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Original Article

128-Slice MDCT angiographic evaluation of coronary artery anomalies in the South Asian (Indian) population – A first experience

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ABSTRACT

Objective: To identify the incidence of coronary artery anomalies and their subtypes in the South Asian (Indian) population using 128-slice MDCT angiography.
Methods: This was a retrospective study involving 3300 patients who were referred for coronary MDCT angiography over a period of 8 years (2008–2016). All patients were evaluated by means of 128 slice MDCT scanner (SIEMENS SOMATOM AS+).
Results: A total of 171 coronary artery anomalies (5.2%) were identified. These included 109 peripheral branch anomalies, 56 ACAOS with abnormal course, 5 anomalies of coronary origin only & 1 coronary arterio-venous fistula. Of these 28 RCA anomalies had malignant interarterial course and 27 LCA anomalies had benign retroaortic course and one with intramyocardial course.
Conclusion: 128 slice MDCT coronary angiography provides high temporal & spatial resolution along with a very precise volume rendering 3D imaging which enables the diagnosis of coronary artery anomalies unchallenging. Our study showed that the incidence of coronary artery anomalies was far higher in the Indian population when compared with the western or global population, emphasising further the need for such a study, in view of the high incidence of cardiovascular diseases in India when compared with the rest of the world.

1. Introduction

The incidence of congenital anomalies of the coronary arteries in the general population ranges from 1 to 2%.[1] Although their incidences are uncommon, their clinical significance should not be ignored, as some of these course anomalies are considered "malignant" and increases the risk of myocardial ischaemia and sudden death especially in children and younger adults. The various "malignant" course anomalies include origins of left coronary artery from the pulmonary trunk and interarterial vessel courses.[2,3] ECG gated Multi Detector Computed Tomography (MDCT) offers several advantage over conventional catheter angiography which includes a 3-dimensional view, better delineation of the origin of the ostium and proximal origin of a coronary artery anomaly and most importantly a non-invasive approach.[4] To the best of our knowledge ours is the only one that used a 128 slice MDCT to evaluate 3300 patients from a single centre for coronary artery anomalies. Being a tertiary non-referral cardiac centre with the added advantage of an absence of a referral bias, we felt the importance and dire need of such a study, as cardiovascular diseases (CVDs) form the leading cause of mortality in India, where ischaemic heart disease and stroke account for >80% of these deaths. Also according to the Global Burden of Disease study, the estimated age standardised CVD death rates were far higher in the Indian population (272 per 100,000) when compared with the global average (235 per 100,000).[5]

Abbreviations: MDCT, multidetector computed tomography; CVDs, coronary vascular diseases; RCA, right coronary artery; LCA, left coronary artery; LAD, left anterior descending artery; LCX, left circumflex artery; MIP, maximum intensity projection; VR, volume rendering.

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Table 1
Classification of coronary anomalies proposed by Schmitt et al.

Class	Anomaly
A-Origin and course anomalies of the central coronary segments: -	*1-Right coronary artery anomalies:* a-Origin of the RCA from the LEFT CORONARY SINUS or LCA, anterior/interarterial course b-Origin of the RCA from the LEFT CORONARY SINUS or LCA, posterior course. c-Origin of the RCA from the NON CORONARY SINUS, posterior course. d-Origin of the RCA from the pulmonary artery, anterior course. *2-Left coronary artery anomalies:* a-Origin of the LCA from the RIGHT CORONARY SINUS or RCA, anterior course. b-Origin of the LCA from the RIGHT CORONARY SINUS, NON CORONARY SINUS or RCA, posterior course c-Origin of the LCA from the RIGHT CORONARY SINUS or RCA, interarterial course. d-Origin of the LCA from the RIGHT CORONARY SINUS or RCA, septal course. e-Origin of the LCA from the pulmonary artery, posterior course. 3-*Anomalies of the central branches of left coronary artery:* a-Origin of the LAD from the RIGHT CORONARY SINUS or RCA, anterior course. b-Origin of the LAD from the RIGHT CORONARY SINUS or RCA, interarterial course. c-Origin of the LCX from the RIGHT CORONARY SINUS, NON CORONARY SINUS or RCA, posterior course. 4-*Anomalies of both the right and left coronary arteries:* a-Orthotopic origins from the clockwise rotated aortic bulb. b-Orthotopic origins from the counter-clockwise rotated aortic bulb. c-Three origins from the RIGHT CORONARY SINUS, variable courses. d-Three origins from the LEFT CORONARY SINUS, variable courses.
B-Anomalies of only coronary origin:	*1-Origin anomalies of the right coronary artery:* a-RCA origin above the sinotubular ridge (high take-off) b-RCA ostium absent (single coronary artery syndrome) 2-Origin anomalies of left coronary artery: Separate origins of the LAD and LCX from the LEFT CORONARY SINUS
C-Origin and course anomalies of the peripheral coronary segments:	*1-Anomalies of peripheral branches of the RCA* Mainly the proximal RCA vessels affected with different pathways *2-Anomalies of peripheral branches of the LCA* Mainly the distal LCA vessels affected with different pathways.
D-Arterio-venous coronary fistulas:	1-Fistulas originating from the right coronary artery 2-Fistulas originating from the left coronary artery 3-Fistulas originating from both the right and left coronary arteries.

Abbreviations: RCA, right coronary artery; LCA, left coronary artery; LAD, left anterior descending artery; LCX, left circumflex artery.

2. Materials and methods

This was a retrospective study involving 3300 patients with suspected coronary artery diseases who underwent retrospectively gated coronary MDCT Angiography using a 128-slice MDCT scanner (SIEMENS SOMATOM AS+) over a period of 8 years from 2008 to 2016. Monitoring of ECG was done continuously during the examinations. All images were acquired using a single inspiratory breath hold technique. 130 ml of iodinated contrast was administered at the rate of 4 ml/s using an 18-gauge cannula. In all patients reconstruction algorithms were used for image reconstruction. Post processing techniques such as maximum intensity projection (MIP) and volume rendering (VR) were further used to evaluate the origin and course of the coronary vessels.

Anomalies of the coronary artery can be classified into 4 groups according to the study conducted by Schmitt et al. in 2005 (Table 1): 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 (A-V) anomalies of the coronary arteries. These groups were further subdivided into 4 sub-groups: anomalies of RCA, LCA, LAD or LCX and those of both RCA & LCA.[2]

3. Results

Among the 3300 patients evaluated, 171 patients presented with anomalous coronary artery from the opposite sinus i.e. a prevalence of approximately 5.2% (Fig. 1). This was far higher than the findings seen in the study conducted by the Cleveland Clinic Foundation in North America involving 26,595 patients in 1990, where the prevalence of coronary artery anomalies was 1.3%. To the best of our knowledge ours is the first single institution study conducted to identify the prevalence of coronary artery anomalies in the South Asian (Indian) population using 128 slice MDCT. The exact cause for coronary anomalies is uncertain, and has no inheritance pattern or sex pre-dominance. Previous literatures have identified the origin of right coronary artery (RCA) from the Left Sinus of Valsalva (LSV) and an absent LMCA to be the most commonly encountered anomalies.[6,7]

In our study, coronary artery dominance were as follows (Fig. 2): right coronary dominance in 2425 patients (73.5%), left coronary dominance in 374 patients (11.3%) and Co-dominance in 501 patients (15.2%). Anomalies of origin and course of the central coronary artery segments were seen in 56 patients, while anomalies of only the coronary artery origin were seen in 5 patients. Origin and course anomalies of the peripheral coronary segments were see in 109 patients and coronary arterio-venous fistula was seen in only 1 patient (Tables 2 and 3). The origin and course anomalies of the central coronary artery segment were seen in equal proportions (i.e. 50%) in both the RCA and LCA (Table 4).

Anomalies of the peripheral coronary segments were seen in 109 patients (63.7%). The conus artery originated directly from the right coronary sinus in 108 patients while the SA nodal artery originated from the right coronary sinus in 1 patient.

In all the 28 *right coronary artery (RCA) origin and course anomalies*, the RCA originated from the left coronary sinus then had an inter-arterial course between the pulmonary artery and the aortic root (Figs. 3 and 4).