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ANATOMICAL VARIATION OF THE LEFT CORONARY ARTERY: DESCRIPTION OF A CASE OF TRIFURCATION WITH INTERMEDIATE BRANCH

VARIAÇÃO ANATÔMICA DA ARTÉRIA CORONÁRIA ESQUERDA: DESCRIÇÃO DE UM CASO DE TRIFURCAÇÃO COM RAMO INTERMEDIÁRIO

VARIACIÓN ANATÓMICA DE LA ARTERIA CORONARIA IZQUIERDA: DESCRIPCIÓN DE UN CASO DE TRIFURCACIÓN CON RAMA INTERMEDIA

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ABSTRACT

The left coronary artery (LCA), in its classic pattern, divides into two main branches: the anterior interventricular and circumflex branches. However, anatomical variations can occur, including the presence of additional branches, commonly referred to as intermediate branches. This study describes a case of LCA trifurcation, identified during routine dissection of a specimen belonging to the Human Anatomy Laboratory of the Amazonas State University. After exposure of the coronary system, the emergence of an intermediate branch was observed, which was subjected to morphometric analysis using a digital caliper. The vessel measured 1.8 mm in diameter, 39.2 mm in length, and originated approximately 14.2 mm from the beginning of the LCA. Although bifurcation is the most prevalent form of branching, the occurrence of trifurcation reinforces the morphological complexity and diversity of coronary variations. Furthermore, although often not associated with functional repercussions, such variations may, under specific circumstances, represent a predisposing factor for atherosclerosis and ischemic events, highlighting the importance of their anatomical documentation.

Keywords: Left Coronary Artery. Intermediate Branch. Anatomy.

RESUMO

A artéria coronária esquerda (ACE), em seu padrão clássico, divide-se em dois ramos principais: o interventricular anterior e o circunflexo. No entanto, variações anatômicas podem ocorrer, incluindo a presença de ramos adicionais, comumente chamados de ramos intermediários. Este estudo descreve um caso de trifurcação da ACE, identificada durante dissecção de rotina de um espécime pertencente ao Laboratório de Anatomia Humana da Universidade Estadual do Amazonas. Após a exposição do sistema coronário, observou-se a emergência de um ramo intermediário, o qual foi submetido à análise morfométrica com paquímetro digital. O vaso media 1,8 mm de diâmetro, 39,2 mm de comprimento e originava-se a aproximadamente 14,2 mm do início da ACE. Embora a bifurcação seja a forma mais

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prevalente de ramificação, a ocorrência de trifurcação reforça a complexidade morfológica e a diversidade das variações coronárias. Além disso, embora frequentemente não associadas a repercussões funcionais, tais variações podem, em circunstâncias específicas, representar um fator predisponente para aterosclerose e eventos isquêmicos, destacando a importância de sua documentação anatômica.

Palavras-chave: Artéria Coronária Esquerda. Ramo Intermediário. Anatomia.

RESUMEN
La arteria coronaria izquierda (ACI), en su configuración clásica, se divide en dos ramas principales: la arteria interventricular anterior y la arteria circunfleja. Sin embargo, pueden presentarse variaciones anatómicas, como la presencia de ramas adicionales, comúnmente denominadas ramas intermedias. Este estudio describe un caso de trifurcación de la ACI, identificado durante la disección de rutina de un cadáver perteneciente al Laboratorio de Anatomía Humana de la Universidad Estatal de Amazonas. Tras la exposición del sistema coronario, se observó la emergencia de una rama intermedia, la cual fue sometida a análisis morfométrico mediante un calibrador digital. Dicha arteria medía 1,8 mm de diámetro, 39,2 mm de longitud y se originaba a aproximadamente 14,2 mm del inicio de la ACI. Si bien la bifurcación es la forma de ramificación más frecuente, la presencia de trifurcación subraya la complejidad morfológica y la diversidad de las variaciones coronarias. Además, si bien estas variaciones no suelen tener repercusiones funcionales, en determinadas circunstancias pueden constituir un factor predisponente para la aterosclerosis y los eventos isquémicos, lo que justifica la importancia de su documentación anatómica.

Palabras clave: Arteria Coronaria Izquierda. Rama Intermedia. Anatomía.

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1 INTRODUCTION

The coronary arteries constitute the primary blood supply network of the myocardium, ensuring the continuous supply of oxygen and nutrients essential for maintaining cardiac output (HE et al., 2018). Classically, the right coronary artery (RCA) and the left coronary artery (LCA) originate in the corresponding right and left aortic sinuses, running through the coronary sulcus before branching off to supply the atria and ventricles (AGRAWAL et al., 2017).

In the most common pattern, the LCA presents a dichotomous division, giving rise to the anterior interventricular branch—also called the left anterior descending artery—and the circumflex branch (ADAM et al., 2021). However, morphological variations are relatively common and may include the emergence of three or more main branches from the left coronary trunk, forming trifurcation, quadrifurcation, or even pentafurcation patterns (CHEN et al., 2020). In these cases, the additional branch is generally described as an intermediate branch (IR), whose origin may be in the LCA trunk itself, in the proximal portion of the anterior interventricular branch, or even in the circumflex branch. The IR course, when present, runs obliquely over the sternocostal surface of the left ventricle, distributing to the mid-region between the cardiac base and apex (HE et al., 2018; AGRAWAL et al., 2017).

From an anatomical perspective, the LCA presents a greater diversity of variations than the RCA. These particularities can alter the classic bifurcation pattern, resulting in anomalies defined as characteristics present in less than 1% of the general population, involving alterations in the origin, course, or termination of the coronary vessels (GALBRAITH, 2010).

From the perspective of embryonic development, the morphogenesis of the coronary system occurs during the first trimester of pregnancy. During this period, the primitive myocardium is covered by a rudimentary vascular plexus, derived from migratory progenitor cells originating from the endocardium and the sinus venosus. This plexus, upon connecting with the aorta, begins to receive blood flow, giving rise to the primitive coronary arteries (ADAM et al., 2021). The subsequent process of growth, remodeling, and selective regression of this plexus results in the final conformation of the adult coronary arterial system. However, temporal failures in the connection with the aortic circulation can compromise this progression, favoring the emergence of structural variations or anomalies (SHARMA, 2017).

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In light of these considerations, the present study describes a case of trifurcation of the left coronary artery, contributing to the understanding of anatomical variations and their clinical relevance.

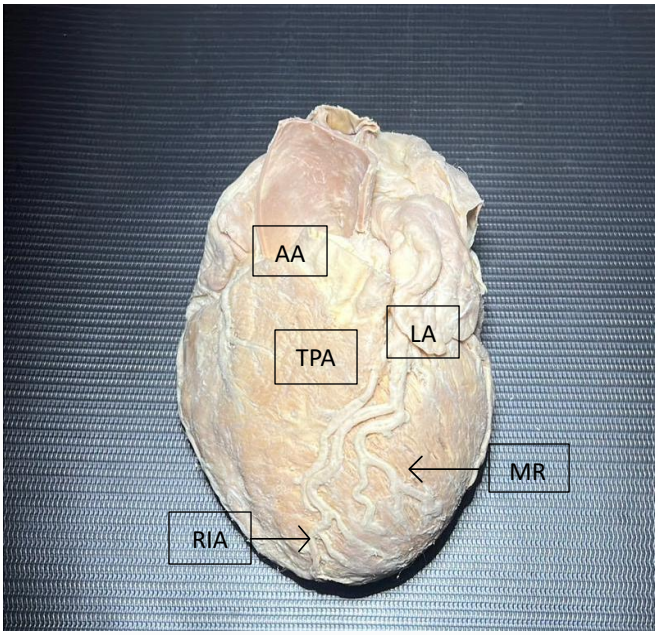
2 CASE REPORT

During the anatomical dissection of a male cadaver heart at the Human Anatomy Laboratory of the School of Health Sciences, a trifurcation of the LCA was discovered.

During the dissection, the main trunk of the LCA was exposed, as well as its respective branches: the anterior interventricular branch, the circumflex branch, and the intermediate branch (Figure 1). Morphometry of the intermediate branch was performed using a digital caliper (MTX), measuring 1.8 mm in diameter, 39.2 mm in length, and originating approximately 14.2 mm from the origin of the LCA (Figure 2). The aforementioned structures can be seen in Figures 1 and 2 below:

Figure 1

Anterior view of dissected heart



Legend: Aortic Artery (AA), Truncopulmonary Artery (TPA),Left Atrium (LA), Marginal Branch (MR) and Anterior Interventricular Branch (RIA).

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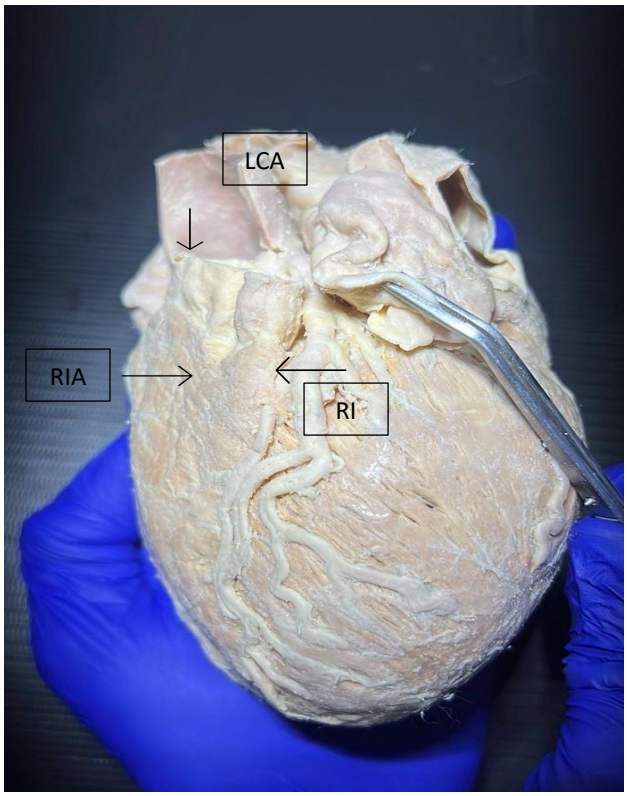
Figure 2

Left lateral view of the heart



Legend: Intermediate Branch (RI), Anterior Interventricular Branch (RIA), Left Coronary Artery (LCA).

3 DISCUSSION

Although classical coronary anatomy is widely described in the literature, the diversity of variations and anomalies in its origin, course, and termination remains a topic of significant debate (LOUKAS, 2009). The main trunk of the left coronary artery (LCA) generally emerges from the left aortic sinus and runs between the left atrium and the pulmonary trunk. It has a short course and is predominantly divided into two branches: the anterior interventricular and circumflex branches (KOŞAR, 2009). Despite this pattern, it is not uncommon to identify a third branch of significant caliber, called the intermediate branch, which inserts between the two main branches (HE et al., 2018).

The prevalence of coronary anomalies in the general population ranges from 0.3% to 1.6%, depending on the diagnostic methodology used, whether in autopsy studies or catheterization procedures (GALBRAITH, 2010). In the present report, the presence of LCA trifurcation was observed, originating from the intermediate branch between the anterior interventricular and circumflex branches.

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Population studies demonstrate that the frequency of coronary trifurcation varies by ethnicity. Kovacevic (2021) reported an incidence of 6.7%, more prevalent in non-Caucasians, with this pattern accounting for up to 90% of the myocardium. Altin et al. (2015) observed bifurcation in 64% of cases, trifurcation in 31%, and tetrafurcation in 5%. Reig et al. (2004) reported bifurcation in 62% and trifurcation in 38%, while Hosapatna (2013) described bifurcation in 93.3% and trifurcation in 6.7%. Similarly, Diwan et al. (2017) found bifurcation in 84% and trifurcation in 6%. These data reinforce that, although less frequent, trifurcation constitutes a relevant and not uncommon anatomical pattern.

From an embryological perspective, recent advances indicate that the formation of coronary arteries results predominantly from a process of vasculogenesis, followed by connection to the aortic flow, and not solely from angiogenesis or branching from the aorta (SHARMA et al., 2017). Experimental studies in animal models suggest that coronary development initially occurs in the subepicardial tissue of the transition zones, possibly guided by molecular signals emitted by the myocardium itself (KOVACEVIC, 2021). This mechanism may explain the individual variability observed in the final conformation of the LCA.

Angelini and colleagues emphasize the need to differentiate normal anatomical patterns from variations and anomalies, proposing that the latter are characterized by rare occurrences in the general population. Coronary anomalies can be grouped into three main categories: (1) origin and course anomalies, when the artery arises from an unusual point or follows an unusual path; (2) intrinsic anomalies, such as myocardial bridging; and (3) termination anomalies, when the vessel drains into atypical structures, such as fistulas (GHADRI et al., 2014).

The presence of an intermediate branch, in turn, raises concern regarding possible hemodynamic repercussions. Some authors suggest that it may act as a protective factor by expanding the irrigation area and reducing the risk of ischemia in adjacent regions (ABUCHAIN et al., 2009). In contrast, Galbraith (2010) observed an association between the presence of the intermediate branch and more extensive infarctions in the anterior wall of the left ventricle, a hypothesis attributed to increased turbulence and hemodynamic overload at the proximal bifurcation of the anterior interventricular branch, favoring the development of atherosclerosis.

Thus, trifurcation of the LCA, although not the predominant pattern, should be recognized as an anatomical variation of clinical importance, the understanding of which can

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aid in the interpretation of imaging studies, surgical planning, and cardiovascular risk assessment.

4 CONCLUSION

Coronary morphology presents wide variability, reflected in multiple possible origins, courses, and branching of its vessels. Recognizing these particularities is crucial, as they can influence both the interpretation of imaging studies and clinical and surgical management. Although bifurcation represents the most common branching pattern of the left coronary artery, the occurrence of trifurcation with the presence of an intermediate branch highlights the complexity and diversity of this anatomical territory. Although, in most cases, such variations are not associated with significant hemodynamic repercussions, some studies suggest that the intermediate branch may be a predisposing factor for the development of atherosclerosis and ischemic events, reinforcing the importance of its identification and adequate anatomical characterization.

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