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A STUDY OF CORONARY DOMINANCE USING SILICON CASTS & ITS CLINICAL SIGNIFICANCE.

Anatomy

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ABSTRACT

Introduction: Coronary artery disease has become one of the major causes of death in the recent years in developing countries like India. The coronary dominance pattern varies in different regions & populations. Our aim is to determine the coronary dominance using low cost silicon casts among the south Indian population & to determine its clinical significance.

Methodology: In the present study 110 adult human cadaveric hearts (90 males & 20 females) were utilized & silicon material was injected into each coronary artery & cast was removed. The origin of posterior inter-ventricular artery was taken as the criteria for determining the dominance pattern.

Result: Out of 110 hearts, 92 (83.63%) had right dominance, 12 (10.90%) had left dominance & only 6 (5.45%) had co-dominant patterns.

Conclusion: Knowledge of coronary dominance will help the cardiologist & cardiac surgeons to evaluate and plan treatment of patients with unstable angina & myocardial infarction among the south Indian population. This is a new innovative technique wherein silicon is being used to study the vascular pattern, silicon was found to have more advantages than resins. Silicon casts can be utilized to study various vascular patterns of different viscera in intricate details by the future researchers & academicians in future.

KEYWORDS

Coronary arteries, coronary dominance, silicon casts.

INTRODUCTION:

The heart is supplied by the right & left coronary arteries, the left coronary artery (LCA) divides into left anterior descending artery & circumflex artery to supply blood to the anterior, posterior & lateral aspect of the heart. The right coronary artery (RCA) divides into posterior descending artery and acute marginal artery, it goes to supply the right ventricle, right atrium, sinu-atrial node, atrio-ventricular node and parts of left ventricle according to Standring S et al. (2005)[1]. Das H et al. (2010) [2] stated that the origin of posterior inter-ventricular artery (PIVA) from either the left coronary artery or right coronary artery trunks determines the basis of the term "dominance". If the PIVA originates from left circumflex artery (branch of LCA) then it's coined as "left dominance" & if it arises from RCA then it's termed as "right dominance", & suppose it arises from both the left circumflex artery & RCA then it's coined as "co-dominance" or "balanced pattern" [2]. Datta AK. (2008)[3] reported that in 70% of cases the PIVA arises from the RCA and only 10% from the LCA. The LCA provides nutritional supply to the entire left ventricle & left ventricular septum, therefore, people suffering from coronary diseases leading to LCA obstruction may produce output failure of systemic circulation. 20% of cases show co-dominance. These are the individuals that are least affected by coronary disease [3]. Studies conducted by Falci Jr R et al. (1996) [4] & Knaapen M et al (2013) [5] showed that left dominance was associated with high mortality caused by acute MI & arteriosclerosis[4,5]. Goldberg et al. (2007)[6] observed that Coronary artery disease has become a major cause of death especially in developed countries and now slowly showing a higher incidence in developing countries as well due to changes in the life style, adopting to sedentary work style & urbanization[6]. Amin K et al.(2004) [7] stated in his study that the coronary dominance is related to inferior wall infarcts which can cause severe atrio-ventricular blocks in 30% of cases, the dominant RCA supplies the AV node, hence, inferior wall infarcts due to RCA occlusion has a higher risk of AV blocks when compared to the LCA occlusion [7]. Determination of coronary dominance has been studied by various authors using different methods like angiographic studies, corrosion cast techniques & dissection method, our study was performed using a newer innovative low-cost luminal cast technique wherein silicone material is being used for the first time in India for studying the coronary arterial patterns & dominance. Coronary dominance was found to vary in different population; our present study was aimed to detect coronary dominance among south Indian population using newer silicon cast method. Coronary dominance is of great importance for cardiologist & cardiac surgeons when it comes to selecting a perfect modality of treatment since the left dominance is very closely related to coronary artery disease.

MATERIALS & METHOD:

This study was carried out at JSS Medical College after taking Ethical clearance from the JSS Ethical Committee of JSS Academy of Higher Education & Research. A total of 110 human hearts freshly collected from the mortuary of Forensic departments of JSS Medical College & Mysore Medical College & Research Centre, Mysore for the duration of 2 years (2017-2019).

Exclusion Criteria: Hearts with history of trauma, cardiac surgeries, scarring due to myocardial infarction & cardiomegaly were not utilized for this study.

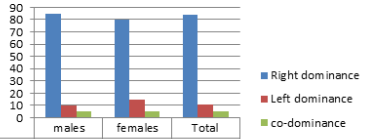
Each specimen was immediately washed thoroughly in running tap water to remove all the blood clots & debris from the major vessels of the heart. The aortic trunk was incised vertically and the three aortic sinuses were identified along with their coronary ostia. The origin of RCA & LCA was identified & variations noted. A cannula was inserted into each ostium & tied firmly to the trunk; the nozzle of the silicon gun was attached to cannula & the cartridge was adjusted and the silicon material was slowly injected into each ostium. The heart was then immersed in concentrated HCl for 24hours until the cardiac tissue got corroded completely. All the cardiac debris was removed & the silicon cast was carefully separated & dried under sunlight for 2-3days. All the branches were studied & data collected. Types of coronary dominance & the origin of PIVA was noted & statistically evaluated.

RESULTS:

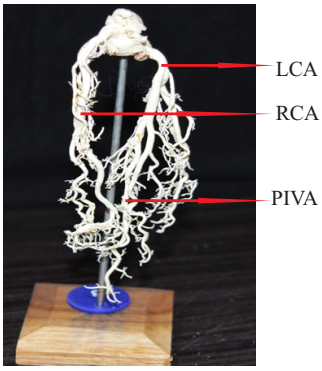
In our study 110 human hearts were utilized, 90 males & 20 female hearts. 76 out of 90 male hearts showed right dominance (84.44%), whereas in females 16 out of 20 showed right dominance (80%) and totally 92 out of 110 specimens showed right dominance (83.63%).Only 9 out of 90 male hearts showed left dominance (10%) & 3 out of 20 hearts among females (15%) & totally 12 out of 110 (10.90%).With regards to co-dominance 5 out of 90 males (5.55%) & 1

out of 20 female hearts (5%) showed co-dominance, totally only 6 out of 110 (5.45%) showed co-dominance (Refer Figures 1, 2 & 3) . The data was analyzed using descriptive statistics to calculate the percentages. Both the RCA & LCA were arising from their respective coronary ostia, no anomalous origin of the coronary arteries was observed. Multiple accessory coronary ostia were observed originating from the right posterior aortic sinus in close relation to the right coronary ostia. No inter-coronary anastomoses were observed in this study.

Figure 1: Gender based comparison of coronary dominance pattern (%) .

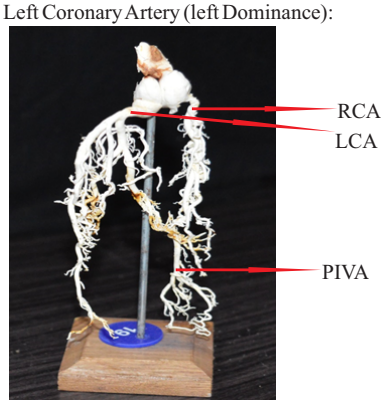


	males	females	Total
Right dominance	84.44	80	83.63
Left dominance	10	15	10.9
co-dominance	5.55	5	5.45



LCA: Left Coronary Artery ; **RCA:** Right Coronary Artery; **PIVA:** Posterior Inter-ventricular Artery.

Figure 2: Silicon Cast Showing The Posterior Inter-ventricular Artery Arising From The Left Coronary Artery (left Dominance):



LCA: Left coronary artery ; **RCA:** Right coronary artery; **PIVA:** Posterior inter-ventricular artery.

Figure 3: Silicon Cast Showing The Posterior Inter-ventricular Artery Arising From The Right Coronary Artery (right Dominance):

DISCUSSION:

Ahmed et al. (1972) [8] used plastic resin in 94 hearts & observed right dominance in 70.2% of cases [8]. Didio LJ & Wakefield TW (1975) [9] observed right dominance in 73.5% of cases in 98 hearts after injecting gelatin mixed with a contrast media[9]. According to Tsikaras et al. (1985)[10] vascular anatomy of any viscera can be studied by injecting latex resins & polymerizing substances (vinylite, acrylic, etc.) followed by corrosion of organ tissue using acids & by angiographies. These methods can provide small branching details & anastomosis but direct anatomical relationship cannot be identified. Advantages of the acrylic resin casts are that they are less expensive, easily available, fast setting & good visualization of small calibers of each branch can be well appreciated & measured [10].The silicon material that we have used for this study has more advantages than the resin like it's less expensive; easily available, fast setting, good visualization of small caliber vessels, casts are easy to handle, non-breakable, flexible, resilient to strong acid or temperature, high corrosion resistant, no prior formalin preservation is required & can be preserved for a longer duration when compared to the resin casts which are very delicate and can break easily. The use of silicon casts to study the coronary vasculature has not been found in the previous literature hence we assume that this was the first time we have used the silicon casts to study the coronary arteries among the south Indian population. Abuchaim DCS et al. (2009) [11] used acrylic resin cast in 25 hearts to study the vascular pattern of dominance & found that 18 molds (72%) were showing right dominance, 5 molds (20%) had left dominance & only 2 molds (8%) were co-dominant [11](Refer Table:1). Reddy JV & Lokanandham S (2013) [12] used 6% polyvinyl acetate resin for vascular casts in 80 hearts, he observed right dominance in 86.25%, left dominance in 11.25% and co-dominance in 2.5% of cases [12]. Recently, Shanmugam S & Hottigoudar YS (2019) [13] used an innovative method to study the coronary venous tree by using a polyurethane foam, the major disadvantage they encountered was breakage of the cast & tedious procedure [13]. Dakhane PS & Pakhale SV (2015)[14] studied 1000 hearts for coronary dominance using angiography method in Jalgaon region of North Maharashtra, North India & observed that 82.4% showed right dominance,13.3% had left dominance & only 4.3% of the subjects showed co-dominance [14] (Refer Table:1).These results of north India population is similar to our results observed among the south Indians. Apsara MP & Rajesh S (2017)[15] conducted study on 50 hearts using dissection method & observed that 38 (76%) showed right dominance, 10 (20%) had left dominance & 2 (4%) showed co-dominance [15]. Kapil H et al (2014) [16] in his study done at Belgaum, South India in 75 hearts, 61.34% had right dominance, 24% showed left dominance & 14.67% had co-dominance [16]. Schlesinger MJ (1940) [17] studied 225 hearts by dissection method and found that right dominance was 48%, but the co-dominance was more 34% compared to the left dominance which was only 18% [17].Similarly, Cavalcanti JS (1995) [18] studied 100 hearts by dissection method and found that right dominance was 69.09%, whereas, the co-dominance was more 19.09% than the left dominance 11.82% [18]. (Refer Table: 1). James TN (1961) [19] did not find any co-dominance pattern and right dominance was 90% & left dominance was 10% only [19]. Kalpana R (2003)[20] by dissection method in 100 hearts found that 89% was right dominance, 11% was left dominance and there was no co-dominance [20]. Hirak Das et al. (2010)[21] by dissection method noticed 70% right dominance, 18.57% left dominance & 11.43% co-dominance patterns[21]. Barambe VK & Arole VU (2011)[22] stated in their studies that four parameters are required to assess the coronary artery dominance pattern. Dominant vessel is that which: (i). gives origin to posterior inter-ventricular branch; (ii) crosses the crux cordis; (iii) giving origin to atrio-ventricular nodal artery and (iv) giving origin to sinu-atrial nodal artery [22]. Darmender P et al (2014) [23] observed that there is an association between the coronary dominance and sinu-atrial nodal artery. According to him the sinu-atrial nodal artery was a branch of the dominant coronary artery [23]. Another interesting observation was made by Chethan P et al (2014) [24], he mentioned that there was a relationship between the coronary dominance and left coronary artery trunk division (bifurcation, trifurcation & tetrafurcation) he reported that tetrafurcation was seen only in right dominant hearts [24].This observation was seen in our study also wherein the left coronary artery tetrafurcation (3.63%) was seen only in the right dominant hearts & that the highest prevalence of bifurcation of left coronary artery (62.72%) was irrespective of dominant pattern .Murphy ES et al (1977) [25] noticed a significant association between the left coronary artery dominance and aortic stenosis [25].Morris GM et al (2010) [26] suggested that patients with aortic stenosis showed a close association with left dominance & there was a reduced prevalence of left dominance among the patients with mitral regurgitation [26].Furthermore, Pal M et al (2016)[27] stated that the degree of severity of myocardial infarction is more in left dominant hearts & may cause death due to left coronary artery obstruction [27]. Boucek RJ et al (1980)[28] in their seminal article stated that the left predominance in human heart is phylogenitically more primitive than other patterns [28].

Table 1: Comparison Of Coronary Dominance With Previous Studies:

Author & Year	Type of study	RD %	LD%	CD%
Schlesinger MJ,1940 [17]	Dissection	48	18	34
James TN,1961 [19]	Dissection	90	10	0

Cavalcanti JS,1995 [18]	Dissection	69.09	11.82	19.1
Kalpana R, 2003 [20]	Dissection	89	11	0
Abuchaim DCS et al,2009 [10]	Resin cast	72	20	8
Hirak Das et al,2010 [21]	Dissection	70	18.57	11.4
Reddy VJ et al,2013 [11]	Resin cast	86.25	11.25	2.5
Kapil A et al,2014 [16]	Dissection	61.34	24	14.7
Dakhane PS et al,2015 [14]	Angiography	82.4	13.3	4.3
Apsara MP et al,2017 [15]	Dissection	76	20	4
Present study	Silicon cast	83.63	10.9	5.45

RD: Right dominance; **LD:** Left dominance; **CD:** Co-dominance.

CONCLUSION:

With the increasing rate of coronary artery diseases in south India, it has become important to study the coronary dominance patterns among south Indian population, since it has been established that the coronary dominance varies with different regions & population. The order of dominance in our study was the right dominance 83.63%; left dominance 10.90% & co-dominance 5.45%. Silicon casts are a boon to the anatomy researchers & academicians who would like to study the vascular patterns of various viscera in detail as it has many advantages over the resins which are commonly used. Such an innovative technique can be adopted for further research of vascular studies.

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NO CONFLICT OF INTEREST.

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