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" A STUDY ON CORONARY ARTERY DOMINANCE- ANATOMICAL APPROACH WITH CLINICAL INSIGHT"

KEYWORDS

Coronary artery, Right dominance, Left dominance, Balanced.

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ABSTRACT Background: The incidence of coronary heart disease has been increasing worldwide and has become one of the major causes of morbidity and mortality, probably because of the change in lifestyle. The knowledge of the dominant pattern of coronary arteries is clinically relevant as it influences the interpretation of the findings in certain heart diseases and their treatment pattern. Aim: The present study aims to document the pattern of coronary artery dominance on anatomical basis, with an insight on the influence of the different patterns on clinical manifestations. Materials and Methods: The study was conducted in the Dept. of Anatomy, Govt. Medical College, Kozhikode in 60 hearts, 30 from adult cadavers and 30 from stillborn full term fetuses. The coronary artery dominance was determined on the basis of the origin of posterior interventricular artery. Results: Right dominance was found in 53 hearts (88.4%), left dominance in 5 (8.3%) and balanced pattern in 2 (3.3%). With review of relevant literature, the significance of each pattern and its possible association with clinical manifestations were analysed.

INTRODUCTION

The problem of coronary heart disease has gained great importance nowadays due to its increasing frequency and associated danger. In India its prevalence had increased rapidly from 1% in 1960 to 9.7% in 1995 in urban population[1]. A detailed knowledge of the various aspects of coronary arteries and their dominance pattern correlated with coronary pathophysiology appears significant for diagnosis and proper management of coronary heart diseases. For past many years, extensive works on coronary arteries have been undertaken by various workers who contributed significantly in the field of cardiology. The excellent works by James TN (1958, 1961) are valuable contributions in the field of coronary anatomy.[2,3]

Human heart is nourished by the right and left coronary arteries which arise respectively from the right (anterior) and left (left posterior) aortic sinuses. There are wide variations with regard to the origin, course, termination and branching pattern of coronary arteries. The original description of coronary preponderance or dominance by Bianchi (1904) was based on the single criterion as to which coronary artery crosses the crux.[4] Accordingly, the commonest pattern was described as right dominant. The term 'dominant' is used to refer to the coronary artery giving off the posterior interventricular (descending) branch which supplies the posterior part of the ventricular septum and often part of the posterolateral wall of the left ventricle. In 'right dominance' the posterior interventricular artery is derived from the right coronary; in 'left dominance'it is derived from the left coronary artery. In the 'balanced pattern' branches of both arteries run in or near the posterior interventricular groove. The dominant artery is usually the right (60%).[5]

Even though the right dominant pattern is predominant, the left coronary artery is almost always considered more important than right coronary artery as it is the major source of blood flow to the left ventricle in almost all humans even in those with anatomical right dominance.[6] Left dominance and co-dominance (balanced) are generally considered to be normal variants with no particular prognostic significance. However, the relatively low prevalence of left and co-dominance may reflect a small biologic disadvantage relative to right dominance. It is possible that left and co-dominance may represent less well balanced circulation with more myocardium at risk.[7]

AIMS AND OBJECTIVES

The Present study aims to document the pattern of coronary dominance in cadaveric hearts, both adult and foetal, with an interest to correlate each pattern with coronary heart diseases, by relevant review of literature.

MATERIALS AND METHODS

The study of coronary arteries was undertaken in the Dept. of Anatomy, Govt. Medical College, Kozhikode. 60 hearts were utilized for the purpose, of which 30 belonged to adult cadavers mainly meant for undergraduate dissection and the remaining 30 were foetal hearts dissected out from stillborn full term fetuses. The fetuses were collected from the Institute of Maternal and Child Health attached to the Medical College and were preserved using 10% formalin by multiple injections and kept immersed in formalin till taken for dissection.

In adult cadavers, the thorax was opened , pericardium was incised to expose the heart in situ. In each heart, both coronary arteries were carefully dissected, starting from their origin. All the branches, both major and all visible minor, were carefully traced till their termination. In each heart, care was taken to identify the origin of posterior interventricular branch, whether from right coronary, left coronary (circumflex branch) or both. In all cases, posterior interventricular artery(arteries) was traced to termination. In each heart, the type of dominance, whether right, left or balanced pattern was determined, documented and photographed.

In foetus, the heart was exposed by opening thorax and pericardial cavity. Removed the heart by cutting superior and inferior venae cavae, pulmonary veins, arch of aorta and pulmonary trunk. In each heart the coronary arterial system was meticulously traced and pattern of dominance determined by the same method as in the adult cadaver.

RESULTS

The coronary artery which reaches the crux, crosses it and gives rise to posterior interventricular branch determines the dominance. On this criterion, dominance was determined in each of the 60 hearts studied. 53 hearts (88.3%) were found to be of 'right dominant' pattern as the posterior interventricular artery was arising from right coronary(Fig.1). In 5 specimens (8.3%), the circumflex branch of left coronary artery continued as the posterior interventricular branch thus showing the 'left dominant' pattern(Fig.2).

In 2 specimens (3.3%), both of which were foetal, the right coronary trunk and circumflex branch of left coronary artery reached the crux

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and both of them gave rise to posterior interventricular branch thus becoming 'balanced' pattern of coronary dominance (Fig. 3). The results were analysed irrespective of whether that of adult or foetal heart or whether that of male or female. The patterns of dominance in the present study are shown in Table 1.The results are compared with those of other authors in Table 2.

Table 1: Showing dominance pattern. Total No. of Hearts - 60

Dominance	No. of Hearts	Percentage (%)
Right dominance	53	88.4
Left dominance	5	8.3
Balanced	2	3.3

Table 2: Showing comparison of dominance pattern with other authors.

Authors	Right dominance	Left dominance	Balanced
Schelesinger (1940)	48%	18%	34%
James (1961)	90%	10%	_
Bezbaruah (2003)	76%	20%	4%
Kalpana (2003)	89%	11%	_
Ortale (2004)	62.50%	12.50%	25%
Kaimkhani (2005)	60.40%	15%	24.50%
Cademartiri (2008)	86.6%	9.2%	4.2%
Das (2010)	70%	18.57%	11.43%
Moore (2010)	67%	15%	18%
Vinitha (2015)	62%	22%	16%
Priyadharshini (2016)	84%	8%	8%
Present study	88.4%	8.3%	3.3%

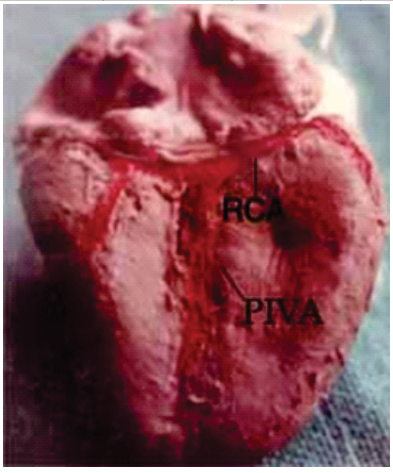

Fig. 1 Heart showing right dominance
RCA –Right coronary artery
PIVA-Posterior interventricular artery

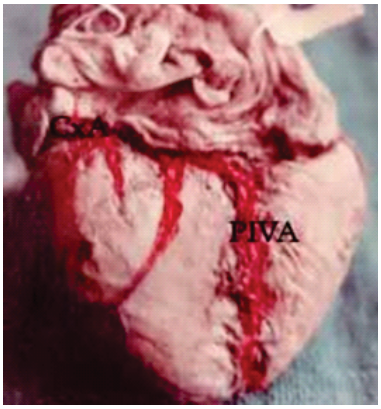

Fig.2 Heart showing left dominance
CxA- Circumflex artery

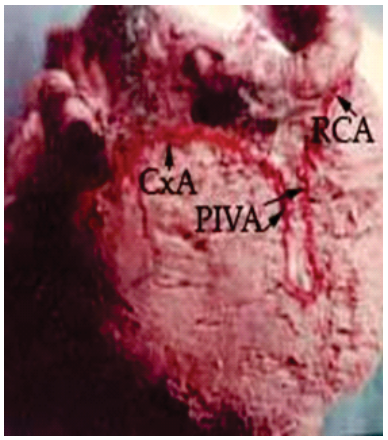

Fig .3 Heart showing balanced pattern

DISCUSSION

The variation in the origin of the posterior interventricular artery is expressed by the term ' coronary dominance or preponderance'. The term 'right or left dominance' was used to show which coronary artery irrigates the heart's diaphragmatic surface, based on the origin of the posterior interventricular artery. The origin of the artery from both right coronary and circumflex arteries was termed as 'balanced pattern'(Schlesinger,1940)[8].

Following the above criterion, in the present study, the incidence of right dominance was found significantly higher, followed by left dominance and then balanced pattern, the finding similar to that of Bezbaruah (2003)[9] , Cademartiri (2008)[10], Das (2010)[11], Vinitha (2015)[12], Priyadharshini (2016)[13] .Authors like James (1961)[3] and Kalpana (2003)[14], in their studies reported only right and left dominances, there being no balanced pattern. According to Schlesinger (1940)[8], Cavalcanti (1995)[15] ,Ortale (2004)[16] , Kaimkhani (2005)[17], Moore(2010)[18] , though the commonest pattern was right dominant, the balanced pattern was the second common.

The pattern of coronary artery dominance has much clinical relevance; the coronary blood flow volume in the right coronary/circumflex artery decides this significance. Patients with left dominance usually have only the left coronary artery to supply the majority of the myocardium and more than 90 % of coronary blood flow enters this vessel.

Left coronary dominance is a variant of the normal coronary anatomy in which the left circumflex artery reaches the crux and supplies both posterior descending and posterolateral branches.[19] Although right dominant circulation is more common in general population, both the coronary diseases and coronary artery variations are more common in individuals with left dominant circulation.[20]

Left dominance was found to have significantly higher mortality than right dominance and mixed types.[21] It was observed that the left anterior descending artery, in left coronary dominance , wraps around the apex of heart supplying major portion of the myocardium and angiographic interventions in such cases have important clinical significance. Lesions in left anterior descending artery would have more profound clinical importance in left dominant heart than right dominant [22].A proximal stenosis of the left coronary artery may cause more extensive ischemia and bad prognosis in the left dominant system than in the right.

Even though the origin of SA node artery is unrelated to coronary dominance, the origin of AV node artery is dependent on the dominance pattern. Dominance has important role in inferior infarcts of heart which can cause various degrees of atrioventricular block in approximately 30% of cases. The dominant right coronary

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artery usually supplies the AV node. Therefore an inferior wall infarct caused by occlusion of right coronary artery will have higher risk of AV block.[23]

Left or co-dominant coronary arterial circulation may represent less well balanced myocardial perfusion and thus confer worse prognosis in acute coronary syndrome especially for culprit lesions arising from the left coronary artery. Left and co-dominant patterns are associated with modestly increased post-percutaneous coronary intervention in-hospital mortality in patients with acute coronary syndrome.[7]

Vasheghani- Farahani et al[24], in their study demonstrates a relation between angiographic coronary artery disease severity and the involved arterial territory and dominancy patterns. The right dominant patients tent to have three- vessel disease, stenosis of more than 50% in right coronary artery and left circumflex territories, more than the left dominant patients. According to Murphy et al[25] patients with left dominance have a shorter left main coronary artery than patients with right dominance. The increased prevalence of a dominant left coronary arterial system in aortic stenosis suggests that this may be part of a developmental complex. They also have an increased risk of perioperative myocardial infarction if there is associated obstructive coronary artery disease.

In the study conducted by Veltman et al[26], it was found that in patients with ST-segment elevation myocardial infarction (STEMI), a left dominant coronary artery system is linked with higher risk of 30-day mortality and early reinfarction compared with right dominance. Ghaffari et al[27], in their study including 678 consecutive patients with an indication for coronary angiography, it was concluded that left coronary dominance was not associated with atherosclerotic involvement of left anterior descending ostium and ischemic mitral regurgitation.

Left coronary dominance has been shown to be associated with aortic valve disorders in different studies.[19,25] A recent postmortem analysis showed a decreasing prevalence of left dominance or co-dominant coronary system with the increasing age, suggesting a worse prognosis for subjects with these dominance patterns.[28] One explanation could be the larger myocardial area at risk in case of an acute myocardial infarction especially in cases with left main stem involvement.

In general, a dominant left circumflex artery has several acute angles in its course including at its origin and at its distal end where it becomes posterior descending artery. These acute angles lead to turbulence and shear stress during blood flow that, in turn, may enhance thrombus formation and platelet activity.[29] The acute angles and resultant turbulence and shear stress also contribute to the difficulty of left circumflex artery interventions.

CONCLUSION

The invasive cardiac procedures like coronary angiography, angioplasty and bypass surgery have become so frequent nowadays that a detailed knowledge of the anatomical pattern of coronary arteries including their anomalies, variations and dominance pattern has gained much relevance. The coronary dominance pattern is highly variable, though right dominance is found significantly higher in many studies. Coronary artery dominance influences the relative contribution of the two coronary arteries to the total left ventricular blood flow. A single coronary supply to the left ventricle, typical of patients with left dominance should be recognized as a high risk factor in coronary heart diseases. The left and co-dominant patterns may be considered as less well-balanced circulation with more myocardium at risk, rendering the patients more vulnerable. The significance of coronary dominance should be taken into consideration when treating conditions like acute coronary syndrome and dealing patients with percutaneous coronary intervention. Study of coronary dominance would be of use to cardiologists, cardiothoracic surgeons and interventional radiologists to predefine the abnormalities of the coronary arterial system before clinical procedures.

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