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Original Article

Prevalence and spectrum of coronary artery anomalies in 8021 patients: A single center study in South India

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ABSTRACT

Objective: To identify the prevalence of coronary artery anomalies (CAAs) and their subtypes based on Angelini et al. classification in symptomatic yet stable population of South India using 64- slice dual source multi detector CT coronary angiography (MDCT-CA).
Methods: We retrospectively reviewed reports of 8021 symptomatic patients predominantly South Indians who were referred for CT coronary angiography (CT-CA) to our tertiary cardiac care center in Hyderabad, India from January 2011 to March 2017.
Results: We identified a total of 838 coronary artery anomalies in 812 patients with a prevalence of 10.09%. 96.9% of patients were older than 30 years of age with a M:F ratio of 1.39:1. Coronary artery disease (CAD) was seen in 61.5% of these patients. Among these anomalies, myocardial bridging (MB) was the most common anomaly followed by anomalous location of coronary ostium at improper sinus (ACOIS).
Conclusion: There is no significant difference in prevalence of CAAs (including and excluding MB) in Indian and World population. CAAs were more common in males than females and most of these patients remain asymptomatic during first three decades of their life. Myocardial bridging is the most common anomaly detected by MDCT-CA followed by ACOIS. Right coronary artery (RCA) arising from left coronary sinus (LCS) is the most commonly encountered ACOIS.

1. Introduction

Coronary artery anomalies (CAAs) are a diverse group of congenital anomalies with many varieties (Fig. 1), various presentations and different pathophysiologic mechanisms.[1] Continuous and profound changes are taking place in the subject of CAAs regarding their definition, classification, diagnostic work up and treatment of these anomalies.[2–7] The incidence of coronary artery anomalies is ranging from 0.17% in autopsy cases to 1.2% in angiographically evaluated cases.[8,9] The incidence of CAAs in Indian population is 0.95%.[10] Although CAAs are rare, they are still very important as they can cause sudden cardiac deaths.[3–5]

64 slice dual source multi detector CT coronary angiography (MDCT-CA) is very reliable in detecting CAAs by providing excellent non-invasive 3D imaging of coronary arteries. To the best of our knowledge, there were no other studies with data as large as ours done on South Indian population in a single tertiary cardiac care center. Studying the prevalence, spectrum of CAAs, their sexual distribution and age of presentation in South Indian population provides an insight into disease burden and their relative contribution to cardiovascular diseases, which is a leading cause of deaths in India.[11]

2. Material and methods

This was a retrospective observational study involving 8021 symptomatic, stable patients who underwent MDCT-CA using a 64-slice Dual Source CT scanner (SIEMENS SOMATOM DEFINITION) over a period of 75 months from January 2011 to March 2017. The indications for MDCT-CA broadly were to rule out CAAs in patients with angina equivalent in less than 30 years of age and to rule out coronary artery diseases (CAD) in patients greater than 30 years of

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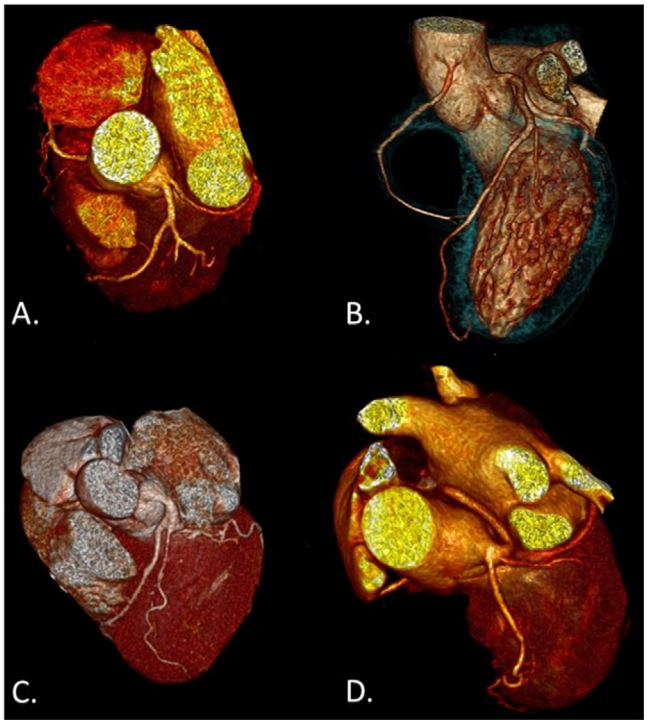

Fig. 1. Coronary artery anomalies. A: Separate origins of LAD and LCX from LCS with absent main trunk. B: High origin of RCA. C: Ectatic LMCA. D: LCA-RA fistula.

age with Framingham risk scores (FRS) greater than 10% and less than 20% over 10 years. Low risk (less than 10%) and high risk (greater than 20%) patients did not undergo MDCT-CA.

2.1. Preparation

Ivabradine, beta blockers and calcium channel blockers (in asthmatics) were used in patients with high heart rate to bring down heart rate to less than 75 beats per sec. Tab sorbitrate 5 mg sublingual was administered before acquiring images for better coronary vessel delineation.

2.2. Procedure

Non-contrast scan is first acquired to assess calcium score of coronary arteries. If the calcium score is <500, then contrast (1.5 ml/kg body wt. of low osmolar non-ionic iodinated contrast was administered intravenously at the rate of 5 ml/s followed by 40 ml saline flush at the same rate) is administered to acquire complete CT coronary angiographic data. In all patients, images were acquired using retrospective ECG gating and single breath hold technique with following parameters: 120 kV, >400 mAs, detector collimation 64/0.6 mm, 0.6 mm slice thickness, 0.6 mm increment, 256 matrix, 0.2 pitch and cardiac window. Image reconstructions done using best diastole and best systole reconstruction algorithms. For three dimensional images, the volumetric CT data sets were processed on a separate work station using circulation software (SIEMENS).

All identified CAAs were classified based on Angelini et al's classification (Table 1).

3. Results

Among 8021 symptomatic yet stable South Indian patients, we identified 838 coronary artery anomalies in 812 patients with a prevalence rate of 10.09%. These patients include 473 males and 339 females with a M:F = 1.39:1 between ages of 10 and 77 years. Age of presentation in these 812 patients was given in bar diagram (Fig. 2). Only 3.07% of symptomatic patients presented in first three decades of their life. CAD was seen in 61.5% of these patients with CAAs.

Among 838 CAAs, 95 were anomalies of origin and course (1.18%), 740 were anomalies of intrinsic anatomy (9.22%), 3 were anomalies of termination (0.03%) and 0 cases of anomalous anastomotic vessels. Details of coronary anomalies detected in our study is based on Angelini et al's classification (Table 2).

Myocardial bridging (MB) was the most common anomaly among anomalies of intrinsic anatomy as well as total anomalies with a prevalence of 9.05%. CAD was seen in 62% of patients with MB. When excluding MB, prevalence of CAAs was 1.36%. Anomalous location of coronary ostium at improper sinus (ACOIS) was the second most common anomaly with a prevalence of 0.87%. Among ACOIS, anomalous origin of right coronary artery (RCA) from left coronary sinus (LCS) was the most common type with a prevalence of 0.51%.

4. Discussion

Coronary artery anomaly is defined as any coronary arterial pattern with a feature (e.g., origination, course, and termination) that is rarely seen in the general population.[12] At present, there is no generally accepted classification for CAAs and the definition of normality and abnormality is yet to be clarified.[13] We followed Angelini et al. classification of CAAs in our study. Some authors consider MB as a normal variant rather than anomaly, hence we also studied prevalence of CAAs excluding MB.[14,15]

The prevalence of congenital CAAs in various studies was ranging from 6.4 to18.4%.[16,17] The prevalence in our study was 10.09% which was well within the aforementioned range. The prevalence of congenital CAAs excluding MB in various studies conducted in different populations of world was ranging from 0.46 to 3.1%.[8,18] The prevalence in our study which was primarily based on South Indian Population was 1.36% (excluding MB).

Present guidelines suggest the use of MDCT for the evaluation of CAAs.[19] Throughout past years. there have been multiple studies which showed that MDCT-CA (even with older scanner technology) is a reliable non-invasive technique to identify CAAs.[20–23] Prevalence of CAAs detected by MDCT-CA in world population was 7.9%–18.4% depending on various inclusion criteria and when MB was excluded, it was 1.029%–2.88%.[18,24–26] Prevalence in our study was within the aforementioned ranges concluding that there is no significant difference in prevalence of CAAs (including and excluding MB) in Indian and World population.

Detection of coronary artery anomalies using doppler 2D-ECHO is difficult.[27] Prevalence of CAAs detected by ECHO was 0.17%–0.4%, indicating low sensitivity of ECHO in detecting CAAs when compared to MDCT-CA.[28,29] Prevalence of CAAs detected by ICA is between 0.3–2.7% even when MB was included.[30,31] Temporal resolution of ICA is 33 ms operating at 30 frames per second and spatial resolution of typical fluoroscopy is 0.16 mm.[32,33] We are yet to achieve these temporal and spatial resolutions using CT technology. The radiation dose for a retrospective ECG-gated 64-MDCT-CA is 13–15 mSv for males and 18–21 mSv for females.[34] Coronary MRA can detect coronary artery anomalies of origin and visualize their course with added advantage of no ionizing radiation. Lack of radiation is particularly important while imaging children, pregnant women and young adults. But the diagnostic quality is not as good as MDCT-CA and is still undergoing technical developments to improve its diagnostic quality in assessing coronary arteries.[35]

Table 1
Angelini et al Classification of Coronary Artery Anomalies.[1]

Classes	Anomalies
A: Anomalies of origin and course:-	1. Absent left main trunk (LMCA) with separate origins of LAD and LCX 2. Anomalous location of coronary ostium within aortic root or near proper coronary cusp (for each artery): a. High b. Low c. commissural: 3. Anomalous location of coronary ostium outside normal coronary cusp: a. Non coronary sinus (NCS) b. Ascending aorta c. Left ventricle d. Right ventricle e. Pulmonary artery f. Aortic arch g. Innominate artery h. Right carotid artery i. Interal mammary artery j. Bronchial artery k. Subclavian artery l. Descending thoracic artery 4. Anomalous location of coronary ostium at improper sinus: a. RCA arising from LCS, with anomalous course b. LAD arising from RCS, with anomalous course c. LCX arising from RCS, with anomalous course d. LMCA arising from RCS, with anomalous course 5. Single coronary artery (SCA)
B: Anomalies of intrinsic anatomy:-	1. Congenital ostial stenosis/atresia 2. Coronary ostial dimple 3. Coronary ectasia/aneurysm 4. Absent Coronary artery 5. Coronary hypoplasia 6. Intramural coronary artery (Muscular bridging) 7. Subendocardial course 8. Coronary crossing 9. Anomalous origin of PDA from anterior descending or septal perforating branch 10. Split RCA 11. Split LAD 12. Ectopic origin of first septal branch
C: Anomalies of termination:-	1. Inadequate arteriolar/capillary ramifications 2. Fistulas from RCA, LCA or infundibular artery to: a) Right ventricle (RV) b) Right atrium (RA) c) Coronary sinus d) Superior vena cava e) Pulmonary artery f) Pulmonary vein g) Left atrium (LA) h) Left ventricle (LV) i) Multiple
D: Anomalous anastomotic vessels:-	

Abbreviations: SCA- single coronary artery; RCA- Right coronary artery; LCA- left coronary artery; LMCA- Left main coronary artery; LAD- Left anterior descending artery; LCX- Left circumflex artery; RCS- right coronary sinus; LCS- Left coronary sinus, NCS- Non coronary sinus, PDA- Posterior descending artery, RA-Right Atrium.

5. Limitations

1. The study had been performed in patients with intermediate risk of CAD. Hence, does not represent the actual prevalence of CAAs in the general population.
2. The prevalence of CAD in the population of CAAs may be under-represented since only intermediate risk group had been taken.
3. CAAs were generally seen in the young population and this population was not been adequately represented in this study.
4. This was a single center study in an urban population and hence could not truly represent the magnitude of the problem in a country like India where 60% of the population resides in the rural India.

6. Conclusion

There is no significant difference in prevalence of CAAs (including and excluding MB) in Indian and World population. CAAs were more common in males than females and most of these patients remain asymptomatic during first three decades of their life. Myocardial bridging is the most common anomaly detected by MDCT-CA followed by ACOIS. RCA arising from LCS is the most commonly encountered ACOIS.

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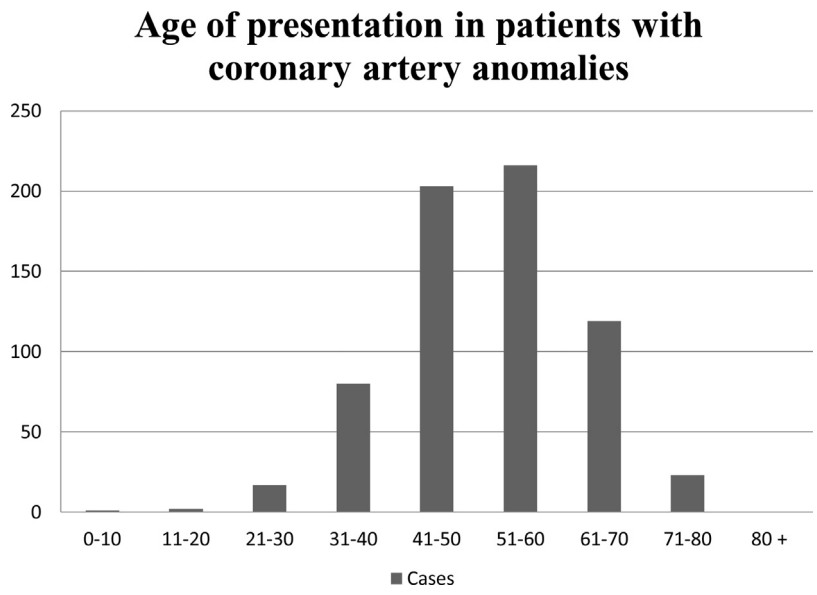

Fig. 2. Bar diagram showing age of presentation in patients withCoronary artery anomalies in our study.

Table 2
Cases detected based on Angelini et al Classification of CAAs.

Classes	Anomalies	Number of cases	Percentage (%) among total anomalies
A: Anomalies of origin and course:-	1. Absent left main trunk (LMCA) with separate origins of LAD and LCX	15	1.78
	2. Anomalous location of coronary ostium within aortic root or near proper coronary sinus (for each artery):		
	a. High origins	6	0.71
	3.Anomalous location of coronary ostium outside normal coronary sinus:		
	a. Non Coronary Sinus (NCS)	3	0.35
	b. Main Pulmonary artery (MPA)	1	0.11
	4. Anomalous location of coronary ostium at improper sinus (ACOIS):		
	a. RCA arising from LCS, with anomalous course	41	4.89
	b. LAD arising from RCS, with anomalous course	1	0.11
	c. LCX arising from RCS, with anomalous course	16	1.90
	d. LMCA arising from RCS, with anomalous course	12	1.43
	5. Single coronary artery (SCA)	10	1.19
B: Anomalies of intrinsic anatomy:-	1. Congenital ostial stenosis/atresia	1	0.11
	2. Coronary ectasia/aneurysm	4	0.47
	3. Coronary hypoplasia	2	0.23
	4. Intramural coronary artery (Myocardial bridging)	728	86.87
	5. Split LAD	5	0.59
C: Anomalies of termination:-	1. Fistulas from RCA, LCA or infundibular artery to:	1	0.11
	a) Right ventricle	1	0.11
	b) Right atrium	1	0.11
	c) Pulmonary artery	0	0.00
D: Anomalous anastomotic vessels			
	Grand Total:	838	

CAA-Coronary artery anomalies; RCA- Right coronary artery;LCA- Left coronary artery;LAD- Left anterior descending artery; LCX- Left circumflex artery; RCS- right coronary sinus; LCS- Left coronary sinus.

Conflict of interest

None.

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