Coronary Artery Diameter in a Cohort of Adult Pakistani Population

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Abstract

Objective:
To study the diameter of coronary arteries in a cohort of adult Pakistani population and to compare these with the diameters of Caucasians mentioned in the literature.
Methods:
A study of 220 adult patients referred to National Institute of Cardiovascular Disease (NICVD) for diagnostic coronary angiography between May 2000 to December 2000.
Results:
The mean diameter of Right Coronary Artery (RCA) was found to be 3.08 + 0.78 mm with a 95% CI of 2.9-3.2, and of Left Main Coronary Artery (LMCA), 4.28 + 0.82 with a 95% CI of 4.2 - 4.4. While the mean diameter of Left Anterior Descending Artery (LAD) was 3.22 + 0.74 with a 95% CI of 3.1-3.33, and that of the Circumflex Artery (CX) 3.02 + 0.75 with a 95% CI 2.9-3.1. The total coronary area (TCA), diameter of three vessels was 9.32 + 1.68 with a 95% CI of 9.1-9.5, while the sum of 4 vessels diameter was 13.6 + 2.26 with a 95% CI of 13.3-13.9.
Conclusion:
The diameters of coronary arteries of Pakistani population are not significantly different from that of Caucasians and the cause of increased mortality in the people of South Asians origin seems to be other than the diameter of coronary arteries (JPMA 54:258;2004).

Introduction

Several studies around the world have consistently revealed an increased likelihood of coronary artery disease (CAD) at an earlier age with more extensive disease in people of South Asian origin.1-5 It has been found that infarcts and cardiac failure are commonly associated with coronary arteries with relatively small internal diameter but seldom found in hearts with larger coronary arteries.6,7

More severe CAD and high mortality in the people of South Asian origin may be due to smaller diameter of their coronary arteries.8 The prevalence of the major risk factors like high serum total cholesterol, high blood pressure and cigarette smoking have failed to explain the high incidence of CAD in Asian Indians.9-12

The present study was therefore undertaken to measure the diameter of coronary arteries in adult Pakistani population by digital quantitative coronary arteriography (QCA) and compare the relative diameters with the ones mentioned in the literature for Caucasians.8

Patients & Methods

Consecutive series of adult patients admitted to NICVD Karachi for diagnostic coronary angiography between May to December 2000 were recruited. During this period 220 patients met the following criteria for inclusion.

Age >18 years, no apparent stenosis 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 and Johnson's) 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.

Selective coronary arteriography was done by femoral approach using Judkin's technique13 with a catheter of a No. 6 French size.

Contrast agent Diatrizoate (Urografin 76% - Schering) a sodium /meglumine salt each ml containing 0.1 g sodium diatrizoate and 0.66 g meglumine diatrizoate in aqueous solution) was the only contrast medium used.

Quantitative analysis of digital arteriograms was performed with a commercially available computer system DPF-2000 (Toshiba Corporation-Japan) and propriety software. It consists of digitization, calibration and contour detection.14,15 Calibration was performed by catheter as a scaling device.16

Angiographic Views

LAO 60o view was taken to measure the diameter of the RCA and the CX artery and RAO 30o view was taken to measure the diameter of the LAD and the LMCA. The rationale for taking LAO view for the RCA and CX artery and RAO to measure the LAD is that in these projections the vessels and the catheter tip run in a plane nearly parallel to the X-ray table. There were no marked changes in magnification of the vessel in comparison to the catheter.16

The following measurements of vessel lumen diameter were made from LAO 60o:

i) Proximal RCA at a point neither less than 0.5 cm nor greater than 2.5 cm from its ostium.

ii) Proximal CX artery within its first 2 cm (proximal to its first marginal branch)

The following measurements of vessel lumen diameter were made from RAO 30o:

i) Proximal LAD with in its first 1.5 cm (proximal to its first septal/diagonal branch).

ii) Proximal LMCA

The total vessel diameter (total coronary area i.e. TCA) was taken as the sum of cross sectional area of the 3 major coronary arteries i.e. RCA, LAD, CX supplying the left ventricle. This is because of marked variability in the individual pattern of distribution.16

The sum of the cross sectional area of all four major coronary arteries i.e. RCA, LMCA, LAD and CX artery was also measured.

All the measurement was made using DCA, which have been shown to be comparable to electronic caliper.17 Results of all coronary measurements were reported as mean value with standard deviation and 95% confidence interval.

Statistical Analysis

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.

Results

A total of 220 patients were recruited in this study. Of those 174 were males and 46 females. The mean age, mean weight and mean BMI of the patients were 50 + 9.6 years,

Vessel	Mean + SD	95%C.I.
RCA	3.08 + 0.78	2.9-3.2
LMCA	4.28 + 0.82	4.2-4.4
LAD	3.22 + 0.74	3.1-3.3
CX	3.02 + 0.75	2.9-3.1
TCA	9.37 + 1.68	9.1-9.5
4Vessels total	13.6 + 2.26	13.3-13.9

70.8+10.2 Kg and 26.8+3.7 respectively. Among risk factors 55 were diabetic, 156 were hypertensive, 98 were smokers and 200 had sedentary (no physical activity) life style.

Mean diameters of proximal RCA, LMCA, LAD, CX,

Table 2. Comparsion of mean diameter of Coronary Arteries with
other angiographic studies.

Vessel	Present study (n=220)	MacAlpin et al16 Cauca-sain (n=99)	Mussrat18 Asian (n=60)	Dhawan and Bray8 Asian (n=70)	Caucasian (n=72)
RCA	3.08	3.2	2.7	-	-
LMCA	4.28	4.0*	4.0	-	-

LAD	3.22	3.4*	3.12	-	-
CX	3.02	3.0	3.1	-	-
TCA	9.37	9.6	8.9	12.8	13.8
4 Vesseles Total	13.6	13.6	12.9	-	-

* P value is less than 0.05 ($p < 0.05$) Compare with present study

--	=	Not given
SD	=	Standard Deviation
RCA	=	Right Coronary Artery
LMCA	=	Left Main Coronary Artery
LAD	=	Left Anterior Descending Artery
CX	=	Circumflex Artery
TCA	=	Total Coronary Area (RCA + LAD + CX)
4 Vessels Total	=	TCA + LMCA

3 vessel and 4 vessel are given in Table 1, while Table 2 (Figure) shows comparison of mean diameter of coronary arteries with those of angiographic studies conducted by others.8,16,18

Discussion

Coronary arteriography remains the standard of measuring CAD. It is the primary method of defining the anatomy of arteries in living beings.19,20 In man it is the only method short of postmortem examination that will precisely define the coronary artery anatomy.21

Coronary anatomy including diameter of 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.8

All possible sources of errors were taken into account, for example measurements were taken during the diastole of ventricle that was confirmed by R-wave on the monitor. Similarly a significant error in the measurement of luminal diameter can occur due to the amount of the radio-opaque material in the wall of the catheter as this affects the catheter edge and calibration results obtained using angiographic catheter. It was ensured that the artery was adequately opacified and only those subjects were included in which No. 6F catheter of same manufacturer was used. Although frame selection22, vessel size, magnification and location in the field did not affect computerised measurement.23 We only measured coronary diameter in same angiographic views in all patients, with the catheter and arteries in the middle of the frame.

The measurements of coronary diameter in this study are the same in most cases with those obtained by other angiographically16,18, on postmortem examination25 and that by Electron Beam Computed Tomography (EBCT).25

MacAlpin et al.16 demonstrated that by using the catheter as a calibrating object reasonably accurate assessment of human coronary artery size could be made.16 He measured the diameter of coronary arteries on angiograms with the help of hand held caliper while Mussarat and Samad18 used digital QCA. Zamir and Sinclair24 measured the diameter of the LMCA (4.0 mm) and the RCA (3.12 mm) using corrosion casts of the coronary net work on 13 cadaver heart. Recently Reznikova et al.25 measured coronary diameter with electron-beam computed tomography (EBCT) in 20 adult German (LMCA

4.3mm, CX 3.1 mm, LAD 3.5 mm, RCA 3.4 mm and TCA 10 mm).
Statistical comparison of this study was done with that of MacAlpin et al.16 because of comparable sample size. A significant difference ($p<0.05$) was found only between the LMCA and the LAD diameters. The diameter of all other coronary arteries were not significantly different especially TCA showed no significant difference, which is more important because of marked variation in individual coronary arteries.
The sum of three vessels diameter (TCA) and the total diameter of all four coronary vessels is also not significantly different from that of Caucasians16, except for one study by Dhawan and Bray.8 However, in their study they have taken the diameter of three vessels (RCA, LAD and CX) as total coronary artery diameter and when these values are compared with the sum of 4 vessels diameters in ours and other studies, the difference becomes insignificant. The also used a different technique, which may also explain the difference.
The difference in the coronary artery size of Pakistanis from Indians and similarity to Caucacians may be due to genetic variation in our study.26
This study concludes that the diameter of coronary arteries of Pakistani population is not significantly different from that of Caucasians and that the increase morbidity and mortality in the people of South Asian origin may be due to some other factor(s) related to change in the life style of local population. It is therefore suggested that further work be directed to determine cause of increased prevalence of CAD in the Asians as compared to the Caucasians.

REFERENCES

1. McKeigue PM, Ferrie JE, Pierpont T, et al. Association of early onset coronary heart disease in south Asian men with glucose intolerance and hyperinsulinemia. Circulation 1993;878:152-61.
2. Enas EA, Mehta JL. Malignant Coronary artery disease in young Asian Indians: Thoughts on pathogenesis, prevention and treatment. Clin Cardiol 1995;18:131-5.
3. Hughes LO, Raval U, Raftery EB. First myocardial infarction in Asians and white men Br Med J 1989;298:1345-50.
4. Lowry PJ , Glover DJ, Mace PJE et al. Coronary artery disease in Asians in Birmingham. Br Heart J 1984;52:610-13.
5. Enas A, Yusuf S, Mehta JL. Prevalence of coronary artery disease in Asians Indians. Ed. Am J Cardiol 1992;70:945-9.
6. Wilens SL, Plair CM , Henderson D. Size of the major epicardial coronary arteries at necropsy. JAMA1966;198:1325-9.
7. Milles G, Dalessandro W. The relationship of the weight of the heart and the circumference of the coronary arteries to myocardial infarction and myocardial failure. Am J Path 1954;30:31-7.
8. Dhawan J, Bray CL. Are Asian coronary arteries smaller than Caucasian? A study on angiographic coronary artery size estimation during life. Int J Cardiol 1995;49:267-9.
9. McKeigue PM, Miller GJ, Marmot MG. Coronary heart disease in South Asians: a review . Clin Epidemiol 1989;42:579-609.
10. Beckles BLA, Miller GJ, Kirkwood BR, et al. High total and cardiovascular disease mortality in adults of Indian descent in Trinidad, unexplained by major coronary risk factors. Lancet 1986;1:1298-1301.

11. Miller GJ, Beckles BLA, Maude GD, et al. Ethnicity and other characteristics predictive of CHD in a developing community: Principal result of the St. James survey. Trinidad. Int J Epidemiol 1989;18:808-17.
12. Balarajan R, Yuen P. British smoking and drinking habits: variation by country of birth. Commun Med 1986;8:237-9.
13. Judkin MP. Selective coronary arteriography. I. A percutaneous transfemoral technique. Radiology 1967;89:815-24.
14. Lefree MT, Simon SB, Mancini GJB, et al. Digital radiographic assessment of coronary arterial diameter and videodensitometric cross sectional area. Proc SPIE 1986;626:334-41.
15. Mancini GJB, Simon SB, Mc Gillem MJ, et al. Automated quantitative coronary arteriography: Morphologic and physiologic validation in vivo of a rapid digital angiographic method. Circulation 1987;75:452-60.
16. MacAlpin RN, Abbasi AS, Grollman JH, et al. Human coronary artery size during life. Diag Radiol 1972;108:567-76.
17. Katritsis D, Lythall DA, Cooper IC, et al. Assessment of coronary angiography: Comparison of visual assessment, hand held caliper measurement, and automated digital quantitation. Cathet Cardiovasc Diagn 1988;15:237-42.
18. Mussarat J, Samad A. Coronary artery diameters in adult patients and pattern of obstructive coronary artery disease. Specialist 1999;15:277-82.
19. Ross J Jr. Guideline for coronary angiography: A report of the American College of Cardiology. Circulation 1987:70:963A-77A.
20. Bashore TM. State of the art of coronary angiography. J Invas Cardiol 1991;3 (Suppl B):47B-59B.
21. Schwartz JN, King Y, Hackel DB, et al. Comparison of angiographic and postmortem finding in patients with CAD. Am J Cardiol. 1975;36:174-8.
22. Reiber JHC, Van Elidik-Hellemen P, Visser-Akkerman N, et al. Variabilities in measurement of coronary arterial dimension resulting from variations in cineframe selection. Cathet Cardiovasc Diagn 1988;14:221-8.
23. Spears JR, Sandor T, Als AV, et al. Computerized image analysis for quantitative measurement of vessel diameter from cineangiogram. Circulation 1983;68:453-61.
24. Zamir M, Sinclair P. Roots and Caliber of the Human Coronary Arteries. Am J Anatomy 1988;183:226-34.
25. Reznikova S, Pump H, Moehlenkamp S, et al. Contrast enhanced electron- beam computed tomography in the evaluation of coronary artery size in patient with CAD. First international society of atherosclerosis imaging. Feb. 2-4, 2001, San Diego, CA. (Abstract)
26. "Encyclopaedia Americana", Vol 21. New York: Americana Corporation, 1997, p. 237.