



Anatomical variations of coronary artery and frequency of median artery: A cadaveric study from Northern India

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Abstract

Introduction: Clinicians and anatomists have been examining coronary artery variations for a long time. However, there is still no consensus on the normality or abnormality of coronary arteries. The present survey was therefore conducted to find out the variations in left coronary artery (LCA) and right coronary artery (RCA) branches, the existence and occurrence of the median artery in northern Indian population.



Material and methods: The present study was planned and conducted during March 2012 to September 2014 at Department of Anatomy, Major S. D. Singh Medical College, Fatehgarh; a tertiary care teaching hospital. The hearts of 40 adult northern Indian cadavers fixed with 10% formaldehyde were used. To determine the dominant circulation, the artery that supplies the posterior inter ventricular sulcus was investigated. Dissections were performed under a dissection microscope and photographed.

Results: LCA branched out of the aortic sinus in all the hearts and had an average diameter of 4.44 ± 1.79 mm. In 45% hearts, the LCA was separated into the anterior inter ventricular branch and the circumflex branch (bifurcation). In 42.5% hearts, in addition to the anterior inter ventricular branch and the circumflex branch; there was a median artery that coursed on the front wall of the left ventricle (trifurcation). In 10% hearts, branching occurred as in trifurcation but with two median arteries emerging from the LCA (quadrifurcation). Myocardial bridges were found on the LCA branches in 19 of the 24 hearts in which the median artery existed.

Conclusion: There is an important relationship between the existence of the median artery and myocardial bridges. The median artery might be important as it may not result in any clinical symptom for many years in a large number of subjects. Knowledge of individual and racial variations in coronary arteries is essential for the diagnosis and treatment of coronary artery patients.

Key words

Coronary artery, Variations, Median artery, Frequency.

Introduction

The arterial supply of the heart is provided by the right and left coronary arteries. They are located between the epicardium and myocardium; these vessels arise from the bulbus aorta as two branches of the ascending aorta [1]. The left main coronary artery originates from the left coronary sinus of valsalva. It usually has a short common stem, which bifurcates or trifurcates. Its branches are the anterior descending (inter ventricular) coronary artery, the left circumflex coronary artery and median branch (merely a left ventricular branch which happens to originate from the main artery) [2]. The left coronary artery (LCA) is wider in diameter than the right coronary artery (RCA). It is generally divided into two main branches; the anterior inter ventricular branch and the circumflex branch [3].

In addition to these branches (14–40%), a third branch, known as the median or inter median

artery, has been reported to exist [4, 5]. The median artery can arise from the LCA (trifurcation or quadrifurcation) or from the proximal part of the anterior inter ventricular branch or circumflex artery. It goes obliquely around the sternocostal surface of the left ventricle and is spread around the middle area between the base and the apex of the heart [6]. The RCA begins at the right aortic sinus and goes along the coronary sulcus. It supplies the right atrium, right ventricle, atrioventricular septum and a part of the left ventricle. Along its course, it produces a conus branch, a right marginal branch and a posterior inter ventricular branch.

The dominance of the coronary artery system was defined according to the coronary artery that supplies the back of inter ventricular septum or produces the posterior inter ventricular branch [3]. In humans, it has been reported that the posterior inter ventricular branch branches off from the RCA in 75% of cases (right dominance) and from the LCA in

10% of cases (left dominance), and goes around the back of the anterior inter ventricular branch, creating an anastomosis with the posterior inter ventricular branch in 15% of cases (equal dominance) [1]. The present survey was therefore conducted to find out the variations in LCA and RCA branches, the existence and occurrence of the median artery in northern Indian population.

Material and methods

The present study was planned and conducted during March 2012 to September 2014 at Department of Anatomy, Major S. D. Singh Medical College, Fatehgarh; a tertiary care teaching hospital located in rural Uttar Pradesh. The hearts of 40 adult northern Indian cadavers from both genders (aged 24–68 years) that were fixed with 10% formaldehyde were used for this study. The events followed were well-matched with the ethical standards for human experimentation, which were based on the Helsinki Declaration. Ethical committee approved the study.

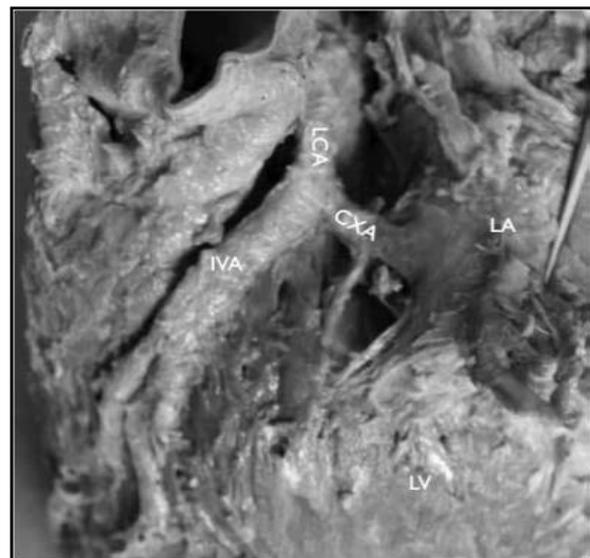
The epicardium layer was detached by micro-dissection, and the coronary arteries were observed. The exit point of the LCA from the aorta, the courses and variations of the anterior inter ventricular branch and circumflex branch, and the existence of the median artery was investigated. The exit points of the RCA and conus branch, the courses of the posterior inter ventricular branch and the variations of the RCA branches were noted down. The external diameters at the starting points of these branches were measured using 0.01 mm sensitive digital calipers. To determine the dominant circulation, the artery that supplies the posterior inter ventricular sulcus was investigated. Dissections were performed under a dissection microscope and photographed. After compilation of collected data, analysis was done using Statistical Package for Social Sciences

(SPSS), version 20 (IBM, Chicago, USA). The results were expressed as mean \pm standard deviation.

Results

The present study, carried out in the Department of Anatomy of a tertiary care teaching hospital included a total of 40 hearts of adult northern Indian cadavers. LCA branched out of the aortic sinus in all the hearts and had an average diameter of 4.44 ± 1.79 mm. In 18 (45%) hearts, the LCA was separated into the anterior inter ventricular branch and the circumflex branch (bifurcation). (**Figure - 1**)

Figure – 1: Two branches arising as the anterior inter ventricular branch (IVA) and the circumflex branch (CXA) (bifurcation) of the left coronary artery (LCA). [LA: left auricle; LV: left ventricle]



In 17 (42.5%) hearts, in addition to the anterior inter ventricular branch and the circumflex branch; there was a median artery that coursed on the front wall of the left ventricle (trifurcation). (**Figure - 2**)

In four (10%) hearts, branching occurred as in trifurcation but with two median arteries emerging from the LCA (quadrifurcation). (**Figure - 3**)

Figure – 2: Three branches arising as the anterior inter ventricular branch (IVA), the circumflex branch (CXA) and the median artery (MA), which course on the front wall of the left ventricle (trifurcation) from the left coronary artery (LCA). [LA: left auricle; LV: left ventricle; RA: right auricle; D: diagonal artery]

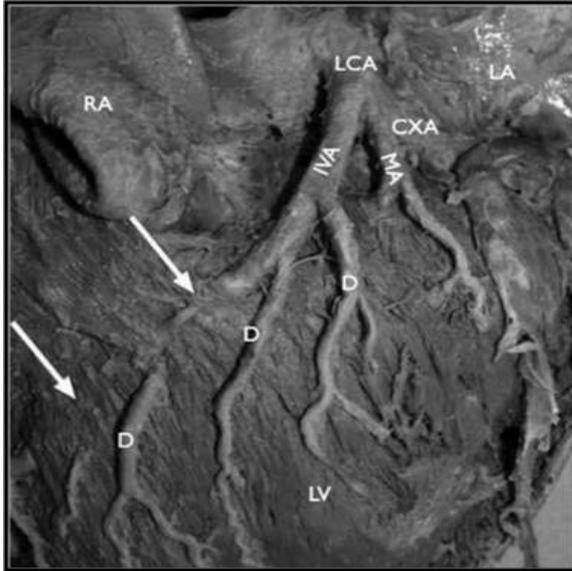
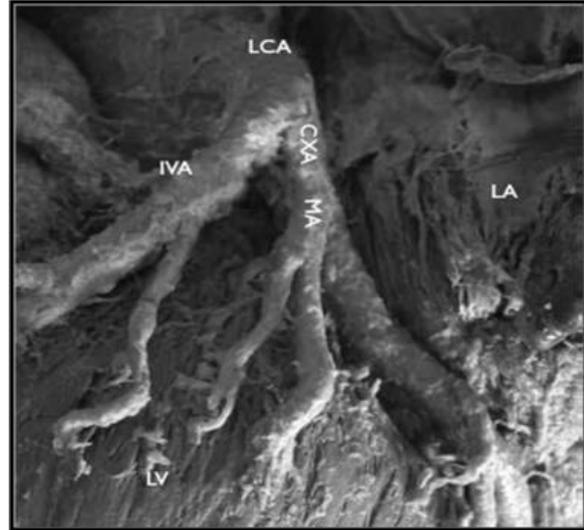


Figure – 4: The median artery (MA) arising from the circumflex branch (CXA). [LA: left auricle; LV: left ventricle; IVA: anterior inter ventricular branch; LCA: left coronary artery]



In 14 (35%) hearts, the conus branch, which is classically known as a branch of the RCA, branched out from the RCA. **(Figure - 5)**

Figure – 3: Four branches arising as the anterior inter ventricular branch (IVA), the circumflex branch (CXA), and two median arteries (MA) (quadrifurcation) of the left coronary artery (LCA). [LA: left auricle; LV: left ventricle]

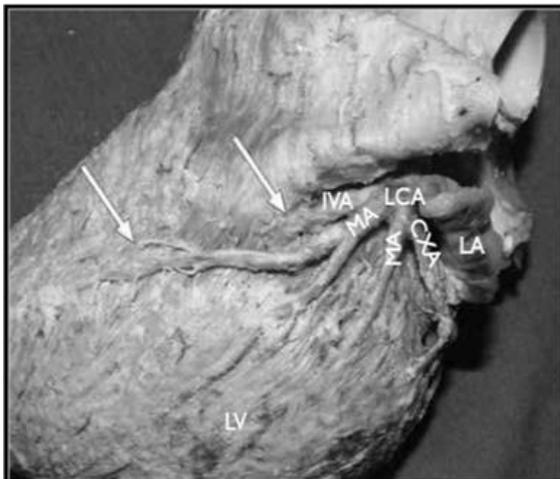
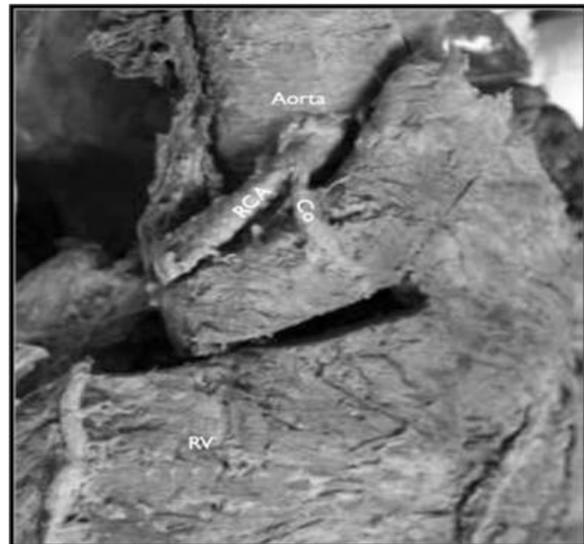


Figure – 5: The conus branch (Co) originating from the right coronary artery (RCA). [RV: right ventricle]



In three hearts, the median artery first branched out as one branch and then divided into two. **(Figure - 4)**

In 29 (72.5%) hearts, the conus branch branched out from the right aortic sinus. **(Figure - 6)** The posterior inter ventricular branch arose from the

RCA in 32 (80%) hearts and from the left circumflex branch in two (5%) hearts. (Figure - 7)

found on the LCA branches in 19 of the 24 hearts in which the median artery existed.

Figure – 6: The conus branch (Co) branching out from the right aortic sinus. [RCA: right coronary artery; RV: right ventricle]

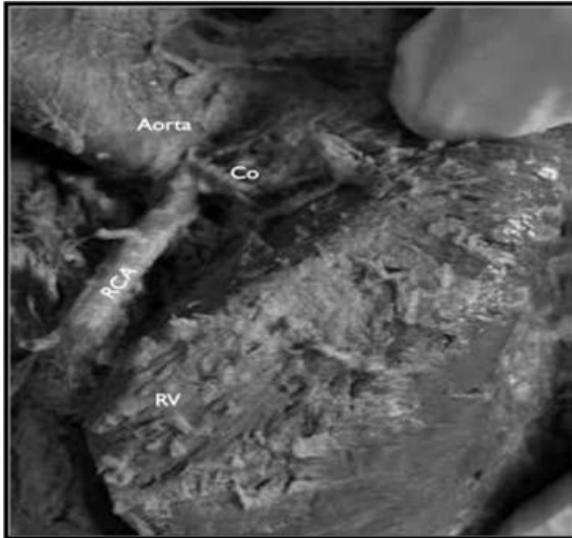
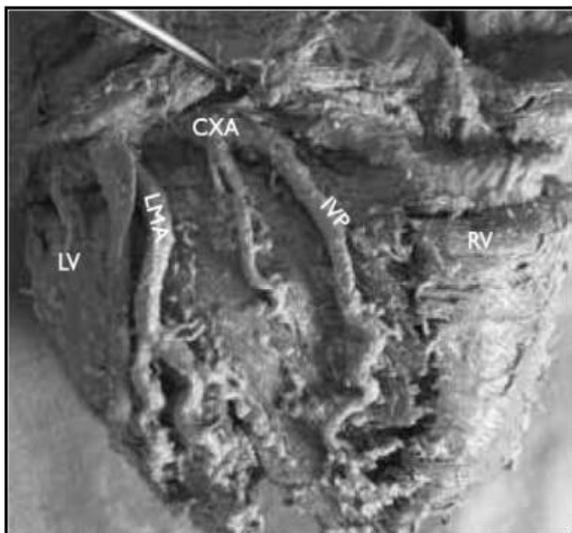


Figure – 7: The posterior inter ventricular branch (IVP) arising from the left circumflex branch (CXA). [LV: left ventricle; RV: right ventricle; LMA: left marginal artery]



The coronary dominance of all hearts in this study was as follows: right dominance was found in 16 (40%) hearts, left dominance, in seven (17.5%) hearts, and equal dominance, in 17 (42.5%) hearts. Myocardial bridges were

Discussion

Clinicians and anatomists have been examining coronary artery variations for a long time. However, there is still no consensus on the normality or abnormality of coronary arteries. In angiographic and cadaver studies carried out among different ethnic groups, Garg, et al. reported that the most frequent coronary artery variations were observed in the RCA (62%) and the left circumflex branch (27%) [6], while Topaz, et al. observed 48.71% of variations in the RCA and 35.89% in the left circumflex branch [5]. In our study, as in previous studies, it was determined that the most frequent variation (64%) was the conus branch of the RCA, which originates from the aortic sinus. Researchers have reported different results regarding the LCA branching frequency [7]. While the rates of bifurcation and trifurcation in our study were very similar to each other and to the rates found by Surucu, et al. [8], the quadri-division rate was similar to the results reported by Leguerrier, et al. [9]. The similarity between the bifurcation and trifurcation rates suggests that the normal division of the LCA into two branches should be reconsidered. (Table - 1)

Kronzon, et al. [10] reported right dominance in his angiographic study of 104 participants whereas Kurjia, et al. [11] noted that establishing the location and origin of the conus artery in relation to the right ventricular outflow tract radiologically prior to surgery is essential for the treatment of tetralogy of fallot. Ortale, et al. [12] examined dominant circulation in 40 cadaver hearts, and accepted the posterior inter ventricular branch arising from the RCA and its branches supplying at least the middle medial part of the left ventricular posterior face as right dominance (62.5%). (Table - 2)



It was observed in the current study that myocardial bridges were found on the LCA branches in 19 of the 24 hearts in which the median artery existed. Results suggest that there is a statistically significant relationship between the presence of the median artery and myocardial bridges ($p = 0.04$). The result of this study is in agreement with previous studies by Loukas M and Lee TM [13, 14]. Our findings confirm the results of another study [13] bridges. This suggests that the median artery might be important in myocardial bridges, which exists in embryos but do not result in any clinical symptoms for many years in a large number of people.

Conclusion

The findings from the present study show an important relationship between the existence of the median artery and myocardial bridges. The median artery might be important as it may not result in any clinical symptom for many years in a large number of subjects. Knowledge of individual and racial variations in coronary arteries is essential for the diagnosis and treatment of coronary artery patients.

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Table - 1: A comparison of the frequency of left coronary artery branching types among various studies.

Study/author	No. of participants	Study Method	Percentage of participants		
			Bifurcation	Trifurcation	Quadrifurcation
Kalbfleisch, et al. [7]	141	Angiography	51.1	44.4	4.3
Surucu, et al. [8]	40	Dissection	47.5	47.5	2.5
Leguerrier, et al. [9]	80	Dissection	65–70	20–30	5–10
Current study	40	Dissection	45	42.5	10

Table - 2: A comparison of the frequency of coronary circulation types among various studies.

Study/author	No. of participants	Study Method	Percentage of participants		
			Left	Equal	Right
Kronzon, et al. [10]	104	Angiography	10	3	87
Kurjia, et al. [11]	119	Dissection	14	40	46
Ortale, et al. [12]	40	Dissection	12.5	25	62.5
Current study	40	Dissection	17.5	42.5	40