

Original Research Article

A CADAVERIC STUDY OF CORONARY DOMINANCE AND PREVALENCE OF MYOCARDIAL BRIDGES IN SOUTH INDIAN POPULATION

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ABSTRACT

Background: Cardiovascular disease is one of the leading causes of morbidity and mortality in the world. The aim of this study is to observe the branching pattern of left coronary artery with special attention to the origin and termination of the posterior interventricular artery(PIVA), to determine the coronary dominance and the occurrence of myocardial bridges over the anterior interventricular artery(AIVA). Myocardial bridging is a congenital anomalous condition in which a coronary artery takes a “tunneled” course under a “bridge” of overlying myocardium. The vessel is compressed in systole, resulting in angina, myocardial ischemia, acute coronary syndrome, left ventricular dysfunction, sudden cardiac death and arrhythmias.

Materials and Methods: This study was taken up at the Institute of Anatomy, Madurai Medical College with 60 heart specimens collected from the cadavers of the same Institute and from the Department of Forensic Medicine. The heart specimens of different age groups, sex and socioeconomic status were preserved in 10% formalin and studied by the conventional dissection method.

Results: Among the 60 heart specimens studied, left coronary artery was seen bifurcating in 62%, trifurcating in 32% and quadfurcating in 6%. Regarding dominance, right dominance with PIVA arising from right coronary artery was seen in 53 specimens (88.3%), left dominance with PIVA being the continuation of left circumflex artery(LCX) was seen in 5 specimens(8.3%) and PIVA was arising from both coronaries in 2 specimens(3.4%). Among the 5 left dominant specimens, PIVA was seen as a continuation of LCX artery in 4 and single whereas in 1 specimen the PIVA was seen to be double. With regard to termination of PIVA, it terminated in the middle of posterior interventricular sulcus(PIVS) in 2 specimens and at the junction of anterior 1/3 and posterior 2/3 of PIVS in the rest. Myocardial bridges were seen over anterior interventricular artery in 15 specimens (25%).

Conclusion: Right dominance is seen in majority of hearts followed by left dominance and the balanced pattern being the least. Presence of myocardial bridges was predominantly seen over AIVA.

KEY WORDS: Coronary dominance, posterior interventricular artery, myocardial bridges.

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INTRODUCTION

The branching structure of vascular system has been the subject of much discussion and debate since it was suggested that these systems have fracial architecture. Till date, selective coronary arteriography being the clinical gold standard

for evaluating coronary anatomy, knowledge of its morphology and its variations is essential for correct interpretation of angiographic data and for hemodynamic and surgical manipulations. Left coronary artery arises from the left posterior aortic sinus. The artery lies between the

pulmonary trunk and the left auricle emerging into the atrio-ventricular groove in which it turns left. Reaching the groove, the coronary artery divides into two or three branches. Anterior interventricular artery commonly described as its continuation, descends obliquely forwards and to the left in the interventricular groove. In 1/3 of specimens, it invariably reaches the apex to enter the posterior interventricular groove and passes ½ of the way along its length where it meets the terminal twigs of the posterior interventricular branches of the right coronary artery. The circumflex artery curves left in the atrio-ventricular groove continuing round the left cardiac border into the posterior part of the groove and ending left of the crux in most hearts but sometimes continuing as posterior interventricular artery.

Variations in the coronary arterial system mainly affect the diaphragmatic aspect of the ventricles and reflect the relative dominance of coronary arterial supply. The term dominant is used to refer to the coronary artery giving off posterior interventricular artery(PIVA) branch which supplies the posterior part of ventricular septum and often part of the posterolateral wall of left ventricle. The right artery is the dominant artery in 60% of hearts. On approaching the crux of the heart, the right coronary artery (RCA) normally produces upto 3 PIVA branches. The PIVA itself lying in the interventricular groove(IVG) may be flanked either to the right or the left or on both sides by these parallel branches. When the flanking vessels exist, branches of PIVA are small and sparse. The PIVA is occasionally replaced by left coronary branches. In right coronary dominance, the PIVA is derived from RCA; in left coronary dominance from left coronary artery (LCA). In the so called balanced pattern, branches of both arteries run in or near the posterior interventricular sulcus (PIVS).(Gray) [1]

MATERIALS AND METHODS

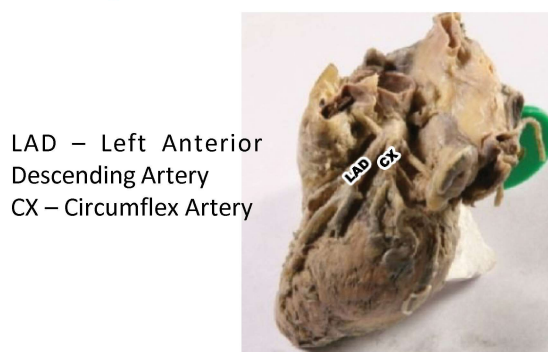
60 heart specimens used for the present study of branching pattern of left coronary artery and coronary dominance were obtained from the cadavers of Institute of Anatomy and Forensic department, Madurai Medical College with age, sex, socioeconomic status no bar. The heart

specimens were removed from the cadavers as per dissection method enunciated in the Cunningham's manual [2]. The specimens were preserved in 10% formalin solution. During the study, the visceral pericardium was stripped off the LCA issuing from the ascending aorta from the left posterior aortic sinus(LPAS). The left coronary artery it's origin, course and branches were traced as per Gray's text book of Anatomy with special note to the PIVA for the study of coronary dominance and the presence of myocardial bridges over the left anterior descending artery.

RESULTS

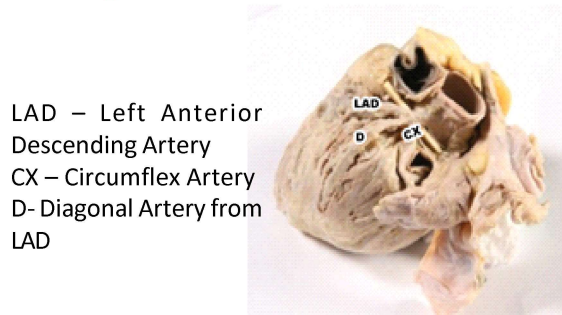
In this study, bifurcation of left coronary artery was seen in 62%, trifurcation in 32% and quadfurcation in 6%. Regarding dominance, right dominance was seen in 53 specimens and left dominance with left circumflex artery continuing as PIVA in 5 specimens. Among the 5 specimens, in 4, PIVA was found single whereas double PIVA was seen in one specimen. Balanced pattern with PIVA originating from both was seen in 2 specimens. With regard to its termination, it terminated in the middle of PIVS in two specimens and at the junction of anterior 1/3 and posterior 2/3 of PIVS in the rest. Myocardial bridges(MB) over anterior interventricular artery(AIVA) was seen in 15 specimens

Fig. 1: Bifurcation of left coronary artery.



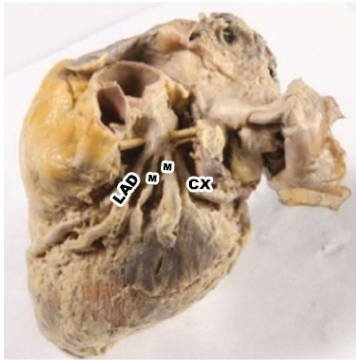
LAD – Left Anterior Descending Artery
CX – Circumflex Artery

Fig. 2: Trifurcation of Left coronary artery



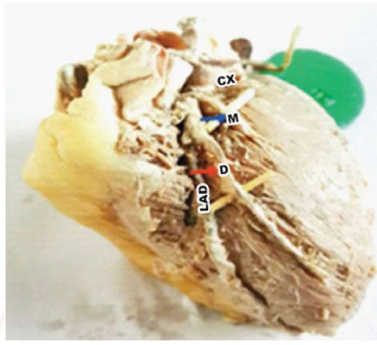
LAD – Left Anterior Descending Artery
CX – Circumflex Artery
D- Diagonal Artery from LAD

Fig. 3: Quadfurcation of Left coronary artery.



LAD – Left Anterior Descending Artery
CX – Circumflex Artery
M - Median Artery

Fig. 4: Bifurcation of Left Coronary artery with Median artery.



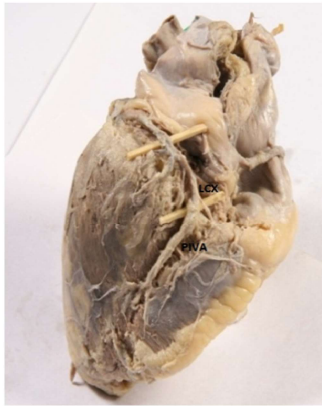
D - Diagonal Artery from LAD
M - Median Artery

Fig. 5: Right coronary dominance.



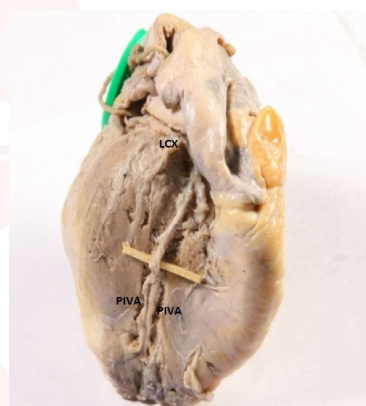
RCA – Right coronary artery
PIVA – Posterior interventricular artery

Fig. 6: Left coronary dominance.



LCX – Left Coronary artery
PIVA – Posterior interventricular artery

Fig. 7: Left dominance with double PIVA.



LCA – Left Coronary artery
PIVA – Posterior interventricular artery

Fig. 8: Co-Dominance.



PIVA – Posterior interventricular artery
LCA – Left coronary artery
RCA – Right coronary artery

Table 1: Branching pattern of left coronary artery.

Number of branches	Baptista [4]	Cavalcanti [5]	Reig&Petit [6]	Lujinovic [7]	Present study
Bifurcation	54.70%	60%	62%	65%	62%
Trifurcation	38.30%	38.18%	38%	35%	32%
Quadfurcation	6.70%				6%

Table 2: Percentage frequency of coronary right, left and co-dominance in various studies.

Sl.no	Author & Year	Rt Dominant %	Lt dominant %	Co dominant %
1	Schlesinger(1940) [11]	48	18	34
2	Cavalcanti JS(1995) [5]	82	12	—
3	Kalpna R(2003) [15]	89	11	—
4	Venkateshu KV(2005) [16]	68.75	16.66	14.58
5	Das H(2010) [17]	70	18.57	11.43
6	Reddy V(2013) [18]	86.25	11.25	2.5
7	VinithaG(2015) [19]	62	22	16
8	Madhushree Pal(2016) [20]	70	22	8
9	Arindom Banerjee(2016) [21]	76.67	16.67	0.07
10	Present study	88.3	8.3	3.4

Table 3: Myocardial bridges over AIVA-occurrence.

Study of myocardial bridges over AIVA by			
Dissection method	%	Angio study	%
Geiringer (1951) [27]	23%	Kramer (1982) [36]	12%
Penther et al (1977) [35]	17.60%	Irvin (1982) [37]	7.50%
Present study	15%	Angelini (1983) [13]	5.50%

DISCUSSION

According to Davidson's Text Book[3], regarding the division of main trunk of left coronary artery, the single main stem of left coronary artery within 2.5 cm of its origin divides into Left anterior descending and circumflex arteries. The division of the common trunk into anterior interventricular, circumflex and median or intermediate artery is a variation found in between 25-40% of cases . A number of studies have been undertaken by different authors regarding branching of LCA with varying percentages which are shown in (Table -1) [4,5,6,7]. The most frequent type of division of the main trunk of left coronary was bifurcation & arteria mediana was detected in seven hearts (Cent Kilic) [8]. In 15% cases a third branch arises in between left anterior descending & circumflex known as the ramus intermedius or intermediate branch. This intermediate branch behaves as a diagonal branch of the circumflex. Incidence of ramus would vary between 10-30% depending upon the series. The peculiarity of this vessel is it does not run in anatomical groove. It simply slides over the free surface of left ventricle (Venkatesan) [9]. In this study, bifurcation of LCA was seen in 62% (Fig-1), trifurcation in 32 % (Fig-2), quadfurcation in 6% (Fig-3) In this study, median artery was seen arising at the junction of its bifurcation in 11 specimens.(Fig-4) Among the various types of coronary circulation, Hettler[10] has defined the following types: left coronary dominance, right coronary dominance and codominance. The term dominant coronary artery was introduced by Schlesinger[11] who used it to indicate the areas of heart supplied by each artery. The origin of PIVA is one of the parameters on which Schlesinger system of arterial dominance is based. In rare cases, the PIVA is entirely replaced by a dominant long AIVA (Levin & Baltaxe,)[12].

An unusual coronary variant of PIVA originating from the LAD has also been reported. In most

cases, PIVA terminates halfway between the crux and the apex (Angelini et al)[13] who reported single PIVA in 70% cases and double PIVA accompanied by right or left branch in 6% & 10% cases replaced by a left coronary artery. In this study, LCA dominance was found in 8.3% of specimens. Various studies by different authors on coronary dominance is shown in table 2 [11,5,14,15,16,17,18,19,20]

Dominance pattern of heart has an important clinical significance as the extent of myocardial perfusion area is associated with coronary blood flow volume(Sakamoto[21]. Rt dominant patients tend to have 3 vessel disease, stenosis of more than 50% in RCA & LCX territories more than Lt dominant patients (Vashegani-Farahani)[22]. According to Michele et al [23]ECG study, in approximately 70% of the population, the Posterior Descending Artery(PDA) originates from RCA. It is co-dominant in 20% meaning both the RCA and LCX feed the PDA and in 10% are left dominant meaning the LCX alone supplies.

In majority individuals PIVA originated from RCA with right dominance(Sabnis,[24] reported the origin of PIVA branch of(b/o) RCA in 76.8%, b/o LCA in 18.5% and from both in 4.6%. He also observed parallel branches(double, triple) of PIVA in his study. Accord to Gray, in 70% of cases PIVA is single and in 6% it is double. Cavalcanti[5] showed left dominance in11% of his study. In left dominance, the PIVA originated in the Left circumflex artery(LCX) artery in 10-15% cases(Ludinhhausen[25] In this study, Right dominance was seen in 88.3 % (Fig-5), left dominance in 8.3 % (Fig- 6) % with a double PIVA arising from LCA in one specimen.(Fig-7) and co dominance in 3.4 % (Fig-8).

A Myocardial bridge(MB) is defined as an intramyocardial segment of an epicardial coronary artery. Perhaps first described by Reyman[26] in 1737, one of the first description of MB in the modern literature was published by Geiringer[27] in 1951. Geiringer noted that although this trivial and slight deviation from normal had been largely overlooked as a potential etiology for pathology, this altered anatomic course might influence the development of atherosclerosis. In an unselected human autopsy series of 100 patients, he

identified MB in 23 hearts(Vivian)[28].

MB has been observed to provoke symptoms in association with strenuous physical activity and hypertrophic cardiomyopathy; more recently bridging has been thought to cause coronary vasospasm. Autopsy findings tend to reveal higher incidence of MB than do angiography series but both show an almost uniform predilection for LCA distribution especially in regard to bridging that manifests itself clinically.(Trung) [29].

MB, both superficial and deep commonly involved LAD. Traditionally, conventional coronary angiogram(CCA) has been considered the gold standard for detection of systolic compression of tunneled segment. However, the depiction rate of MB with CCA is only 0.5 - 4.5% of general population when compared to the incidence of MB in autopsy studies(15-85%)(Jin Ho Hwang) [30]. MB may be a normal variant, however a tunneled LAD is reported in approximately 5 % of field deaths among athletes. (Anand Rahalkar)[31]

Marios Loukas[32] showed that the presence of myocardial bridges(MB) appeared to be related to coronary dominance especially in left coronary circulation. 66.6% of the hearts with bridges were left dominant.MB occurs most often over the Anterior Interventricular branch of LCA & its diagonal branch (Sally Allwork [33]. Ilia et al[34] concluded that lesions in LAD would have profound clinical importance in left dominant heart than right. Study on myocardial bridges by various authors by different methods are depicted in Table –3[13,27,35,,36,37].

CONCLUSION

Failure to recognize variations in coronary arterial origin can prolong arteriographic procedures and lead to errors in interpretation of coronary artery anatomy and pathology. The performance of high quality coronary arteriography safely defining each and every coronary stenosis in an optimal view is an important measure of an operator's skill in cardiac catheterization which emphasizes the importance of complete knowledge of coronary artery anatomy & dominance. This study done in South India would provide a guide to the prevalence

of right and left coronary dominance and myocardial bridges in our population.

Conflicts of Interests: None

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