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Left Main Coronary Artery Angiographic Profile In Left Dominant Coronary System - A Prospective Observational Study

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Abstract

Introduction: Coronary arterial systems have been divided into right, left and codominant system based on the artery which gives the PDA and PLB branches. Although the left dominant system comprises only 10-20% of the total population still the mortality/morbidity associated with acute coronary syndrome in patients with left dominant system is high and studies show that the left main anatomy in the left dominant system differs from right dominant system making it difficult to intervene. This study was done to evaluate these characteristics which can affect prognosis and ease of intervention.

Methods: This prospective observational study was conducted on patients who were admitted in department of cardiology with stable coronary artery disease or ACS and underwent angiography in department's cath lab. The length, width and bifurcation angle of the left main coronary artery was measured by automated edge detection on quantitative coronary angiography in all the patients.

Results: Coronary angiogram of 499 patients were analyzed, out of which **67 (13.4%)** were codominant, **80 (16.0%)** were left dominant and **352 (70.5%)** were right dominant. The mean length of left main in right dominant system was **9.57mm** and that in left dominant system was significantly shorter i.e., **7.41mm (p<0.05).** The mean width of the left main was **4.07, 4.00, 4.17mm** in right, left and codominant system respectively, so it was narrowest in left dominant system although not significantly(p=.236). The bifurcation angle was <90 in **100 patients (28.4%)** of right dominant system and **51 (63.8%)** of left dominant system. Also, out of the **7** deaths which was recorded in the population 5 were cases who had left dominant system.

Conclusion: The left main coronary artery in left dominant system is shorter and slightly narrower with a higher percentage of acute bifurcation angle as compared to the right and co dominant systems. These anatomic characteristics can be taken into account while explaining the bad prognosis in patients with left dominant system as they may be responsible for difficult intervention in left dominant system.

Keywords: Left dominant, Angiography, Left Main, Myocardial infarction, PCI

Introduction

The heart vasculature comprises three main epicardial arteries that divide into smaller, thinner branches that eventually form the arterioles. The main epicardial vessels are the left main coronary artery (LMCA) and the right coronary artery (RCA).

The RCA originates from the right sinus of Valsalva and courses across the right atrioventricular (AV) groove. Proximal RCA gives branches for the right atrium, the SA node in 60% of cases, and the branch to the conus. At the acute margin of the ventricle, the RCA provides the acute margin branch.

The RCA then continues to the crux cordis (where the AV groove intersects the posterior

interventricular sulcus), where it branches into the posterior descending artery (PDA) and the posterolateral (PL) branches. This anatomy is the most common and is termed *right coronary dominance.*

Approximately 80% of the population displays a right dominance, meaning both the PDA and the PL branches are supplied by the RCA, while 10% of the population has a *left coronary dominance*, with PDA and PL branches deriving from the left circumflex artery (LCx) artery.

The remaining 10% display codominance, or balanced coronary dominance, with the PDA arising from the RCA and the PL branches arising from the Cx.

There have been a large number of studies conducted to determine the significance of cardiac dominance on patient outcome and pathology. Most of them concluded that left dominant circulation is associated with worse outcomes in different settings They also concluded that left main disease has an additional prognostic value among patients with left heart dominant circulation. Parikh et al determined that Left and codominant coronary artery circulation confer modestly increased risk of in-hospital mortality after percutaneous coronary intervention (PCI) for acute coronary syndrome (ACS), particularly in lesions in the LM/LCx territory [1]. Kuno et al concluded that, a dominant LCx has several acute angles in its course, including at its origin [2].

Despite this the exact anatomical and angiographic profile of the Left main coronary artery in these patients and its relation to prognosis is largely unknown.

So this study was aimed to find out angiographic/anatomical characteristics of the left main coronary artery in left dominant system in terms of its length, width and bifurcation angle and its comparison with other systems and to assess whether these findings had an impact on the overall prognosis in these patients

Aims And Objectives

To study the Left Main Coronary Artery angiographic profile in patients with left dominant coronary system.

To find out the anatomical/angiographic characteristics of left main coronary artery in left dominant system and their potential effect on prognosis.

Materials And Method

This was a prospective observational study conducted in the department of cardiology, Govt. Kilpauk Medical College and Associated Hospitals, Chennai. Coronary angiograms of 499 patients who underwent the procedure in department's catheterisation laboratory from January 2021 to December 2021 were studied following a total consecutive method of sampling. Prior to the commencement of this study, the research protocol was approved by the Research Review Committee of Department of Cardiology and the Ethical Committee of Govt. Kilpauk Medical College.

Patients with Stable CAD, Acute Coronary syndrome or any other diagnoses, either treatment naïve or on optimal medical management and undergoing coronary angiogram in the department were included after they gave proper informed consent, excluding those who had a prior history of PCI or had severe triple vessel disease or showed trifurcation of the left main coronary artery. Coronary angiograms were performed via either radial or femoral approach in all standard views. In selected cases additional views were taken. Angiograms were analysed visually for severity of stenosis and types of lesion. The length, width and bifurcation angle of the LMCA was measured by automated edge detection on quantitative coronary angiography in all the patients.

Parameters recorded in patients with left, right and codominant systems were length, width and bifurcation angle of the LMCA, Severity of Coronary artery disease in LMCA/Left anterior descending artery/ left circumflex artery in terms of lesion location, severity, length and eccentricity. Sociodemographic details of the patients were recorded. Data collection was done on online platform using google forms with all the relevant variables.

Statistical Analysis

The collected data was downloaded in MS excel format and checked for normalcy. Appropriate

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statistical tests were used for analysis. P value <0.05 was taken as significant. The records were explored by employing SPSS version 22.0 statistical software acquired by International Business Machines (IBM) Company, developed by Norman H. Nie, Address: Corporate headquarters, 1 New Orchard Road Armonk, New York, USA 10504-1722.

Tools And Definitions Used:

These measurements were carried out using computer assisted algorithms to perform automated edge detection on quantitative coronary angiography.

Stenoses were defined as minimal if the narrowing is less than 50%, moderate between 50% and 70%, and severe or significant for a diameter reduction of 70% or more.

Results

Baseline Characteristics:-

Minimum age was 25 yrs and maximum age was 80 yrs. Mean age was 52.17 yrs. 368 (73.7%) were males and 131 (26.3%) were females.

Diabetes mellitus was the most common risk factor (n=182,36.5%) followed by hypertension (n=162,32.5%). Smoking was reported by 94 patients (18.8%). 34 (6.8%) were known case of coronary artery disease while 12 (2.4%) were obese.

Table 1-Baseline characteristics of the patients (n=499)

S .No	Variables	Numbers,N (%)
1	Age	52.17
2	Gender(male/female)	368/131 (73.7/26.3)
3	Diabetes	182 (36.5)
4	Hypertension	162 (32.5%)
5	Coronary artery disease	34 (6.8%)
6	Smoking	94 (18.8%)
7	Obesity	12 (2.4%)

Clinical Characteristics: -

177(34.1%) patients presented with anterior wall myocardial infarction (AWMI) while 122 (24.4%) had chronic stable angina (CSA). 120 (24.0%) patients had inferior wall myocardial infarction(IWMI). The number of patients with non ST elevation myocardial infarction (NSTEMI) and unstable angina were 61(12.2%) and 9(1.8%) respectively. Remaining 10 patients had other diagnoses like ischemic cardiomyopathy, severe valvular heart disease, intracardiac mass or preoperative patients. Out of the total 294 patients of ST elevation myocardial infarction 233(78.4%) were thrombolysed (230 with streptokinase and 3 with Tenecteplase).

Table 2. Clinical characteristics of the patients (n=499)

S. No.	Clinical Diagnoses	Number, N (%)
1	AWMI	177(34.1%)
2	IWMI	120(24.0%)
3	CSA	122(24.4%)
4	Unstable Angina	9(1.8%)
5	NSTEMI	61(12.2%)

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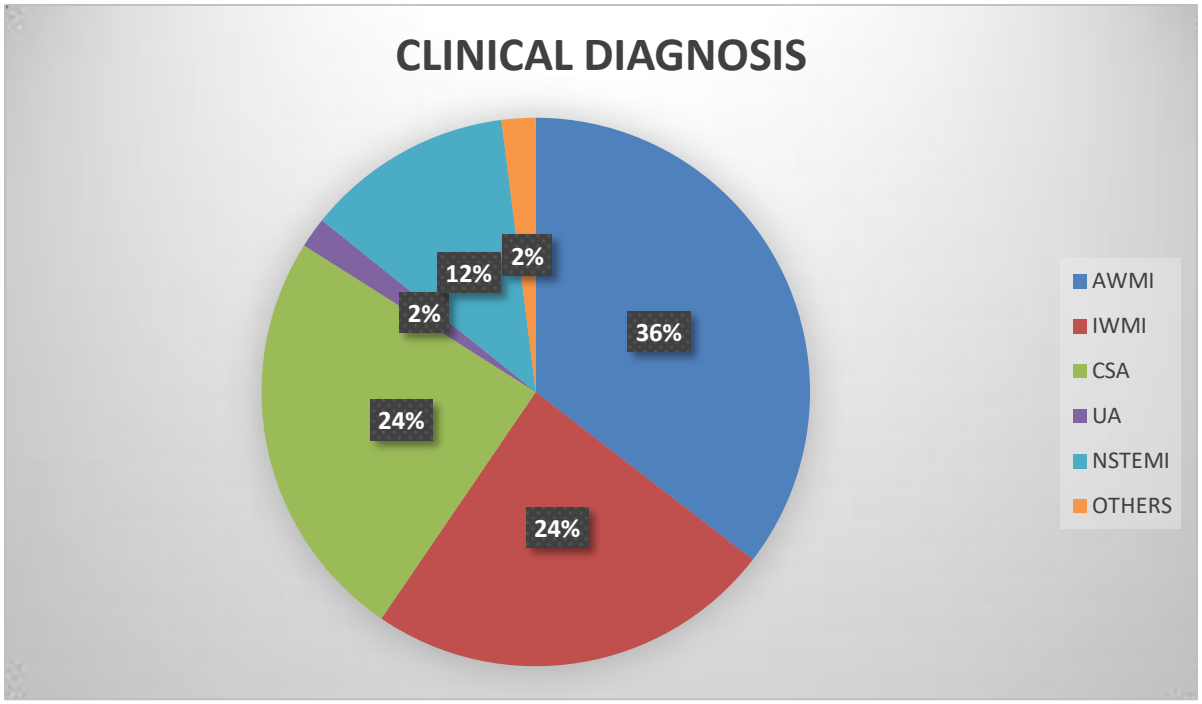
6	Others	10(2.0%)

AWMI: Anterior wall myocardial infarction; IWMI: Inferior wall myocardial infarction; NSTEMI: Non- ST elevation MI; CSA: Chronic stable angina; UA: Unstable angina



AWMI: Anterior wall myocardial infarction; IWMI: Inferior wall myocardial infarction; NSTEMI: Non- ST elevation MI; CSA: Chronic stable angina; UA: Unstable angina

In hospital outcomes:-

During the course of hospitalisation major complications developed in 81 patients out of which majority (30, 6.0%) had acute pulmonary edema. 26 patients developed arrythmias including bradyarrhythmia and tachyarrhythmias and 16 developed cardiogenic shock. two patients died due to sudden cardiac death while another 5 patients died due to other causes like cardiogenic shock, refractory arrhythmias etc. Rest 418 (83.6%) patients had an uneventful course of hospitalisation.

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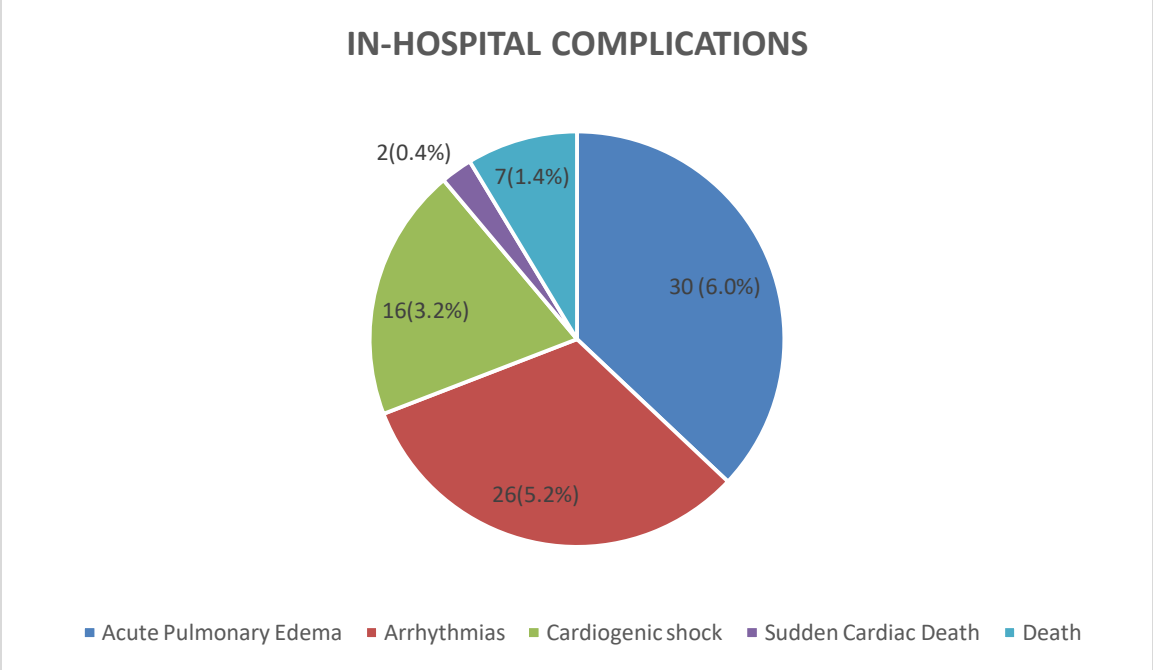
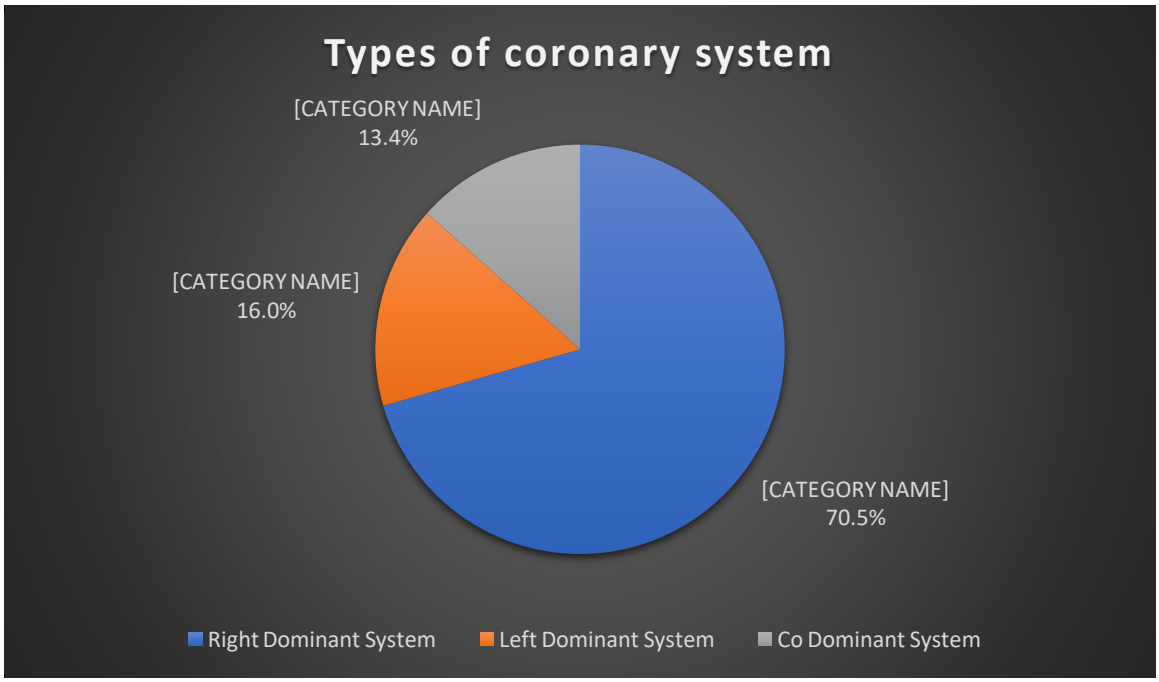


Coronary angiographic data and percutaneous coronary intervention:-

Angiography was done by either radial route after Allen's test or femoral route (TIG Cath-Terumo Inc., USA; JL/JR Medtronic, USA) in 499 patients. Of the total 499 patients right radial artery approach was used in 339 patients and right femoral artery approach was used in 158 patients. Right ulnar artery approach was used in 2 patients. 352(70.5%) patients had right dominant system, 80(16.0%) had left dominant system and 67(13.4%) had codominant system.



Angiograms of 85 patients were normal i.e, showed normal epicardial coronaries while 6 patients had recanalized culprit artery post lysis. 56 (11.4%) patients had minimal/borderline stenosis that did not warrant intervention. 151(30.4%) had single vessel disease, 97(19.4%) had double vessel and 67(13.4%) had triple vessel disease. Left main disease was present in 28 (5.1%) patients.

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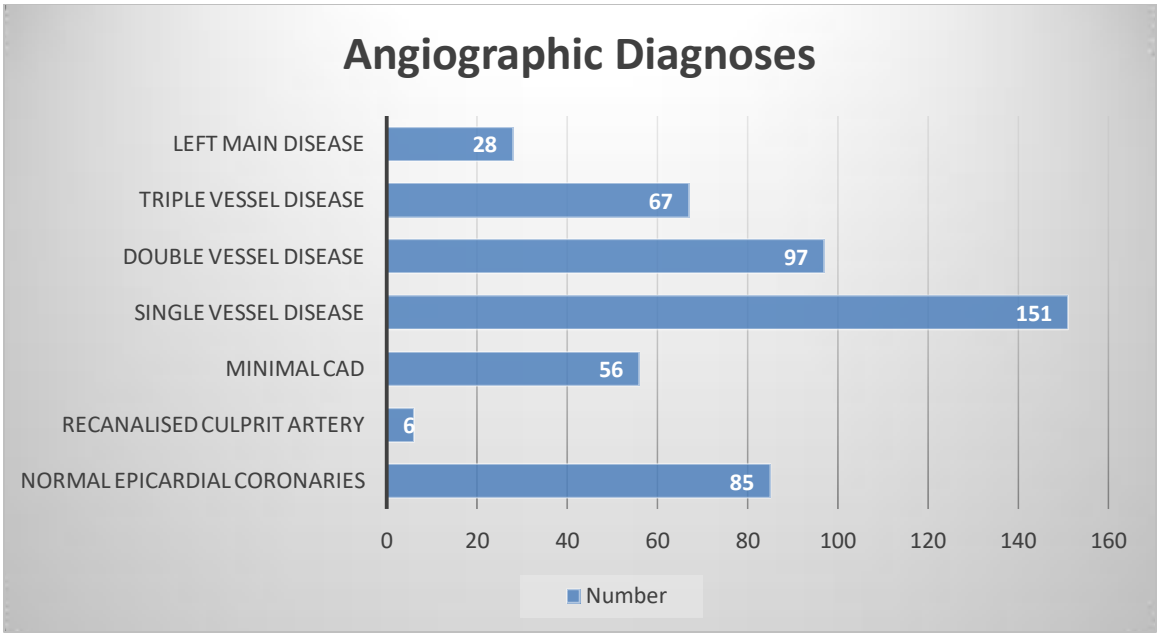
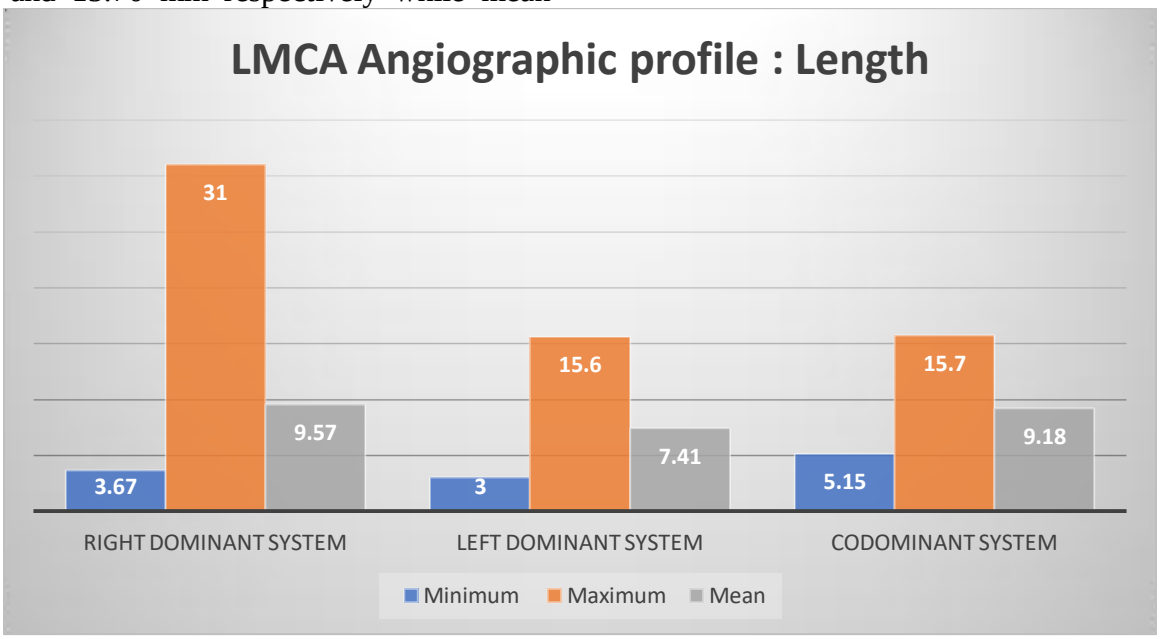


A total of 226 percutaneous transluminal coronary angioplasty was performed and out of which maximum 159 were done for single vessel disease with maximum 116 on left anterior descending artery.

Coming to LMCA angiographic profile, left main was absent in 6 (1.2%) patients. And in these patients left anterior descending and left circumflex arteries had separate ostia. In patients with right dominant system the minimum and maximum lengths of the left main was 3.67mm and 31.00mm respectively, the mean length was 9.57mm. In patients with codominant system minimum and maximum lengths were 5.15 and 15.70 mm respectively while mean length was 9.18 mm. Finally, in patients with left dominant system the minimum and maximum lengths were 3.00mm and 15.60mm respectively. The mean length was 7.41mm ($p<0.0001$).The minimum and maximum widths of left main coronary artery in right dominant system were 1.50mm and 6.40mm respectively and the mean width was 4.07mm. In codominant system minimum and maximum widths were 3.10 and 5.35mm respectively while mean was 4.17mm. In left dominant system the minimum and maximum widths were 2.80mm and 5.69mm respectively and the mean width was 4.00mm ($p<.236$).



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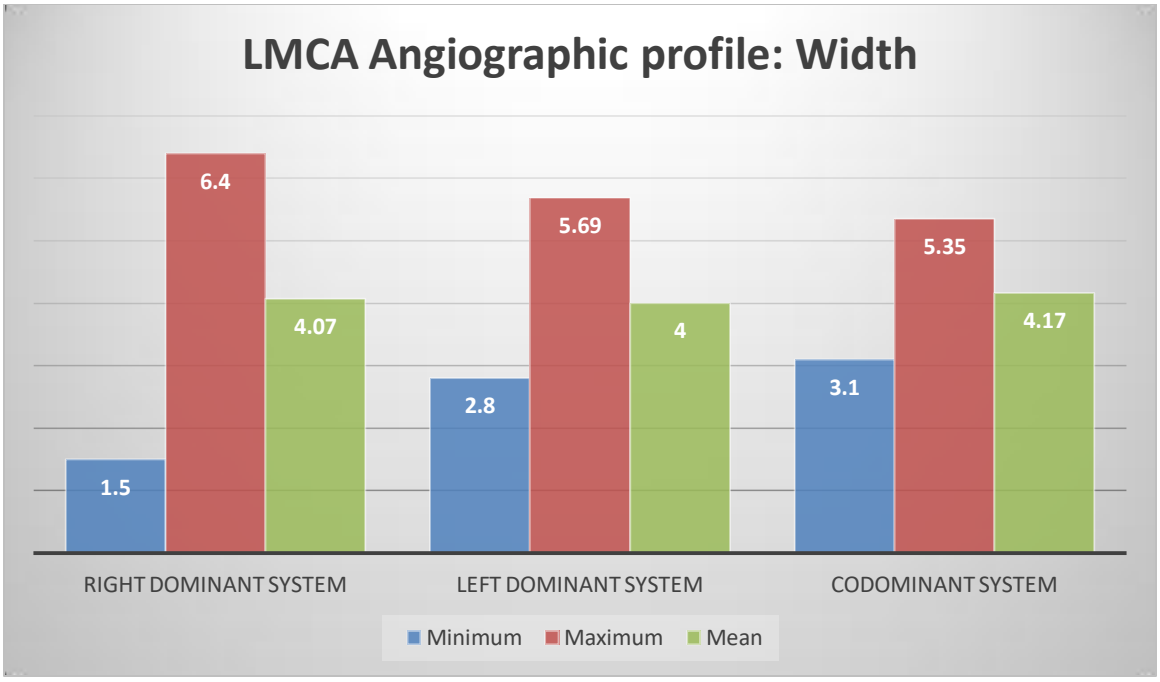
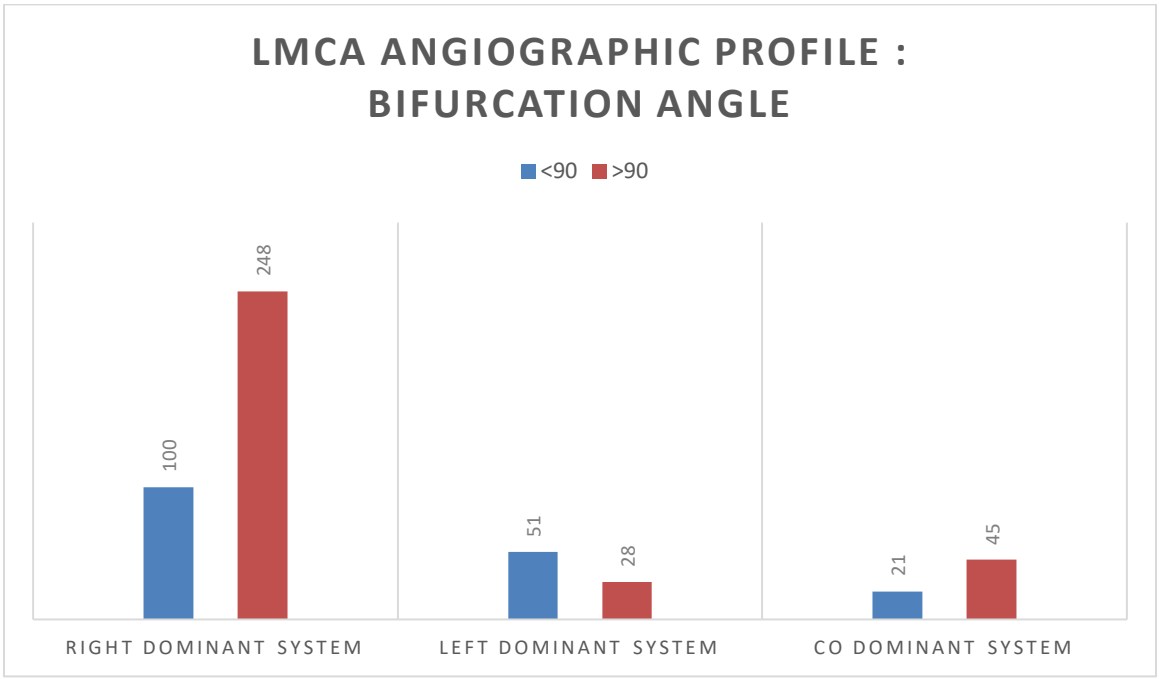


The bifurcation angle was <90 in **100 patients (28.4%)** of right dominant system, **51 (63.8%)** of left dominant system and **22 (32.8%)** of the codominant system. So, the bifurcation angle was acute in more percentage of patients with left dominant system



Mortality data:-

Total of 7 patients of this cohort died during the course of index hospitalisation. 2 of them died due to sudden cardiac arrest and rest succumbed to cardiogenic shock or refractory arryhthmia. Out of these patients 5 had left dominant system and 2 had right dominant system ($p<0.001$). 6 patients succumbed to the complications of the procedure (PCI) and one died after coronary angiogram.

Discussion

This prospective observational study was conducted on 499 patients with coronary artery disease admitted at government kilpauk medical college, Chennai who underwent coronary angiogram. After matching the inclusion criteria 499 patients were recruited in the

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study and coronary angiogram was performed. Measurements of length, width and bifurcation angle of the left main coronary artery were recorded using automated edge detection and visual estimation on the quantitative coronary angiography.

Studies comparing these parameters in different types of coronary circulation are lacking. In fact, we couldn't find any such study done previously. However, a number of studies have assessed the significance of cardiac dominance on patient outcome and pathology.

Most of them concluded that left dominant circulation is associated with worse outcomes in different settings. Left heart dominance was described to be a high-risk feature for percutaneous coronary intervention as well. Omerbasic et al concluded that patients with left coronary dominance have a reduced prognosis in surgical myocardial revascularization [4]. Parikh et al determined that Left and codominant coronary artery circulation confer modestly increased risk of in-hospital mortality after PCI for ACS, particularly in lesions in the LM/LCX territory. Murphy et al found that there appears to be an increased prevalence of left heart dominance in patients undergoing aortic valve replacement and that the left main coronary artery is significantly shorter than those seen in right heart dominant patients [5]. In CASS study the highest surgical mortality occurred among patients with LM stenosis with 90% or more. Patients with left dominance had surgical mortality 4 times higher than those with right coronary dominance [6]. Kuno et al, concluded that a dominant LCX has several acute angles in its course, including at its origin. These acute angles lead to turbulence and shear stress during blood flow that, in turn, may enhance thrombus formation and platelet activity. The acute angles, and resultant turbulence and shear stress, also contribute to the difficulty of LCX interventions.

In our study, the mean length of the left main coronary artery was 9.57mm in right dominant system, 7.41 mm in left dominant system and 9.18 mm in co dominant system. The mean length of the LMCA in the left dominant system was significantly shorter ($p<.0001$). The mean width of the LMCA in the right, left and codominant systems were 4.07mm, 4.00mm and 4.17mm respectively. The width of LMCA was narrower in left dominant system although not significantly ($p=.236$). The bifurcation angle of LMCA was <90 in 100 patients (28.4%) of right dominant system, 51 (63.8%) of left dominant system and 22 (32.8%) of patients in the codominat system. So, the angle of bifurcation of the LMCA in the left dominant system was acute in higher percentage of patients compared to right dominant system and codominant system($p<.001$). Also, mortality data suggests that the number of deaths in the left dominant group was higher than the right dominant group (5 vs 2). These deaths can be attributed to the difficulty faced during the intervention over these patients as 6 of them had developed complications related to PCI.

Finally, this study shows that there are significant variations in the anatomy of the left main coronary artery depending upon the type of dominance which can be used to explain the poorer prognosis of the patients undergoing PCI with left dominant system compared to other types.

Conclusion

The left main coronary artery in left dominant system is shorter and slightly narrower with a higher percentage of acute bifurcation angle as compared to the right and co dominant systems. These anatomic characteristics can be taken into account while explaining the bad prognosis in patients with left dominant system as they may be responsible for difficult intervention in left dominant system.

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