



STUDY OF BRANCHING DISTRIBUTION AND DOMINANCE PATTERN OF CORONARY ARTERIES IN ADULT HUMAN HEART

Anatomy

Dr. Garima Anant Junior Resident Deptt of Anatomy DMCH Darbhanga Laheriasarai.

Dr. Sweta Rani Junior Resident Deptt of Anatomy DMCH Darbhanga Laheriasarai.

Dr. Lalan Prasad Sah Junior Resident Deptt of Anatomy DMCH Darbhanga Laheriasarai.

Dr. G.S.Jha* Assistant Prof. Deptt of Anatomy DMCH Darbhanga Laheriasarai. *Corresponding Author

Dr. S.K.Karn Associate Prof. Deptt of Anatomy DMCH Darbhanga Laheriasarai.

ABSTRACT

Background: The myocardium is supplied by a pair of coronary arteries which arise from the ascending aorta. 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.

Material And Methods: The present observational descriptive study was conducted at Dept. of Anatomy DMCH darbhanga bihar. The branching pattern and variations of the coronary arteries in adult human cadaveric hearts. adult cadavers from both genders (aged 25–70 years) that were fixed with 10% formaldehyde which were collected and used for the present study.

Results: Total 50 cases, the dissected (RCA) right coronary artery arose from the anterior aortic sinus. Left coronary artery was found to arise from left posterior coronary sinus in 49 hearts and in one heart from right posterior sinus of the ascending aorta. In anterior aortic and left posterior sinus one opening was present in 35 (70%) and 46 (84%) cases respectively.

Conclusion - It was observed that in 45 (90%) cases where the right ostia were situated just below the sinutubular ridge.

KEYWORDS

Coronary Arteries, adult Human Cadaveric Heart, Cadavers

INTRODUCTION

The myocardium is supplied by a pair of coronary arteries which arise from the ascending aorta. 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.¹ As the arterial supply to the myocardium is very critical for the normal functioning of the heart, the variations which exist in its branches are gaining importance, more so, because of the angiographic procedures and the numerous bypass surgeries which are being done.²

There is a progressive path for cardiovascular diseases management in the last few decades. More than one incorruptible lesion is nowadays amenable to correction due to more and newer surgical and interventional techniques. In congenital and acquired cardiovascular diseases management a good and precise knowledge of normal and anomalies of coronary circulation crucial. Numerous data on the variations of the arteries have been reported, The recent coronary arteriography provides an accurate localisation of variation and underlying pathology. The advances in coronary arterial bypass surgeries and modern methods of revascularisation make it necessary to have thorough knowledge of coronary artery and circulation.⁴

“Anomaly” refers to the variation which happens in around 1% of the general population. Thorough Knowledge regarding normal anatomy of coronary arteries, its variations and anomalies is obligatory for good clinical outcome following therapeutic procedures, like coronary artery bypass grafting, angioplasty, etc.³ The present study was conducted to observe the origin, branching pattern, termination and variations of coronary arteries in human cadaveric hearts.

MATERIAL AND METHODS

Length of RCA (cm)	No. of cases	Percentage
6-8 cm	6	12%
8-14 cm	42	84%
14-17 cm	2	4%
Length of LCA (mm)		
< 5 mm	40	(80%)
5-7 mm	6	(12%)
7-10 mm	4	(8%)
Length of LCA (cm)		

3-5 cm	10	20%
5-9 cm	35	70%
9-11 cm	05	10%
Length of posterior descending (cm)		
Table-3		

The present observational descriptive study was conducted at Deptt. of Anatomy; Darbhanga Medical College and hospital Laheriasarai, to the branching pattern and variations of the coronary arteries in adult human cadaveric hearts. Study includes hearts of adult cadavers from both genders (aged 25–70 years) that were fixed with 10% formaldehyde which were collected and used for the present study. Total 50 human hearts were collected from the embalmed cadavers of both the sexes, from the deptt of Anatomy at DMCH. They were preserved in 10% formalin. The specimens were serially numbered from 1 to 50.

The hearts were examined as per the general principles of anatomy. The coronary arteries were observed after removing visceral pericardium. The coronary arteries and their branches were dissected on the surface of the heart in the atrioventricular and interventricular grooves.

By micro dissection the epicardium was removed, and coronary arteries were observed. The exit point of the LCA from the aorta, the courses and variations of the circumflex branch and anterior interventricular branch, and the presence of the median artery were investigated. The exit points of the RCA and conus branch, the courses of the posterior interventricular branch and the variations of the RCA branches were determined. 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 interventricular sulcus was investigated. The pericardial cavity was opened and explored. Anatomy of the great arteries before transecting them about 3 cm above the aortic and pulmonary valves was observed. The pulmonary veins were checked and transected. The superior vena cava was transected about 2 cm above the point where the crest of the right atrial appendage meets the superior vena cava. The inferior vena cava was transected close to the diaphragm.

right coronary artery in 46 (92%) of the cases thereby the diaphragmatic surface of the heart is supplied by the right coronary

artery. Hence, in the present study, 46 (92%) of the hearts are right dominant. Only 4 (8%) cases posterior interventricular septum is supplied by left circumflex artery so heart is left dominant.

In the present study for right coronary artery branch the range of length of was depicted to be 6-8 cm in 6 (12%), 8-14 cm in 42 (84%), and 14-17 cm in 2 (4%) of cases. In 40 (80%) of the cases, the trunk of the left coronary artery was short measuring less than 5 mm and in 6 (12%) of the specimens, found more than 10 mm. The average length ranged from 2 mm to 17 mm. The length of left Circumflex artery was observed to be 3-5 cm in 20%, 5-9 cm in 70%, and 9-11 cm in 10% of all cases respectively. Average length for left circumflex artery 3 cm to 11 cm. Lengths of posterior descending branch of 3-5 cm were in 17 (34%) cases. Majority of cases have length between 5-7 cm i.e. 64%. Average length for posterior descending length i.e. 3 to 9 cm (table-2).

It was observed that right coronary artery concluded between crux and obtuse margin of heart in majority of cases 30 (60%) while in 10 (20%) cases it was terminated in between the acute margin of the heart and the crux (table-3).

In 2 (4%) of the cases, the right coronary artery concluded at the obtuse margin of the heart. In majority cases 35 (70%) bifurcation of left of coronary artery was found. Trifurcation and quadfurcation of trunk of the left coronary artery was depicted in 12 (24%) and 3 (6%) of the cases, respectively. In these specimens, trunk of the left coronary branched into left anterior descending artery, which continued as anterior interventricular artery, one or two median arteries and circumflex artery.

TABLE1.

Coronary artery	No. of cases	%
Branch of RCA		
Posterior descending or posterior interventricular artery	46	92%
Branch to sinoatrial node	50	100%
Branch to AV node	45	90%
Acute marginal branch	50	100%
Branch of LCA		
Left anterior descending or left anterior interventricular artery	50	100%
Circumflex coronary artery	50	100%
Ramus intermedius branch	8	16%
Left conus artery	1	2%

Length of RCA (cm)	No. of cases	Percentage
6-8 cm	6	12%
8-14 cm	42	84%
14-17 cm	2	4%
Length of LCA (mm)		
< 5 mm	40	(80%)
5-7 mm	6	(12%)
7-10 mm	4	(8%)
Length of LCA (cm)		
3-5 cm	10	20%
5-9 cm	35	70%
9-11 cm	05	10%
Length of posterior descending (cm)		
3-5 cm	17	34%
5-7 cm	32	64%
7-9 cm	01	02%

Table-2: Length of the trunk of Right Coronary Artery

between crux and obtuse margin of heart. In 03 (6%) of the cases, the circumflex artery concluded at the obtuse margin of the heart and in 7 (14%) of cases, the circumflex artery terminated by supplying the posterior interventricular septum as the posterior interventricular artery.

DISCUSSION

The extensive use of advanced image diagnostic techniques and the development of non-aggressive treatments, a in-depth knowledge of anatomy of the normal coronary and its variations and anomalies is important. Branches of coronary arteries may vary in origin, distribution, number and size. The name and nature of a coronary artery or a branch is defined by that vessel's distal vascularisation pattern or territory, rather than by its origin. As per the observations of

Loukas et al. (2009), it is necessary to determine the incidence of the variations, which are possibly capable of inducing sudden cardiac death, in order to evaluate the value of screening.⁶

In the present study, the dissected right coronary artery (RCA) was found to originate from the anterior aortic sinus in all 50 cases while Left coronary artery arose from left posterior coronary sinus in 49 hearts and in one heart from right posterior sinus of the ascending aorta in all the specimens studied and there were no variations in the location of the ostia.

Same observations were also found by the Kalpana R (2003) i.e. the Right and left coronary ostia were present at the anterior aortic and left posterior aortic sinus respectively in all the 100 specimens studied and there were no variations in the location of the ostia.⁷ Study done by Subhash D Joshi et al on 105 embalmed heart specimens found that neither openings were detected in the pulmonary sinuses nor in the right posterior aortic sinus.⁴ Study conducted by Jyoti P kulkarni et al revealed that in all 60 cases, the dissected the dissected right coronary artery (RCA) and left coronary artery (LCA) were found to originate from anterior aortic sinus and the left posterior aortic sinus, respectively.⁸ In a dissection study on heart specimens received from medico legal autopsies and performed by Sahni and Jit et al⁹, revealed that anomalous origin of any coronary artery was not found in any case. Baroldi and Scmazzonei In 1967, described 36% prevalence of independent origin of right conus.¹⁰ Similar findings also noted by Bhimalli *et al.*¹¹ However, ectopic origin may have for RCA from left posterior aortic sinus. On angiographic studies 0.0008% prevalence of this ectopic origin was observed, as mentioned by Yamanaka and Hobbs¹² and 0.043-0.46%, as revealed by Solanki et al.¹³ Grag and Tiwari et al¹⁴ observed anomalous coronaries in 0.95% of individuals. Of these cases, about 90% were anomalies of origin. Harikrishnan et al.¹⁵ reported an incidence of 0.45% of anomalies of origin of coronary artery.

Present study revealed that in the anterior aortic sinus multiple openings were seen. The extra openings of pinhead size were seen. Multiple openings were detected only in three cases in the left posterior aortic sinus. The presence of multiple orifices in the right aortic sinus is the most frequent variation while second most is the presence of an accessory orifice for the conal artery. Study done by Joshi et al⁴ found that in approximately 8% of hearts, in right coronary sinus three or more openings were present. Standring et al. (2005) have reported that in 36% of individuals the incidence of extra openings in the right aortic sinus. Sahni and Jit et al⁹ reported extra openings in 34.8% of male hearts and 27.8% of female hearts. Wolloscheck et al. (2001)¹⁶ reported extra ostia in 65% of cases in an anatomic and transthoracic echocardiographic study.

In our study, most cases, the ostia were positioned below the level of the sinutubular ridge. It was observed that in 45 (90%) cases where the right ostia and 39 (78%) cases where left ostia were situated just below the sinutubular ridge, the ridge was arched to accommodate the ostia within the sinus. Right and left ostia at level of sinutubular ridge were present in (6%) and 8 (16%) of cases respectively. A study conducted by Shinde VS et al reported that the majority of the coronary ostia were present below the sinutubular ridge this may be functionally more efficient than the ostia above the sinutubular ridge.¹⁷ Study done by Patil R et al¹⁸ reported that the coronary ostia were below the sinutubular ridge in 34 specimens (89.47% of cases) while coronary ostia were opening above the sinutubular ridge in 4 specimens (10.52% of cases). Turner and Navratnam et al¹⁹ found that 62 of the 74 main coronary ostia lay either at or immediately below the sinutubular ridge. Joshi SD et al⁴ reported that the majority of ostia lay below the sinutubular ridge. An accessory origin or an abnormal location of the coronary orifices may be disturbed by performing an aortotomy incision for aortic exposure. Precise knowledge of coronary ostia related to the aortic root is vital for various interventional and surgical cardiovascular procedures.¹⁸

In present study; Posterior descending (PD) and branch to AV node was observed to be a branch of RCA in 46 (92%) and 45 (90%) cases respectively. In all the cases the branch to SA node and acute marginal branch was found to be a branch from RCA. Similar observation were observed in the study conducted by Kulkarni J, in all 60 cases the branch to SA node was seen to originate from the RCA. However in 35% of cases Hutchison found a variable origin of the branch to SA node from circumflex coronary artery, which is a significant finding.

In the present study for right coronary artery branch the range of length was depicted to be 6-8 cm in 6 (12%), 8-14 cm in 42 (84%), and 14-17 cm in 2 (4%) of cases. Findings of study done by Kulkarni J⁸ showed analogous findings with present study. Study done by Bhimalli S et al.¹¹ revealed average length of the RCA around 7 cm and length of RCA was 11 cm in the case reported by Vathsala V et al.²¹ From the It was observed that right coronary artery concluded between crux and obtuse margin of heart in majority of cases 30 (60%) while in 10 (20%) cases it was terminated in between the acute margin of the heart and the crux. The inverse relationship between the RCA and left circumflex branch is most simply expressed as right or left dominance, depending on which artery gives rise to the PIVA. right coronary artery giving origin to posterior inter ventricular artery is the commonest anatomy in man, and referred to as right dominance, which occurred in 92% of the hearts in our study and a left dominance, was observed in 8%. Ortale et al examined dominant circulation in 40 cadaver hearts, and accepted the posterior interventricular 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%).²²

When the common trunk of left coronary artery is less than 5 mm then it is considered to be short and when it is more than 15 mm it is considered as long common trunk. In present it was revealed that the trunk of the left coronary artery study in 40 (80%) of the cases, was short measuring less than 5 mm while in 6 (12%) cases, the trunk of the left coronary artery measured more than 10 mm. The average length ranged from 2 mm to 17 mm. Results were consistent with other studies like Reig and Petit et al²³ with an average of 10.8 mm. Kalpana R. (2003)⁷ observed length of the main trunk of LCA ranges between 6 mm to 15 mm. Study conducted by Kulkarni et al,⁸ revealed the length of LCA to be 5 mm in 76.7% of specimens, while it was observed to be 10 mm in 5% of specimens. Waller et al.,²⁴ observed the length of Left Coronary Artery to be 6 mm in 76% of all specimens and 10 mm in 3% of specimens. Fox et al., found the length of Left Coronary Artery to be <6 mm in 36% of all specimens while >20 mm in 5% of all specimens on cine angiograms.

CONCLUSION

A proper knowledge of anatomy of coronary arteries and its variations are needed 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.

REFERENCES

1. Viegas J. The heart: Learning how our blood circulates. 1st ed. New York: The Rosen Publishing Group, Inc; 2002. 24-32 p.
2. Nissen SE, Gurley JC, Grines CL, Booth DC, McClure R, Berk M, et al. Intravascular Ultrasound Assessment of Lumen Size and Wall Morphology in Normal Subjects and Patients With Coronary Artery Disease. *Circulation*. 1991;84:1087-99.
3. Yamanaka O, Hobbs RE. Coronary artery anomalies in 126,595 patients undergoing coronary arteriography. *Cathet Cardiovasc Diagn*. 1990;21:28-40.
4. SDSS, Joshi SDSS, Athavale SA. Origins of the coronary arteries and their significance. *Clinics (Sao Paulo)*. 2010;65:79-84.
5. Angelini P. Normal and anomalous coronary arteries: Definitions and classification. *Am Heart J*. 1989;117:418-34.
6. Loukas M, Groat C, Khangura R, Owens DG, Anderson RH. The normal and abnormal anatomy of the coronary arteries. Vol. 22, *Clinical Anatomy*. 2009. p. 114-28.
7. R. A Study On Principal Branches of Coronary Arteries In Humans. *J Anat Soc India*. 2003;52:137-40.
8. Kulkarni J. Variant anatomy of coronary arteries. *Hear India*. 2013;1:46.
9. Sahni D, Jit I. Origin and size of the coronary arteries in the north-west Indians. *Indian Heart J*. 1989;41:221-8.
10. P, Bannister L, Berry M, Collins P, Dyson M, Dussek J. Cardiovascular system, The arterial system. In: Glabella G, editor. *Gray's Anatomy The Anatomical Basis of Medicine and Surgery*. 39th ed. London: Churchill Livingstone Elsevier Ltd; 2005. p. 1505-10.
11. Bhimalli S, Dixit D, Siddibhavi M, Shirol VS. A study of variations in coronary arterial system in cadaveric. *World J Sci Technol*. 2011;1:30-5.
12. Bergman R, Afifi A, Miyauchi R. *Illustrated Encyclopedia of Human Anatomic Variation*. In 2005.
13. Solanki P, Gerula C, Randhawa P, Benz M, Maher J, Haider B, et al. Right coronary artery anatomical variants: Where and how. *J Invasive Cardiol*. 2010;22:103-6.
14. Garg N, Tewari S, Kapoor A, Gupta DK, Sinha N. Primary congenital anomalies of the coronary arteries: a coronary arteriographic study. *Int J Cardiol*. 2000;74:3946.
15. Harikrishnan S, Jacob SP, Tharakan J, Titus T, Kumar VKA, Bhat A, et al. Congenital coronary anomalies of origin and distribution in adults: A coronary arteriographic study. *Indian Heart J*. 2002;54:271-5.
16. Wolloscheck T, Zipfel J, Konerding MA. Aortic valve structures as landmarks for determining coronary artery ostia in transthoracic echocardiography. *Herz*. 2001;26:461-7.
17. Shinde V, Mallikarjun M, Patil V. study of coronary ostia in north Karnataka region. *Anat Karnataka*. 2011;5:13-6.
18. Patil RG. A study of location and measurement of coronary ostia in adult human hearts. *Indian J Pharm Sci Res*. 2015;5:2248-9126.
19. Turner K, Navaratnam V. The positions of coronary arterial ostia. *Clin Anat*. 1996;9:376-80.
20. Kini S, Bis KG, Weaver L. Normal and variant coronary arterial and venous anatomy on

- high-resolution CT angiography. *Am J Roentgenol*. 2007;188:1665-74.
21. Vathsala V, Johnson W, Devi YD, Prabhu K. Multiple Variations of Coronary Arteries—An Anatomic study: A Case Report. *JCDR*. 2011;
22. Ortale JR, Keiralla LCB, Sacilotto L. The posterior ventricular branches of the coronary arteries in the human heart. *Arq Bras Cardiol*. 2004;82:468-72, 463-7.
23. Reig J, Petit M. Main Trunk of the Left Coronary Artery: Anatomic Study of the Parameters of Clinical Interest. *Clin Anat*. 2004;17:6-13.
24. Waller B, Schlant R. *Anatomy of Heart*. Husst's The Heart. 13th ed. The McGraw-Hill Companies, Inc.; 2011.
25. Fox C, Davies MJ, Webb-People MM. Length of left main coronary artery. *Br Hear J*. 1973;35:796-8.