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To Evaluate the Different Divisions and Variations of The Coronary Arteries in The Cadaveric Human Heart

Devendra Kumar Sirohi[1]

[1]Associate Professor, Department of Anatomy, Venkateshwara IMS, Gajraula, Uttar Pradesh, India.

Abstract

Background: Knowledge of anatomical changes in the coronary artery and its branches is essential for cardiac surgeons to improve imaging methods and perform coronary artery bypass grafting with greater precision. The corpse had several abnormalities of the coronary arteries upon detection. **Aim:** To evaluate the different divisions and Variations of the coronary arteries in the cadaveric human heart. **Methodology:** The research used adult cadavers of both genders (aged 23–68 years) to examine the hearts. The hearts were preserved using a 10% formaldehyde solution and were gathered specifically for this investigation. Approval was received from the Institutional Ethical Committee of the college. We obtained 80 human hearts from the preserved bodies of both males and females, which were stored in the Department of Anatomy, Venkateshwara IMS. The specimens were immersed in a solution of formaldehyde diluted to a concentration of 10%. The hearts were analysed according to the fundamental principles of anatomy. **Results:** 74 cases (92.5%) and 73 cases (91.25%), the PD branch and the branch to the AV node were identified as branches of the RCA, respectively. Both the branch to the SA node and the acute marginal branch were consistently identified as branches originating from the RCA in all patients. In this investigation, it was shown that in all 65 instances, the obtuse marginal artery originated from the circumflex coronary artery. In 6 instances (7.5% of the total) the presence of the posterior descending or posterior interventricular artery and the branch to the AV node was found. In 9 cases (11.25% of the total), the same arteries were also present. Therefore, in the current investigation, 74 out of 80 hearts (92.5%) exhibit right dominance. The left circumflex artery supplies the posterior interventricular septum in just 6 occurrences, accounting for 7.5% of the total. As a result, the heart is considered left dominant. **Conclusion:** A comprehensive understanding of the architecture of coronary arteries and their variations is essential for achieving favourable clinical outcomes in the treatment of coronary artery disorders.

Keywords: Divisions, Variations, coronary arteries, Cadaveric, human heart.

INTRODUCTION

The incidence of coronary artery disorders is rapidly rising in contemporary society. The study of the structure of the coronary artery has lately been highlighted in relation to the use of coronary arteriography. A comprehensive understanding of the normal and variant architecture of the coronary artery is crucial and necessary due to the progress in coronary arterial bypass procedures and new techniques of myocardial revascularization.[1] Therefore, a thorough understanding and therapy of cardiac illnesses heavily relies on the accurate knowledge of variable cardiac architecture. The heart receives blood from two coronary arteries, namely the RCA and the LCA. The right coronary artery (RCA) arises from the anterior aortic sinus located at the base of the ascending aorta, whereas the left coronary artery (LCA) originates from the left posterior aortic sinus at the same location. The right coronary artery (RCA) originates at the connection point between the pulmonary trunk and the right auricle. It then follows a path down the right coronary sulcus, curves around the lower border of the heart, and continues across the lower surface.

Address for correspondence*

Dr. Devendra Kumar Sirohi

Associate Professor, Department of Anatomy,
Venkateshwara IMS, Gajraula, Uttar Pradesh, India.

Finally, it terminates by connecting with the circumflex branch of the left coronary artery (LCA) by an anastomosis. The LCA, which runs between the pulmonary trunk and left auricle, bifurcates into the anterior interventricular artery and circumflex artery.[2] In recent decades, there has been a gradual and systematic approach to managing cardiovascular illnesses. Nowadays, there are several lesions that may be corrected using advanced surgical and interventional procedures. A thorough understanding of the normal and abnormal aspects of coronary circulation is essential in the therapy of congenital and acquired cardiovascular disorders. Extensive data about the different forms of arteries have been documented. However, it is advisable to do more investigation into their clinical importance.[3] The modern coronary arteriography offers a precise identification of any deviations and the underlying disease. A comprehensive understanding of coronary artery and circulation is essential due to the advancements in coronary arterial bypass procedures and current revascularization techniques.[4,5] An "anomaly" is a deviation that occurs in around 1% of the overall population. A comprehensive understanding of the typical structure of coronary arteries, as well as their variations and abnormalities, is essential for achieving positive clinical results in therapeutic treatments such as coronary artery bypass grafting and angioplasty.[6,7]

METHODS

This observational descriptive research was undertaken at the

Department of Anatomy to investigate the origin, course, branching pattern, and variations of the coronary arteries in human cadaveric hearts. The research used adult cadavers of both genders (aged 23–68 years) to examine the hearts. The hearts were preserved using a 10% formaldehyde solution and were gathered specifically for this investigation. Approval was received from the Institutional Ethical Committee of the college. We obtained 80 human hearts from the preserved bodies of both males and females, which were stored in the Department of Anatomy, Venkateshwara IMS. The specimens were immersed in a solution of formaldehyde diluted to a concentration of 10%. The specimens were sequentially numbered from 1 to 80.

The hearts were analysed according to the fundamental principles of anatomy. The coronary arteries were examined after the removal of the visceral pericardium. The coronary arteries and their branches were dissected on the surface of the heart inside the atrioventricular and interventricular grooves. The epicardium was removed by micro dissection, allowing for observation of the coronary arteries. The study examined the location at which the LCA exits from the aorta, the different paths and deviations of the circumflex branch and anterior interventricular branch, and the existence of the median artery. The locations where the RCA and conus branch end, the paths taken by the posterior interventricular branch, and the different patterns of branching in the RCA were identified. The initial sizes of these branches were measured using 0.01 mm precise digital callipers. In order to ascertain the prevailing blood flow, an examination was conducted on the artery responsible for supplying the posterior interventricular sulcus. The pericardial cavity was incised and examined. Observation of the anatomical structure of the major arteries was conducted before to their transection, namely at a location about 3 cm above the aortic and pulmonary valves. The pulmonary veins were examined and severed. The superior vena cava was cut about 2 cm above the junction where the crest of the right atrial appendage connects to the superior vena cava. The inferior vena cava was cut near the diaphragm.

Statistical Analysis

Standard methods of descriptive statistics like mean and percentages were used to interpret the results.

RESULTS

The right coronary artery (RCA) originated exclusively from the anterior aortic sinus in all 80 instances. The left coronary artery originated from the left posterior coronary sinus in 78 hearts, while in 2 hearts it originated from the right posterior sinus of the ascending aorta. In 57 instances (71.25%), there was one opening in the anterior aortic sinus, and in 67 cases (83.75%), there was one opening in the left posterior sinus. Among the total of 80 patients, 25 instances (31.25%) had numerous apertures in the anterior aortic sinus. The additional apertures were very small, comparable to the size of a pinhead. In the left posterior sinus, numerous apertures were detected in just 5 instances. It was noted that in 75 instances (equivalent to 93.75% of the total), the right ostia were positioned just below the sinutubular ridge, causing the ridge to curve in order to accommodate the ostia inside the sinus. In 64 (80%) instances, the positions of the left ostia were located below the sinutubular ridge. In 6 instances (7.5%), there were ostia located at the level of the sinutubular ridge on the right side, whereas in 10 cases (12.5%), ostia were found on the left side. Table-1 shows that in 74 cases (92.5%) and 73 cases (91.25%), the Posterior Descending (PD) branch and the branch to the AV node were identified as branches of the Right Coronary Artery (RCA), respectively. Both the branch to the SA node and the acute marginal branch were consistently identified as branches originating from the right coronary artery (RCA) in all patients.

In this investigation, it was shown that in all 65 instances, the obtuse marginal artery originated from the circumflex coronary artery. In 6 instances (7.5% of the total) the presence of the posterior descending or posterior interventricular artery and the branch to the AV node was found. In 9 cases (11.25% of the total), the same arteries were also present. In every instance, the Diagonal branch was seen in the left anterior descending branch. In 92.5% of instances, the right coronary artery supplies the posterior interventricular septum, which in turn supplies the diaphragmatic surface of the heart. Therefore, in the current investigation, 74 out of 80 hearts (92.5%) exhibit right dominance. The left circumflex artery supplies the posterior interventricular septum in just 6 occurrences, accounting for 7.5% of the total. As a result, the heart is considered left dominant. The current research observed that the length of the right coronary artery branch ranged from 6 to 8 cm in 9 instances (11.25%), from 8 to 14 cm in 68 cases (85%), and from 14 to 17 cm in 3 cases (3.75%). The observed lengths of the left Circumflex artery were as follows: 3-5 cm in 21.25% of patients, 5-9 cm in 67.5% of cases, and 9-11 cm in 11.25% of cases. The average length of the left circumflex artery ranges from 3 cm to 11 cm. In 27 instances (33.75%), the posterior descending branch measured between 3 and 5 cm in length. The majority of instances had a length ranging from 5 to 7 cm, which accounts for 63.75% of the total. The average length for the posterior descending artery is between 3 and 9 cm, as seen in table 2. The study found that in the majority of instances (58.75%), the right coronary artery terminated between the crux and obtuse margin of the heart. In 21.25% of cases, it terminated between the acute margin of the heart and the crux (table-3). In 4 out of 100 instances, the right coronary artery terminated at the obtuse border of the heart. The majority of patients (71.25%) had a bifurcation of the left coronary artery. In 19 instances (23.75%), the trunk of the left coronary artery showed trifurcation, whereas in 4 cases (5%), it showed quadfurcation. These specimens demonstrate that the trunk of the left coronary artery divides into the left anterior descending artery, which then becomes the anterior interventricular artery, along with one or two median arteries and the circumflex artery. In most instances, the circumflex artery terminates between the crux and obtuse edge of the heart, accounting for 64 occurrences or 80% of the total. In 4 out of 5% of instances, the circumflex artery ended at the obtuse edge of the heart. In 12 out of 15% of cases, the circumflex artery supplied the posterior interventricular septum, acting as the posterior interventricular artery.

Table 1: Variation in the branching pattern of right coronary artery.

Coronary artery	Number	%
Branch of RCA		
Posterior descending or posterior interventricular artery	74	92.5
Branch to sinoatrial node	80	100
Branch to AV node	73	91.25
Acute marginal branch	80	100
Branch of LCA		
Left anterior descending or left anterior interventricular artery	80	100
Circumflex coronary artery	80	100
Ramus intermedius branch	13	16.25
Left conus artery	2	2.5
Branch of Circumflex Artery		
Obtuse marginal branch	65	81.25
Branch to AV node	9	11.25
Posterior descending or posterior interventricular artery	6	7.5
Branch of Left Anterior Descending		
Diagonals branch	80	100

Table 2: Length of the trunk of Right Coronary Artery

Length of RCA (cm)	Number	Percentage
6-8 cm	9	11.25
8-14 cm	68	85
14-17 cm	3	3.75
Length of LCA (mm)		
< 5 mm	65	81.25
5-7 mm	9	11.25
7-10 mm	6	7.5
Length of LCA (cm)		
3-5 cm	17	21.25
5-9 cm	54	67.5
9-11 cm	9	11.25
Length of posterior descending (cm)		
3-5 cm	27	33.75
5-7 cm	51	63.75
7-9 cm	2	2.5

Table 3: Termination of Right Coronary Artery

Termination of RCA	Number	%
Between acute margin and crux of heart	17	21.25
At Posterior interventricular septum	12	15
Between crux and obtuse margin of heart	47	58.75
At the obtuse margin of heart	4	5
Termination of circumflex artery		
At the posterior interventricular septum	12	15
Between crux and obtuse margin of heart	64	80
At the obtuse margin, of heart	4	5

DISCUSSION

In the present day, due to the widespread use of sophisticated imaging diagnostic methods and the progress made in non-invasive therapies, it is crucial to possess a comprehensive understanding of the typical structure and variations of the coronary artery, as well as any abnormalities that may be present. Coronary artery branches may differ in terms of their source, spread, quantity, and dimensions. The nomenclature and characteristics of a coronary artery or its branch are determined by the vascularization pattern or area at its distal end, rather than its point of origin. According to Loukas et al.'s findings, it is important to identify the occurrence of variants that might potentially cause sudden cardiac death.[8]

In this study, it was observed that the dissected right coronary artery (RCA) originated from the anterior aortic sinus in all 80 cases. The left coronary artery, on the other hand, arose from the left posterior coronary sinus in 78 hearts and from the right posterior sinus of the ascending aorta in 2 hearts. No variations were found in the location of the ostia in any of the specimens examined. The study conducted by Kalpana R et al discovered that the right and left coronary ostia were consistently located in the anterior aortic and left posterior aortic sinus respectively in all 100 specimens examined. Furthermore, no alterations in the ostia's position were noted.[9] A study done by Jyoti P Kulkarni et colleagues discovered that in all 60 instances, the dissected right coronary artery (RCA) and left coronary artery (LCA) were seen to originate from the anterior aortic sinus and the left posterior aortic sinus, respectively.[10] A dissection research conducted by Sahni and Jit et al on heart tissues obtained from medico-legal autopsy identified no instances of anomalous origin of any coronary artery in any of the cases.[11] Baroldi and Scomazzoni In 1967, a study reported a frequency of 36% for the independent genesis of the right conus. Bhimalli et al. have observed similar results.[13] However, it is possible for the right coronary artery to have an ectopic origin from the left posterior aortic sinus. The frequency of this ectopic origin was discovered to be 0.0008% on angiographic examinations, as reported by Yarnanaka and Hobbs,[14], and 0.043-0.46% as shown by Solanki et al.The user's text is "[15]". Grag and Tiwari et al,[16] reported the presence of aberrant coronaries in 0.95% of people. Out of these instances, almost 90% were abnormalities of origin. According to Harikrishnan et al., the occurrence rate of abnormalities at the origin of the coronary artery was 0.45%.[17] The current investigation discovered the presence of numerous apertures in the anterior aortic sinus. The additional apertures of minuscule dimensions were seen. Only three patients had multiple apertures in the left posterior aortic sinus. The most common variant is the existence of several openings in the right aortic sinus, followed by the second most common variation, which is the presence of an additional opening for the conal artery. In a research conducted by Wolloscheck et al., it was shown that 65% of patients had additional ostia, as seen during an anatomic and transthoracic echocardiographic examination.[18] In our investigation, we discovered that in 75 out of 80 instances (93.75%), the right ostia were located exactly below the

sinutubular ridge. It was noted that the ridge was curved in order to accommodate the ostia inside the sinus. In 64 (80%) instances, the left ostia were located below the sinutubular ridge. In 6 instances (7.5%), there were ostia located at the level of the sinutubular ridge on the right side, whereas in 10 cases (12.5%), ostia were found on the left side. In a research done by Shinde VS et al, it was shown that most of the coronary ostia were located below the sinutubular ridge. This positioning may provide greater functional efficiency compared to ostia located above the sinutubular ridge.[19] A study conducted by Patil R et al found that in 34 specimens (89.47% of cases), the coronary ostia were positioned below the sinutubular ridge, whereas in 4 specimens (10.52% of cases), the coronary ostia were located above the sinutubular ridge [20]. Turner and Navratnam et al discovered that out of the 74 primary coronary ostia, 62 were located either at or directly below the sinutubular ridge.[21] Accurate understanding of the coronary ostia in relation to the aortic root is crucial for a range of interventional and surgical cardiovascular procedures.[20] In the current research, it was observed that 74 individuals (92.5%) had the PD branch and 73 individuals (91.25%) had the branch to the AV node as branches of the RCA. Both the branch to the SA node and the acute marginal branch were consistently identified as branches originating from the RCA in all patients. Both the branch to the SA node and the acute marginal branch were consistently identified as branches originating from the RCA. The research done by Kulkarni J found that in all 60 instances, the branch to the SA node originated from the RCA. However, Hutchison discovered that in 35% of patients, there was a varied origin of the branch to the SA node from the circumflex coronary artery. This result is considered noteworthy.[21] The current research observed that the length of the right coronary artery branch ranged from 6 to 8 cm in 9 instances (11.25%), from 8 to 14 cm in 68 cases (85%), and from 14 to 17 cm in 3 cases (3.75%). The research conducted by Kulkarni J demonstrated similar results to the current study.[10] A study conducted by Bhimalli S et al,[13] found that the typical length of the right coronary artery (RCA) is around 7 cm, but in a reported instance by Vathsala V et al,[22] the length of the RCA was 11 cm.

The majority of instances (58.75%) showed that the right coronary artery terminated between the crux and obtuse margin of the heart, whereas in 21.25% of cases it terminated between the acute margin of the heart and the crux. The connection between the right coronary artery (RCA) and the left circumflex branch may be described as either right or left dominance, depending on which artery gives birth to the PIVA.[23] The most prevalent anatomical configuration in humans is the right dominance, where the right coronary artery gives rise to the posterior interventricular artery. This was identified in 92.5% of the hearts in our research. A left dominance, on the other hand, was found in 7.5% of the cases. Ortale et colleagues conducted a study on 40 cadaver hearts to investigate the main circulation patterns. They found that in 62.5% of cases, the posterior interventricular branch originated from the right coronary artery (RCA) and its branches supplied at least the middle medial section of the left ventricular posterior face.[24]

A common trunk of the left coronary artery is deemed short when its diameter is less than 5 mm, and long when it exceeds 15 mm. Currently, it has been shown that the majority of instances have a length ranging from 5 to 7 cm, specifically accounting for 63.75%. The average length of the posterior descending artery is between 3 and 9 centimetres. The average length varied between 2 mm and 17 mm. The findings were in line with previous research conducted by Reig and Petit et al, indicating an average measurement of 10.8 mm.[25] According to Waller et al., the length of the Left Coronary Artery was found to be 6 mm in 76% of all specimens and 10 mm in 3% of specimens. In their study, Fox et al. discovered that the length of the Left Coronary Artery was less than 6 mm in 36% of all specimens, whereas it was more than 20 mm in 5% of all specimens as shown on cine angiofilms.[26,27]

CONCLUSION

A comprehensive understanding of the architecture of coronary arteries and their variations is essential for achieving favourable clinical outcomes in the treatment of coronary artery disorders.

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