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A Morphological Study of Variations in the Branching Pattern of Left Coronary Artery in Human Cadaveric Hearts

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ABSTRACT

Background: Left coronary artery (LCA) originates from left posterior aortic sinus of ascending aorta and supplies greater volume of the myocardium.There is a wide variability in the branching pattern of left coronary artery i.e. bifurcation, trifurcation, quadrifurcation or sometimes pentafurcation. Presence of even minor variations may lead to considerable amount of mortality and morbidity among patients when encountered during surgery.Thus knowledge of normal coronary circulation and its variations is important in the diagnosis and management of congenital and acquired heart diseases.**Materials and Methods:** 40 human formalised adult, apparently normal looking hearts of unknown sex were dissected to note the branching pattern of left coronary artery .**Results:**The main trunk of left coronary artery bifurcated in 33 specimens (82.5%), trifurcated in 6 specimens (15%) and quadrifurcated in 1 specimen (2.5%).**Conclusion:**Due to wide range of variations in the branching pattern of left coronary artery, this study would be of great help to the surgeons, cardiologists and radiologists in diagnosing and performing various procedures like coronary artery catheterization, angiography, angioplasty and bypass surgeries.

Key Words: Left coronary artery, branching pattern, left anterior descending artery, left circumflex artery

INTRODUCTION

The heart pumps blood for the entire tissues in the human body through aorta. However, the heart itself gets it nutrition through coronary arteries, which are usually two in number, placed like a crown on the heart namely the right and left coronary artery.[1] Left coronary artery originates from left posterior aortic sinus of ascending aorta.It is larger in calibre, supplying greater volume of myocardium, including almost all the left ventricle and atrium, except in so called right dominance, where the right coronary partly supplies a posterior region of the left ventricle.[2]

The risk of heart failure is more common due to left coronary artery blockage because 68.8% of the cardiac muscle mass is irrigated by left coronary artery [41.5% by left anterior descending (LAD) and 27.3% by left circumflex artery (LCx)] .[3]With the rising disease burden, an in-depth study of the coronary arteries has become imperative for better understanding of the coronary pathophysiology and better management of coronary heart disease.[4] The rise in coronary heart disease in India has led to rapid transition in health status,[5] there is 2 fold rise and 6 fold rise of coronary heart disease in people older than 20 years in Rural and Urban population respectively from period of 1960-2000.[6]

There is a wide variability in the branching pattern of left coronary artery i.e. bifurcation, trifurcation, quadrifurcation or sometimes pentafurcation. Usually left coronary artery divides

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into two arteries which are the anterior interventicular artery and circumflex artery. There could be few advantages and disadvantages of having trifurcation instead of bifurcation. The advantage of trifurcation is that it can possibly protect against ventricular fibrillation during acute occlusion of LAD by providing electrical stability but the disadvantage is that people with large ramus may be compromised by having very small diagonal or obtuse marginal branch and also trifurcation with a small calibre ramus is more prone for atherosclerosis since it restricts left main flow by venturi effect.[7]Furlong et al[8]suggested that a short left main coronary artery or wide angle between its two main branches may result in perfusion of the left circumflex artery or less commonly the left anterior descending artery. In such cases, with an early bifurcation of the left main coronary artery, the coronary cannula may selectively perfuse one main branch and to a greater or lesser degree occlude the other. Thus, a portion of myocardium remains under-perfused throughout the bypass and infarction may result.

A lot of progress has been made in the last few decades in the management of cardio-vascular diseases. Congenital, inflammatory, metabolic and degenerative diseases may involve the coronary circulation and increasingly complex cardiac surgical repairs demand enhanced understanding of the basic anatomy to improve the operative outcomes.[9] The incidence of congenital coronary artery anomalies is 5-6%.[10] Recognition and adequate visualization of the anomaly is essential for proper patient management, especially in patients undergoing evaluation for percutaneous coronary intervention, coronary artery surgery or prosthetic valve replacement .[11]

Presence of even minor variations may lead to considerable amount of mortality and morbidity among patients when encountered during surgery. Thus knowledge of normalcoronary circulation and its variationsis important in the diagnosis and management of congenital and acquired heart diseases. Due to wide range of variations in the branching pattern, this study on morphometry of branching pattern of the left coronary artery would be of great help to the anatomists, radiologists, surgeons and cardiologists.

MATERIALS AND METHODS

A cross sectional study on 40 human formalised adult, apparently normal looking hearts of unknown sex taken from the Department of Anatomy, GGS Medical College,Faridkot was done. After removal of the epicardium and fat, the left coronary artery was dissected meticulously along its course with the help of dissection instruments. The various branching patterns of left coronary artery were noted.

OBSERVATION AND RESULTS

Out of the 40 specimen studied, 33 (82.5%) showed bifurcation of the left coronary artery (dividing into left anterior descending and left circumflex artery). Trifurcation was seen in 6 (15%) cases where as tetrafurcation was seen in only 1 (2.5%) case. Among the 6 specimens showing trifurcation, there were 2 cases in which the median artery/intermediate artery was a large ramus supplying area in the angle between left anterior descending (LAD) and left circumflex artery(LCx) in addition to diagonal and left marginal artery, where as in the other 4 cases, diagonal artery was arising directly from the main trunk of the LCA along with LAD and LCx. In tetrafurcation, the main trunk of LCA gave 4 branches: LAD, diagonal artery, LCx and left marginal artery.

Table 1: Showing distribution of branching pattern of Left coronary artery.

Branching pattern	No of specimens(n)	Percentage(%)
Bifurcation	33	82.5
Trifurcation	6	15.0

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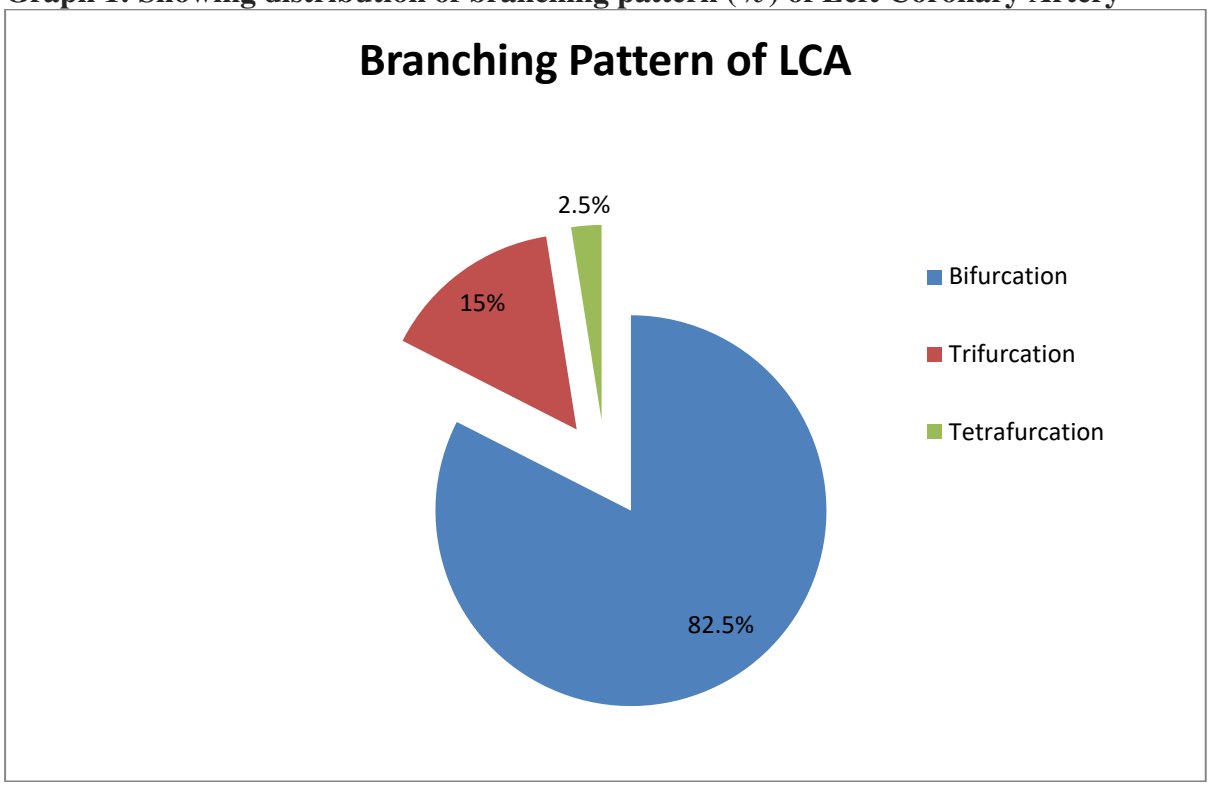
Tetrafurcation	1	2.5

Graph 1: Showing distribution of branching pattern (%) of Left Coronary Artery



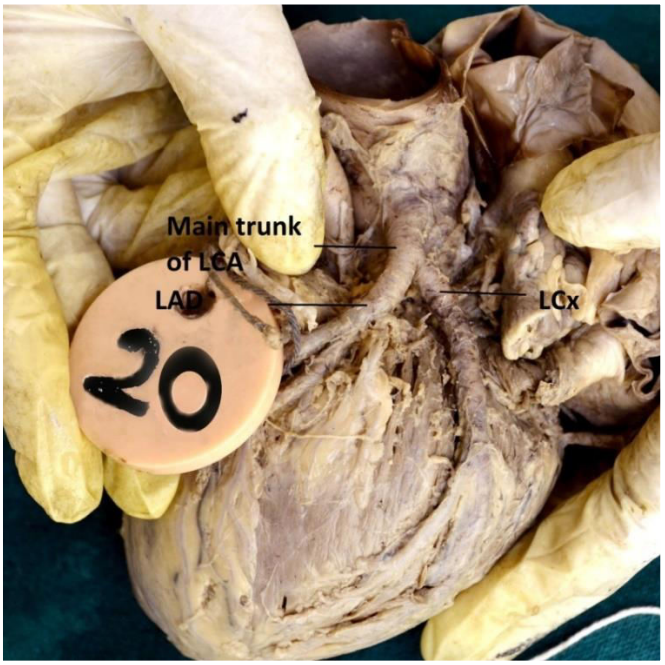


Figure 1: Showing division of main trunk of Left coronary artery (LCA) into Left anterior descending (LAD) and Left circumflex artery(LCx).

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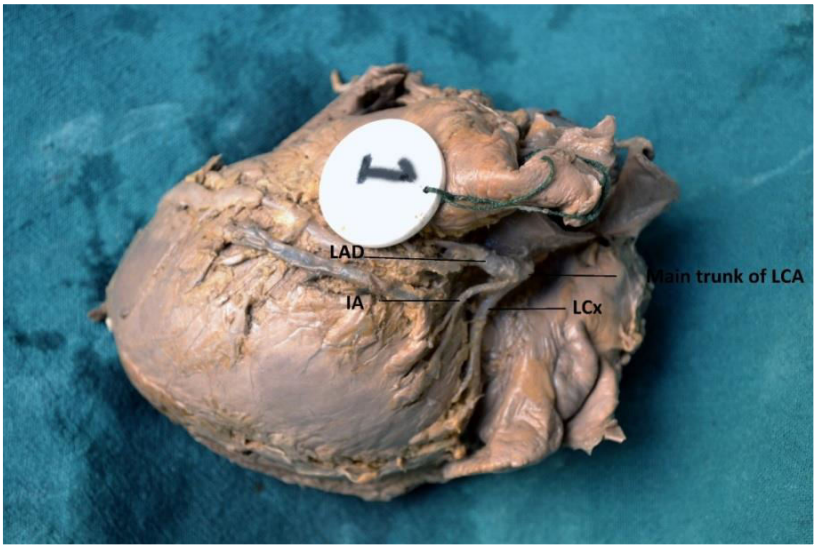

Figure 2: Showing trifurcation of main trunk of Left coronary artery (LCA) into Left anterior descending (LAD), Intermediate artery (IA) and Left circumflex artery (LCx).

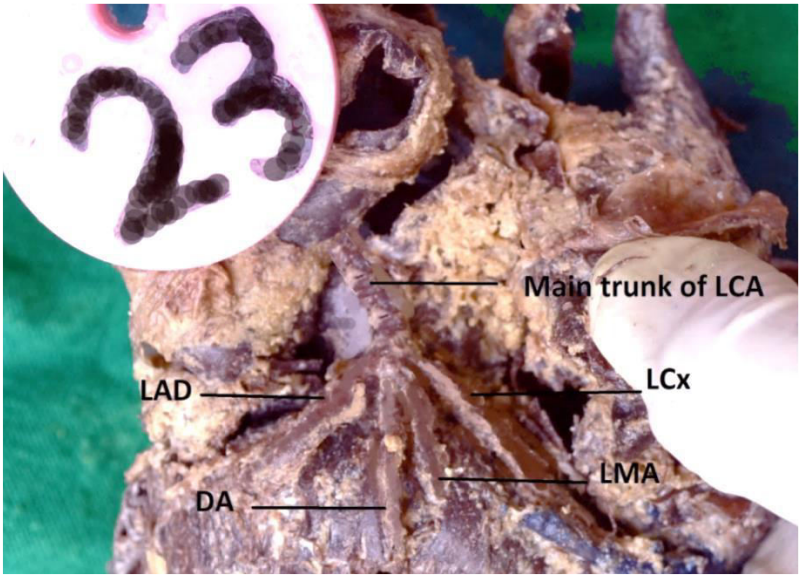

Figure 3: Showing quadrifurcation of main trunk of Left coronary artery (LCA) into Left anterior descending (LAD), Diagonal artery (DA), Left marginal artery (LMA) and Left circumflex artery (LCx).

DISCUSSION

The variation in the branching pattern of Left coronary artery (LCA) has been extensively studied by many workers. The branching pattern has been studied on cadaveric hearts and also on coronary angiograms. The present study was conducted on 40 formalised human hearts of unknown sex in North Indian Population. The main trunk of left coronary artery (LCA) bifurcated in 33 specimens (82.5%), trifurcated in 6 specimens (15%) and quadrifurcated in 1 specimen (2.5%).

In the year 1991, Baptista et al[12]performed investigations on 150 dissected cadaveric human hearts in Toledo, United States and observed that the left coronary artery (LCA) bifurcated in 54.7%, trifurcated in 38.7% and quadrifurcated in 6.7%; the latter two patterns produced a diagonal artery.Cavalcanti et al[13]studied 110 formaldehyde fixed adult human hearts of both

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sexes. Among the 38.18% cases presenting trifurcation of LCA,35.70% cases showed division of LCA into anterior interventricular, circumflex and left marginal branches whereas in 64.30% cases LCA divided into anterior interventricular, circumflex and lateral branches. In 60% of the hearts examined, the LCA presented a bifurcation into anterior interventricular and circumflex branches and in 1.82% of the cases these two branches arose directly from the aorta.Kalpana[9] studied branching pattern of LCA in 100 cadaveric hearts and observed that the main trunk of LCA bifurcated in 47%, trifurcated in 40% and quadrifurcated in 11% of specimens. One specimen showed pentafurcation.

Reiget al[14]observed that LCA bifurcated in 62% cases and divided into three or more branches in 38% cases. In the year 2004, Surucu et al[15] noted that there were 2 branches of left main coronary artery in 19 hearts, 3 branches in 19 hearts, 4 branches in 1 heart and 5 branches in another. Ballesteros et al[16]studied154 cadaveric human hearts in Colombia and found that LCA bifurcated in 80 hearts (52%), trifurcated in 65 hearts (42.2%) and tetrafurcated in 9 hearts (5.8%).Fazliogullari et al[17] studied 50 adult cadaveric hearts in Turkey and found that theLCA gave rise to two branches in 46% cases, three branches in 44% cases and four branches in 10% cases with two median arteries emerging from the left coronaryartery.

Dombe et al[18]noted that in 54.7% cases LCA bifurcated, in 35.9% cases trifurcated, in 7.8% cases quadrifurcated and in 1.6% cases left anterior descending and left circumflex artery directly arose fromostium.In a study done by Hosapatnaet al[19]on 30 heart specimens, it was noted that in 93.3% cases LCA divided into two branches and in 6.7% cases it divided into three branches.Ispaset al[20]noted that LCA divided into two terminal branches in 62% cases and into three in 38% cases.Dharmendra et al[21]performed a study on 93 formalin fixed hearts in Andhra Pradesh and found out that main trunk of the left coronary artery bifurcated in 58.6% case, trifurcated in 35.48% cases and tetrafurcated in 6.45%cases.

Kulkarni[22]recorded that in 83.3% of the cases, LCA bifurcated into left anterior descending and left circumflex branch while in 16.6% of the cases, it trifurcated into left anterior descending, left circumflex and ramus intermedius branch.Anbumanietal[1]observed bifurcation, trifurcation and quadrifurcation of trunk of LCA in 70%, 26% and 4% of specimensrespectively.Ravi et al[23]recorded bifurcation, trifurcation, tetrafurcation and pentafurcation of LCA in 80%, 13.3%, 3.3% and 3.3% of the specimens respectively.Bheleet al[24]found bifurcation of LCA in 70% and trifurcation and quadrifurcation in 24% and 6% specimens respectively. Bhingardeveet al[7] reported the bifurcation of LCA in 58%, trifurcation in 32% and tetrafurcation in 10%specimens. Mallashettyet al[25]found that the LCA bifurcated in 66.67% cases, trifurcated in 23.33% cases and quadrifurcated in 10% specimens. Manickavasuki et al[26] noted that the main trunk of LCA was hypoplastic in 12% specimens, single branch in 2% specimens, bifurcated in 30%, trifurcated in 34% specimens, quadrifurcated in 16% and pentafurcated in 6%cases. Lakshmiprabhaet al[27]recorded that theLCA bifurcated in 30 specimens (54.54%), trifurcated in 23 specimens (41.82%), tetrafurcated in 1 specimen (1.82%) and pentafurcated in 1 specimen (1.82%).

Singh et al[28]in the year 2017 performed an investigation on 500 coronary angiograms in South Africa and found that the LCA was bifurcated in 65.8%, while trifurcation and quadrifurcation occurred in 20.4% and 1.6% respectively. The left coronary artery was absent in 11.8% of cases with the bifurcation and trifurcation of its branches in 10.8% and 1.4% respectively.

So, after comparing the observations made on the branching pattern of Left coronary artery (LCA) in the present study with those of the other authors it can be concluded that the most common pattern of branching is the bifurcation of LCA into Left anterior descending artery(LAD) and Left circumflexartery (LCx); and the least observed pattern is its pentafucration. The values recorded in thepresent study are nearer to those recorded by

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Kulkarni[22] and Ravi et al[23], but Kulkarni[22]recorded no tetrafurcation or pentafurcation whereas Ravi et al[23] recorded pentafurcation also in addition to bifurcation, trifurcation and tetrafurcation of the LCA. Baptista et al[12]and Dombe et al[18]also reported that there was a direct origin of the left anterior descending and circumflex artery from the ostium in 1.8% and 1.6% cases respectively.The difference seen between the values of present study and those recorded by other workers could be explained on the basis of geographic, ethnic and racial variations.

CONCLUSION

Due to wide range of variations in the branching pattern of left coronary artery, this study would be of great help to the surgeons, cardiologists and radiologists in diagnosing and performing various procedures like coronary arterycatheterization,angiography,angioplasty and bypass surgeries.

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