Original Article

Correlation Between Coronary Artery Branching Pattern and Cardiac Dominance: A Cadaveric Anatomical Study

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Abstract

Background: Cardiac dominance and coronary artery branching pattern are important anatomical characteristics that influence myocardial blood supply and have significant implications during coronary angiography, percutaneous coronary intervention, and coronary artery bypass grafting. Understanding their relationship is essential for safe and effective cardiovascular procedures. The aim is to evaluate the correlation between the coronary artery branching pattern and cardiac dominance in adult human cadaveric hearts. **Material and Methods:** A descriptive cross-sectional cadaveric study was conducted on 80 embalmed adult human hearts. The coronary arteries were dissected to determine the pattern of cardiac dominance, the branching pattern of the left coronary artery, and associated anatomical variations. Cardiac dominance was classified according to the origin of the posterior interventricular artery. Data were analyzed using IBM SPSS Statistics version 26.0, and associations were assessed using the Chi-square test, with $p < 0.05$ considered statistically significant. **Results:** Right coronary dominance was observed in 64 (80.0%) specimens, followed by left dominance in 10 (12.5%) and co-dominance in 6 (7.5%) specimens. A significant association was found between the branching pattern of the left coronary artery and cardiac dominance ($p = 0.041$). Right dominance was most associated with bifurcation of the left coronary artery, whereas trifurcation was relatively more frequent in left-dominant hearts. Coronary artery variations were significantly more common in left- and co-dominant hearts than in right-dominant hearts ($p = 0.032$). **Conclusion:** Right coronary dominance was the predominant anatomical pattern in the present study. Significant correlations were observed between cardiac dominance, the branching pattern of the left coronary artery, and coronary artery variations. These findings provide clinically relevant anatomical information that may facilitate accurate interpretation of coronary imaging and improve the planning of coronary interventions and surgical revascularization.

Keywords: Coronary artery, Cardiac dominance, Coronary branching pattern, Left coronary artery, Cadaveric study, Coronary anatomy.

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Introduction

Despite tremendous improvements in the diagnoses and treatment of cardiovascular diseases, coronary artery disease (CAD) remains the number one killer worldwide. To perform coronary angiography, percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG) and other cardiac procedures, it is important to understand the structure of coronary arteries. The coronary arteries typically run a well-recognised pattern but there is inter-individual variation in the pattern of branching, terminal distribution and coronary dominance. The anatomical variations could have an impact upon myocardial perfusion, collateralisation and/or procedural results and therefore are clinically relevant.[1-4]

The cardiac dominance is based on the origin of the back wall interventricular artery and ranges from right dominance, left dominance, and co-dominance. Left and co-dominance are less common and are found in different ethnic groups than right dominance. The anatomic arrangement of the dominant CA has a significant impact on myocardial ischemia, infarction, and planning of the coronary revascularisation procedures, due to the fact that it delivers an abundance of blood supply to the inferior wall of left ventricle and the posterior interventricular septum.[1,5,6]

There is an enormous anatomical variation in the pattern of branching of coronary arteries especially the left coronary artery. Bifurcation into anterior interventricular, circumflex and an unnamed artery that communicates with another via the ramus intermedius is called the "conventional" pattern, but trifurcation and quadrifurcation are recognized variants. Cadaveric studies have recently demonstrated that these differences are relatively frequent and can result in myocardial vascular territories, impact collateral circulation and complicate coronary angiography and coronary surgical revascularisation.[2,7-9]

Some new evidence confirms that coronary artery branching pattern may be related to cardiac dominance. The recent study

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of the anatomy has shown that there are anatomical differences in coronary branching with coronary vascular architecture and the distribution of the posterior interventricular artery. These relationships can be of importance in the interpretation of myocardial imaging, as well as operative planning. However, a few studies have been conducted to assess the relationship between branching pattern of coronary arteries and cardiac dominance in humans specifically, the Indian population is not so well documented.[3,5,8]

Although imaging techniques have been improved over the years, cadaveric dissection is the most reliable approach to investigate the morphology of coronary arteries, allowing direct visualization of their origin, branching pattern and terminal distribution without any bias of imaging techniques. Population-based cadaveric studies serve as important anatomical information to supplement the radiological assessment and are used to enhance safe diagnostic, interventional and surgical cardiovascular practice.[2,9-11]

Materials and Methods

Study Design: The study was descriptive, cross sectional, cadaveric study conducted in Department of Anatomy in Index Medical College Hospital and Research Centre, Indore, Sagar division of madhya Pradesh, India to investigate the correlation between the coronary artery branching pattern and cardiac dominance.

Sample specimens and Dissection

A total of 80 embalmed adult human cadaveric hearts with intact coronary arteries were included. After careful removal of the epicardial fat, the coronary arteries were dissected and the origin of the posterior interventricular artery, and branching pattern of the left coronary artery and associated variations were rec traced from their origin to their terminal branches. Cardiac dominance was determined according to the origin of the posterior interventricular artery, and the branching pattern of the left coronary artery, along with associated anatomical variations, was documented.

Statistical Analysis: IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA) was used to analyze data. Frequencies and percentages were used to make categorical variables readable. Relationship between coronary artery branching pattern, anatomical variations, and cardiac dominance was evaluated by Chi-square test and values of $p < 0.05$ was taken as significant.

Ethical Considerations: The research was conducted on cadaver specimens in accordance with institutional rules for anatomical research.

Results

A total of 80 embalmed adult human cadaveric hearts were included in the study. Cardiac dominance was determined based on the origin of the posterior interventricular artery, and its association with the branching pattern of the left coronary artery and other anatomical variations was evaluated.

The posterior interventricular artery originated from the right coronary artery in 64 (80.0%) specimens, from the circumflex artery in 10 (12.5%), and received contributions from both arteries in 6 (7.5%) specimens [Table 1].

Table 1: Origin of the Posterior Interventricular Artery (n = 80)

Origin of Posterior Interventricular Artery	Number (n)	Percentage (%)
Right coronary artery	64	80.0
Circumflex artery	10	12.5
Both arteries	6	7.5

Accordingly, right coronary dominance was observed in 64 (80.0%) specimens, left dominance in 10 (12.5%), and co-dominance in 6 (7.5%) specimens [Table 2].

Table 2: Pattern of Cardiac Dominance (n = 80)

Cardiac Dominance	Number (n)	Percentage (%)
Right dominance	64	80.0
Left dominance	10	12.5
Co-dominance	6	7.5

A significant association was observed between the branching pattern of the left coronary artery and cardiac dominance (χ^2 test, $p = 0.041$). Right dominance predominated in specimens with bifurcation (49/57; 86.0%), whereas left dominance was relatively more frequent in specimens exhibiting trifurcation (6/20; 30.0%) [Table 3].

Table 3: Correlation Between Left Coronary Artery Branching Pattern and Cardiac Dominance (n = 80)

Branching Pattern	Right Dominance n (%)	Left Dominance n (%)	Co-dominance n (%)	Total	p-value
Bifurcation	49 (86.0)	4 (7.0)	4 (7.0)	57	0.041
Trifurcation	13 (65.0)	6 (30.0)	1 (5.0)	20	
Quadrifurcation	2 (66.7)	0 (0.0)	1 (33.3)	3	

The prevalence of anatomical variations differed significantly according to the pattern of cardiac dominance (χ^2 test, $p = 0.032$). Anatomical variations were present in 21 (32.8%) right-dominant hearts, 7 (70.0%) left-dominant hearts, and 3 (50.0%) co-dominant hearts [Table 4].

Table 4: Correlation Between Anatomical Variations and Cardiac Dominance (n = 80)

Cardiac Dominance	Anatomical Variation Present n (%)	Anatomical Variation Absent n (%)	Total	p-value
Right dominance	21 (32.8)	43 (67.2)	64	0.032
Left dominance	7 (70.0)	3 (30.0)	10	
Co-dominance	3 (50.0)	3 (50.0)	6	

Discussion

The present study showed that right coronary dominance was the most common (80.0%) followed by left dominance (12.5%) and co dominance (7.5%). These results compare favorably with other recent cadaveric studies by Lane et al,[5] Patel et al,[9] and Otieno et al,[10] that all found the most common pattern to be right dominance in about 70-85% of their cadaver specimens. This has been summarized in a recent systematic review by Vidhale et al,[8] which shows that right coronary dominance is the more common anatomical feature in various populations. Right dominance is important in the clinical setting because it is the determinant of arterial supply to the inferior wall of the left ventricle and the posterior interventricular septum.

Left coronary artery branching pattern was found to be significantly associated with cardiac dominance ($p = 0.041$). Bifurcation of the left coronary artery occurred most commonly with right dominance and trifurcation of the left coronary artery occurred with the relatively greater frequency in right dominance. Although studies specifically evaluating this relationship remain limited, Lane et al,[5] reported that variations in coronary branching architecture are associated with differences in coronary dominance and myocardial vascular distribution. Similarly, Mishra et al,[2] and Shihas and Jayachandran,[12] demonstrated that variations in the terminal branching pattern of the left coronary artery contribute to differences in coronary arterial morphology.

The present findings support these observations by demonstrating a statistically significant relationship between the mode of division of the left coronary artery and the pattern of coronary dominance.

The present study also demonstrated a significant association between anatomical variations and cardiac dominance ($p = 0.032$). Anatomical variations were more frequently encountered in left-dominant and co-dominant hearts than in right-dominant hearts. Similar observations have been reported by Patel et al,[9] and Otieno et al,[10] who noted a higher prevalence of branching variations in non-right dominant coronary circulation. Furthermore, the systematic review by Vidhale et al,[8] concluded that branching variations of the coronary arteries contribute to population-based differences in coronary dominance and myocardial vascular distribution.

Overall, the present study demonstrates that right coronary dominance is the predominant pattern in the central Indian population and that cardiac dominance is significantly associated with variations in the branching pattern of the left coronary artery and other coronary anatomical variations. The results are useful for anatomical data in coronary angiography, MDMCA, CABG, and PCI, where knowledge of coronary dominance, branching morphology, and knowledge of coronary anatomy is crucial for the procedure and for optimal clinical outcome.

Conclusion

The present cadaveric study proved that right coronary dominance is the most common type of coronary dominance, followed by left dominance and co-dominance. There was a significant correlation between the branching pattern of the left coronary artery and cardiac dominance as well as cardiac dominance and coronary artery variations. The results of this study show the impact of coronary artery morphology on the myocardial blood supply pattern. Understanding of these anatomical relationships is crucial in the correct interpretation of coronary angiography, planning of CABG, PCI and other cardiovascular procedures.

The study gives insight to anatomical details of coronary dominance in the middle Indian population and adds to the published literature on coronary artery morphology.

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Conflicts of interest

There are no conflicts of interest.

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