SUPERDOMINANT LEFT CORONARY ARTERY

ARTÉRIA CORONÁRIA ESQUERDA SUPERDOMINANTE

ARTERIA CORONARIA IZQUIERDA SUPERDOMINANTE

João Gabriel Duarte Silva Guimarães[1], Ketheleen Kariny Pond Pereira[2], Fábio Moniz de Rezende[3]

ABSTRACT

Coronary dominance is generally determined by the origin of the posterior interventricular branch, with right dominance being the most common pattern. However, few reports describe the overdominant left coronary pattern. Therefore, we aimed to report a case of left coronary overdominance, where the posterior interventricular branch was a continuation of the anterior interventricular branch. Although not immediately clinically relevant, certain anomalies can lead to serious complications, such as angina and heart failure. The formation of vascular sinusoids in the embryonic myocardium and their subsequent involution during fetal development may be related to the formation of these anomalies. Therefore, detailed anatomical knowledge of the coronary arteries is essential for identifying variations that may impact cardiovascular health and for preventing ischemic events.

Keywords: Coronary Dominance. Left Coronary Artery. Superdominant Anterior Interventricular Branch.

RESUMO

A dominância coronária é geralmente determinada pela origem do ramo interventricular posterior, sendo a dominância direita o padrão mais comum. No entanto, poucos relatos descrevem o padrão coronário esquerdo superdominante. Portanto, nosso objetivo é relatar um caso de superdominância coronária esquerda, em que o ramo interventricular posterior foi uma continuação do ramo interventricular anterior. Embora não sejam clinicamente relevantes de imediato, certas anomalias podem levar a complicações graves, como angina e insuficiência cardíaca. A formação de sinusoides vasculares no miocárdio embrionário e sua subsequente involução durante o desenvolvimento fetal podem estar relacionadas à formação dessas anomalias. Portanto, o conhecimento anatômico detalhado das artérias coronárias é essencial para identificar variações que podem impactar a saúde cardiovascular e para prevenir eventos isquêmicos.

Palavras-chave: Dominância Coronária. Artéria Coronária Esquerda. Ramo Interventricular Anterior Superdominante.

RESUMEN

---

[1] Graduating in Medicine. Faculdade Santa Teresa.
[2] Graduating in Medicine. Faculdade Santa Teresa.
[3] Doctor. Faculdade Santa Teresa.

La dominancia coronaria generalmente se determina por el origen de la rama interventricular posterior, siendo la dominancia derecha el patrón más común. Sin embargo, pocos informes describen el patrón coronario izquierdo sobredominante. Por lo tanto, nuestro objetivo fue informar un caso de sobredominancia coronaria izquierda, donde la rama interventricular posterior fue una continuación de la rama interventricular anterior. Aunque no son clínicamente relevantes de inmediato, ciertas anomalías pueden conducir a complicaciones graves, como angina e insuficiencia cardíaca. La formación de sinusoides vasculares en el miocardio embrionario y su posterior involución durante el desarrollo fetal pueden estar relacionadas con la formación de estas anomalías. Por lo tanto, el conocimiento anatómico detallado de las arterias coronarias es esencial para identificar variaciones que puedan afectar la salud cardiovascular y para prevenir eventos isquémicos.

Palabras clave: Dominancia Coronaria. Arteria Coronaria Izquierda. Rama Interventricular Anterior Superdominante.

1 INTRODUCTION

The right and left coronary arteries emerge perpendicular to the aorta, and their proximal course runs through the coronary sulcus. There is usually an ostium in the left aortic sinus, giving rise to the left main trunk of the left coronary artery, which bifurcates into the anterior interventricular (AIV) and circumflex (CR) branches. The course of the anterior interventricular branch can be observed in the anterior interventricular sulcus toward the apex, while the circumflex branch follows the left coronary sulcus, its length varying according to the dominance pattern (ABUCHAIM et al., 2009). An additional branch may emerge between the two branches, resulting in the trifurcation of the left main trunk of the left coronary artery. From the anterior interventricular branch, the diagonal arteries branch off, which irrigate the anterolateral wall of the left ventricle, and the perforating arteries, responsible for irrigating the anterior two-thirds of the interventricular septum (AGRAWAL, 2017).

The left marginal branch, originating from the circumflex branch, is responsible for irrigating the left lateral wall of the heart (GALBRAITH, 2010). In cases of right coronary artery dominance, this branch may represent the final segment of the circumflex branch. The coronary dominance pattern is usually right, with an incidence of 67% of cases, while left dominance is observed in 15% of the population, and a codominant pattern in 18% of cases. Sometimes, when left dominance occurs, the anterior interventricular branch bypasses the cardiac apex and follows the posterior interventricular sulcus until reaching the crus of the heart. This is an important structural alteration and is termed a superdominant anterior interventricular branch (AGRAWAL, 2017).

Coronary artery anomalies represent a heterogeneous group of congenital abnormalities characterized by considerable variability in their pathophysiological mechanisms and clinical manifestations. Ongoing debates persist regarding their true incidence, appropriate classification, genetic background, and optimal management strategies. In most cases, these anomalies are identified incidentally during coronary angiography or post-mortem examinations. Although relatively rare and often detected incidentally during coronary angiography, they have generated interest (DE SOUZA BATISTA, 2011). However, it is essential to establish clear morphological criteria to describe normal coronary arteries. He et al. (2018) proposed criteria to define normal coronary anatomy, taking into account several morphological characteristics of the arteries, such as the number of ostia, their location, course, and branches. Furthermore, it is essential to

differentiate between normal variants of coronary anatomy and coronary anomalies per se. Anatomical features of coronary arteries should be considered variants, rather than congenital anomalies, when found in more than 1% of the general population (DIWAN, 2017). Thus, the present study aims to report a case of superdominant anterior interventricular branch.

2 CASE REPORT

During a routine dissection of a heart belonging to the Human Anatomy Laboratory (ESA), an superdominant pattern of the left coronary artery (LCA) was identified. The procedure involved exposing the main trunk of the LCA and its corresponding branches: the anterior interventricular branch and the circumflex branch (see Figure 1). The anterior interventricular branch was noted to bypass the cardiac apex and continue as the posterior interventricular branch. These structures can be seen in Figure 1.

Figure 1

Anterior view of dissected heart
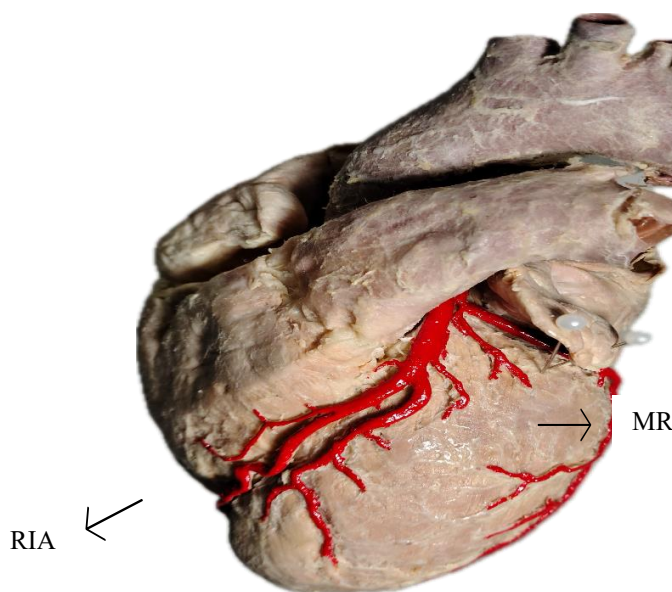
Legend: Marginal Branch (MR) and Anterior Interventricular Branch (RIA).

3 DISCUSSION

The left main coronary trunk originates in the left aortic sinus and passes between the pulmonary artery and the left atrium (GALBRAITH, 2010). Its average length is 2 to 4 cm, and it usually bifurcates into the anterior interventricular branch and the circumflex branch. The left main coronary trunk descends toward the cardiac apex through the epicardial fat in

the anterior interventricular sulcus. Its length varies from 10 to 13 cm, and it gives off diagonal and septal branches along its course, supplying blood to the anterior wall of the ventricles, the apex, and a significant portion of the interventricular septum (HE, 2018). The left main coronary trunk, 5 to 8 cm long, crosses the coronary sulcus on the diaphragmatic surface of the heart, giving rise to the marginal branches and supplying primarily the lateral wall of the left ventricle. In turn, the RCA runs to the right, between the pulmonary trunk artery and the right atrium, descending the right coronary sulcus and continuing posteriorly past the right margin. Its length is approximately 12 to 14 cm, and along its course, it can give off several branches, such as the branch of the conus arteriosus, sinoatrial branch, right ventricular branch, branch of the atrioventricular node, and posterior interventricular branch (AGRAWAL, 2017).

No two coronary anatomical patterns are identical, and there is wide variability within the distribution considered normal. Coronary artery anomalies represent significant deviations from normality, but fortunately, they have a relatively constant incidence of less than 1.5% across different racial groups (DIWAN, 2017). These anomalies can be found incidentally and often have no clinical significance (CHEN, 2020). However, depending on the origin, course, and termination of the anomalous vessel, these abnormalities can cause angina, heart failure, and even sudden death (ALTIN, 2015).

It is well established that coronary dominance is determined by the origin of the posterior interventricular branch, which can be from the right coronary artery (RCA), the circumflex artery (CEA), or both (PIMENTA et al., 2024). However, this study aimed to report a case of a lower incidence of coronary dominance, known as "hyperdominant anterior interventricular branch (AIB)," "superdominant AIB," or "type IV AIB" (AGRAWAL, 2017). Although this condition is often identified incidentally, its clinical relevance lies in the fact that, if involved during an acute coronary syndrome, it can result in significant left ventricular ischemia or extensive infarctions in the anterior and inferior cardiac surfaces (affecting more than 50% of the myocardium) (GHADRI, 2014).

Lipton et al. proposed a classification system for single coronary arteries (SCAs), which was later refined by Yamanaka and Hobbs, based on the vessel's origin and anatomical course. In this scheme, Group I SCAs are described as "superdominant" arteries that follow the course of either the right coronary artery (RCA) or the left coronary artery (LCA) and supply the entire heart. A superdominant RCA (variant IR in Lipton's classification) is extremely rare. This anomaly is often associated with the congenital absence of the left

circumflex artery, representing an anatomical adaptation that allows the RCA to perfuse territories normally supplied by the LCA. Studies indicate that approximately 90% of patients with congenital absence of the left circumflex artery have a superdominant RCA. The estimated incidence of this anomaly is about 0.067%.. Cadaver studies reveal an even lower incidence; for example, in an analysis of 18,950 autopsies, only 54 cases of coronary anomalies were identified, corresponding to an incidence of 0.3% (GHADRI, 2014).

Embryologically, during the early stages of human fetal development, vascular sinusoids form in the embryonic myocardium. With the process of myocardial compaction, these sinusoids gradually disappear, giving way to a network of veins, arteries, and capillaries (KOŞAR, 2009). Primitive coronary vessels emerge approximately in the seventh week of gestation, after the formation of the aorta from the division of the truncus arteriosus (HOSAPATNA, 2013). As the coronary arterial network develops, endothelial growth emerges at the base of the truncus arteriosus, which subsequently merges with the coronary arterial network originating from the sinusoids, establishing the definitive coronary arterial circulation. Anomalies in involution, flow position, or septation of the truncus arteriosus can result in anomalous origin of the coronary arteries. Due to the complex embryological process involved, it is expected that deviations in development may lead to congenital anomalies.

4 CONCLUSION

Coronary artery anomalies, although rare, can have significant clinical implications depending on their origin and course. Although they are often identified incidentally and asymptomatic, they can be associated with serious complications such as angina, heart failure, and even sudden death. Coronary dominance in particular is an important factor in cardiac physiology, and variations such as those observed in this study highlight the importance of detailed anatomical knowledge in preventing ischemic events.

REFERENCES

Abuchaim, D. C. S., & et al. (2009). Coronary dominance patterns in the human heart investigated by corrosion casting. Brazilian Journal of Cardiovascular Surgery, 24(4), 514–518.

Agrawal, H., & et al. (2017). Anatomic types of anomalous aortic origin of a coronary artery: A pictorial summary. Congenital Heart Disease, 12(5), 603–606. https://doi.org/10.1111/chd.12511

Altin, C., & et al. (2015). Coronary anatomy, anatomic variations and anomalies: A retrospective coronary angiography study. Singapore Medical Journal, 56(6), 339–345. https://doi.org/10.11622/smedj.2015097

Chen, X., & et al. (2020). Image-based morphometric studies of human coronary artery bifurcations with/without coronary artery disease. Computer Methods in Biomechanics and Biomedical Engineering, 24(7), 740–752. https://doi.org/10.1080/10255842.2020.1842376

de Souza Batista, A. V., Porto, E. A., & Molina, G. P. (2011). Study of the anatomy of the left coronary artery and its variations: Perspectives of a new classification. Health & Science Journal, 2(1), 55–65.

Diwan, D., & et al. (2017). Main trunk of left coronary artery: Anatomy and clinical implications. Journal of Medical Sciences and Clinical Research, 5(1), 15658–15663. https://doi.org/10.18535/jmscr/v5i1.15

Galbraith, E. M., & et al. (2010). Comparison of location of "culprit lesions" in left anterior descending coronary artery among patients with anterior wall ST-segment elevation myocardial infarction having ramus intermedius coronary arteries versus patients not having such arteries. The American Journal of Cardiology, 106(2), 162–166. https://doi.org/10.1016/j.amjcard.2010.03.008

Ghadri, J. R., & et al. (2014). Congenital coronary anomalies detected by coronary computed tomography compared to invasive coronary angiography. BMC Cardiovascular Disorders, 14, 81. https://doi.org/10.1186/1471-2261-14-81

He, Y., & et al. (2018). Validation of the V-RESOLVE (Visual Estimation for Risk Prediction of Side Branch Occlusion in Coronary Bifurcation Intervention) score system. Catheterization and Cardiovascular Interventions, 91(S1), 591–598. https://doi.org/10.1002/ccd.27427

Hosapatna, M., & et al. (2013). Anatomical variations in the left coronary artery and its branches. Singapore Medical Journal, 54(1), 49–52. https://doi.org/10.11622/smedj.2013012

Lipton, M. J., & et al. (1979). Isolated single coronary artery: Diagnosis, angiographic classification, and clinical significance. Radiology, 130(1), 39–47. https://doi.org/10.1148/130.1.39

Koşar, P., & et al. (2009). Anatomic variations and anomalies of the coronary arteries: 64-slice CT angiographic appearance. Diagnostic and Interventional Radiology, 15(4), 275–283.

Pimenta, H. B., & et al. (2024). Artéria coronária esquerda superdominante. In Ciência, cuidado e saúde: Contextualizando saberes (Vol. 4, pp. 69–76). Editora Científica Digital.