PATTERN OF CORONARY ARTERIAL DISTRIBUTION AND ITS RELATION TO CORONARY ARTERY DIAMETER

Zahid Ali Kaimkhani, M. Moazzam Ali, Azhar M. A. Faruqi*

Department of Anatomy, Ziauddin Medical University and *Department of Cardiology, National Institute of Cardiovascular Diseases, Karachi

Background: This study was carried out to determine the pattern of coronary arterial distribution and its relation with coronary artery diameter in adult Pakistani population as demonstrated by selective coronary angiography. **Methods:** Consecutive series of 220 adult subjects who underwent diagnostic coronary angiography at National Institute of Cardiovascular Disease (NICVD) between May 2000 and December 2000 were studied. Patients whose age was more than 18 years, with no apparent disease in the proximal arterial segment, proximal artery and tip of the catheter in the middle of the frame and catheter of a No. 6 French size of same manufacturer used were included in this study. Patients who were given vasodilator before or during the procedure, angiograms showing complete proximal occlusions or ectatic arteries were excluded. **Results**: Sixty percent subjects had right dominance pattern of which 78.1% were male and 21.8% female. By contrast 15% had left coronary dominance, of which 78.7 % were male and 21.2% female. Where as, 24% patients had co-dominant (balanced) circulation with 83.3 % male and 16.6 % female. In patients with left dominant pattern, the mean diameter of the right coronary artery (RCA) was significantly smaller ($p<0.001$) as compared to dominant right or co-dominant pattern. Where as in patients with right dominant pattern, the mean diameter of the circumflex (CX) artery was significantly smaller ($p<0.001$) as compared to dominant left. **Conclusion:** The coronary arterial distribution in Pakistani population is not significantly different from that given in the literature and the diameter of the RCA and the CX artery are significantly affected by dominance pattern.

Key words. Coronary anatomy, dominant pattern, diameter, angiography, Pakistani population.

INTRODUCTION

The introduction of selective coronary arterial catheterization by Sones and Shirey[1] made possible the delineation of various forms of coronary arterial anatomy in patients. Many different studies have been conducted to describe various patterns of coronary artery distribution on the inferior surface of the left ventricle.[2-4] Haller, cited by Chuadry[4] observed a fairly accurate account of the coronary arteries of human heart in 1811. He observed that right coronary artery (RCA) was larger than the left. Bianchi in 1904, cited by Chuadry[4], first described what has come to be known as coronary artery dominance. According to his finding 10% of cases had right dominance,17% cases were left dominant ,where as 73% were co-dominant. Spaltcholz in 1924, cited by Chuadry[4] also studied the dominance of coronary arteries. His findings were similar to that of Bianchi. Schlesinger[2], however, reported that 48% of his sample had right–sided dominance, while 18% had left-sided dominance and 34% co-dominance. He was also the investigator who clearly described the criteria for arterial dominance. According to his criteria (which are still being followed) the artery that gives rise to the posterior descending artery (PDA) or supplies the posterior part of the interventricular septum and the crux cordis[5] is designated as dominant artery. The pattern is co-

dominant if the above areas are supplied by both[4-7] left and right coronary arteries. Clinical angiographic studies have documented an association of coronary dominance pattern and valvular heart disease[8,9]. Ilia et al investigated the relation between the length of the left anterior descending (LAD) and coronary dominance.[10] They found that LAD in left dominance is usually long and wraps around the apex. The report of Balci and Yilmaz[11] did not corroborate a correlation between dominant pattern and extent of atherosclerosis.

In the present study we investigated the pattern of coronary arterial distribution and its relation with coronary artery diameter in adult Pakistani population.

MATERIAL AND METHODS

A consecutive series of 220 adult patients aged 18 years and above admitted to NICVD Karachi for diagnostic coronary angiography from May 2000 to December 2000 were included. The criteria for selection of patients were as follows:

No apparent disease in the proximal arterial segment, proximal artery and tip of the catheter in the middle of the frame and catheter of a No. 6 French size of same manufacturer (Cordis- Corp Johnson & Johnson's) used.

Patients who were given vasodilator before or during the procedure, those whose angiograms showed complete proximal occlusions or ectatic arteries were excluded.

Selective coronary arteriography was done by the femoral approach using Judkin's technique[12] with a No. 6 French size catheter in all the patients.

The contrast agent, Diatrizoate (Urografin 76% - Schering) was used. This contained 0.1gm sodium diatrizoate and 0.66 gm meglumine diatrizoate per ml in aqueous solution.

Quantitative analysis of digital arteriograms was performed with a commercially available digital image analysis system DPF-2000 (Toshiba Corporation Japan). Calibration was performed by using a catheter as a scaling device.[13]

The criterion used in coronary artery surgery study (CASS)[5] was employed to determine coronary artery dominance. According to this in right dominance, the PDA arises from the RCA and at least one other branch of the RCA extends past the PDA in the atrioventricular groove, giving off one or more posterolateral (PL) branch to the inferior surface of left ventricle. In this case distal circumflex (CX) is very small or absent. In left dominance the PDA and all PL branches arise from the CX and the RCA is small and terminates at the acute margin where in, co-dominant circulation the RCA gives off the PDA only.

For the dominant pattern left anterior oblique (LAO) view of the left main coronary artery (LMCA) was analyzed. This view allows interpretation of coronary dominance and provides good view of middle and distal segment of the LAD and the CX artery.

LAO 60^0 view was taken to measure the diameter of the RCA and the CX arteries and right anterior oblique (RAO) 30^0 view was used to measure the diameter of the LAD and the LMCA.

Data analysis was done on computer package "EPI-info" version 6.0 software of CDC (Centre for Disease Control, Atlanta, USA). Student's "t-test" was used for comparison of mean and standard deviation of continuous variables. In all statistical analysis only p-values <0.05 are considered significant. The values are expressed as mean and standard deviation (SD).

RESULTS

Two hundred and twenty patients were included in this study. There were 175 male and 45 female. The mean age, mean weight and body mass index (BMI) were 50±9.6 Years, 70.8±10.2 Kg and 26.8±3.7 respectively. Among the risk factors, 169 had coronary artery disease (CAD), 55 were diabetic, 156 were hypertensive and 98 were smokers.

Of the 220 patients 133 (60.45%) patients had manifested right coronary dominance with 78.1% male and 21.8% female. By contrast 33 (15%) had left coronary dominance of which 78.7 % were male and 21.2% female. Whereas, 54 (24%) patients had co-dominant (balanced) circulation with 83.3 % male and 16.6 % female (Table 1).

Table 2 shows the correlation between sex and dominant pattern. Of the total 175 male 59.4 percent had right coronary dominance, 14.8 percent had left coronary dominance and the rest 25.7 percent showed a co-dominant pattern. Out of a total of 45 female in our study 64.4 percent demonstrated right coronary dominance, 15.5 percent left coronary dominance and the rest 20 percent had co-dominant circulation. No statistically significant difference was found in any of the coronary arteries.

A comparison of coronary arterial distribution found by different investigators[2,4,6,8-9,13-16] with present study is shown in Table 3.

Table-1: Pattern of coronary arterial distribution

Vessels	Dominant Pattern (n=220)	Male (n=175)	Female (n=45)
	No. (%)	No. (%)	No. (%)
Right dominant	133 (60.4)	104 (78.1)	29 (21.8)
Left dominant	33 (15.0)	26 (78.7)	07 (21.2)
Co –dominant	54 (24.5)	45 (83.3)	09 (16.6)

Table-2: Pattern of dominance in relation to gender

Dominant Pattern	Male (n=175)	Female (n=45)
Right dominant	59.4%	64.4%
Left dominant	14.9%	15.2%
Co –dominant	25.7%	20.4%

Table-3: Coronary Arterial Distribution Reported by Different Investigators

	Right dominant	Left dominant	Co-dominant
Present study	60.45%	15%	24.5%
Mac Alpin[13]	55%	9%	35%

Bergman et al[6].	50%	20%	30%
Vasko [14]	48%	16%	36%
Schlesinger[2]	48%	18%	34%
Franch et al[15]	70%	10%	20%
Chaudhry [4]	75.73%	11.65%	12.6%
Kronzon et al.[16]	87%	10%	3%
Murphy et al[8]	79%	9%	12%
Hutchins et al[9]	70%	10%	20%

Table 4 shows the correlation between coronary artery distribution and their diameters. In subjects with left dominant pattern, the mean diameter (mm) of the RCA was significantly smaller ($p<0.001$) as compared to patients with dominant right or co-dominant pattern. Where as, in right dominant pattern, the mean diameter of the CX was significantly smaller ($p<0.001$) as compared to subjects with left dominant circulation. However, the difference in diameter of other coronary arteries was not statistically significant.

Table-4: Comparison of Mean Coronary Artery Diameter (mm) in relation with the Coronary Artery Dominance pattern

The values are expressed as mean±SD.

Vessels	**Dominant Pattern**		
	Right (n = 133)	Left (n = 33)	Co dominant (n = 54)
RCA	3.21 ± 0.7	2.47 ± 0.56*	3.14 ± 0.78
LMCA	4.26 ± 0.81	4.44 ± 1.10	4.26 ± 0.65
LAD	3.21 ± 0.79	3.28 ± 0.73	3.22 ± 0.59
CX	2.93 ± 0.77*	3.33 ± 0.78	3.04 ± 0.64
TCA	9.35 ± 1.78	9.08 ±1.46	9.40 ± 1.52

* p-value is < 0.001, RCA, Right Coronary Artery, LMCA, Left Main Coronary Artery; LAD, Left Anterior Descending Artery; CX, Circumflex Artery;TCA, Total Coronary Area (RCA + LAD + CX)

DISCUSSION

The criteria introduced by the outstanding work of Schlesinger et al[2] for the determination of coronary arterial dominance have been used in a variety of studies. According to Schlesinger's classification, the artery supplying the crux of the heart is the basis in the differentiation of right dominance, left dominance and balanced hearts. A similar criterion was recommended in CASS study[5] for the determination of coronary artery dominance.

This was second study conducted in Pakistan, earlier in 1965 in a postmortem study (n=103), Chaudhry[4] observed that the pattern of distribution of the coronary arteries was distinctively non-constant. He also observed that no two hearts showed any resemblance in the pattern of two coronary arteries. In this study we observed a constant pattern of arterial distribution which is comparable with what is given in the literature.[2,6,9,-13-15]

No sex difference was noted in coronary dominance pattern in our study. This is in agreement with other published reports.[2,4]

According to Last anatomy[17], 10% hearts are left dominant and remaining 90% are right dominant. Gray's Anatomy[7], however, noted that 70% hearts are left dominant and rest 30% are co-dominant. This may be because of different criteria to define the dominant pattern. Gray's Anatomy[7] considers not only the origin of the PDA, but also the blood supply of the posterior part of the ventricular septum and postero-lateral wall as criteria for dominance. By contrast, in Last's Anatomy[17] the source of the PDA is the only criteria for dominance pattern.

However, in contrast to anatomical dominance, functional dominance based on perfusion studies consider the LCA to be the dominant artery as it is the major source of blood flow to the left ventricle in almost all humans, even in those with anatomical RCA dominance. Moore1930, cited by Chuadry[4], was the first to observe this in dog hearts followed by Gross and Kugel[18] in human hearts in 1933. This also agrees with the evidence based on postmortem studies of coronary perfusion rate[14] and coronary size and arteriographic studies[3] in living subjects. For this reason LCA is almost always considered more important than dominant the RCA.

Dodge et al[19] clarified that size of the RCA and the CX artery are affected by anatomic variations. They noted that the mean diameter of the RCA was significantly smaller in left dominant pattern where as the mean diameter of the CX artery was significantly smaller in right dominant pattern. Pepine[20] also found that diameter of the LMCA and the RCA vary depending upon the dominance. We reported a significant relation between the size of the RCA, the CX artery and pattern of coronary arterial distribution. Our findings are in agreement with those of both Dodge et al and Pepine.

CONCLUSION

Our study showed that coronary arterial distribution in Pakistani population is not significantly different from that given in the literature. This study also clearly demonstrates a relation between the pattern of coronary artery dominance and the diameter of the RCA and the CX artery; however, the reasons for this relation are not clear. It may be speculated that the mechanism that determines which coronary artery will assume dominance in the embryo also influences the diameter of RCA and the CX artery. We recommend that future studies should investigate this aspect so that some definite conclusions could be drawn.

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Address For Correspondence:

Zahid Ali Kaimkhani, Department of Anatomy, Ziauddin Medical University, St-4 Block 6, Shahrah-e-Ghalib, Clifton, Karachi, 75600 Pakistan. Phone #. 92-21-5862937-9, Fax : 92-21-5862940

Email: zahidkk@hotmail.com