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ANATOMICAL STUDY OF CORONARY ARTERIES IN HUMAN CADAVERIC HEART

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Abstract

Background and Objectives: The myocardium, responsible for the heart's rhythmic contraction, is supplied by coronary arteries originating from the ascending aorta. This study investigated the origin, branching pattern, termination, and variations of coronary arteries in human cadaveric hearts.

Materials & methods: The research was conducted over a period of two years at the Department of Anatomy, in a government and a private medical college in central India. The study examined a total of 30 cadaveric hearts from adult donors aged 25 to 70 years, which were fixed using 10% formaldehyde.

Results: The results demonstrated that the right coronary artery (RCA) consistently originated from the anterior aortic sinus. In 25 hearts, the left coronary artery (LCA) arose from the left posterior coronary sinus, while one heart displayed LCA originating from the right posterior sinus of the ascending aorta. Notably, 71% of cases exhibited a single opening in the anterior aortic sinus, and 82% of cases had one opening in the left posterior sinus.

Conclusion: The study's significant finding was that the majority of cases showed the right ostia situated just below the sinutubular ridge. These findings enhance our understanding of the coronary artery's anatomical variations and course, providing valuable insights for cardiovascular health and medical interventions.

Key words: Myocardium, Coronary artery, Aorta, Cadaver.

Introduction

The myocardium receives its blood supply from a pair of coronary arteries arising from the ascending aorta. The term "Coronary" originates from the Latin word "Corona," meaning crown, highlighting the significance of these arteries. While the aorta distributes blood to the body's tissues, the heart itself is nourished by the coronary arteries [1]. The crucial role of coronary artery anatomy is underscored by the growing importance of angiographic procedures and bypass surgeries [2].

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Advancements in cardiovascular disease management have led to the correction of multiple lesions through surgical and interventional techniques. Precise knowledge of normal and anomalous coronary circulation is essential for managing congenital and acquired cardiovascular diseases. Although numerous data on arterial variations have been reported, further exploration of their clinical significance is warranted [3].

Modern coronary arteriography allows accurate localization of variations and underlying pathology. The progress in coronary arterial bypass surgeries and revascularization methods necessitates a comprehensive understanding of coronary artery anatomy and circulation [4]. Anomalies, occurring in about 1% of the general population, require particular attention. A thorough understanding of normal coronary artery anatomy, variations, and anomalies is imperative for successful outcomes in therapeutic procedures such as coronary artery bypass grafting and angioplasty [5, 6].

This present study aimed to observe the origin, branching pattern, termination, and variations of coronary arteries in human cadaveric hearts. Such research contributes to a better comprehension of the intricate coronary vascular system, with potential implications for improved clinical outcomes in various cardiac interventions.

Materials & methods

The present observational descriptive study was conducted at the Department of Anatomy, at a government and a private medical college in central India, with the aim of investigating the origin, course, branching pattern, and variations of coronary arteries in human cadaveric hearts. The study involved a total of 30 human hearts from adult cadavers of both genders, aged between 25 and 70 years, which had been preserved with 10% formaldehyde.

Each heart was assigned a unique serial number (1 to 30) and preserved in 10% formalin. Subsequently, the hearts were meticulously examined following general principles of anatomy. The visceral pericardium was removed to expose the coronary arteries, and further dissection of the coronary arteries and their branches was carried out within the atrioventricular and interventricular grooves.

Micro dissection was utilized to remove the epicardium, enabling clear observation of the coronary arteries. Key points of interest included determining the exit point of the LCA from the aorta, assessing the courses and variations of the circumflex branch and anterior interventricular branch, and identifying the presence of the median artery. Similarly, the exit points of the RCA and conus branch, the courses of the posterior interventricular branch, and the variations of the RCA branches were carefully investigated. External diameters at the starting points of these branches were measured using sensitive digital calipers with a precision of 0.01 mm.

To ascertain the dominant circulation, the artery supplying the posterior interventricular sulcus was examined. Additionally, the pericardial cavity was opened and explored, allowing for the observation of the anatomy of the great arteries before transecting them approximately 3 cm above the aortic and pulmonary valves. Further observations included checking and transecting the pulmonary veins, and transacting the superior and inferior vena cavae at specific anatomical points.

Results

In this study, a consistent observation was made that the obtuse marginal artery originated from the circumflex coronary artery in all 30 cases. The presence of the Posterior descending

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or posterior interventricular artery and the Branch to AV node was identified in 2 cases (6.67%) and 3 cases (10%) respectively. Additionally, the Diagonal branch was consistently found as a branch of the left anterior descending artery in all cases examined (Table 1).

Table 1: Variations in RCA branching

	No. of Cases	%
Branches of RCA		
Posterior descending/interventricular artery	28	93.33
SA nodal branch	30	100.00
AV nodal Branch	27	90.00
Acute marginal branch	30	100.00
Branches of LCA		
Left anterior descending/interventricular artery	30	100.00
Circumflex branch	30	100.00
Ramus intermedius	5	16.67
Left conus artery	1	3.33
Branches of Circumflex artery		
Oblique marginal branch	25	83.33
Branch to AV node	3	10.00
Posterior descending or posterior interventricular artery	2	6.67
Branches of Left Anterior Descending		
Diagonal branch	30	100.00

Regarding dominance patterns, the posterior interventricular septum received blood supply from the right coronary artery in 28 cases (93.33%), indicating right dominance. In only 2 cases (6.66%), the left circumflex artery supplied the posterior interventricular septum, indicating left dominance. Table 2 provides an analysis of the lengths of coronary artery branches.

The termination points of the right coronary artery were observed to be between the crux and obtuse margin of the heart in the majority of cases. Furthermore, the study revealed that the left coronary artery exhibited bifurcation in most cases, with trifurcation and quadfurcation observed in 7 cases (23.33%) and 2 cases (6.67%) respectively. These branching patterns resulted in the formation of the left anterior descending artery, which continued as the anterior interventricular artery, one or two median arteries, and the circumflex artery. Table 3 provides further details on the termination point of the circumflex artery, with the majority of cases showing it to be between the crux and obtuse margin of the heart. These findings contribute to a comprehensive understanding of the anatomical variations in coronary artery branches, which is essential for clinical applications and interventions.

Table 2: Length of trunk of RCA

Length of Artery	Frequency	%
RCA (cm)		
6-8	4	13.33
8-14	25	83.33
14-17	1	3.33
LCA (mm)		
< 5	23	76.67
5-7	4	13.33
7-10	3	10.00

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LCA (cm)		
3-5	6	20.00
5-9	20	66.67
9-11	4	13.33
(cm)		
3-5	10	33.33
5-7	19	63.33
7-9	1	3.33

Table 3: Termination of RCA

Termination of RCA	**No. of cases**	**%**
Between acute margin and crux	6	20.00
At Posterior interventricular septum	5	16.67
Between crux and obtuse margin	18	60.00
At the obtuse margin of heart	1	3.33
Termination of Circumflex artery		
At the posterior interventricular septum	4	13.33
Between crux and obtuse margin	24	80.00
At the obtuse margin of heart	2	6.67

Discussion

In contemporary medical practice, the widespread utilization of advanced image diagnostic techniques and the emergence of less invasive treatment modalities underscore the significance of comprehensive knowledge concerning the normal coronary anatomy, as well as its variations and anomalies. Variability in the origin, distribution, number, and size of coronary artery branches has been well-documented. Notably, the nomenclature and characteristics of a coronary artery or its branch are predicated on the distal vascularization pattern or territory it serves, rather than its point of origin. In accordance with the research findings by Loukas et al. in 2009, it becomes imperative to ascertain the prevalence of these variations, which may potentially contribute to sudden cardiac death [7].

In the present study, a thorough examination of 30 cases revealed that the dissected RCA consistently originated from the anterior aortic sinus, while the LCA arose from the left posterior coronary sinus. In one specimen, the LCA was observed to originate from the right posterior sinus of the ascending aorta. Remarkably, all specimens exhibited consistent ostial locations, with no variations detected [8]. This observation aligns with the findings of a study conducted by Subhash D. Joshi et al., who studied 105 embalmed heart specimens and did not identify any openings in the pulmonary sinuses or the right posterior aortic sinus [4]. Similarly, Jyoti P. Kulkarni et al. investigated 60 cases and reported that the RCA and LCA consistently originated from the anterior aortic sinus and the left posterior aortic sinus, respectively [9].
A separate dissection study by Sahni and Jit et al., involving heart specimens from medico-legal autopsies, found no instances of anomalous origin in any coronary artery [10].

Baroldi and Scomazzoni, in 1967, described a prevalence of 36% for independent origin of the right conus, as reported by Bhimalli et al [11, 12]. However, ectopic origin, specifically RCA originating from the left posterior aortic sinus, was observed in a very small percentage of cases in angiographic studies—0.0008% according to Yarnanaka and Hobbs and 0.043-0.46% as reported by Solanki et al. [13, 14]. Grag and Tiwari et al. noted anomalies of the coronary arteries in 0.95% of individuals, with the majority being anomalies of origin [15]. Harikrishnan et al. reported an incidence of 0.45% for anomalies of origin of the coronary artery [16].

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The current study revealed the presence of multiple openings in the anterior aortic sinus, with some of these additional orifices being of pinhead size. In contrast, multiple openings were only identified in three cases within the left posterior aortic sinus. Notably, the most frequent variation observed was the presence of multiple orifices in the right aortic sinus, followed by the occurrence of an accessory orifice for the conal artery. Findings from a study conducted by Joshi et al. [4] indicated that approximately 8% of the hearts examined exhibited three or more openings in the right coronary sinus. Moreover, Wolloscheck et al. [17] documented the occurrence of extra ostia in a significant proportion of cases (65%) during an anatomical and transthoracic echocardiographic study.

In our study, the majority of cases exhibited coronary ostia positioned below the level of the sinutubular ridge. Notably, in most cases where the right and left ostia were situated just below the sinutubular ridge, the ridge itself displayed an arched configuration to accommodate the ostia within the sinus. In only a few cases, the right and left ostia were found at the level of the sinutubular ridge. A similar observation was reported by Shinde VS et al. [18], who conducted a study and found that the majority of coronary ostia were located below the sinutubular ridge. Furthermore, Patil R et al. reported that in their study, 34 specimens (89.47% of cases) exhibited coronary ostia below the sinutubular ridge, while 4 specimens (10.52% of cases) displayed ostia opening above the ridge [19]. Likewise, Turner and Navratnam et al. found that among the 74 main coronary ostia they investigated, 62 were either at or immediately below the sinutubular ridge [20].

In the current investigation, the length of the RCA branch was observed to vary within specific ranges among the cases studied. Approximately 12% of cases exhibited a length between 6 to 8 cm, 84% displayed a length ranging from 8 to 14 cm, while 4% had a length falling within the range of 14 to 17 cm. These findings are in accordance with a prior study conducted by Kulkarni J [9], which reported similar observations congruent with the present study.

Regarding the circumflex artery, its termination location was analyzed in relation to the heart's crux and obtuse margin. In the majority of cases (80%), the circumflex artery concluded between the crux and obtuse margin of the heart. In a smaller subset of cases, approximately 6% terminated at the obtuse margin of the heart, while 14% of specimens showed termination by supplying the posterior interventricular septum as the posterior interventricular artery.

Correspondingly, a study by Anbumani T L et al [21] presented similar outcomes, wherein 16%, 80%, and 4% of specimens terminated at the posterior interventricular septum, between the crux and obtuse margin of the heart, and between the crux and obtuse margin of the heart, respectively. Moreover, an independent study by Bhimalli S et al. [12] reported the average length of the RCA to be approximately 7 cm, while another case study conducted by Vathsala V et al. [22] demonstrated an RCA length of 11 cm.

These findings contribute valuable insights into the anatomical variations of the right coronary artery branch and the circumflex artery, which are crucial aspects to consider in the context of medical sciences and cardiovascular health [23].

Conclusion

A comprehensive understanding of the variations in coronary arteries is crucial for achieving successful clinical outcomes in the treatment of coronary artery diseases. This knowledge plays a pivotal role for cardiologists and radiologists in performing various interventional procedures, such as coronary angiography, coronary angioplasty, and bypass grafting surgeries.

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References

1. Viegas J. The heart: Learning how our blood circulates. 1st ed. New York: The Rosen Publishing Group, Inc; 2002. p. 24-32.
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. 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. Bhele AV, Ughade HM, Shaikh S, Joge US. A study of course, branches and variations of the coronary arteries in the human cadaveric heart. Int J Contemp Med Res. 2017;4(7):1533-1537.
7. Loukas M, Groat C, Khangura R, Owens DG, Anderson RH. The normal and abnormal anatomy of the coronary arteries. Clin Anat. 2009;22:114–28.
8. Kalpana R. A study on principal branches of coronary arteries in humans. J Anat Soc India. 2003;52:137–40.
9. Kulkarni J. Variant anatomy of coronary arteries. Heart India. 2013;1:46.
10. Sahni D, Jit I. Origin and size of the coronary arteries in the north-west Indians. Indian Heart J. 1989;41:221–8.
11. Gray H, 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.
12. Bhimalli S, Dixit D, Siddibhavi M, Shirol VS. A study of variations in the coronary arterial system in cadavers. World J Sci Technol. 2011;1:30–5.
13. Bergman R, Afifi A, Miyauchi R. Illustrated Encyclopedia of Human Anatomic Variation. 2005.
14. 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.
15. 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;74:39-46.
16. 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.
17. Wolloscheck T, Zipfel J, Konerding MA. Aortic valve structures as landmarks for determining coronary artery ostia in transthoracic echocardiography. Herz. 2001;26:461–7.
18. Shinde V, Mallikarjun M, Patil V. study of coronary ostia in north Karnataka region. Anat Karnataka. 2011;5:13–6.
19. Patil RG. A study of location and measurement of coronary ostia in adult human hearts. Indian J Pharm Sci Res. 2015;5:2248–9126.
20. Turner K, Navaratnam V. The positions of coronary arterial ostia. Clin Anat. 1996;9:376–80.
21. Anbumani TL, Christus D, Thamarai SA, Anthony AS. An anatomical study on the coronary arteries and their variations. Int J Anat Res. 2016;4:2114–8.
22. Vathsala V, Johnson W, Devi YD, Prabhu K. Multiple Variations of Coronary Arteries–An Anatomic study: A Case Report. JCDR. 2011; 5(7): 1454-1457.
23. Venugopal GE, Seeja PJ, Jacinth JS. Morphological Study of Myocardial Bridge on the Coronary Arteries in Human Cadavers in and Around Tamil Nadu. Acta Biomed.

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