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LEFT MAIN CORONARY ARTERY RAMIFICATION – BIFURCATION VS TRIFURCATION

Anatomy

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ABSTRACT

BACK GROUND OF STUDY: A detailed awareness of branching pattern of left main coronary artery is of immense help for various diagnostic and therapeutic measures on coronary arteries, in this era of increasing coronary artery disease.

MATERIALS & METHODS: Fifty human hearts were included in the study group. The LMCA and its branches were studied in detail after removing the epicardium and subepicardial fat.

RESULTS: This dissection study on the ramification of LMCA could detect bifurcation , trifurcation and quadrifurcation in 76%, 22% and 2% respectively.

KEYWORDS

Left main coronary artery (LMCA), Left anterior descending artery (LAD), Left Circumflex artery (LCX)

INTRODUCTION

The increase in prevalence of Coronary artery Disease (CAD) has brought to focus certain aspects of coronary artery anatomy, which needs to be studied in detail. One such area is the Left Main Coronary Artery (LMCA) morphology, course and its branches. Because critical LMCA occlusion is of paramount importance which can cause sudden death in CAD patients, this has always been a challenging clinical scenario for both Cardiologists and Cardiac Surgeons. This is even more complex when the disease affects the terminal portion of LMCA (which shows different branching patterns like bifurcation/ trifurcation/ quadrifurcation). Understanding the prevalence of each type of ramification is of enormous help to the clinicians to reduce the complications in various interventional procedures and to plan grafts in coronary bypass operations.

AIMS AND OBJECTIVES

Though extensive studies were conducted on coronary arteries and their variations, only a few studies concentrated on the ramification of LMCA alone and its importance in clinical practice. Present study focused on the ramification of LMCA, since a sound knowledge on this topic would be helpful to interventional Cardiologists and Cardiac Surgeons when they deal with the corrective procedures of LMCA block.

MATERIALS AND METHODS

This human cadaveric study looked at the anatomical details of termination of LMCA in 50 hearts, in the Department of anatomy, Govt Medical College, Thiruvananthapuram, Kerala, India. Different patterns of termination of LMCA was studied in detail after removing the epicardium and sub epicardial fat. Photographs were taken after giving red colour to the arteries . The collected data was tabulated, analysed and compared with that of previous authors. Bar diagrams showing the frequency of each pattern, were prepared.

RESULTS AND ANALYSIS

Bifurcation (Fig 1) was noticed in 76% followed by trifurcation (Fig 2) in 22%. One specimen (2%) showed quadrifurcation (Fig 3) in which the left main trunk divided into four branches. Data is shown in Table 1 and Figure 4. Present study result also goes in accordance with the reports by other authors (Table 2), with a high prevalence of bifurcation.

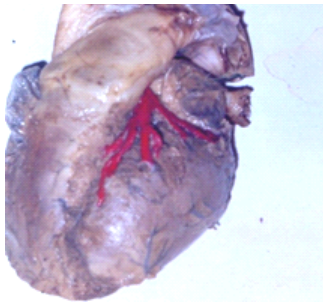

FIG 1. Bifurcation of LMCA

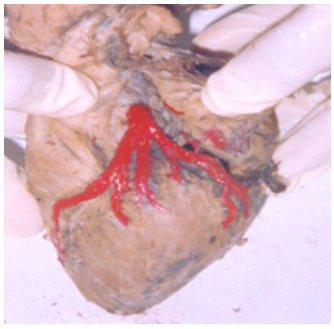

FIG 2. Trifurcation of LMCA

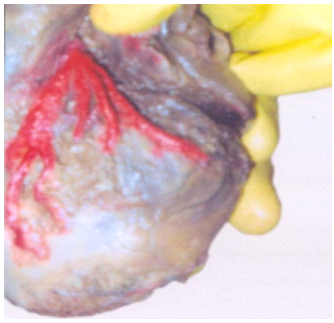

FIG 3. Quadrifurcation of LMCA

Table 1 Ramification of LMCA

Type	Total (50)	
	Number	Percentage (%)
Bifurcation	38	76 %
Trifurcation	11	22%
Quadrifurcation	1	2%

Table 2 Ramification of LMCA – Comparative analysis

	Authors	Bifurcation	Trifurcation	Quadrifurcation	Pentafurcation
1	Hirak[7]	60%	35%	5%	
2	Ortale et al[8]	50%	46%	4%	
3	Nickolic et al[9]	74.6%	23.6%	1.8%	
4	Ajayi et al[5]	78.2%	20.4%	1.4%	
5	Patel et al[18]	74%	18%	6%	2%
6	Lakshmi et al[10]	60%	28%	10%	2%
7	Present study	76%	22%	2%	

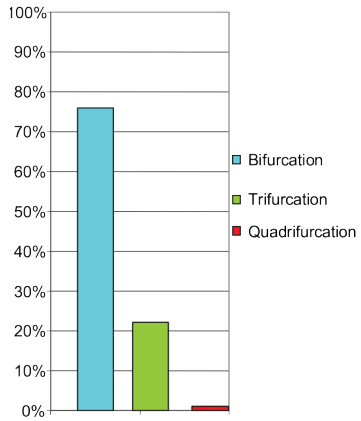

FIG 4. Bar diagrams showing ramification of LMCA

DISCUSSION

Left Main Coronary Artery (LMCA) is a major arterial trunk which divides into Left Anterior Descending artery – LAD (anterior inter ventricular artery) and Left Circumflex artery (LCX) soon after its origin from left coronary sinus (bifurcation of LMCA). The anterior ventricular branches which arise from LAD supply both right and left ventricles. One of these left ventricular branches is large and arises separately from LMCA at the junction of LAD and LCX . This is known as Diagonal artery (trifurcation of LMCA). This left diagonal artery is reported in 33-50 % or more individuals,which may be duplicated sometimes (Gray[1]). Banchi[2] termed these complimentary branches as Median arteries. The Median artery originates in the vertex of the angle formed by the main terminal branches of LMCA, possesses a substantial caliber and has an area of distribution extending half way down the free wall of left ventricle (Angelini[3], James[4]).

Ajayi et al[5] proposes the term ' Left ramus medianus artery 'as the nomenclature for this additional terminal branch of LMCA and highlights the importance of identification of this vessel as the extent of its supply may decrease the effect of occlusion of LCX and LAD on myocardium. They opine that these branches have no unanimity regarding their anatomical nomenclature.

Angiographic and dissection studies, done by Lujinovic et al[6] show high prevalence of trifurcation (35%) in dissected specimens than in angiograms (29%). Hirak[7] reported 35% prevalence of trifurcation in Assamese population. Diagonal artery and its anastomoses presents important pattern of collateral circulation, which has special meaning under conditions of coronary insufficiency. The higher prevalence of trifurcation (46%) was detected by Ortale et al[8]also.

Branching pattern of LMCA in nonhuman primates was studied by Nickolic et al[9]. They observed myocardial bridges over the diagonal branch. According to them, the branching pattern, spatial distribution and the presence of myocardial bridges all show the similarity of the coronary arteries to that of human coronary arteries.

As per Lakshmi et al[10] LMCA shows abundant variations in branching pattern. (1) Bifurcation into LAD and LCX (most common type). (2)Trifurcation into LAD, LCX and a diagonal branch.(3) Quadrifurcation into LAD, LCX and two diagonal branches. (4) Pentafurcation gives off LAD, LCX and three diagonal branches. Chethan et al[11] studied the relation between the coronary artery dominance and LMCA division. They reported that quadrifurcation was seen only in right dominant hearts.

A study by Ogengo et al[12] in Kenyan population, describes variant patterns of termination of LMCA in more than 45% cases. In their reports also the most frequent termination pattern was bifurcation (54.8%), followed by trifurcation (32.2%), quadrifurcation (9.6%) and pentafurcation (3.4%) which calls for extra caution during interventional coronary angiography, instrumentation and surgery.

Identification of the median artery is important clinically even though its area of distribution is small because in its absence, that area is supplied by branches of LCX and LAD. So in the occlusion of LCX and LAD, more area is affected. When this median artery is present, its origin is the frequent site of narrowing (Dombe et al[13]).

An interesting observation regarding the terminology of diagonal branch was done by Agnihotri et al[14]. In their opinion the wide range in frequency of trifurcation of LMCA could 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 LAD and LCX, whereas a broader approach envisages that the diagonal artery originates in the vertex of the angle formed by the terminal branches of LMCA or in the initial millimetres of LAD and LCX.

Beton et al[15] did a detailed study on LMCA termination, considering its cranial take off angle at aortopulmonary junction and subclassified the bifurcated vessel into 3 types. Their study results also show high prevalence for bifurcation (67.7%). Diwan et al[16] opine that the recognition of variations of LMCA termination is important because it may cause technical difficulties during coronary catheterization and stenting, because of its potential supply to a significant territory of myocardium. Their stdudy on coronary angiograms shows high prevalence of trifurcation in males.

Tyczynski et al[17] mention an interesting case of pentafurcation of LMCA with significant ostial lesions in LAD as well as in three intermediate branches and tandem lesions in the RCA . A detailed knowledge of LMCA termination is important to minimize misinterpretation of coronary angiograms and inadvertent vascular injuries. Patel et al[18] report pentafurcation in 2% specimens.

Percutaneous treatment of LMCA bifurcation for acute coronary syndrome (ACS) is complex and associated with poorer results as per Tyczynski's[19] study reports. They observe that when additional branches take off from the LMCA, Percutaneous Coronary Intervention (PCI) may be challenging. Additionally, they propose modified Medina classification for quadrifurcation lesions. They state that surgery is the gold standard procedure for atherosclerotic lesions of quadrifurcated LMCA, in stable patients.

CONCLUSION

Present human cadaveric study on the ramification of LMCA could detect bifurcation , trifurcation and quadrifurcation in 76%, 22% and 2% respectively. This result is almost similar to that of other reports in different geographical population. An extensive knowledge on the variations of LMCA branching pattern and territory of supply of each branch will be helpful to interventional cardiologists and cardiac surgeons during management of atherosclerotic lesions of these vessels.

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