Section: Anatomy

Original Research Article

AN ANGIOGRAPHIC STUDY OF LEFT CORONARY ARTERY VARIATIONS: IMPLICATIONS FOR ACUTE CORONARY SYNDROME MANAGEMENT

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ABSTRACT

Background: Cardiovascular diseases are the leading cause of mortality globally, accounting for one-third of all deaths. Coronary artery variations can complicate procedures like coronary artery bypass grafting (CABG) and percutaneous coronary interventions (PCI). This study aims to evaluate LCA variations, including branching patterns, proximal lengths, angles of division, and dominance, in patients with acute coronary syndromes (ACS).

Material and Methods: This cross-sectional study was conducted at GSL Medical College, East Godavari District, Andhra Pradesh, over one year (January–December 2014). A total of 234 coronary angiograms were analyzed. Patients aged 40–60 years presenting with ACS (Acute coronary syndrome) were included, while those with valvular heart disease, severe vessel tortuosity, or previous CABG were excluded. Parameters studied included branching patterns, angles of division, proximal lengths of LCA branches, and coronary dominance. Data were analyzed using SPSS, with $p < 0.05$ considered statistically significant.

Results: Branching Patterns: Bifurcation (82.9%) was more common than trifurcation (17%). Angles of Division: The mean angle of division between AIA (anterior interosseous artery) and CX (The circumflex artery) in bifurcation patterns was 156.4° ± 16.4°. Angles in bifurcation patterns were significantly larger than in trifurcation ($p < 0.0001$). No significant differences were found between male and female angles. Proximal Lengths: The average lengths of LCA, AIA, RM, and CX were 10 mm, 25 mm, 32 mm, and 19 mm, respectively. No correlation was found between proximal artery lengths and branching patterns due to limited quadrification cases.

Conclusion: This study highlights critical anatomical variations in LCA branching patterns, angles, and lengths. Awareness of these variations is essential for minimizing procedural complications in CABG and PCI, enhancing outcomes in patients with ACS.

Keywords: Coronary artery variations, Left Coronary Artery, Angiography, Acute Coronary Syndrome, Bifurcation, Trifurcation, Coronary dominance.

INTRODUCTION

Cardiovascular diseases are the leading cause of mortality worldwide; responsible for one-third of all deaths. With the ever increasing load of coronary heart diseases, a detailed study of coronary arteries is necessary to know the variations, basing on which the problems occurring during Coronary artery bypass grafting (CABG) can be prevented to some extent.[1]

There are two coronary arteries, Right Coronary Artery (RCA) and Left Coronary Artery (LCA) which delivers oxygen-rich blood to the heart. The Left Coronary Artery (LCA) is an artery of great challenge for interventional Cardiologists and Radiologists.[2] Therefore a detailed knowledge of

its anatomy is mandatory for avoiding misdiagnosis of left coronary illnesses and for proper placement of a stent during percutaneous coronary intervention. Proficiency in the anatomy of coronary arteries and their variations is significant for proper interpretation of the coronary angiographies, assessment of the complexity and result of the coronary insufficiency as well as surgical myocardium revascularization. LCA presents a wide range of variations in its origin, length and branching pattern. Knowledge of these variations is of paramount importance in management of acquired heart diseases. Failure to distinguish these variations may lead to misinterpretations and complications during heart surgery.[3,4]

The right coronary artery supplies all of the right ventricle (except a small region to the right of the anterior interventricular groove); a variable part of the diaphragmatic aspect of the left ventricle; the posteroinferior one-third of the intraventricular septum; the right atrium and part of the left atrium; the conduction system as far as the proximal parts of the right and left crura. Left coronary distribution is reciprocal, and includes most of the left ventricle; a narrow strip of right ventricle; the anterior two-thirds of the interventricular septum; most of the left atrium.[5,6]

The aims of the study is to identify variations of coronary arteries in angiograms of Acute coronary syndrome patients and to correlate with normal anatomy of coronary arteries. To study the proximal lengths of the LCA, CX, angle of divisions, branching pattern and coronary dominance pattern in this study.

MATERIALS AND METHODS

It was a Cross sectional study conducted at GSL Medical College, East Godavari District, Andhra Pradesh for a period of One year, 1st January 2014 – 31st December 2014. 234 consecutive coronary angiograms obtained from the cardiac catheterization laboratory, after taking consent and permission from concerned patients and authorities. Underwent coronary angiography for evaluation of symptoms of chest pain and ischemic heart diseases at Department of Cardiology, GSL Medical College, East Godavari District.

Inclusion Criteria

- Evaluation of symptoms of chest pain and ischemic heart diseases
- Patients with Acute coronary syndromes
- (patients of age 40 -60 yrs)

Exclusion Criteria

- Patients with Valvular heart disease, left ventricular hypertrophy.
- Patients who have severe tortuous vessels.
- Children, young adults.
- Patients who have undergone coronary artery bypass grafting. (CABG).
- Congenital anomalies of heart.

The baseline clinical status and angiograms of patients where obtained from G.S.L Medical College, Rajahmundry, East Godavari district, after ethical clearance.

The following parameters where taken for study

- Branching pattern
- Angle of division between branches of LCA.
- Proximal lengths of LCA, RM, CX.
- Dominance.

Statistical Analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS). Proportions were compared by using ANOVA and Kruskal wallis test to find out the statistical significance. Value of $p < 0.05$ is considered as statistically significant. Statistical analyses were made for all variables separately and they are analysed accordingly.

RESULTS

Table 1: The maximum and minimum angles of division AIA – CX, AIA – RM, RM -CX in Males and Females

Angle of division	Mean Values (in degree)		P value
	Females	Males	
AIA – CX	72.5	77.4	0.14
AIA – RM	58.7	73.1	0.08
RM -CX	47.27	50.7	0.56

As per table 1 in the present study the mean angle of division between AIA and CX of LCA was 156.40 – 16.40. The mean angle of division of trifurcation pattern was 103.40 – 27.70. The angle of division was increased in bifurcation patterns than trifurcation pattern. The angle of division in bifurcation pattern in the present study shows a significant increase. P values 0.14, 0.08, 0.56 of AIA-CX, AIA-RM, RM-CX. The angles of division in females and males where recorded, in females AIA – CX (72.50), AIA – RM (58.70), RM – CX (47.270) and in males were 77.40, 73.10, 50.70 respectively and the p values were 0.14, 0.08, 0.56 which concludes that the angles of division does not significantly vary between females and males. Although there are no previous records about comparing angles of division between females and males.

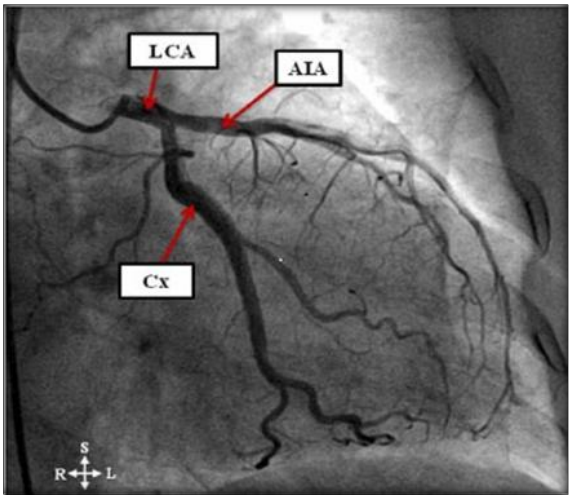

Figure 1: Showing LCA, AIA, CX, bifurcation

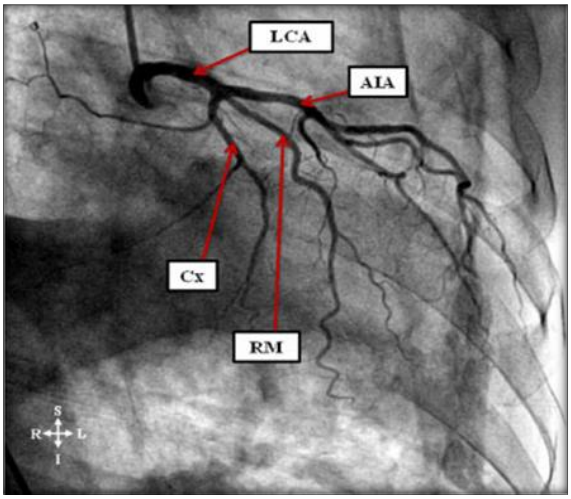

Figure 2: Showing LCA, AIA, RM, CX, trifurcation

Table 2 (a,b): Lengths of proximal arteries LCA, AIA, CX with their mean and p values among females and Males

FEMALES			
LENGTH	**BIFURCATION**	**TRIFURCATION**	**P VALUE**
LCA	1cm (10mm)	0.7cm (7mm)	0.06
AIA	2.4cm (24mm)	3cm (30mm)	0.21
CX	1.9cm (19mm)	2.6cm (26mm)	0.1

MALES			
LENGTH	**BIFURCATION**	**TRIFURCATION**	**P VALUE**
LCA	1cm (10mm)	1cm (10mm)	0.83
AIA	2.3cm (23mm)	2.9cm (29mm)	0.08
CX	1.9cm (19mm)	2cm (20mm)	0.41

As per table 2 comparing the mean length of the LCA between males and females in adults. There was no statistically significant difference in the mean length of the LCA recorded for males (10.3±4.1 mm) and females (10.6±4.4 mm) in the. In the different branching patterns, the mean length of the LCA in the bifurcation and trifurcation patterns were 10.1 mm and 11.4 mm for the bifurcation and trifurcation of the LCA, respectively. The single specimen that presented with a quadrification pattern had a length of 14.8 mm.

Table 3: Lengths of proximal arteries of 1- LCA, 2- AIA, 3- RM, 4- CX (QUADRIFICATION)

MEAN VALUES OF PROXIMAL LENGTH OF THE ARTERIES			
LENGTH	**FEMALE**	**MALE**	**P VALUE**
LCA	0.9cm (9mm)	1cm (10mm)	0.35
AIA	2.5cm (25mm)	2.4cm (24mm)	0.8
RM	3.1cm (31mm)	3.2cm (32mm)	0.8
CX	2 cm (20mm)	1.9cm (19mm)	0.66

As per table 3 this study confirms that the mean length of LCA is longer in trifurcation than in bifurcation pattern. However, it could not validate the association between the lengths of the LCA and its branching pattern due to the small sample size of the quadrification pattern in this study. Furthermore, this finding may therefore suggest that a higher number of LCA branches is associated with longer LCA length. The average proximal lengths of LCA, AIA, RM, CX in the present study are 10, 25, 32, 19 measured in millimetres (mm) respectively. The lengths of the arteries come under long arteries as per Reig & Petit classification. There was no correlation between length and dominance, and angle of division as in the present study the dominance was right dominant. There was no correlation between angle of division and lengths of the arteries.

DISCUSSIONS

The length of LCA was measured in each of the angiograms from its orifice, which is visualised by spillback of contrast medium into the aorta during selective injection, to its point of division into its terminal branches. LCA Measurements in all patients were made in a single frame projection that shows its point of branching clearly.

The branching patterns of LCA were recorded as 122/151 (80.8%), 28/151 (18.5%) and 1/151(0.7%) for bifurcation, trifurcation by AJAYI, N. O et al, whereas in the present study the branching pattern

of LCA were recorded as 194/234 (82.9%), 40/234 (17%) for bifurcation and trifurcation respectively.[3]
The mean angle of division between the two main branches, AIA and Cx arteries of the LCA was 86.20 ± 26.10. This is similar to the value (86.7º) reported by Reig & Petit but it differs from a CT study by Bergman et al,[4] who reported a mean angle of 69.30. The mean angle of division in the trifurcation pattern was 105.10 (range 51.3º – 168.5º) was significantly larger than the mean angle of 81.3º (range 27º – 148.6º) recorded for the bifurcation of the LCA (p= 0.0001). Therefore, the result of the study by AJAYI, N. O et al reports a significant increase in the angle of division of the LCA in the presence of RM artery.[3]
A wide variety of branching pattern of LCA was reported in previous studies conducted on different populations, and the most common branching pattern of LCA reported till date is bifurcation into LAD & LCX arteries. Results of the further study are with earlier reports that bifurcation is the most common branching pattern. The incidence of bifurcation in the present study is greater than that reported by some authors. Trifurcation is less common and lowest reported in the present study. The incidence of both these patterns did not differ significantly between males and females (p value 0.825).
Usually the incidence of bifurcation is more than the incidence of trifurcation, although reported exactly the same incidence of both these patterns and Fazluogullari Z et al reported almost equal incidence. In the their study the incidence of trifurcation (24%) is approximately one third the incidence of bifurcation (76%).[6]
Considering the of extreme values, Reig & Petit classified the LCA as 'short' if it is < 5mm and 'long' if it is > 15 mm. AJAYI, N. O et al reported that the LCA length was recorded < 5 mm in 8 (5.3%) and > 15 mm in 16 (10.6%) of the angiograms. Tomar et al. noted that the early bifurcation of the LCA may cause peri-operative occlusion of its main branch by a balloon-tipped perfusion cannula with resultant myocardial infarction, and in such cases, separate cannulation of the AIA and Cx artery is recommended. Therefore, 5.3% of the sample population could be at risk of iatrogenic myocardial ischemia.[5]
In the present study we found that 4 cases (4.5%) having separate ostia for LAD and LCx while Cengiz et al, in Kenya show 2% for separate ostia, both of them was a post-mortem studies, this differences probably related to racial differences.[7]
Dr Tomar S et al conducted a study in which 43% of the cases, the length of LMCA was between 5-15 mm (normal range), 38% of the cases of the LMCA length was less than 5 mm (short) and 13.6% were long (more than 15 mm), these results was compatible in which the incidence of normal length of LMCA (5-15) was high and the incidence of long LMCA was low.[5]
David et al and few studies found a correlation between length of main trunk of LCA and the location of atherosclerotic lesions in CAD. They found a much shorter mean length of main LCA in patients with proximal CAD than those with distal lesions. The length of LAD and CX arteries is inversely proportional to the length of main trunk of LCA. Thus a shorter main trunk of LCA is associated with long untethered proximal segments in the LAD and LCX arteries which may then be prone to excessive systolic motion and hence to increased risk of atheromatous degeneration.[8,9,10]
The length of main trunk of LCA is an anatomical variable which alter haemodynamics and thus may affect distribution of atherosclerotic lesions. In view of the poor prognosis of proximal lesions and their suitability for bypass grafting, the discovery of innate anatomical risk factors which favors their formation is of importance.
The condition in which a coronary artery segment tunnelled within a band of myocardial muscle is named as myocardial bridge (MB). This is accepted to be a benign variant and asymptomatic in most of the cases.[11,12] On the other hand, MB can be clinically significant and may cause various clinical manifestations such as malignant arrhythmias, myocardial infarction and sudden death in rare instances by systolic compression of the tunneled segment persisting into diastole during stress and changing regional hemodynamics that contribute to atherosclerotic plaque formation proximal to the bridge in a higher frequency.[12]

CONCLUSION

The branching patterns of LCA were recorded as 122/151 (80.8%), 28/151 (18.5%) and 1/151(0.7%) for bifurcation, trifurcation, the branching pattern of LCA were recorded as 194/234 (82.9%), 40/234 (17%) for bifurcation and trifurcation respectively.
The average proximal lengths of LCA, AIA, RM, CX in the present study are 10, 25, 32, 19 measured in millimetres (mm) respectively. The lengths of the arteries come under long arteries. There was no correlation between length and dominance, and angle of division as in the present study the dominance was right dominant. There was no correlation between angle of division and lengths of the arteries.
Anatomic variations of the heart vessels are usually common, RCA is the most common anatomical dominance pattern in the heart. The understanding of the LCA anatomy is of clinical importance due to the extensive use of radiographic images for diagnostic and interventional purposes. The present study did not find a significant correlation between the length of the LCA and its angle of division, further study with a large sample size may be considered. A detailed knowledge of the LCA anatomy and its variations is of clinical importance in the management of patients with coronary arterial

diseases. There seems to be no significant difference between the findings from this study and others from different populations. In conclusion, Cardiologists and Cardiac surgeons should be familiar with these entities for the proper management of patients undergoing cardiac surgery or coronary angioplasty.

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