

Research Article - Basic and Applied Anatomy

A study on coronary dominance and luminal diameters of major coronary arteries in cadaveric human hearts of the Maharashtra population

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Abstract

The study was undertaken to assess the coronary dominance and variations in luminal diameters of major coronary arteries and to compare the relation between the coronary dominance and variation in luminal diameter and between coronary dominance and number of vessels measuring less than 2.5 mm in diameter, in 75 cadaveric human hearts obtained from the Department of Anatomy from the various medical colleges of western Maharashtra, India. Out of 75 hearts, 58 (77.33%) showed right dominance, 14 (18.67%) showed left dominance and 3 (4%) showed codominant pattern. No significant difference was noted in the luminal diameters of coronary arteries (right coronary artery, marginal artery, posterior interventricular artery, left coronary artery, anterior interventricular branch, circumflex branch) among the dominance type. It was also observed that 63 hearts (84%) showed more than 2 arteries measuring less than 2.5mm in diameter. To conclude, a majority of the population has a right predominance and hence the chances of suffering from coronary artery disease are relatively less, but however 84% of the sample under study had more than two coronary arteries measuring less than 2.5 mm in diameter out of the 6 arteries studied, thus increasing susceptibility of thrombosis in these arteries and therefore increasing the chances of myocardial infarction.

Key words

Right dominance, left dominance, codominance, posterior interventricular artery.

Introduction

Coronary heart disease (CHD) is a leading cause of mortality and morbidity in developed countries. The prevalence in India had increased rapidly from 1% in 1960 to 9.7% in 1995 and it is further increasing year after a year. This raise in the disease burden may be due to changing lifestyle, urbanization and sedentary lifestyle (Mandal et al. 2009). Hence an in-depth study of the coronary arteries has become important for better understanding the coronary pathophysiology and better management of coronary heart diseases like myocardial infarction and angina pectoris.

The heart is supplied by two coronary arteries (right and left) and their branches. Coronary arteries are known for their wide variations with regard to origin, size, course, termination and branching pattern (Das et al., 2010). Knowledge of this vari-

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ant anatomy and anomalies of coronary circulation is an increasingly vital component in the management of congenital and acquired heart diseases (Kalpana, 2003).

The origin of the posterior interventricular artery (PIVA) from either of the two coronary trunks forms the basis for the use of the term "dominance". The origin of PIVA from the left circumflex artery (branch of left coronary trunk) was termed "left dominance", that from the right coronary artery was termed "right dominance" and that from both the left circumflex artery and right coronary trunk was termed "codominance" or "balanced pattern dominance" (Das et al., 2010).

The diameter of the coronary vessels has been a topic of interest for the researchers, because of its implications in the mortality and morbidity and because of the fact that vessel size has important therapeutic implications, as the knowledge of the approximate normal coronary artery diameter at any particular location alongside its course becomes the first approach in estimating the severity of the coronary artery disease (Dhawan and Bray, 1995; Ilayperuma, 2011).

Many studies have been done in the past to determine the patterns and dimensions of coronary vessels with varying results (MacAlpin et al., 1972; Saikrishna et al., 2006). The wide divergence in the epidemiological records on the incidence and prevalence of cardiovascular disease in different countries and regions has vital therapeutic implication concerning various coronary intervention like coronary angioplasty and coronary artery bypass grafting. For this reason, an extensive study on the anatomic variations of coronary artery in the population of the region is necessary, since very little is known about the coronary artery variations in the population in the state of Maharashtra, India. The following study was therefore undertaken with the aim of studying the normal variation in predominance (right, left or balanced pattern) and the luminal diameters of the coronaries (right coronary artery, marginal branch, posterior interventricular branch, left coronary artery, anterior interventricular branch, circumflex branch) in cadaveric human hearts of Maharashtra population.

Material and methods

A cross sectional study was undertaken on 75 human cadaveric hearts without obvious pathology and atherosclerosis, of all age groups and both sexes. The hearts were labeled and preserved in 10% formalin. The coronary arteries were dissected and were followed till their termination by removing the pericardium and the epicardial fat. The arteries were painted using oil paints for better identification. The dominance pattern was then noted by determining the origin of the posterior interventricular artery. The major coronary arteries as defined in the introduction were carefully incised at their origin and the luminal diameter was measured using a digital Vernier caliper accurate up to 0.02 mm. The data obtained were then tabulated and analyzed statistically by computing mean values and standard deviation and evaluating differences by Kruskal Wallis and Student's *t* tests. $P < 0.05$ was considered significant.

Results

The most common pattern is right predominance followed by left predominance and then balanced pattern (Table 1). Eighty-four per cent of the examined hearts had

Table 1. Distribution of cadaveric hearts according to coronary artery predominance.

Dominance	Number	Percentage
Right dominant	58	77.33
Left dominant	14	18.67
Codominant	3	4.00
Total	75	100.00

Table 2. Distribution of cadaveric hearts according to the number of major coronary arteries with lumen diameter less than 2.5 mm.

Number of arteries with less than 2.5 mm luminal diameter	Number of hearts	
	Number	Percentage
One	01	1.33
Two	11	14.67
Three	19	25.33
Four	22	29.33
Five	20	26.67
Six	02	2.67
Total	75	100.00

Table 3. Luminal diameter of the coronary arteries according to dominance (mean ± standard deviation; no difference was significant).

Arteries	Lumen diameter (mm)		
	Right dominance	Left dominance	Codominance
Right coronary artery	2.85 ± 0.88	2.60 ± 1.20	2.01 ± 0.60
Marginal artery	1.24 ± 0.46	1.25 ± 0.80	1.56 ± 0.40
Posterior interventricular branch	1.87 ± 0.72	1.59 ± 0.74	1.69 ± 0.22
Left coronary artery	3.71 ± 1.15	3.46 ± 1.02	5.24 ± 1.62
Anterior interventricular branch	2.35 ± 0.85	2.49 ± 0.70	2.36 ± 0.46
Circumflex branch	1.93 ± 0.75	2.16 ± 0.92	2.72 ± 0.32

more than two coronary arteries less than 2.5 mm in diameter (Table 2). No significant relation was found between the dominance pattern and the luminal diameter of the coronary arteries (Table 3). Coronary arteries in Maharashtrian population were significantly narrower than Indo-Asian and Caucasian population, as estimated in previous studies of other authors (Lip et al., 1999), except that this did not hold true for the left and right coronary arteries in comparison with Indo-Asian population (Table 4).

Table 4. Comparison between coronary artery diameter (mean \pm standard deviation) of Maharashtra population (this study) and that of other populations as measured by Lip et al. (1999). Comparisons were

Artery	Lumen diameter (mm)			Lumen diameter (mm)	
	Present study (n = 75)	Indo-Asians (n = 39)	P	Caucasians (n = 77)	P
Left coronary artery	3.72 \pm 1.18	3.98 \pm 0.67	not significant	4.44 \pm 0.91	<0.001
Anterior interventricular branch	2.38 \pm 0.80	3.22 \pm 0.56	0.001	5.53 \pm 0.69	<0.001
Circumflex branch	2.01 \pm 0.78	3.01 \pm 0.66	0.001	3.17 \pm 0.63	<0.001
Marginal artery	1.26 \pm 0.54	1.96 \pm 0.53	<0.001	2.08 \pm 0.62	<0.001
Right coronary artery	2.77 \pm 0.94	2.98 \pm 0.63	not significant	3.35 \pm 0.69	<0.001

Discussion

Coronary heart disease is the leading cause of death in the developing countries and one of the causes is anomalous origin of coronary arteries (Kaur et al., 2012). Hence, clinicians and anatomists have been examining coronary artery variations for a long time. In particular, from the 1960s, when the use of selective coronary angiography began, the number of investigations on this topic has increased. However, there is still no consensus on the normality or abnormality of coronary arteries. While it is generally accepted that the human heart has two main coronary arteries (right and left), some claim that the condition of possessing three or four coronary arteries is normal (Angelini, 1989). In general, coronary artery variations are regarded as major or minor, important or unimportant. Minor anomalies are not clinically evident and are usually accepted as normal changes. The major anomalies that are accepted as variations are reported in less than 1% of the general population (Angelini, 1989). Hence, knowledge of these normal variations is important for cardiothoracic surgeons and radiologists while performing therapeutic and diagnostic procedures.

In the present study the most common form of coronary circulation was found to be right dominance followed by left dominance and then codominance, which is in accordance with the study done by Das et al. (2010) in population of Assam indicating that there are no regional variations as far as the dominance pattern is concerned.

There was lack of adequate description of the caliber of normal coronary arteries, prior to the middle of the 20th century. Later several studies were conducted. The treatment mainly depends upon the size of the coronary artery during the management of coronary artery disease, since smaller arteries affects outcome in procedures such as balloon angioplasty and stenting, and may cause anastomotic difficulties during bypass grafting (Abrams, 1982; Zindrou et al., 2006). It has also been reported that patients with small vessels are at a higher risk of having an adverse outcome following coronary stent placement due to higher incidence of re-stenosis (Elezi et al., 1998). There is evidence that acute or subacute stent occlusion or thrombosis is more common in vessels less than 2.5 mm in diameter. On smaller caliber arteries, atheromatous disease may have more severe effect, since a moderate stenosis in a 2.5 mm wide vessel would have more effects on flow than the same degree of stenosis

in a larger vessel (Lip et al., 1999). Hence, precise knowledge of the expected normal luminal diameters of major branches of coronaries is the first step towards developing a quantitative estimate of the severity of coronary artery disease.

The luminal diameter of the coronary arteries was found here to be significantly smaller when compared with Caucasian and Indo-Asian populations except for the left and right coronary arteries which were found to be similar to those of Indo-Asian population. This can be due to the lower stature of the Maharashtrian than the Caucasian population (Lip et al., 1909). In addition, this study did not establish any significant relation between the luminal diameters of the coronary arteries and the dominance pattern, in contrast to Dhakal et al. (2015), indicating that there should be other factors responsible for the higher susceptibility of left dominant subjects to coronary artery disease, which require further extensive investigation to be identified.

Based on the results of this study, it can be proposed that Maharashtrian population has an increased risk of coronary artery disease because a vast majority (84%) of the population has coronary arteries less than 2.5 mm in diameter, which would predispose to occlusion.

Acknowledgement:

The author (Nihal.S.Kiran) expresses sincere gratitude towards the Short Term Studentship programme initiated by the Indian Council of Medical Research for providing valuable insight, guidance and support for the completion of the project (grant No: 2016-02639).

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