

Dimensions of Normal Coronary Arteries in a Tertiary Cardiac Center Kathmandu

Padam PD Sharma, Chandra M Poudel, Hemant Shrestha, Surya Devkota, Sanjeev Thapa, Bhawani Manandhar, Rajaram Khanal, Smriti Shakya, Shovit Thapa, Ratna M Gajurel

Author(s) affiliation

Department of Cardiology,
Maharajgunj Medical Campus,
Manmohan Cardiothoracic Vascular
and Transplant Center, Institute of
Medicine, Maharajgunj, Kathmandu,
Nepal

Corresponding author

Surya Devkota, MD, DM
suryakchan@gmail.com

Submitted

Aug 20, 2023

Accepted

Oct 31, 2023

ABSTRACT

Introduction

Coronary artery disease is the major cause of morbidity and mortality worldwide. The knowledge of normal coronary artery dimensions is fundamental during the percutaneous coronary intervention for appropriate sizing of the coronary balloons and stents. The dimensions of the coronary arteries differs among individuals of various countries, even among the different ethnicities. So, this study was done to find out the normal coronary artery dimensions.

Methods

This study was done in randomly selected 100 normal coronary angiograms. The diameter and the length of different segments of coronary artery were measured with the use of software as quantitative coronary angiography.

Results

Diameter of left main (LM) coronary artery was 4.06 ± 0.68 mm. Similarly, diameters of prox-left anterior descending (LAD) artery, mid-LAD, dist-LAD, prox-left circumflex (LCx) artery and dist-LCx were 3.26 ± 0.48 mm, 2.67 ± 0.49 mm, 2.01 ± 0.44 mm, 2.91 ± 0.48 mm and 2.38 ± 0.44 mm respectively. The diameters of prox-right coronary artery (RCA), mid-RCA and dist-RCA were 3.2 ± 0.51 mm, 2.89 ± 0.5 mm and 2.43 ± 0.51 mm respectively. The lengths of LM, proximal/mid and distal LAD were 10.06 ± 3.12 mm, 17.91 ± 6.09 mm, 18.28 ± 6.81 mm, 67.94 ± 15.57 mm respectively. The lengths of proximal and distal LCX were 18.95 ± 10.13 mm, and 52.1 ± 17.78 mm respectively. Similarly, the lengths of proximal, mid, and distal RCA were 17.2 ± 4.74 mm, 33.82 ± 9.4 mm, 33.43 ± 12.01 mm respectively. The diameter and length of ramus intermedius (RI) was 2.32 ± 0.56 mm and 70.77 ± 19.75 mm.

Conclusion

LM artery and p-RI had the largest and the smallest diameters respectively. LAD and RI had the longest and the shortest courses respectively.

Keywords

Coronary angiography, coronary artery dimension, coronary artery disease

INTRODUCTION

Coronary artery disease (CAD) is the major cause of morbidity and mortality worldwide with >4.5 million deaths occurring in the developing world.¹ The standard practice of management of acute coronary syndrome (ACS) is invasive coronary angiography (ICA) followed by percutaneous coronary intervention (PCI) or coronary bypass grafting (CABG) on the top of the medical management as per the guideline.² For appropriate management of ACS by PCI, the knowledge of the dimensions of the coronary arteries is mandatory so that the proper stent size could be deployed to the desired segment(s) of the obstructed coronary artery.³

The coronary arteries are wider at the beginning and then gradually taper towards the end. To be more specific in location, these arteries are arbitrarily subdivided into multiple segments. While branching, they obey the Murray's law, that is, the cube of the diameter of the proximal vessel is equal to the sum of the cubes of the diameters of the distal branches.⁴ The average diameter of the left main coronary artery is the largest among all coronary arteries.⁵

The size of the coronary arteries varies among different people of different ethnicities in different parts of the world.⁶ There are limited studies on this in Nepal. So, this study is intended to find the mean dimensions of normal coronary arteries among the Nepalese people.

METHODS

This is a single-center, prospective, observational study. The study was conducted in Manmohan Cardiothoracic Vascular and Transplant Center (MCVTC) after approval by the Institutional Review Committee (IRC) of Institute of Medicine (IOM) [ref no. 248(6-11)E2]. The study was done from December 2022 to September 2023. Written informed consent was obtained from the individual participants.

Patients with normal coronary angiograms done by ICA for the evaluation of the chest pain of suspected of coronary origin were taken for the study. The diameter of coronary artery was measured at the proximal 5 mm of each segment and length is measured from the proximal defining point to the distal defining point. The LM artery was taken from LM ostium to the bi- or tri-furcation point into LAD, LCx and or RI. Proximal LAD segment (p-LAD) was taken from the ostium to the 1st diagonal (D1) [or to the 1st septal branch in case of the absence of the diagonal branch], from D1 to D2 as mid LAD segment (m-LAD), and from D2 to the terminal end as distal LAD segment (d-LAD). Proximal LCx segment (p-LCx) was taken from the ostium to the

1st obtuse marginal (OM1) branch, and the distal LCx segment (d-LCx) from OM1 to the terminal end of LCx. Proximal RCA segment (p-RCA) was measured from the ostium to the 1st curvature, mid RCA segment (m-RCA) from 1st curvature to the 2nd curvature, and the distal RCA segment (d-RCA) from 2nd curvature to the bifurcation point into posterior descending artery (PDA) and posterior lateral vessel (PLV) branch. The proximal RI was taken from the ostium to 5 mm of RI. To avoid foreshortening and lengthening, the segments were measured in perpendicular projections.

The in-built software quantitative angiogram was used to measure the dimensions (diameter/length). The vessel segments LM, p-LAD, p-LCx/d-LCx, and p-RI, were measured in caudal projection, whereas segments m-LAD, and d-LAD were measured in cranial projection. Finally, p-RCA, m-RCA and d-RCA were measured in LAO cranial views.

The sample size was calculated as ⁷:

Sample size for infinite population (S):

$$= Z^2 \times P \times (1-P)M^2(1-P)M^2$$

where,

S = sample size for infinite population

Z = Z score

P = population proportion (assumed as 0.5)

M = Margin of error

Taking confidence level of 95% and margin of error as 5%:

Given: Z = 1.960, P = 0.5, M = 0.05,

S = $(1.960)^2 \times 0.5 \times (1-0.5) 0.05^2 (1-0.5) 0.05^2$

= $3.8416 \times 0.25 / 0.0025 = 384.16$

Adjusted sample size: = $S / (1 + [(S-1) / \text{Population}])$

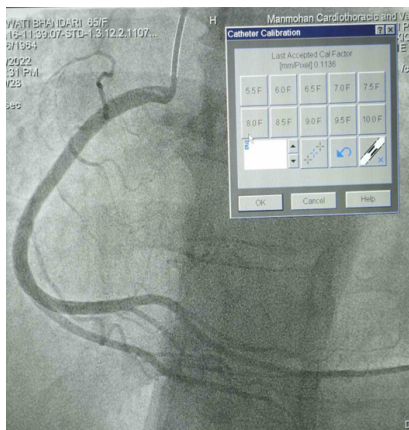
With 20%-30% of the patients with chest pain of suspected coronary origin undergoing ICA will have normal coronaries⁷ and the average total number of patients undergoing ICA in MCVTC in one year period of 528, the adjusted sample size was 100. So, 100 cases with normal coronary angiogram were included in the study.

Statistical analysis was performed using SPSS software. The mean diameters with standard deviation and the mean lengths with standard deviation were calculated.

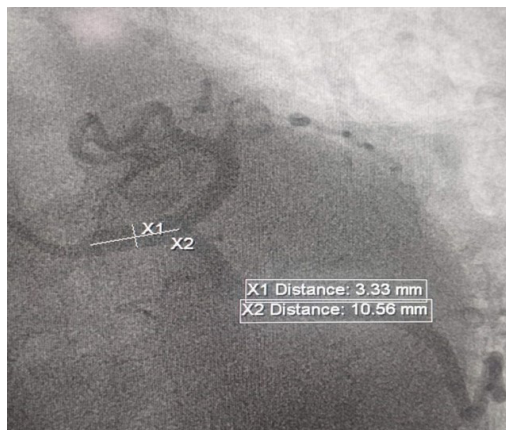
RESULTS

Among 100 patients studied, 60% were males and 40% were females. The median age was 56 years with range from 32 years to 84 years.

Diameter of left main (LM) coronary artery was 4.06 ± 0.68 mm. Diameters of prox-left anterior descending (LAD) artery, mid-LAD, dist-LAD, prox-left circumflex (LCx) artery and dist-LCx were 3.26 ± 0.48 mm, 2.67 ± 0.49 mm, 2.01 ± 0.44 mm, 2.91 ± 0.48 mm and 2.38 ± 0.44 mm respectively. The



Catheter Calibration



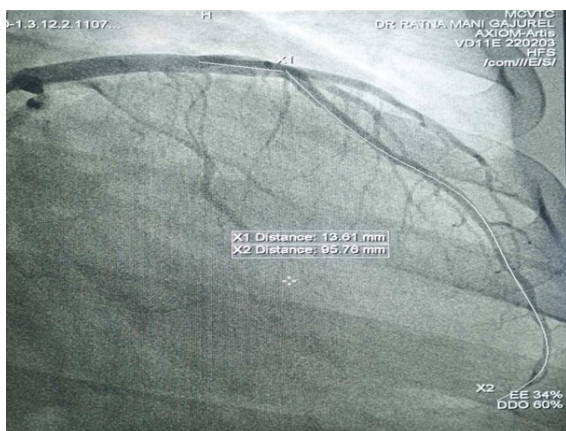
Measurement of LM diameter/length



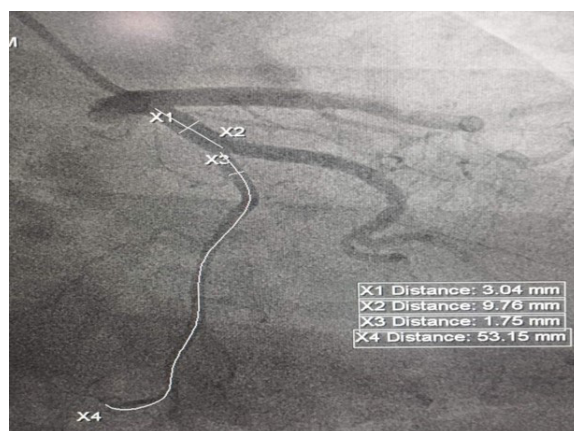
Measurement of p-LAD length



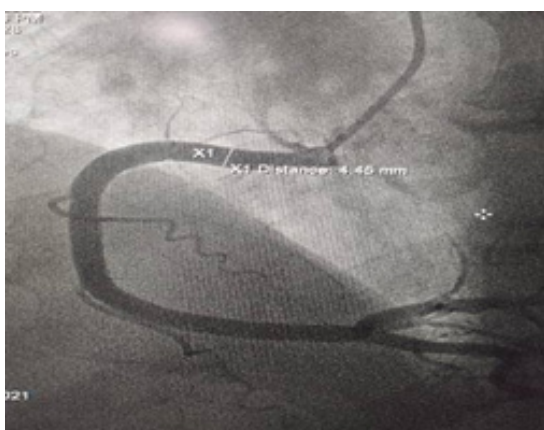
Measurement of p-LAD diameter



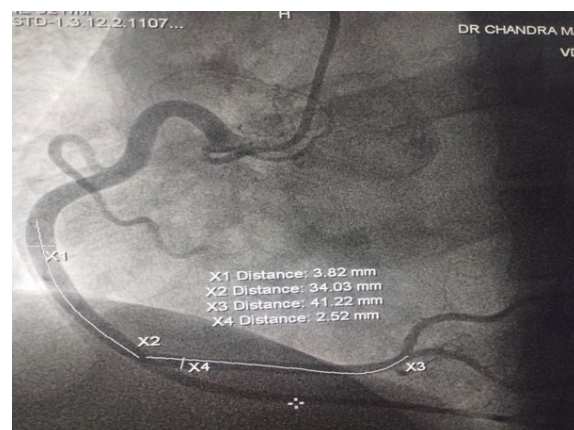
Measurement of LAD length



Measurement of LCx diameter/length



Measurement of p-RCA diameter



Measurement of m-d-RCA diameter/length

Figure 1. Measurement of coronary artery dimensions

Table 1. Diameters of coronary artery segments

Artery segments	Diameters (mean \pm SD)
LM	4.06 \pm 0.68 mm
p-LAD	3.26 \pm 0.48 mm
m-LAD	2.67 \pm 0.49 mm
d-LAD	2.01 \pm 0.44 mm
p-LCx	2.91 \pm 0.48 mm
d-LCx	2.38 \pm 0.44 mm
p-RI	2.32 \pm 0.56 mm
p-RCA	3.2 \pm 0.51 mm
m-RCA	2.89 \pm 0.5 mm
d-RCA	2.43 \pm 0.51 mm

diameters of prox-right coronary artery (RCA), mid-RCA and dist-RCA were 3.2 \pm 0.51 mm, 2.89 \pm 0.5 mm and 2.43 \pm 0.51 mm respectively. (Table 1)

The lengths of LM, proximal/mid and distal LAD were 10.06 \pm 3.12 mm, 17.91 \pm 6.09 mm, 18.28 \pm 6.81 mm, 67.94 \pm 15.57 mm respectively. The lengths of proximal and distal LCX were 18.95 \pm 10.13 mm, and 52.1 \pm 17.78 mm respectively. Similarly, the lengths of proximal, mid, and distal RCA were 17.2 \pm 4.74 mm, 33.82 \pm 9.4 mm, 33.43 \pm 12.01 mm respectively. (Table 2)

The diameter and length of ramus intermedius (RI) was 2.32 \pm 0.56 mm and 70.77 \pm 19.75 mm. LM artery and p-RI had the largest and the smallest diameters respectively. Similarly, LAD and RI had the longest and the shortest courses respectively.

DISCUSSION

The dimensions of the coronary arteries are highly variable in the normal population. This study found the mean dimensions of the normal coronary arteries among the patients undergoing ICA for the evaluation of the chest pain of coronary origin. Left main has the largest diameter followed by proximal LAD among the coronary arteries. Similarly, LAD is the longest coronary artery among all coronaries.

The dimensions of the coronary arteries are as per the dimensions found in other similar studies in South Asia. Coronary artery dimensions in normal Indians as studied by Barendra et. al. showed left main was largest in term of diameter followed by proximal LAD, proximal RCA & proximal LCX respectively (mean diameters 4.08 \pm 0.44mm, 3.27 \pm 0.23mm, 3.20 \pm 0.37mm, 2.97 \pm 0.37mm).⁸ Ashok et al studied coronary artery dimensions in Patan Hospital, Nepal showed the mean diameters of unadjusted LM coronary artery, proximal LAD, proximal LCX, proximal RCA were 4.87 \pm 0.85mm, 3.8 \pm 0.7, 3.4 \pm 0.7, 3.6 \pm 0.85 respectively.⁹ Dodge et al found that LM artery measured 4.5 \pm 0.5 mm,

Table 2. Lengths of coronary artery segments

Artery segments	Lengths (mean \pm SD)
LM	10.06 \pm 3.12 mm
p-LAD	17.91 \pm 6.09 mm
m-LAD	18.28 \pm 6.81 mm
d-LAD	67.94 \pm 15.57 mm
p-LCx	18.95 \pm 10.13 mm
d-LCx	52.01 \pm 17.78 mm
p-RI	70.77 \pm 19.75 mm
p-RCA	17.2 \pm 4.74 mm
m-RCA	33.82 \pm 9.4 mm
d-RCA	33.43 \pm 12.01 mm

proximal LAD artery 3.7 \pm 0.4 mm, and the distal LAD 1.9 \pm 0.4 mm.¹⁰

Dhawan and Bray in their study found that Caucasians had significantly larger total vessel diameter relative to the Asians.¹¹ This observation has vital therapeutic implication concerning coronary intervention like PTCA and CABG in this ethnic group. Our study showed that in Nepalese population, the dimensions of the coronary arteries and their subsegments are smaller than that of international data. We can infer, while selecting stents for PCI in Nepalese patients, smaller yet appropriate size stent will be adequate.

The limitation of this study is that this is a single center study with very small sample size. So, the findings of this study is not generalizable to the whole Nepalese population, but it can be useful for the future reference database for normal coronary artery dimensions.

CONCLUSION

LM artery and p-RI had the largest and the smallest diameters respectively. Similarly, LAD and RI had the longest and the shortest courses respectively.

FINANCIAL SUPPORT

The author(s) did not receive any financial support for the research and/or publication of this article.

CONFLICT OF INTEREST

The author(s) declare that they do not have any conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

- Okrainec K, Banerjee DK, Eisenberg MJ. Coronary artery disease in the developing world. American heart journal. 2004;148(1):7-15.
- Bhatt DL, Lopes RD, Harrington RA. Diagnosis and treatment of acute coronary syndromes: a review. Jama. 2022;327(7):662-75.

3. Colombo A, Stankovic G, Moses JW. Selection of coronary stents. *Journal of the American College of Cardiology*. 2002;40(6):1021-33.
4. Stephenson D, Patronis A, Holland DM, Lockerby DA. Generalizing Murray's law: An optimization principle for fluidic networks of arbitrary shape and scale. *Journal of Applied Physics*. 2015;118(17).
5. Waller BF, Orr CM, Slack JD, Pinkerton CA, Van Tassel J, Peters T. Anatomy, histology, and pathology of coronary arteries: A review relevant to new interventional and imaging techniques—Part I. *Clinical cardiology*. 1992;15(6):451-7.
6. Johnson MR. A normal coronary artery: what size is it? *Circulation*. 1992;86(1):331-3.
7. Chambers J, Christopher B. Chest pain with normal coronary anatomy: a review of natural history and possible etiologic factors. *Progress in cardiovascular diseases*. 1990;33(3):161-84.
8. Raut BK, Patil VN, Cherian G. Coronary artery dimensions in normal Indians. *Indian heart journal*. 2017;69(4):512-4.
9. Adhikari A, Shaha KB. Normal coronary diameters in coronary angiogram at Patan Hospital, Nepal. *Nepal Medical College Journal*. 2021;23(3):247-51.
10. Dodge JT, Brown BG, Bolson EL, Dodge HT. Lumen diameter of normal human coronary arteries. Influence of age, sex, anatomic variation, and left ventricular hypertrophy or dilation. *Circulation*. 1992;86(1):232-46.
11. J. Dhawan et al. Are Asian coronary arteries smaller than Caucasian? A study on angiographic coronary artery size estimation during life. *Int J Cardiol* (1995).