



CORONARY ARTERY DOMINANCE – A CADAVERIC STUDY WITH CLINICAL PERSPECTIVES

Dr. Apsara.M.P

Associate Professor, Department of Anatomy, Govt Medical College, Kozhikode-673008, Kerala, India

Dr. Rajesh. S

Associate Professor, Department of Cardiovascular and Thoracic Surgery, Govt Medical College, Kozhikode- 673008, Kerala, India - Corresponding Author

ABSTRACT

Background of study: In the clinical scenario of increasing prevalence of coronary artery disease, the knowledge of coronary artery dominance in Keralite population will be helpful to clinicians for planning interventional procedures and surgeries.

Materials & methods: A cadaveric study over a period of three years was carried out in fifty human hearts to see the origin of posterior descending artery (PDA), after manual removal of epicardium and subepicardial fat.

Results: Right coronary dominance was noticed in 76% of cases where as left coronary dominance and co-dominance were detected in 20% and 4% respectively.

Summary: RCA dominance (76%) was the most prevalent pattern. There was no gender based variation in coronary artery dominance. Double PDA was detected in 2% of specimens. A sound knowledge of coronary artery dominance is essential before planning angioplasty and bypass surgery of coronary arteries since the left coronary dominance is associated with increased incidence of myocardial infarction as per literature.

KEYWORDS : Coronary artery disease (CAD), Right coronary artery (RCA) dominance, Left coronary artery (LCA) dominance, Co-dominance

INTRODUCTION

Interventions and surgeries for coronary artery disease (CAD) have gained momentum in last two decades of medical practice. The success of these procedures heavily depend on exact anatomical location of the disease and planning the proper line of management. Since posterior descending artery supplies the postero-inferior part of interventricular septum, its revascularization plays a major role in improving the biventricular function in CAD. Extensive studies using various methods like dissection, dye injection, cast preparation, angiography etc were carried out on coronary artery dominance all over the world, but a few studies were reported in Keralites.

It is a well known fact that the origin of posterior descending artery (PDA) is the only factor which determines the coronary artery dominance (predominance / preponderance). PDA usually originates from RCA – RCA dominance or from Circumflex branch of LCA – LCA dominance. It may arise from both RCA & LCA – Co-dominance. Assigning the dominance of coronary circulation is of great significance to cardiologists and cardiac surgeons for choosing the proper treatment modality because most clinical trials report high incidence of coronary artery disease in left dominant hearts.

AIMS AND OBJECTIVES

Increasing the number of coronary care units in our country points out the importance of sound knowledge of coronary arteries and their dominant patterns in different population. Present study aims to detect the prevalence of coronary artery dominance in Keralite population, since posterior descending artery block is a major cause of myocardial infarction.

MATERIALS AND METHODS

A cadaveric study was carried out in fifty human hearts in the Department of Anatomy, Govt Medical College, Thiruvananthapuram, Kerala, India over a period of three years, with the permission of Human Ethical Committee. Thirty four hearts belonged to male sex and sixteen belonged to female sex. Hearts with severely damaged coronary arteries and foetal hearts were not included in the study group.

Epicardium and subepicardial fat were removed manually. Each coronary artery was traced from its origin to termination. The right coronary artery and circumflex artery were completely exposed and observed for the origin of PDA. The PDA was traced from its origin to termination and photographed. The origin of PDA – the factor which determines the

coronary artery dominance was studied separately in male and female groups. Bardigrams showing the prevalence of each dominant pattern in both male and female study groups were prepared. The tabulated data was statistically analysed using “Chi-Square test” & “P value”.

RESULTS AND ANALYSIS

Three types of origin of PDA were visualized in present study. In 76 % PDA originated from the RCA – Right coronary artery dominance (Figure 1). In 20 % it originated from the circumflex branch of LCA – Left coronary artery dominance (Figure 2). In 4 % PDA originated from both RCA and Circumflex artery - codominance (Figure 3). In one specimen two posterior descending arteries were seen from RCA (Figure 4). The frequencies of different dominant patterns were shown in table 1.

The RCA was the dominant vessel in both male and female groups (76.5 % & 75 % respectively). The LCA dominance was reported in 17.6% of male group & 25 % of female group. The co-dominant pattern was seen only in male study group (5.9 %) (Table 2). Statistically significant gender based variation was not detected in present study ($\chi^2 = 1.2$, P value = 0.538). Figure 5 (Bar diagrams) represents the prevalence of each dominant pattern in both male and female study groups. The data collected from the present work was compared with previous reports in this field (Table 3).

Table 1- Prevalence of coronary artery dominance

Dominant pattern	Gross anatomical study (50)	
	Number	Percentage (%)
RCA dominance	38	76%
LCA dominance	10	20%
Co dominance	2	4%

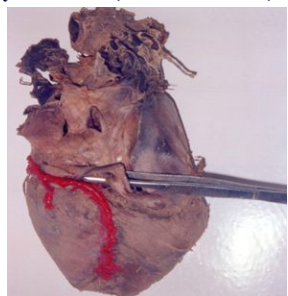
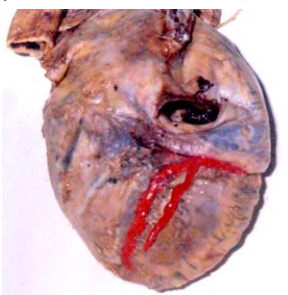
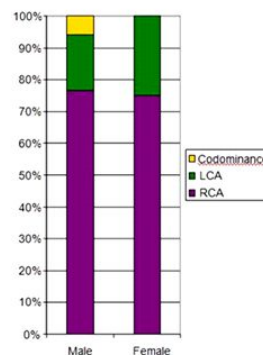
Table 2 - Gender based comparison of coronary artery dominance

Dominant pattern	Males (34)		Females (16)	
	Number	Percentage (%)	Number	Percentage (%)
RCA dominance	26	76.5%	12	75%
LCA dominance	6	17.6%	4	25%
Co-dominance	2	5.9%	-	0%

$\chi^2 = 1.2$ P value = 0.538

Table 3- Coronary artery dominance – comparative analysis

Sl no	Authors	RCA dominance %	LCA dominance %	Co-dominance %
1	Schlesinger ¹ (1940)	48	18	34
2	Jain & Hazary ³ (1958)	56.6	10	33.4
3	Reig et al ¹⁶ (1987)	71.4	14.3	14.3
4	Cavalcantiet al ³⁷ (1987)	69.09	11.82	19.09
5	Kalpana R ³⁸ (2003)	89	11	0
6	Loukas et al ¹⁴ (2006)	66.6	24.6	8.7
7	Pelter et al ¹³⁵ (2011)	70	20	10
8	Gaffari et al ²⁷ (2013)	78.6	8.9	12.5
9	Chethan et al ¹² (2014)	74	11	14.8
10	Khan et al ³¹ (2015)	84.9	11.3	3.8
11	Pal et al ²⁴ (2016)	70	22	8
12	Present work	76	20	4

**FIG. 1** Posterior view of heart showing the origin of posterior descending artery from RCA (RCA dominance)**FIG. 2** Posterior view of heart showing the origin of posterior descending artery from left circumflex artery (LCA dominance)**FIG. 3** Posterior view of heart showing the origin of posterior descending artery from both RCA and LCx (Co-dominance)**FIG. 4** Posterior view of heart showing double posterior descending artery from RCA**FIG. 5** Gender based comparison of coronary artery dominance

DISCUSSION

A detailed study of coronary arterial pattern was done by Schlesinger¹ to describe the dominance of coronary artery. He used the term dominance to indicate the areas of heart supplied by RCA and LCA. He described three types of coronary artery dominance with highest percentage for RCA dominance (48%), followed by balanced circulation (co-dominance) (34%). The lowest prevalence was for LCA dominance (18%). The radiographic study on human hearts by Ayer and Rao² showed an equal prevalence (28% each) for LCA predominance and balanced circulation. RCA was the dominant vessel in their study group too (44%). They stated that the balanced circulation was more frequent in fetuses than in the adults.

The radio-opaque study on coronary arterial pattern in human hearts by Jain and Hazary³ reported highest prevalence of right coronary predominance (56.6%). In their study the balanced circulation and left coronary predominance were 33.4% and 10% respectively. They studied the same pattern in other mammals and reported that the left coronary artery predominated and supplied the whole of inter ventricular septum. The animal study by Oliveria et al⁴ reported higher percentage of LCA dominance in dogs.

A human cadaveric hearts study done by Bordoloi⁵ shows higher percentage of LCA dominance in males than females. Gohain and Saika⁶ reported a higher percentage of LCA and Co dominant patterns in males than females. An angiographic study by Nepal and Murti⁷ in Nepalese population could not detect a gender based variation in their study group. As per reports by Khan et al⁸ there is no significant association between coronary artery dominance and gender. Present study also could not detect any gender based variation in coronary artery dominance though co-dominant pattern was seen only in males which could not be considered as significant.

As per dissection study by Bharambe and Arole⁹, 4 parameters are needed for coronary artery dominance. They state that dominant vessel is the one which (1) giving origin to posterior interventricular branch (2) crosses the crux cordis (3) giving origin to AV nodal artery (4) giving origin to SA nodal artery. The association between coronary artery dominance and SA nodal artery was evaluated by Darmender et al¹⁰. They stated that the SA nodal artery was a branch of dominant coronary artery.

Ajayi et al¹¹ in their study on coronary artery dominance dependent collaterals, state that the coronary collateral arteries are better developed in right dominant hearts and the morphology of coronary arteries influence the development of collaterals. Chethan et al¹² studied the relation between the coronary artery dominance and the division of main trunk of LCA (bifurcation, trifurcation, quadrifurcation) and reported that quadrifurcation was seen only in right dominant hearts. Highest prevalence was for bifurcation irrespective of dominant pattern. Ilija et al¹³ opine that the left anterior descending branch of LCA is usually long and wraps around the apex in LCA dominant hearts.

The relation between coronary artery dominance and myocardial bridges was studied by Loukas et al¹⁴ and they reported a high prevalence of LCA dominance (66.6%) in hearts that had myocardial bridges. Huswani et al¹⁵ reported a case of left coronary dominance with myocardial bridge of RCA and high take off LCA. Keshaw¹⁶

described four types of dominant patterns (1) right coronary arterial dominance (83%), (2) left coronary arterial dominance (16%), (3) right coronary arterial great dominance (0.7%), (4) coronary arterial nodominance (0.3%). They evaluated the association between coronary arterial pattern and coronary artery disease and concluded that LCA had to supply the entire interventricular septum due to which pulse pressure of blood rised more than 60 mm of Hg in it producing atherosclerosis.

The syndrome of angina pectoris or angina like chest pain with normal coronary arteriogram (CAG), despite positive exercise test results, is called cardiac syndrome X (Zipes)¹⁷. Makarovic et al¹⁸ reported the sex linked association between coronary artery dominance and cardiac syndrome. As per their reports LCA dominance was more frequent in women with non-obstructive coronary artery disease and mixed supply (balanced circulation) was less frequent in men with non obstructive coronary artery disease. Their study showed that the LCA dominance in females and absence of co-dominance in males could cause regional ischemia of heart. Nepal et al¹⁹ suggest that the patients with cardiac syndrome are more likely to have non-dominant RCA (NDRCA) than those with obstructive coronary artery disease.

Knaapen et al²⁰ conducted a study in 1620 coronary angiograms and noticed that the prevalence of left or co dominant coronary systems decreased with increasing age. Their findings could relate to a slightly higher risk of mortality in case of left versus right coronary artery occlusion. A significant association between LCA dominance and aortic stenosis (AS) was noticed by Murphy et al²¹ in their coronary angiogram study in 75 patients with aortic stenosis. As per their study LCA main trunk was short in AS patients with LCA dominance. It was also associated with increased perioperative myocardial infarction in obstructive coronary artery disease. The association between coronary artery dominance and heart valve disease was also studied by Morris et al²². They suggested that in the AS patients group there was a significant association with left dominant coronary circulation and the proportion of patients with left dominance increased with the severity of AS. They could detect a reduced prevalence of left dominance in mitral regurgitation (MR).

Blumgart et al²³ observed an equal prevalence for right coronary preponderance and co-dominance (40% each) with 20% left coronary preponderance. They further stated that the incidence of arterial occlusions was unusually high in left predominant hearts with very high infarction rates. Pal et al²⁴ in their cadaveric study of coronary artery dominance states that the degree of severity of MI is more in left dominant hearts and may lead to death in single attack if there is obstruction in LCA. According to them dominance can be a significant determinant of prognosis in acquired coronary artery disease. A coronary artery obstruction begins to assume significance when it approaches 75 % of cross sectional area of the vessel (Gorlin R)²⁵. Reddy and Lokanadham²⁶ suggested that left predominance in males might be the reason for higher incidence of myocardial infarction in males compared to females. But as per Gaffari et al's²⁷ reports the LCA dominance is not associated with the increased incidence of atherosclerosis of left anterior descending artery ostium (origin).

The left and codominant coronary artery circulation confer modestly increased risk of in hospital mortality after percutaneous coronary intervention (PCI) for acute coronary syndrome (ACS), particularly in lesions in the left main trunk and circumflex arteries, as per Parikh et al's²⁸ clinical study. Vetman et al²⁹ opined that in patients with ST segment elevation MI (STEMI), a left coronary arterial system was linked with higher risk of mortality and early re-infarction compared with right dominance. Their statement was supported by Abu-Assi³⁰ and proved that the left dominance was an independent predictor of re-infarction. Multivariate logistic regression analysis by Kuno et al³¹ highlighted the importance of left dominance as an independent predictor for in hospital mortality. Among their acute coronary syndrome patients who underwent PCI, left dominant (LD) patients had significantly worse hospital outcomes compared to right dominant (RD) patients. The number of patients presenting with symptoms of heart failure, cardiogenic shock or cardiopulmonary arrest were significantly higher in the LD group than RD group in their study. According to them, single coronary supply typical of patients with LD anatomy should be recognized as a high risk feature.

Lam et al³² also observed a higher incidence of peri-procedural (PCI) myocardial infarction in patients with left coronary dominance.

Udristle et al³³ in their study on the pathological and forensic implications of coronary dominance in patients with inferior STEMI, indicate that their population of patients with inferior STEMI right dominant circulation is more common than general population. Though the literature shows increased prevalence of coronary artery disease in left coronary dominant hearts, Gebhard et al's³⁴ reports show the survival after 5 years of follow up did not differ significantly between CAD patients with right or left coronary dominance.

CONCLUSION

The significance of coronary artery dominance was subject of many gross anatomical and clinical studies. According to previous studies there is not much geographical variation in the prevalence of coronary artery dominance. As previous reports in literature, present work also showed a high prevalence of RCA dominance (76%) in Keralite population. LCA dominance and co-dominance were detected in 20 % and 4% respectively. Double PDA from RCA was observed in one heart. Present study could not detect any association between coronary artery dominance and gender. The knowledge of coronary artery dominance will be of immense help to the interventional cardiologists and cardiac surgeons in treating coronary artery disease since the left dominant coronary circulation is associated with increased incidence of myocardial infarction as per many previous clinical reports.

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