

AN ANATOMICAL STUDY ON THE CORONARY ARTERIES AND THEIR VARIATIONS

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ABSTRACT

Background and Aims: The term "Coronary" is derived from the Latin word "Corona", which means crown. The rise in the coronary heart disease in India has led to a rapid transition in health status. The present study is conducted to observe the origin, branching pattern and termination of the coronary arteries in human cadaveric hearts. Preponderance of right coronary dominance or left coronary dominance is also looked for in this study.

Materials and Methods: 50 human hearts were collected from the embalmed cadavers of both the sexes, from the department of Anatomy of our institution. They were preserved in 10% formalin.

Observation: In the present study, right coronary dominance is observed in 84% and left coronary dominance is observed in 16% of specimens. In 2% of specimen, third coronary artery is observed. 4% of short trunk (< 5 mm) and 6% of long trunk (> 15 mm) of left main coronary artery is observed. The average length of left main coronary trunk is 9.34 mm. In 14% of specimens, myocardial bridges are observed.

Conclusion: Knowledge of normal anatomy of coronary arteries, its variations and anomalies related to coronary circulation is mandatory for good clinical outcome following therapeutic procedures, like angioplasty and coronary artery bypass grafting. Thus in the interest of this subject, this study is pursued.

KEY WORDS: Right Coronary Artery, Left Coronary Artery, Coronary Dominance, Circumflex Artery, Posterior Interventricular Artery.

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INTRODUCTION

The term "Coronary" is derived from the Latin word "Corona", which means crown. The heart pumps the blood for the entire tissues in the human body through the aorta. However, the heart itself gets its nutrition through coronary arteries, which are usually two in number, placed like a crown on the heart, namely the right and

left coronary arteries. Coronary arteries are the largest vasa vasorum, as the heart is formed by fusion of two endothelial tubes. The right coronary artery arises from the ostium of the anterior aortic sinus or the right coronary sinus and the left coronary artery arises from the ostium of the left posterior aortic sinus or the left coronary sinus of the ascending aorta [1]

Sometimes the right conus artery, which is usually the first branch of right coronary artery, may arise from the anterior aortic sinus directly. Such an artery is called as third coronary artery [1].

The rise in the coronary heart disease in India has led to a rapid transition in health status [2]. There is a twofold rise and six fold rise of the coronary heart disease in people older than 20 years in rural and urban population, respectively from a period of 1960 to 2000 [3].

“Anomaly” refers to the variation that occurs in less than 1% of the general population [4]. Knowledge of normal anatomy of coronary arteries, its variations and anomalies related to coronary circulation is mandatory for good clinical outcome following therapeutic procedures, like angioplasty, coronary artery bypass grafting etc.

The present study is conducted to observe the origin, branching pattern, termination and variations of the coronary arteries in human cadaveric hearts. Preponderance of right coronary dominance or left coronary dominance is also looked for in this study.

MATERIALS AND METHODS

For the present study, 50 human hearts were collected from the embalmed cadavers of both the sexes, from the department of Anatomy of our institution. They were preserved in 10% formalin. The specimens were serially numbered from 1 to 50. Visceral pericardium is removed to observe the coronary arteries. The right and left coronary arteries were dissected to observe the origin, branching pattern and variations of the arteries.

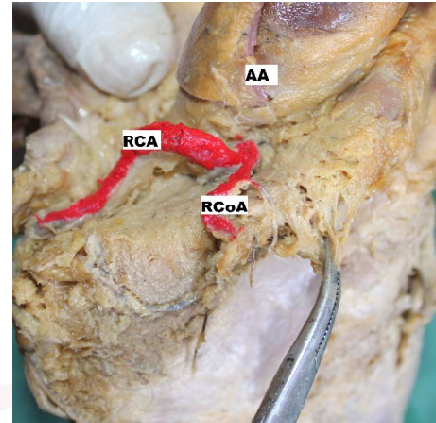
OBSERVATIONS

In the present study, in all the 50 specimens, the right and left coronary arteries arose from the anterior and left posterior coronary sinus of the ascending aorta respectively. In 12% of specimens, the left posterior aortic sinus was above the sino-tubular junction.

Variations Observed in the Right Coronary Arteries: In 2% of specimen, the right conal artery arose from the anterior aortic sinus directly, which is the third coronary artery. [Figure 1]

In 4% of the specimen, the right coronary artery terminated at the obtuse margin of the heart and in 16% of the specimens, the right coronary artery terminated in between the acute margin of the heart and the crux. [Table 1]

Fig. 1: Showing Right conal artery arising along with the Right coronary artery from the anterior aortic sinus.



AA- ascending aorta; RCA- right coronary artery; RCoA: Right conal artery.

Table 1: Termination of Right Coronary Artery.

Between acute margin and crux of heart		At Posterior interventricular septum		Between crux and obtuse margin of heart		At the obtuse margin of heart	
No. of specimens	%	No. of specimens	%	No. of specimens	%	No. of specimens	%
8	16	10	20	30	60	2	4

In 84% of the specimen, the posterior interventricular septum is supplied by the right coronary artery thereby the diaphragmatic surface of the heart is supplied by the right coronary artery. Hence, in the present study, 84% of the hearts are right dominant. [Table 2]

Table 2: Coronary Dominance pattern.

Right Dominance		Left Dominance	
No. of specimens	Percentage	No. of specimens	Percentage
42	84	8	16

Variations of the Left Coronary Arteries: In 4% of the specimens, the trunk of the left coronary artery was short measuring less than 5 mm [Figure 2] and in 6% of the specimens, the trunk of the left coronary artery measured more than 15 mm. The mean length of the main trunk of the left coronary artery is 9.34 mm, and the length ranged from 2 mm to 17 mm. [Table 3]

Table 3: Length of the trunk of Left Coronary Artery.

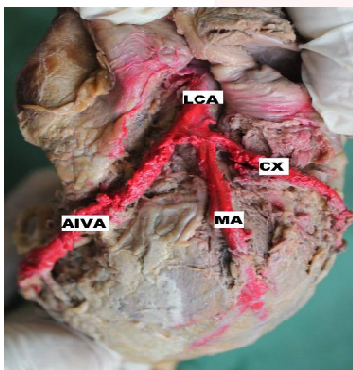
Length of the trunk of Left Coronary Artery					
Less than 5 mm		5 mm to 15 mm		More than 15 mm	
No. of specimens	Percentage	No. of specimens	Percentage	No. of specimens	Percentage
2	4	45	90	3	6

Fig. 2: Showing short main trunk of Left coronary artery.



Trifurcation and quadrifurcation of the trunk of the left coronary artery was observed in 26% and 4% of the specimens, respectively. In these specimens, the left coronary trunk branched into left anterior descending artery, which continued as anterior interventricular artery, one or two median arteries and circumflex artery. [Table 4][Figure 3]

Fig. 3: Trifurcation of main trunk of Left Coronary artery.



LCA- Left coronary artery; AIVA- anterior interventricular artery; MA- Median artery; CX- circumflex artery.

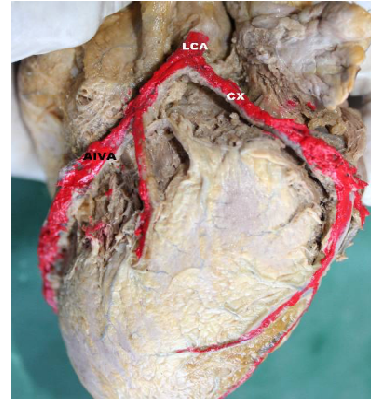
Table 4: Termination of the Left Coronary Artery trunk.

Termination of the Left Coronary Artery trunk					
Bifurcation		Trifurcation		Quadrifurcation	
No. of specimens	Percentage	No. of specimens	Percentage	No. of specimens	Percentage
35	70	13	26	2	4

In 4% of the specimen, the circumflex artery terminated at the obtuse margin of the heart and in 16% of specimens, the circumflex artery terminated by supplying the posterior interven tricular septum as the posterior interventricular artery. [Table 5][Figure4, Figure 5]

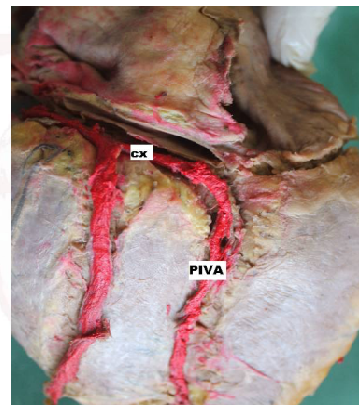
In the present study, in 70% of specimens, posterior recurrent interventricular artery is present, which is the continuation of the anterior interventricular artery winding around the apex of heart. Myocardial bridges are present in 14% of specimens. [Figure 6].

Fig. 4: Showing Circumflex artery terminating at the obtuse margin of heart.



LCA- Left coronary artery; AIVA- anterior interventricular artery; CX- circumflex artery.

Fig. 5: Left coronary dominance: Circumflex artery terminating as Posterior interventricular artery.

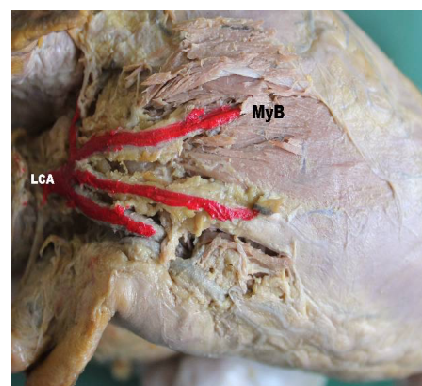


CX- circumflex artery; PIVA: posterior interventricular artery.

Table 5: Termination of Circumflex artery.

Termination of Circumflex artery					
At the posterior interventricular septum		Between crux and obtuse margin of heart		At the obtuse margin of heart	
No. of specimens	Percentage	No. of specimens	Percentage	No. of specimens	Percentage
8	16	40	80	2	4

Fig. 6: Showing Myocardial bridges.



LCA- left coronary artery; MyB- Myocardial Bridge.

DISCUSSION

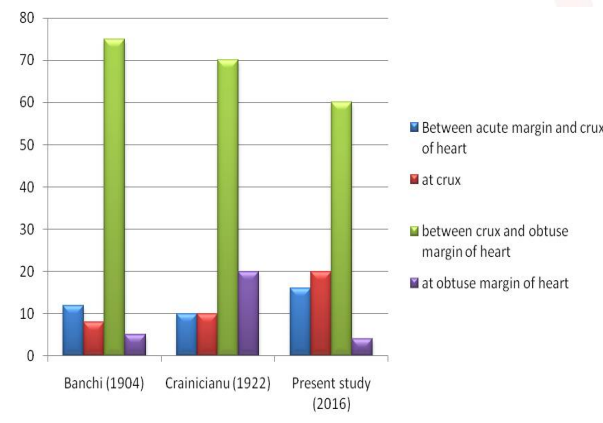
As lot of interventional procedures are done to treat coronary artery diseases, a profound theory comprising of normal and variant pattern of coronary vasculature is mandatory. For a successful coronary angiogram, knowledge about location, level and size of the ostium is mandatory [5]. A high left coronary orifice is associated with long left coronary artery and thereby iatrogenic injury to the artery during surgical procedures like valvular replacement is possible [6]. High left orifice with low right orifice is the second frequent position of coronary orifice observed in 30% of specimens [7]. In the present study in 12% of cases, left coronary orifice is above the Sino-tubular junction.

Coronary dominance is based on the arterial supply to the diaphragmatic surface of heart by either right or left coronary artery [8]. In former studies, 48% of right dominance, 18% of left dominance and 34% of balanced pattern were observed [8]. In the present study, 84% of right dominance and 16% of left dominance is observed. Balanced type is not observed.

The right conal artery, at times arises from the right coronary ostium directly and it is called as third coronary artery. The prevalence of the third coronary artery varies between 33% and 51% [9]. In the present study, third coronary artery is present in 2% of the specimens.

There have been considerable variations in the termination of right coronary artery by various authors. Chart 1 compares the termination of right coronary artery in the present study with other studies [9,10].

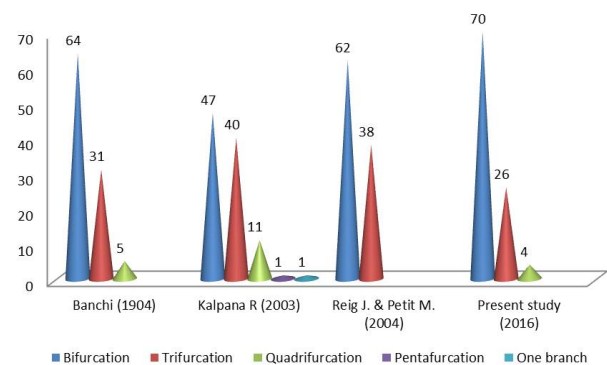
Chart 1: Termination of Right Coronary Artery.



The common trunk of left coronary artery is considered to be short, when it is less than 5 mm. Short trunk of left coronary artery has a clinical significance when perioperative coronary perfusion is performed and also during coronary angiogram [11]. Its frequency varies between 7% and 12% [12,13]. When the length of the left coronary artery is more than 15mm, it is called as long common trunk of left coronary artery. Its frequency varies between 11.5% and 18% [12,13]. In the present study, 4% of short trunk and 6% of long trunk of left coronary artery is observed. The average length of the main trunk of the left coronary artery in the present study is 9.34 mm and it is near consistent with a study by Reig and Petit [14] with an average of 10.8 mm.

Bifurcation of the left coronary artery is commonest branching pattern observed in the present study, which is consistent with other studies [14]. Trifurcation and quadrifurcation of the left coronary artery is also observed in this study. However, pentafurcation and single branch of left coronary artery is not observed in the present study, as it is observed in other studies [15]. The median artery could be an important collateral vessel in certain cases. Chart 2 shows the comparison of branching pattern of left coronary artery observed in the present study with observation of other authors.

Chart 2: Branching pattern of Left Coronary Artery.



In the present study, the posterior recurrent interventricular artery, which is the continuation of anterior interventricular artery, a branch of left coronary artery, winding around the apex of the heart for upto 2 to 5 cm is present in 70% of the specimens, as compared to 80% in a study by Kalpana R [15].

In majority of the specimens, the left circumflex artery terminates between the obtuse margin and crux of heart. In the present study 80% of the circumflex artery ends in similar fashion and the results are consistent with other studies. Table 6 shows the comparison of termination of left circumflex artery in the present study with other studies.

Table 6: Termination of Left Circumflex artery.

Termination of Circumflex artery				
Study	Between crux and acute margin of heart (%)	At the crux (%)	Between crux and obtuse margin of heart (%)	At the obtuse margin of heart (%)
Banchi (1904) [9]	11	70	-	19
James (1961) [16]	9	9	60	22
Present study (2016)	-	16	80	4

The main coronary arteries usually follow an epicardial route, occasionally the arteries penetrates deeper for a while into the myocardium and again follows epicardial route later on. That part of deeper artery is covered by myocardial fibres, which are named as myocardial bridges [17]. Myocardial bridges are more frequently present along the anterior interventricular artery. Contraction of these myocardial bridges may at times lead to ischemic manifestations, even though heart gets its arterial supply during diastole of heart. In the present study, in 14% of the specimens, myocardial bridges are observed along the course of anterior interventricular artery.

CONCLUSION

A proper knowledge of coronary arteries anatomy and its variations are mandatory for a successful clinical outcome following treatment of coronary artery diseases. Knowledge about the variations of coronary arteries is helpful for cardiologists and radiologists in performing various procedures like coronary angiogram, coronary angioplasty, and bypass grafting surgeries etc. Therefore, this study is accomplished to contribute to the subject of coronary arteries anatomy and their variations and it is compared with previous studies, thereby emphasizing the need for proper anatomy for a good clinical outcome.

Conflicts of Interests: None

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