulos C, Tsiamis E, Oikonomou E, et al. (2018) Overview of coronary artery variants, aberrations and anomalies. World J Cardiol 10: 127-140.

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