# Branching pattern of left coronary artery in north Karnataka population

**Pratik Khona[1], Deepali U Kulkarni[2,*]**

[1]Assistant Professor, [2]Associate Professor, [1]Dept of Anatomy, Gadag Institute of Medical Sciences, Gadag, [2]Dept. of Anatomy, Belgaum Institute of Medical Science, Belgaum, Karnataka

***Corresponding Author:**
Email: drumeshkulkarni@gmail.com

## Abstract

**Introduction:** Knowledge of normal anatomy and variations in the branching pattern of coronary arteries is of utmost importance to identify the cause of coronary artery diseases and to intervene it. Since the left main coronary artery (LMCA) system is the commonly affected vessel, this study was conducted to learn the branching pattern of left main coronary artery in North Karnataka population.

**Materials and Methods:** 85 adult heart specimens were collected from routine under graduate and post graduate dissection at Belgaum Institute of Medical Sciences, Belagavi. The left main coronary artery and its branches were dissected and tabulated for number of terminal branches. Photographs were taken wherever necessary and results were compared with previous studies.

**Results:** Out of 85 specimens studied in 49 (57.66 %) specimens the left main coronary artery bifurcated into left anterior descending (LAD) and left circumflex artery (LCx). In 32 (37.66 %) specimens the left main coronary artery trunk trifurcated and the 3 branches were left anterior descending, left circumflex artery and left diagonal (LD) artery. In 3 (3.5 %) specimens it quadrifurcated with 2 left diagonal arteries between the left anterior descending and left circumflex artery, while in 1 (1.18 %) specimen it pentafurcated with 2 left diagonal arteries and one left marginal artery between the left anterior descending and left circumflex artery.

**Conclusion:** The left main coronary artery terminates in bifurcation, trifurcation, quadrifurcation and sometimes pent furcation, such high degree of variability of left coronary artery and its branching patterns have diagnostic and therapeutic implications. Adequate knowledge of these variations and its incidence is important for the interpretation of coronary angiography, cardiac catheterization and myocardial revascularization surgeries.

**Keywords:** Left main coronary artery, Branching pattern, Coronary angiography.

## Introduction

Coronary artery disease has become one of the major causes of death in developed countries. The incidence of coronary artery disease is slowly but surely increasing today in developing countries as well, because of changing life style, urbanization, sedentary life style, hypertension, diabetes and increased type a personality.(1) Recent advances in coronary angiography provide accurate localization of any pathologies and identification of anatomical variations. Coronary artery bypass grafting (CABG) and other modern techniques of myocardial reperfusion require a complete and thorough knowledge of the normal anatomy, possible variations and anomalies of coronary arteries.(2)

When we come across coronary artery anomalies during surgeries, even minor variations may lead to considerably increased morbidity. Thus it becomes essential that the prior knowledge not only of the normal origin, course and distribution of the left coronary artery but also of its possible variations, common as well as rare is a must for operating surgeon. Many variations in the coronary arterial pattern though clinically silent, may be imposing no limitations on blood flow; such cases require the clinician to be alert. If a coronary artery anomaly is not recognized in time, it may lead to wrong diagnosis leading to incorrect treatment.(3)

The study of variations of coronary arteries especially the left main coronary artery can be of immense help to clinicians planning interventional procedures such as stenting, balloon dilatation or graft surgery, particularly when there are secondary changes of calcification, plaque formation and stenosis.(4)

The present study intends to study the branching patterns for the left main coronary artery in North Karnataka Population. The variations in branching pattern have been reported for other parts of India and world, but the incidence in North Karnataka region has not been vigorously studied. This knowledge of branching pattern has significance as these variations have anatomical, pathophysiological, diagnostic and therapeutic implications.

## Materials and Methods

85 adult heart specimens were collected from routine under graduate and post graduate dissection at Belgaum Institute of Medical Sciences, Belagavi. Hearts with any congenital anamolies, damage due to trauma or external deformities were excluded. These specimens were fixed in 10% formalin and the visceral pericardium was removed to expose the coronary arteries. The left coronary artery was dissected out carefully to avoid damage to small branches. Any variation in the site and pattern of division of the main trunk of LCA was noted. The variant artery was dissected along its course from origin to termination. Photographs were taken wherever necessary. The data

was collected, analyzed and compared with available data.

## Results

Out of 85 specimens studied in 49 (57.66 %) specimens the LMCA bifurcated into LAD and LCx (Fig. 1). In 32 (37.66 %) specimens the LMCA trunk trifurcated and the 3 branches were LAD, LCx and left diagonal artery (Fig. 2). In 3 (3.5 %) specimens it quadrifurcated with 2 left diagonal arteries between the LAD and LCx while in 1 (1.18 %) specimen it pentafurcated with 2 left diagonal arteries and one left marginal artery between the LAD and LCx (Table No 1). Three specimens showed quadrifurcation where in all the three specimens the four branches where the LAD, LCx and two diagonal arteries which supplied the left ventricle and ended before the apex (Fig. 3). The specimen where pentafurcation (Fig. 4) was seen had the termination of LMCA into LAD, LCx and two diagonal arteries which ended before apex and a left marginal artery which ran along the obtuse margin to the apex and ended before it.

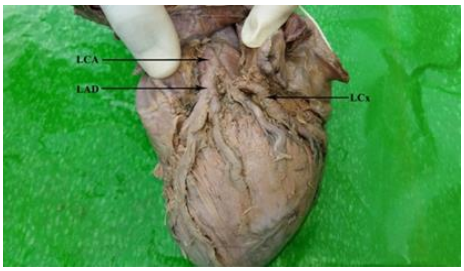


**Fig. 1: Showing the specimen with bifurcation of LCA trunk**

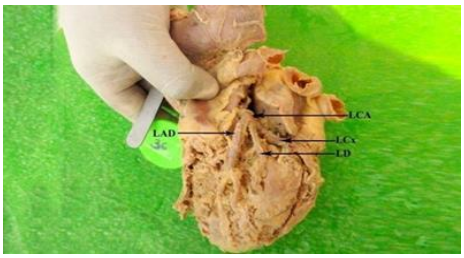


**Fig. 2: Showing the specimen with trifurcation of LCA trunk**

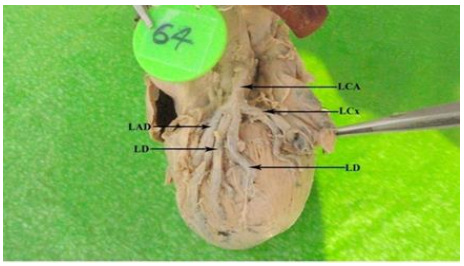


**Fig. 3: Showing the specimen with quadrifurcation of LCA trunk**

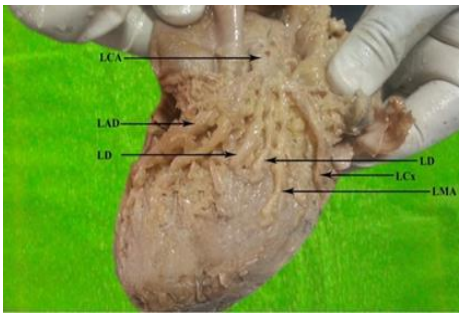


**Fig. 3: Showing the specimen with pentafurcation of LCA trunk (LMA- Left Marginal Artery)**

## Discussion

Coronary arteries branch in such a manner that they occupy the atrioventricular and interventricular sulci in the shape of an inverted crown. The word coronary is derived from the Latin word co-ro-ne, Greek- ko ro ne, means anything hooked or curved. "Corona" meaning "Crown".[5] Two coronary arteries supply the heart, namely right coronary artery and left coronary artery. Most of the area of heart is supplied by the left main coronary artery. The area irrigated by each of the coronary arteries using postmortem angiography shows that the left main coronary artery irrigates 68.8% of the cardiac muscle mass, 41.5% by left anterior descending artery and 27.3% by the left circumflex artery.[6]

In bifurcation of the LMCA artery, a large portion of myocardium is irrigated by a single LAD artery. An occlusion of the LAD artery in such case would then result in a large sized infarct. In trifurcation the same portion of myocardium will be now irrigated separately by the LAD and the LD arteries. An occlusion of either of these arteries would therefore then result in a smaller sized infarct, as the other artery will continue to irrigate the rest of the myocardium. Thus, as a result of trifurcation: Presence of a separate LD artery (median artery) will decrease the size of infarct following occlusion of the LAD artery, which would otherwise have been very large and the occlusion of the LD artery itself could be missed on angiography if only LAD and LCx are looked for, and yet the patient may have a significantly large sized infarct.[7] The left main trifurcating lesions are treated with bypass surgery and treating left main trifurcation disease is now more complex than left main bifurcation disease. Therefore its percutaneous treatment will have a higher rate of adverse events like stent thrombosis. Trifurcation stenting carries a high rate of adverse events and may need to be reserved for patients who are at a high risk of bypass surgery or who refuse surgery.[8] As such adequate understanding and knowledge of the trifurcation pattern is vital for success of the procedure.

The third terminal branch of LMCA (median artery) observed in trifurcation has also been described as "ramus diagonalis".[9] Despite contrary opinion

expressed earlier, authors today clearly state that "ramus diagonalis" presents an important pattern of collateral circulation having special meaning in coronary insufficiency.[9] The region formed by intersection of the LAD artery and the LCx artery with the great cardiac vein is called as Brocq and Mouchet's triangle. This region is traversed by the LD artery in case of trifurcation. This triangle is commonly used to identify pericardium, myocardium and vessels in the neighborhood while performing intravascular ultrasound of coronary arteries. The location of the triangle is also important in procedures like percutaneous mitral annuloplasty.[10]

The varying range of frequency in trifurcated division can be explained by the different approaches used for defining the diagonal branch. The diagonal branch may be considered to be the artery located in the angle formed by the LAD and LCx branch whereas a broader approach envisages that the diagonal branch originates in the vertex of the angle formed by the terminal branches of the left coronary artery or in the initial millimeters of the LAD and LCx branch.[11]

In quadrifurcation and pentafurcation, the additional diagonal arteries are important functionally because of their potential to supply a significant territory of the myocardium. They constitute an important source of collateral circulation in occlusion of LAD or LCx in such cases. The number of additional arteries implies that catheterization of LMCA is more complicated and as their presence will alter the angle of bifurcation and increase vulnerability to atherosclerosis.[12] These variant patterns of termination may arise from disturbances in usual regression of vascular sprouts from the network of vessels in the interventricular and atrioventricular grooves during early development. [13,14,15]

The comparison of the pattern of termination of the LMCA with previous workers shows that the most common type of termination of LMCA found in present study was bifurcation (57.66 %) which was similar to study of Shilpa B et al.[1] (56.6 %). The trifurcation in present study was seen in 37.66 % of specimens which was nearer to the study of Baptista[7] (38.7 %) and P Dharmendra et al.[16] (35.48 %). The quadrifurcation in present study was seen in 3.5 % of specimens which was nearer to the study of P Dharmendra et al.[16] (6.45 %) and Baptista[7] (6.7 %). The rarest termination is pentafurcation which in present study was seen in 1.18 % of specimens and was consistent with Kalpana R[17] and Shilpa Bhimalli et al.[1] that was 1 %. The results of present study are very similar to the findings by Shilpa B et al.[1] as both the studies are from North Karnataka region (Table No 2).

**Table 1: Showing the pattern of termination of the LMCA trunk in present study**

| Pattern of Termination of LMCA | No. of Specimens | Percentage |
|---|---|---|
| **Bifurcation** | 49 | 57.66 % |
| **Trifurcation** | 32 | 37.66 % |
| **Quadrifurcation** | 3 | 3.5 % |
| **Pentafurcation** | 1 | 1.18 % |

**Table 2: Showing the comparison of pattern of termination of the LMCA with previous workers**

| Pattern of Termination of LMCA | Kalpana R (n = 100) | P Dharmendra et al. (n = 93) | Baptista C A (n = 150) | Shilpa Bhimalli et al. (n = 60) | Present study (n = 85) |
|---|---|---|---|---|---|
| **Bifurcation** | 47 % | 58.06 % | 54.7 % | 56.6 % | **57.66 %** |
| **Trifurcation** | 40 % | 35.48 % | 38.7 % | 33.3 % | **37.66 %** |
| **Quadrifurcation** | 11 % | 6.45 % | 6.7 % | 8.33 % | **3.5 %** |
| **Pentafurcation** | 1 % | 0 | 0 | 1 % | **1.18 %** |

## Conclusion

Many variations from the standard description of branching pattern of left main coronary artery were found in the present study. Many findings from our study were almost similar to the study by Shilpa B et al., as both the studies were from the same region. Few differences in findings from previous workers were noted the reason for which may be due to regional variations or no. of specimens studied. The findings of the present study will be useful for the cardiologists and cardio-thoracic surgeons of North Karnataka region in planning interventional procedures and surgeries in a better way knowing the variations of branching patterns of LMCA.

## References

1. Shilpa B, Daksha D, Mahantesh S, Shirol VS. A Study of Variations in Coronary Arterial System in Cadaveric Human Heart, World Journal of Science and Technology 2011;1(5):30-35.
2. Patel MP, Dixit DP, Pandya AM, Gohil DV, Singel TC. A study of incidence of Single coronary artery. International Journal of Biology & Medical Research.2012;3(1):1348-1350.
3. Vaishaly K B and Vasanti A. A study of the distribution of the left coronary artery – clinical importance, Eur. J. Anat 2013.17(4):250-256.
4. Rahalkar AM, Rahalkar MD- Pictoral essay: Coronary artery variants and anomalies 2009 February; 19(1): 49-53.
5. Co-ro-ne. Dorland's illustrated medical dictionary. 30th edition, Philadelphia: Saunders, 2000:420.
6. Kalbfleisch H, Hort W. Quantitative study on the size of coronary artery supplying areas postmortem. AM Heart.1977; 94:183-188.
7. Baptista, CA, DiDio LJ, Prates JC. Types of division of left coronary artery and the ramus diagonalis of the human heart. Japanese Heart Journal. 1991. 32(3): 323-335.
8. Nicolas W, Shammas MD, Eric J, Dippel MD, Amber

Avila BSC, Lauren Gehbauer et.al. "Long term outcomes in treating left main trifurcation coronary artery disease with the Paclitaxel-Eluting stent".J.invasive cardiol 2007;19:77-82.

9. Lujinovic A, Ovcina F, Voljevica A, Hasanovic A. Branching of main trunk of left coronary artery and importance of the diagonal branch in cases of coronary insufficiency. Bosn J basic Med Sci, 2005; 5:69-73.
10. Andrade FM, Ribeiro DC, Babinski MA, Cisne R, Góes ML. Triangle of Brocq and Mouchet: anatomical study in Brazilian cadavers and clinical implications. J Morphol Sci,2010;27:127-129.
11. Gaurav A, Maninder K and Gurudeep SK. Branching Patterns of Left Coronary artery among North Indians. Anatomy Africa2013;2(2):145-150.
12. Julius A. Ogeng'o, Musa K. Misiani, Beda O. Olabu, Bethleen M. Waisiko and Acleus Murunga. Variant termination of the left coronary artery: pentafurcation is not uncommon. Eur. J. Anat.2014;18(2):98-101.
13. Ogden J. The origin of coronary arteries. Circulation. 1968;38 (suppl 6):150.
14. Larsen WJ. Development of Vasculature. In: Larsen Human Embryology. Churchill Livingstone, New York, Edinburgh. Chapter 7;1983:191.
15. Kulkarni JP, Mehta L Study of angiographic anatomy of right coronary artery. 10SR JDMS.2012; 2: 39-41.
16. P Dharmendra, Anitha T, Seema M and Pradeep L. Clinically significant anatomical variations of the Left Coronary Artery in Human cadaveric hearts. Int J Cur Res Rev, June 2013;05(12):39-44.
17. Kalpana, R. A study on the principal branches of coronary arteries in humans. Journal of Anatomical Society of India2003;52(2):137-40.