

Evaluation of normal coronary artery dimensions in Indian population-study from a northern Indian medical education and research institute

Saurabh Mehrotra, Shaadab Mohammed, Yashpaul Sharma

ABSTRACT

Aims: The primary objective of this study was to evaluate the normal coronary artery dimensions in the Indian population using quantitative coronary angiography with an aim to determine whether the increased risk of coronary artery diseases in Indians, diabetics in particular is due to narrower coronary arteries as widely believed. **Methods:** A total of 321 patients who underwent coronary angiography for the evaluation of their symptoms and were found to have normal epicardial coronary arteries were included in the study. Written Informed consent was obtained from each patient and the study was conducted according to the applicable guidelines for good clinical practice (GCP). Standard angiographic views were obtained and quantitative coronary Angiography was carried out on longest possible

disease-free segments of coronary arteries. The vessels were assessed in an end diastolic frame. **Results:** There were 165 men and 156 women with a mean age of 49.9 years (+11.22). The mean body surface area among males was significantly higher than females (p value <0.001). The mean coronary artery diameter was higher in males as compared to females and the difference was statistically significant except for diagonal branch of left anterior descending artery, distal right coronary artery and posterior descending artery. The mean coronary artery diameter in diabetic was lower than the non-diabetic patients but the difference was not statistically significant. **Conclusion:** Our study contradicts the general belief that Indians have narrower coronary arteries than their western counterpart.

Keywords: Coronary artery dimensions, Indian population, Normal coronary artery

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INTRODUCTION

Cardiovascular diseases (CVDs) are the leading cause of death worldwide with an estimated 17.5 million deaths in the year 2012 [1]. Amongst these, an estimated 7.4 million deaths happens due to coronary heart disease (CHD) [1]. The prevalence of non-communicable disease (NCD) is on a rise and it is predicted that NCD will contribute half of the total disease burden by 2030 for the low income countries. The alarming rise of CHD in developing countries can be attributed to the proliferation of various risk factors such as diabetes, hypertension, hypercholesterolemia, smoking, obesity as well as physical inactivity. There is a very limited data on the determination of normal coronary artery size using the quantitative coronary arteriographic techniques in living patients with normal arteries [2–4] whereas few earlier studies are based on visual estimates or electronic calliper measurements from cine-angiographic films [5, 6]. Although the dimension of the coronary arteries is highly variable in the normal population, it is widely believed that coronary arteries are narrower in Indo-Asians as compared to Caucasians [7, 8]. Cardiovascular disease is a major cause of morbidity and mortality in individuals with type 1 or 2 diabetes mellitus with up to 75% of all such individuals succumbing to some form of coronary artery disease [9, 10]. Not much data is available that compares coronary artery size in diabetic and non-diabetic individuals. This study aims to evaluate the normal coronary artery dimensions in the Indian population using quantitative coronary angiography. The results of this study will help to determine whether the increased risk of coronary artery diseases in Indians, diabetics in particular, is due to narrower coronary arteries as widely believed.

MATERIALS AND METHODS

The study was conducted at the Department of Cardiology, Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, India. A total of 321 patients who underwent coronary angiography for the evaluation of their symptoms and were found to have normal epicardial coronary arteries free of atheroma or stenosis were included in the study. Written Informed consent was obtained from each patient and the study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the institution's human research committee.

Procedure

Access was established by percutaneous transfemoral or transradial route using the Seldinger technique. An arterial 6F sheath was inserted into the femoral artery or radial artery and selective coronary catheterization carried out with 5F or 6F Judkins or Amplatz right and

left coronary catheters. Selective hooking of coronary ostium was done and non-ionic contrast was injected. Images were then acquired for each coronary artery segment in two orthogonal views and the mean of the two values was taken for statistical analysis. No intracoronary nitroglycerine was administered prior to obtaining the images.

Selection Criteria for Target Vessels

Quantitative coronary angiography (QCA) was used for assessing the dimension of coronary arteries. Contrast filled segments of coronary arteries, free of tortuosity were assessed in an end diastolic frame. Patients with normal coronary arteries were included in the study while the patients who had a previous history of myocardial infarction were excluded from the study.

The digital angiograms were acquired on the GE digital cardio imaging (DCI) system and the images were transferred to a CD-ROM disk from the computer hard disk. The catheter used for angiography became the calibrator for the QCA system by employing an automated and operator independent edge detection technique in which the dimension of coronary artery was measured as a function of the catheter diameter. Computerized software analysis was used to calculate the vessel diameter in millimeter. Figure 1 represents various segments of coronary circulation that were analyzed. For the left coronary artery the segments were left main artery (LM), proximal left anterior descending artery (LAD) before origin of the first septal branch (S), mid left anterior descending artery between origin of first septal and first diagonal (D) branches, distal left anterior descending artery after the first diagonal artery, proximal circumflex (Cx) before origin of the first obtuse marginal (OM), distal circumflex after the origin of the obtuse marginal and the first obtuse marginal branch (OM). Similarly, for the right coronary artery the segments were proximal right coronary artery (RCA) before origin of first acute marginal, mid right coronary artery between first and second acute marginals, distal right coronary artery after the second acute marginal branch, posterior descending artery (RPPD) and the posterior left ventricular branch (PLV). The diameters of these coronary arteries were analyzed. Patients were also grouped as diabetics and non-diabetics and comparison of coronary artery diameters was done between these two groups.

Statistical Analysis

Statistical analysis was performed using the SPSS software package for Windows version 11.0 (SPSS Inc., Chicago, IL). Descriptive statistics was used to describe demographic data. Correlations were estimated by Pearson's correlation coefficient. Independent *t*-test was used for comparison of differences in coronary artery dimensions among males and females. A *p*-value of less than 0.05 was considered statistically significant.

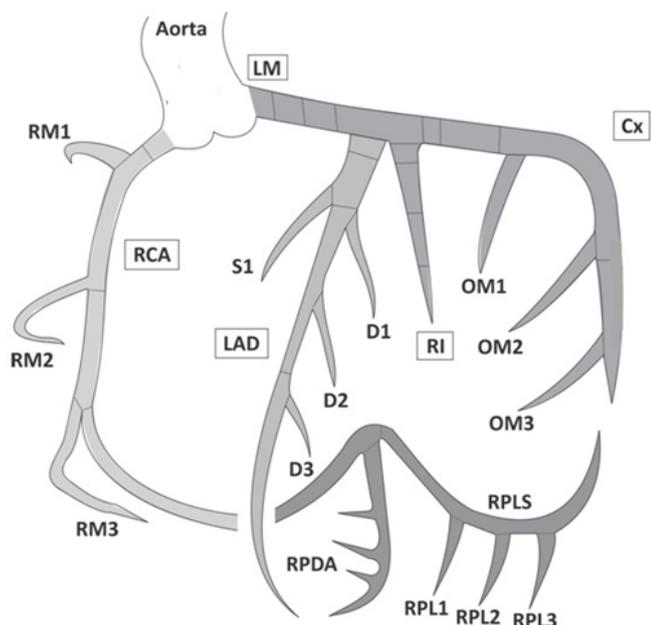


Figure 1: Segments of Coronary Circulation

Abbreviations:

- Cx Circumflex
- D Diagonal
- LAD Left Anterior Descending Artery,
- LM Left Main Artery
- OM Obtuse Marginal
- RCA Right Coronary Artery
- RI Ramus Intermedia
- RM Right Marginal
- RPDA Right Posterior Descending Artery
- RPL Right Posterolateral
- S Septal

RESULTS

A total of 321 patients were included in this study between July 2013 and June 2014. There were 165 men and 156 women with a mean age of 49.9 years (± 11.22) (range 30–67 years). Main baseline patient characteristics are enumerated in Table 1. Patients were matched for their age, clinical symptoms and risk factors like hypertension and diabetes. The mean age among males and females was 49.5 years (± 12.5) and 50.4 years (± 9.5) respectively. The mean body surface area among males was higher than females, which was statistically significant (p -value < 0.001). The mean coronary artery diameter was higher in males as compared to females (Table 2) and the difference was statistically significant except for diagonal branch of left anterior descending artery, distal right coronary artery and posterior descending artery. The mean coronary diameter in our study is higher than the previously reported Indian

population but lower than Iraqi Kurdish population (Table 3).

Our study also compared the mean coronary artery diameter in diabetics and non-diabetics sub-groups. 51 (15.9%) patients had diabetes whereas 270 (84.1%) patients were not diabetic. The mean age in diabetic and non-diabetic sub-group was 52.1 years ($SD \pm 8.8$) and 49.5 years ($SD \pm 11.5$), respectively. The diabetic patients had higher mean body surface area of 1.76 m² ($SD \pm 0.09$) as compared to 1.73 m² ($SD \pm 0.14$) in the non-diabetic patients. There was no statistically significant difference in either the age or BSA between the diabetics and non-diabetics (p value 0.13 and 0.15, respectively) patients. Although the mean coronary artery diameter in diabetic was lower than the non-diabetic patients, the difference was not statistically significant (Table 4).

DISCUSSION

Various studies have reported that the dimensions of normal coronary arteries vary significantly among general population [3, 11–13]. These studies have correlated the genetic factors, age, sex, body surface area, heart weight and ethnic racial factors with the coronary artery anatomy [8, 12, 14–18]. Most of these studies have estimated the coronary artery size either in the patients undergoing coronary artery bypass grafting or in the post-mortem samples. However, visual interpretation of coronary dimensions without accurate quantification has been flawed with high inter-observer variability. Quantitative coronary angiography enables the operator to assess the size of the vessel before performing any intervention as well as obtaining the objective results of the intervention. This digital quantitative estimation of the coronary dimensions has been validated in various studies [18–20].

In the present study we measured the diameters of various segments of coronary artery and compared

Table 1: Baseline patient characteristics

Number of patients	321
Gender, n (%)	
Male	165 (51.4%)
Female	156 (48.6%)
Age (years)	
Mean	49.9 (± 11.22)
Range	19–82
Body surface area (m ²)	
Mean	1.74 (± 0.13)
Range	1.20–2.70
Coronary dominance	
Right	236 (73.5%)
Left	60 (18.7%)
Co-dominance	25 (7.8%)

Table 2: Mean coronary artery diameter in males and females

Segment	Mean Coronary Artery Diameter mm (+SD)		p-value
	Males (n=165)	Females (n=156)	
LMCA	4.43 (±0.60)	4.13 (±0.57)	<0.001*
Proximal Circumflex	3.20 (±0.52)	3.04 (±0.53)	0.008*
Distal Circumflex	2.59 (±0.55)	2.34 (±0.50)	0.009*
Obtuse Marginal	2.15 (±0.44)	2.05 (±0.45)	0.056*
Proximal LAD	3.46 (±0.46)	3.22 (±0.46)	<0.001*
Mid-LAD	2.89 (±0.47)	2.68 (±0.47)	<0.001*
Distal LAD	2.42 (±0.46)	2.20 (±0.44)	<0.001*
Diagonal	2.04 (±0.42)	1.98 (±0.39)	0.094
Proximal RCA	3.17 (±0.54)	3.04 (±0.55)	0.036*
Mid RCA	2.87 (±0.57)	2.75 (±0.55)	0.057*
Distal RCA	2.5 (±0.55)	2.42 (±0.53)	0.189
PDA	1.45 (±0.40)	1.39 (±0.38)	0.083
PLVB	1.59 (±0.37)	1.53 (±0.40)	0.023*

* Significant value

it among males versus females as well as diabetic versus non-diabetic patient population. The mean left main coronary artery diameter in our study was 4.28 mm (±0.6) and it was significantly higher in males as compared to female patients ($p < 0.001$). Similarly, the diameter of proximal circumflex, distal circumflex, obtuse marginal, proximal left anterior descending, mid-left anterior descending, distal left anterior descending, proximal right coronary artery, mid right coronary artery and posterior left ventricular branch of right coronary was also significantly higher in males as compared to female patients. These observations were in concordance with the results of previous studies by Saikrishna et al. [4], Dhawan and Bray [8], and Lip et al. [21].

The mean diameters of LMCA (4.28 mm), proximal circumflex (3.12 mm), proximal LAD (3.34 mm) and proximal RCA (3.11 mm) in our study was higher than one of the previous study from India by Saikrishna et al. [4]: LMCA (3.56 mm), proximal circumflex (2.75 mm), proximal LAD (2.79 mm) and proximal RCA (2.65 mm) but marginally lower than another study from India by Vikram et al. [22]: LMCA (4.3 mm), proximal circumflex (3.16 mm), proximal LAD (3.48 mm) and proximal RCA (3.15 mm) as well as a study in Iraqi Kurdish population by Shukri et al. [11]: LMCA (4.68 mm), proximal circumflex (3.15 mm), proximal LAD (3.46 mm) and proximal RCA (3.14 mm). Similarly, mean diameters in our study was higher to the Indo-Asians sub-group of the study conducted by Lip et al. [21]: LMCA (3.98 mm), proximal circumflex (3.01 mm), proximal LAD (3.22 mm) and

Table 3: Comparison of mean coronary artery diameter among different series

	Our Study		Saikrishna et al.4		Shukri et al.11	
	Mean Coronary Diameter mm (+SD)	Artery	Mean Coronary Diameter mm (+SD)	Artery	Mean Coronary Diameter mm (+SD)	Artery
	Males (n=156)	Females (n=165)	Males (n=61)	Females (n=33)	Males (n=32)	Females (n=56)
LMCA	4.43 (±0.60)	4.13 (±0.57)	3.72 (±0.65)	3.40 (±0.58)	4.86 (+0.77)	4.50 (+0.73)
Proximal Circumflex	3.20 (±0.52)	3.04 (±0.53)	2.82 (±0.63)	2.68 (±0.59)	3.26 (+0.62)	3.03 (+0.39)
Distal Circumflex	2.59 (±0.55)	2.34 (±0.50)	2.10 (±0.68)	1.77 (±0.60)	-	-
Obtuse Marginal	2.15 (±0.44)	2.05 (±0.45)	1.90 (±0.45)	1.82 (±0.37)	-	-
Proximal LAD	3.46 (±0.46)	3.22 (±0.46)	2.85 (±0.59)	2.72 (±0.48)	3.6 (+0.58)	3.31 (+0.46)
Mid-LAD	2.89 (±0.47)	2.68 (±0.47)	2.24 (±0.49)	2.17 (±0.50)	-	-
Distal LAD	2.42 (±0.46)	2.20 (±0.44)	1.63 (±0.38)	1.51 (±0.31)	-	-
Diagonal	2.04 (±0.42)	1.98 (±0.39)	1.61 (±0.39)	1.29 (±0.35)	-	-
Proximal RCA	3.17 (±0.54)	3.04 (±0.55)	2.75 (±0.60)	2.55 (±0.57)	3.26 (+0.65)	3.02 (+0.55)
Mid RCA	2.87 (±0.57)	2.75 (±0.55)	2.47 (±0.66)	2.31 (±0.13)	-	-
Distal RCA	2.5 (±0.55)	2.42 (±0.53)	2.14 (±0.61)	2.01 (±0.40)	-	-
PDA	1.45 (±0.40)	1.39 (±0.38)	1.66 (±0.42)	1.52 (±0.33)	-	-
PLVB	1.59 (±0.37)	1.53 (±0.40)	1.58 (±0.46)	1.40 (±0.35)	-	-

Table 4: Comparison of mean coronary artery diameter in diabetics and non-diabetics

Segment	Mean Coronary Artery Diameter mm (+SD)		p-value
	Diabetics (n = 51)	Non-diabetics (n = 270)	
LMCA	4.24 (±0.62)	4.29 (±0.60)	0.529
Proximal Circumflex	3.14 (±0.61)	3.12 (±0.52)	0.788
Distal Circumflex	2.45 (±0.55)	2.52 (±0.53)	0.378
Obtuse Marginal	2.13 (±0.55)	2.10 (±0.42)	0.658
Proximal LAD	3.31 (±0.49)	3.35 (±0.47)	0.580
Mid-LAD	2.70 (±0.53)	2.80 (±0.47)	0.147
Distal LAD	2.26 (±0.50)	2.32 (±0.45)	0.352
Diagonal	2.01 (±0.44)	2.02 (±0.40)	0.915
Proximal RCA	3.06 (±0.47)	3.11 (±0.56)	0.555
Mid RCA	2.73 (±0.45)	2.82 (±0.58)	0.315
Distal RCA	2.45 (±0.44)	2.47 (±0.56)	0.806
PDA	1.47 (±0.38)	1.41 (±0.39)	0.254
PLVB	1.560 (±0.39)	1.563 (±0.39)	0.978

proximal RCA (2.98 mm) but lower than the Caucasian sub-group: LMCA (4.44 mm), proximal circumflex (3.17 mm), proximal LAD (5.53 mm) and proximal RCA (3.35 mm). As coronary artery dimension correlates with the body weight, the marginally smaller mean coronary artery diameters in Indian population may be attributed to the lesser body weight of the Indian populations as compared to Caucasian and Iraqi Kurdish population.

In the present study, we report a very high right sided dominance of 73.5% as compared to 18.7% of left sided dominance. These results are compatible with right sided dominance ranging between 64.8% and 75% and left sided dominance ranging from 6–8% reported for Indian, Caucasian and Iraqi Kurdish populations respectively.

Our study also compared the mean coronary artery diameter in diabetic versus non-diabetic patients which to the best of our knowledge has not been compared till date. The result showed that mean diameter in diabetics was lower than non-diabetics. However, the difference was not statistically significant. Therefore, it can be interpreted that diabetics does not have narrower coronary arteries as shown in a previous study by Faridullah et al. [23].

CONCLUSION

Our study reports the largest single center data on coronary artery size in Indian population. The study included patients from 5–6 states of northern India, thereby having a diverse representation of the ethnic population as well as clinical presentation. Our study confirms the fact that coronary artery diameter is larger in males as compared to females. However, it contradicts

the general belief that Indians have narrower coronary artery than their western counterpart. Also, there is no significant difference between the coronary artery diameter of diabetic patients as compared to non-diabetic patients.

Author Contributions

Saurabh Mehrotra – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published

Shaadab Mohammed – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published

Yashpaul Sharma – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published

Guarantor

The corresponding author is the guarantor of submission.

Conflict of Interest

The authors report no conflicts of interest in this work. No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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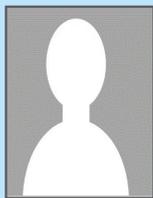
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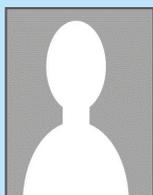
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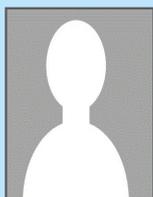
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