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Case Report

Trifurcation of left coronary artery and the presence of prominent conus branch in the right coronary artery: A case study

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Abstract

The left and right coronary arteries play a crucial role in the perfusion of heart. These arteries are situated between the epicardium and myocardium. Typically, the left coronary artery bifurcates into anterior descending artery and circumflex artery. However, during a routine dissection of one of the cadavers, we observed the trifurcation of the left coronary artery, which was traced as median aka intermediate artery which arises as one of its main branches. We also noticed variation in right coronary artery which had very prominent conus branch originating after the right coronary artery arising from right aortic sinus. Materials and methods: Routine dissection was conducted on a 72 year old male cadaver. Conclusion and results: Variant branches of coronary artery noted. Many a times these variations are asymptomatic and cause no distress but knowledge about variation has vital role in treatment and diagnosis of various cardiac illness.

Keywords: Intermediate artery, Median artery, Left coronary artery, Conus branch, Trifurcation

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1. Introduction

Anatomical variation refers to a naturally occurring difference in body structures that deviates from what is commonly described in standard anatomical literature. Normal does not necessarily imply identical in all individuals; hence, variations are to be expected. These differences can involve muscle anatomy, the branching patterns of blood vessels and nerves, nerve supply, bone structure, and ligament attachments. While such variations typically do not disrupt normal physiological functions, they can have significant implications in clinical diagnosis and surgical procedures. Overlooking anatomical variations may result in surgical complications or failure. Therefore, it is essential for anatomists to document and report any variations observed during routine cadaveric dissections. In this context, a case study of an anatomical variation in left coronary artery identified during one such dissection.

The blood supply of the heart is received from the right and left coronary arteries and their respective branches, which are positioned in between the myocardium and epicardium. Both the right (RCA) and left coronary arteries (LCA) originate from aortic sinuses of Valsalva located at the base of the aorta, and they wrap around the base of the ventricles in a crown like manner. The LCA is primarily responsible for supplying blood to most of the left ventricle and a significant portion of the right ventricle. It courses between the pulmonary trunk and the left atrial auricle, then enters the atrioventricular (AV) groove and turns to the left. Within this groove, the LCA typically branches into two major arteries: The left coronary artery (LCA) typically divides into two main branches: the left anterior descending (LAD) artery and the circumflex artery (CA). The LAD, also known as the anterior interventricular artery or the anterior division of the LCA, originates from the retro-pulmonary segment of the LCA. It follows an S-shaped path above the interventricular groove and, in most cases, extends toward the apex of the heart, slightly toward the right side. The circumflex artery, considered the posterior division of the LCA, shows greater variation in its length and distribution. It begins by passing beneath the left atrial appendage and then courses along the left atrioventricular (AV) groove.

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Occasionally, it may reach the diaphragmatic surface of the heart, supply the left atrium and extend into the posterior AV groove. The commonest pattern of branching of LCA is a bifurcation into the LAD and CA. However, in some cases, a third branch arises directly from the main trunk-known as the median or intermediate artery-resulting in a trifurcation pattern. The branches of the LCA primarily for supply blood to the sternocostal surface of the heart and the obtuse margin in the left ventricle.

The right coronary artery (RCA) originates from the right aortic sinus and courses along the right atrioventricular (AV) groove. In its early segment, it extends to the right and reaches the acute margin of the heart, where it gives off the acute marginal artery. From its upper surface, several atrial branches arise, and in many cases, the infundibular (conal) artery also originates here though it may sometimes arise directly from the aorta. In over half of individuals, the artery supplying the sinoatrial (SA) node also branches from this region.

As the RCA continues, it curves around the vestibule of the tricuspid valve and runs toward the cardiac crux, giving off inferior ventricular branches that supply the diaphragmatic surface of the right ventricle. In most people, the RCA provides blood to a substantial portion of this diaphragmatic surface. At the crux, the artery typically gives rise to the posterior (inferior) interventricular artery and the AV nodal artery, and may also supply part of the diaphragmatic surface of the left ventricle a pattern described as right coronary dominance. The conal branch is present in about half the population, and when it is well-developed, it contributes more extensively to the blood supply of the anterior right ventricular wall.

2. Materials and Methods

2.1. Materials

A rare case of intermediate branch of the left coronary artery and also the presence of prominent conus branch from right coronary artery was observed during routine dissection for post graduate studies. The dissection was conducted on the cadaver of 78 years old male in the Department of Rachana Sharir at National Institute of Ayurveda, Jaipur. The cadaver was received through voluntary body donation program. The study adhered strictly to established ethical standards.

2.2. Methodology

A formalin fixed cadaver was used for the dissection. The dissection of thorax was carried out by cutting the consecutive ribs and sternum. The thoracic cavity was exposed. The parietal pericardium was incised after ligating the great vessels of heart by thread. Then the heart along with great vessels were taken out from the pericardial cavity. The aorta and pulmonary trunk were cut. The epicardium was cleared to expose the coronary arteries during the meticulous dissection. The origin of the left coronary artery from left aortic sinus was identified. The coursing pattern of left coronary artery was visualized and its branching patterns were observed. Noting the pattern of branching of LCA and RCA, the in-situ structures were exposed. The relative positions and anatomical landmarks were identified.

3. Case Study

In this specimen, after meticulously removing the surrounding fat to trace the course of the left coronary artery, a trifurcation was observed. Along with the left anterior descending artery and the left circumflex artery, an additional branch, the median artery, also known as the intermediate artery or ramus intermedius was identified. This type of division, where the major trunk of the left coronary artery splits into the anterior interventricular, circumflex, and intermediate arteries, is considered a variation and is reported in approximately 25% to 40% of cases.

The median artery can be identified by three main characteristics:1. It arises either at the point where the main terminal branches of the left coronary artery diverge, or within the first few millimetres of their course. 2. It has a comparatively large diameter. 3. It provides blood to a considerable area of the left ventricle, reaching about halfway down its free wall.

This artery runs obliquely across the sternocostal surface of the left ventricle and typically reaches the midpoint between the base and the apex of the heart. In certain cases, it may extend as far as the apex, continue along the apical two-thirds of the left margin, or even supply the diaphragmatic surface of the left ventricle. At times, its diameter may equal that of the anterior interventricular artery, and in some instances, it can even be larger than the circumflex artery.

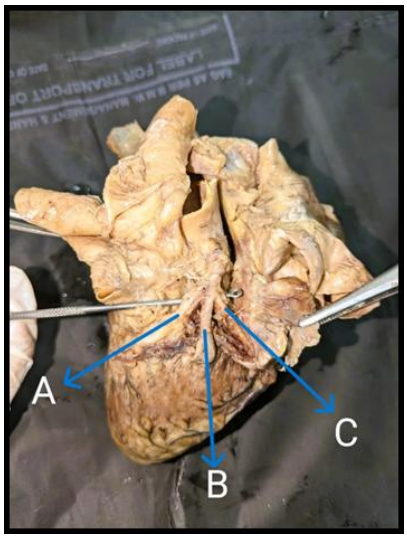

Figure 1: Shows trifurcation of left coronary artery. **A**-Left descending artery, **B**-Intermediate branch, **C**-Left circumflex artery

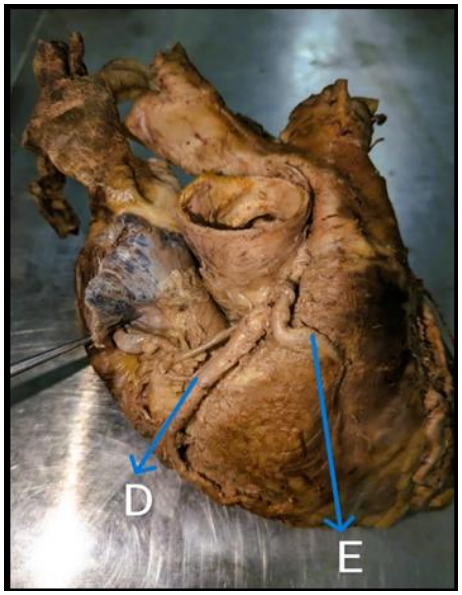

Figure 2: shows prominent conus branch **(D)** from right coronary artery **(E)**.

During the dissection of the right coronary artery (RCA), a prominent branch was identified soon after its origin from the right aortic sinus, supplying the anterior wall of the right ventricle. Tracing the RCA along the right atrioventricular groove revealed that the vessel first courses to the right and reaches the acute margin of the ventricular mass. At this site, it gives rise to the acute marginal artery, while several atrial branches emerge from its superior surface. From this segment, the infundibular (conus) artery and the sinoatrial (SA) nodal artery also arise.

The RCA then curves around the vestibule of the tricuspid valve and advances toward the cardiac crux. Along its pathway, it gives off right inferior ventricular branches that vascularize the diaphragmatic surface of the right ventricle. At the crux, the RCA commonly gives rise to the posterior (inferior) interventricular artery and the atrioventricular (AV) nodal artery, and it may also contribute to the blood supply of the diaphragmatic surface of the left ventricle. This distribution pattern is described as right coronary dominance.

In this specimen, the prominent branch arising from the main trunk of the RCA and supplying the anterior wall of the right ventricle was identified as the conus (infundibular) branch.[1] This artery distributes blood to the anterior wall via its periventricular and ventricular branches. In certain cases, it anastomoses with the infundibular branch of the anterior interventricular artery, forming the arterial circle of Vieussens. Typically, two or three anterior ventricular branches extend toward the apex, although they seldom reach it unless the right marginal artery is included in their course. At the apex, anastomotic connections between these branches and the anterior interventricular artery may occasionally be observed.

4. Result

The left coronary artery trifurcation was observed in the form of a diagonal or median artery arising from the angle between the LAD and the circumflex artery (CA). Although this additional branch supplies a relatively smaller region compared to the LAD and CA, recognizing its presence is clinically important. Variations in the origin and patterns of branching of coronary arteries can complicate imaging using standard catheters. Such anomalies may not only affect the accuracy of diagnostic procedures but also pose challenges during therapeutic interventions for various cardiac conditions.

5. Discussion

Although the right and left coronary arteries are the primary vessels supplying the heart, they exhibit a wide range of anatomical variations. These variations are quite common and may involve the presence of three or even four coronary arteries, as well as differences in branching patterns, such as bifurcation or trifurcation. While some of these variations are classified as major and others as minor, all can have significant clinical implications. They may complicate procedures like the insertion of standard catheters and can lead to challenges in diagnosis.

In a postmortem angiographic study, Kalbfleisch and Hort examined the regions supplied by each coronary artery. Their findings showed that the left coronary artery (LCA) supplies approximately 68.8% of the total cardiac muscle mass and 79% of the left ventricular muscle mass, underscoring the critical anatomical and clinical significance of the LCA.[2]

According to Garg et al, the most commonly observed coronary artery variations occurred in the right coronary artery (RCA) in 62% of cases and in the left circumflex artery in 27% of cases. Similarly, Topaz et al. reported 48.71% of variations in the RCA and 35.89% in the left circumflex branch. In comparison, quadrifurcation of the left coronary artery (LCA) was found to be much less common than its bifurcation or trifurcation. A division of the LCA trunk into the anterior interventricular artery, circumflex artery, and an additional branch known as the median or intermediate artery is seen in approximately 25% to 40% of individuals.[3]

Anil Kumar et al. reported that in the majority of cases (80.76%), the left coronary artery (LCA) bifurcated into two terminal branches the left anterior descending (LAD) artery and the circumflex artery (CA). In 10.25% of cases, a trifurcation was observed, where the LCA gave rise to the LAD, CA, and an additional diagonal branch known as the ramus intermedius. Quadrifurcation, involving the LAD, CA, and two diagonal branches, was seen in 7.69% of cases, while a rare pentafurcation-comprising the LAD, CA, and three diagonal branches was found in 1.28% of cases Similar findings were reported by Fazliogullari et al, Surucu et al.,

Reig & Petit, and Kalpana R. Bosco. In their observations, 2% of specimens showed no division of the LCA trunk, while 42% exhibited bifurcation and 55% demonstrated trifurcation.[5-8]

Hadziselimovic reported that among the cases studied, 52% showed bifurcation of the left coronary artery, 44% exhibited trifurcation, and only 4% had more than three branches.[9] In a separate study, Benther et al. observed that 2% of the specimens had an undivided LCA trunk, 89% showed bifurcation, and 9% displayed trifurcation. These findings highlight that while bifurcation is the most common pattern, variations such as trifurcation and the absence of division do occur, albeit less frequently.[10]

Koerselman et al. observed that in certain cases of coronary artery disease (CAD), particularly those involving chronic total occlusion of the left anterior descending (LAD) artery, the conus artery may function as a collateral route, helping to deliver blood to the compromised areas.[11]

Among 21 specimens, a single conus artery was identified. In 15 of these, it originated from the right coronary artery (RCA), while in the remaining 6 specimens, it arose directly from the anterior aortic sinus.[12,13]

According to Nafees et al, when the conus branch arises independently from the anterior aortic sinus without sharing a common trunk, it is referred to as the third coronary artery (TCA). The occurrence of this anatomical variation ranges between 7% and 50%.

Sankari et al. stated that the presence of the right conus artery can form a collateral link between the right and left coronary systems, which plays an important role in maintaining blood flow during ischemic conditions of the heart.[14]

6. Conclusion

Knowledge about normal and variant anatomy and the anomalies of the coronary artery is most important. Many a times these variations do not hamper the normal functioning of the heart. But when we view through the diagnostic and surgical point of view, the knowledge about variation helps to attain great success. Thus, reporting of the variation found during dissection or investigation is much necessary.

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Conflict of Interest

None.

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