Original research article

Study of Branching, Dominance Pattern of Coronary Arteries in Human Cadaver

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Abstract

Background: Coronary artery anomalies are known to be associated with congenital heart defects, myocardial ischemia and reduced life expectancy. The sound knowledge ofcoronary artery anatomy is necessary for proper management of patients undergoing evaluation for percutaneous coronary intervention, coronary artery surgery or prosthetic valve replacement.

Material and Methods: The presented study is done on 76 adult heart specimens obtained from routine dissection conducted for undergraduate students in the Department of Anatomy at Patna Medical College and Hospital Patna, Bihar. and also at other near by medical colleges of Bihar. The data obtained is tabulated and analyzed stastically.

Conclusion: study is done to know the normal and variant anatomy of Bihar region to provide vital inputs for making a correct diagnosis and planning treatment procedures of coronary angiography, stenting procedures and surgical myocardial revascularization.

Keywords: Left coronary artery; Right coronary artery; Branching pattern.

Introduction

A coronary artery is defined as any artery or arterial branch that carries blood to cardiac parenchyma. The coronary arteries supply blood to the musculature of the heart. The blood provides nutrients and oxygen to the tissue and also carries metabolic and catabolic waste, hence fully functional heart and circulation is a vital part of life. The heart contracts about 3 billion times in a lifetime, 3.7 million times in a year and 1, 00,000 times in a day. So per day heart pumps more than 7 m^3 of blood through 1, 00,000 km of vessels. Coronary artery disease is one of the major causes of death in developing countries. The increasing use of diagnostic and therapeutic interventional procedures necessitates a sound and basic knowledge of the coronary artery pattern. Coronary artery anomalies are gaining consideration as a cause of coronary heart disease in the diagnosis workup. One of the subsets of coronary artery anomalies is the anomalous origin. Coronary artery anomalies are congenital alterations in origin, course or structure of the epicardial coronary arteries. The coronary artery anomalies are mostly asymptomatic, however are the second leading cause of sudden death in young athleteswho are apparently healthy. Knowledge of normal and variant Anatomy and anomalies of coronary circulation is an increasingly vital component in managing congenital and acquired heart

disease. Congenital, inflammatory, metabolic or degenerative disease of heart and complex cardiac surgical repairs demand enhanced understanding of the same to improve operative outcomes. Understanding and diagnosis of coronary artery anomalies are important in considering the severity of coronary artery stenosis, particularly during therapeutic maneuvers such as angioplasty and bypass surgery. The most common cause of sudden cardiac death in young athletes is coronary artery anomalies. The coronary arteries begin to develop in utero at the start of the thirdweek of embryogenesis, the arteries pass through several complex steps during theirdevelopment in utero, some of which are unique to the development of the arteries in the coronary circulation. knowledge of coronary artery pattern and variations is essential. The knowledge of coronary circulation is not only important for anatomists but also for radiologists and cardiologists performing angiographies and shunt surgeries in diagnosis and treatment of congenital, inflammatory, metabolic anddegenerative diseases involving the coronary arteries. Hence this study is done to obtain the data and to enrich the knowledge of the vascular pattern of the coronary arteries, its branches.

Objectives
To study the site of origin of coronary arteries,To study the branching pattern of coronary arteries.
To study the distribution of coronary arteries, To study the dominance pattern of coronary arteries.

Review of Literature
The word coronary is derived from the Latin word co-ro-ne, Greek ko ro ne, means anything hooked or curved. "Corona" meaning "Crown".[13] Coronary arteries branch in such a manner that they occupy the atrioventricular and interventricular sulci in the shape of a crown, hence named as coronary arteries. William, Blake et al in 1964 mentions about earliest coronary artery descriptions. Fallopius in 1562 and Riolanus in 1649 stated that normally a single coronary vessel existed. But in 1761, G. P. Morgagni described about the presence of 2 coronary arteries. Giorgio Baroldi, Oreste Mantero et al in 1956 studied about the collateral circulation of the coronary arteries by the corrosion method and found that the normal human heart possesses arterial anastomosis having a lumen diameter of 20 to 350 microns and lengths ranging from 1 or 2 cm to 4 or 5 cm. Thomas N James et al (1958) studied atrial coronary arteries in 43 human hearts and stated that the artery supplying sinoatrial node is the largest atrial artery. It arose from left coronary artery in 39% and right coronary artery in 61%. The artery toAV node arose from right coronary artery at the junction of interatrial and interventricular septa in 83% cases and left coronary artery from 13% cases. Sally P All work in 1979 stated that single coronary artery may originate either from left posterior or anterior aortic sinus. Branching pattern of single coronary artery is similar to normal arteries and its disposition is according to its origin. Kalpana R in 2003 studied the coronary artery branches in 100 heart specimens by dissection method. Right coronary ostium in 90% cases and Left coronary ostium in 80% cases were below the Sino-tubular Junction (STJ). Both the proximal and distal segments of right coronary artery were present in 89%. The third coronary arterywas present in 24%. Left coronary artery showed bifurcation in 47%, trifurcation in 40%, quadrifurcation in 11%, pentafurcation in 1% and only one branch in 1%. In one specimen, apart from the right coronary artery an anomalous artery arose by a separate ostium from the right aortic sinus and passed towards the left in the course of circumflex branch. 89% of specimens were right dominant and 11% were left dominant. Fazliogullari Z, Karabulut A K 2010 studied the coronary artery variations and the frequency of median artery in 50 adult Turkish cadaver hearts. The LCA branched out from the aortic sinus and had an average diameter of 4.44 ± 1.79mm. Left coronary arteries showed bifurcation in 46% cases,

trifurcation in 44 % cases and quadrifurcation in 10% cases. The median artery was identified in 27 hearts, with a mean diameter of 2.00 mm. The RCA branched out from the right aortic sinus and had an average diameter of 3.32 ± 0.79 mm. The conus artery branched out from the RCA in32% of the hearts and from the right aortic sinus in 68%. Right dominance was observedin 42%, left dominance in 14%, and co-dominance in 44% of the hearts. Myocardial bridges were found on the LCA branches in 22 of the 27 hearts, in which the median artery existed. J. Vasudeva Reddy et al (2013) studied the origin, branching pattern and termination of coronary arteries in population of Andhra Pradesh. He dissected 80 human heart specimens by using vascular corrosion technique. Out of 80 specimens dissected 69 were of right dominance, 9 specimens were of left dominance and 2 specimens were of co-dominance type of coronary circulation.

Material and Methods
This study is 76 heart specimens. The specimenof adult human hearts used for this study were obtained from routine dissection conducted for undergraduate students in the Department of Anatomy at Patna Medical College and Hospital, Patna, Bihar. and also at other nearby medical colleges of Bihar . The detailed architecture, branching, distribution and dominance pattern of coronary arteries is studied by dissection method.

Inclusion Criteria
Heart specimens with intact blood vessels, Adult heart specimens from cadavers of both sexes.

Exclusion criteria
Hearts undergone surgeries, Hearts with lesions due to trauma.
Hearts dissected to study the interior and blood vessels. The specimens are collected from the cadavers during routine dissection for undergraduate medical students. By cutting the ribs and sternum the thoracic cavity is opened. The great vessels are ligated by thread at two places and then cut in between. The parietal pericardium is incised and heart along with great vessels is taken out of the pericardial cavity. Each specimen is thoroughly washed to free it from the blood clots. All specimens are preserved in 10% formalin solution. The specimens are labeled numerically. Coronary arteries and their branches are dissected in all the specimens of heart. First the anterior surface of the heart was dissected.

Results
The present study is carried on 76 specimens of cadaveric hearts and observed for - The origin and course of coronary arteries and branching pattern of coronary arteries.The level of termination and the dominance of coronary arteries. Any variation in relation to origin, course and branching pattern of coronary arteries are noted.

Table 1: Showing number and percentage of coronary arteries

No of coronary arteries	Specimen	Percentage
2	75	99%
3	1	1%
4	0	0%
Total	76	100%

Out of 76 specimens studied there are 2 coronary arteries in 75(99%) cases, 3 coronary arteries in 1 (1%) case and in none of the specimens there are 4 coronary arteries.

Table 2: Showing origin of coronary arteries

Origin of	RT Anterior aortic sinus	LT Posterior aortic sinus	Percentage
RCA	76	0	100%
LCA	0	76	100%

In all the 76 specimens the RCA is taking origin from right anterior aortic sinus and the LCA is taking origin from left posterior aortic sinus. No abnormal origin of RCA and LCA is observed.

Table 3: Showing level of termination of RCA

	Termination of RCA	Specimen	Percentage
a.	At right border	9	12%
b.	At the crux	6	8%
c.	Turn at right angle tocontinue in PIVS	21	27. 5%
d.	Between crux & leftborder	38	50%
e.	At left border	2	2.5%
Total		76	100%

RCA terminates at right border in 9 (12%) out of 76 specimens, at the crux in 6 (8%) specimens, turns at right angle to continue in posterior interventricular sulcus in 21 (27.5%) specimens, terminates between crux and left border in 38 (50%) specimens and in 2 (2.5%) specimens terminates at left border.

In relation to the branching pattern of left coronary artery, out of 76 specimens we found bifurcation in 62 (81.5%) cases followed by trifurcation in 11 (14.5%) cases and quadfurcation in 3 (4%) cases and in none of cases Penta furcation is seen.

Table 4: Showing presence of right marginal artery

Right marginal artery	Specimen	Percentage
Present	67	88%
Absent	9	12%
Total	76	100%

It is observed that the right marginal artery is present in 67 (88%) out of76 cases and is absent in 9 out of 76 cases (12%).

The Left diagonal artery originates from main trunk of LCA in 19(25%)out of 76 cases, in 51(67%) cases arises from LAD, in 6 (8%) cases arises from LCX. It was observed that left diagonal artery terminates before apex in 60(79%) out of 76 cases, it terminates at apex in 16 (21%) cases, in none of cases it terminates beyond apex.
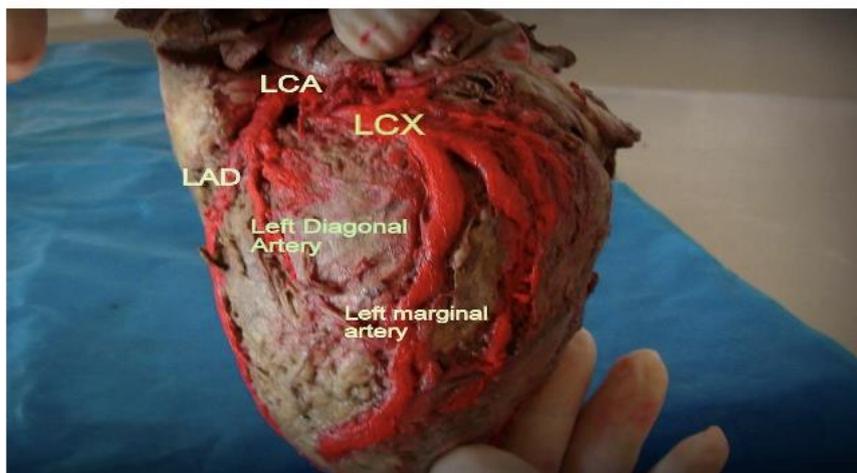
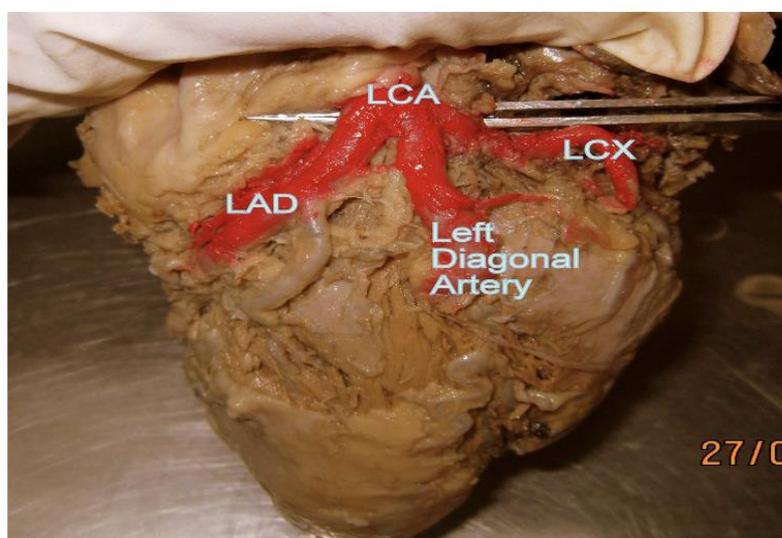**Figure 1: Photograph of anterior view of heart showing origin and branches ofLCA.**

Figure 2: Photograph of anterior view of heart Showing Trifurcation of LCA

Discussion

In the present study majority (99%) cases showed the presence of 2 coronary arteries which was similar to the observations of Almira Lijonovic et al (64%) and Patel M Pet al (89.52%).The incidence of single coronary artery is 0.48% as observed by Patel M P et al, however in the present case none of the specimen showed the presence of single coronary artery.The incidence of termination of LCX artery between obtuse border and crux in the present study (52.5%) is similar when compared with the study done by Hirak Das et al (52.86%). In the present study in noneof the specimens the LCX artery terminated at the acute border. In the present study, higher incidence of termination of LCX artery at obtuse border (21%) and between thecrux and the acute border (16%) is found when compared with other studies. The dominance of coronary artery is determined by the posteriorinterventricular artery (PIVA). It is termed as right dominance if PIVA is a branch of RCA, left dominance if PIVA is a branch of LCA and codominant if PIVA is given by both by RCA and LCA. The incidence of right coronary arterial dominance in present study (83%)is similar compared to that reported by Jose Roberto Ortale et al (88%), MA El Sayed (80%), Vasudeva Reddy J et al (86.25%). The incidence of right coronary arterial dominance (83%), left coronary arterial dominance (14.5%) and codominance (2.5%) obtained in the present study are similar with

findings of Vasudeva Reddy J et al. The incidence of 60.5% and 42% right coronary arterial dominance as reported by Fazlul Aziz Mian et al and Fazliogullari Z et al respectively is lower when compared with our study. Whereas the incidence of left coronary arterial dominanc(19.5%) and codominance (20%) reported by Fazlul Aziz Mian et al was higher whencompared to the present study.

In our present study the incidence of termination of PIVA ¾ way down PIVS (30%) and termination of PIVA at apex (8%) are similar to findings reported by Kalpana R. But the incidence of termination of PIVA upto ¼ way down PIVS (21%) in present study are higher compared to other studies. James et al reported 29% as incidence of termination of PIVA at apex which is higher compared to other studies. Kalpana R reported 52% as incidence of termination of PIVA ½ way down PIVS which is higher compared to other studies. In majority of cases the common pattern of branching of LCA is bifurcation. The results of bifurcation of our study are consistent with earlier reports. The frequency of quadrifurcation of LCA in present study is 4%, which is similar withfindings reported by Das Hirak et al as 5% and by Ballesteros L.E et al as 5.8%. Trifurcation of the LCA is less common and lowest reported in our study (14.5%) when compared with Surucu et al (47.5%), Ballesteros L.E et al (42.2%), Das Hirak et al(35%).Surucu et al (47.5%) and Kalpana (47%) reported lower incidence of bifurcation of LCA as compared to other studies. In our study, it was observed that left diagonal artery terminates before apex in 79% cases, it terminates at apex in 21% cases, in none of cases it terminates beyond apex. Maria Tereza Jordao et al reported that the length of the diagonal artery, as the smallest had 11.3 mm length and the largest 39.5 mm, averaging 22.4 mm.Since measuring the length of the diagonal artery is a cumbersome procedure. Therefore this parameter was used i.e. level of termination of left diagonal artery in relation to apex would be easy to determine the length. Left diagnol artery termination is important for the vascularization of the myocardium in cases of obliteration of the left coronary artery branches.

Conclusion

The present study on branching, distribution and dominance pattern of coronary arteries shows some difference with respect to the results from the above available literature. The No of coronary arteries are 2 in majority of cases and in one heart conus artery is arising directly from the aorta i.e third coronary artery. Conus artery is important because it often forms a vascular anastomostic bridge with a corresponding branch from either the LCA or proximal LAD forming the circle of Vieussens. This bridge may play a role as a collateral pathway to the LAD. In the present study there are no variations in the origin of coronary arteries.

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