

Original Research Article

Clinical profile, risk factors and angiographic characteristics of patients with coronary artery bifurcation lesions

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Abstract

Introduction: Bifurcation coronary lesions constitute 15 – 20% of total coronary lesions. Bifurcation lesions have a diverse clinical presentation, ECG features and angiographic characteristics which are very important in invasive management either by the percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG) in this subset of patients.

Aim of the study: To study the risk factors, mode of presentation in patients with bifurcation lesions, to study the clinical profile in patients with bifurcation lesions, to study the angiographic characteristics of patients with bifurcation lesions, to study the pattern of involvement and hospital outcome in patients presenting with bifurcation lesions.

Materials and methods: The study was conducted in the department of cardiology, Rajiv Gandhi Government General Hospital. In this study, 300 coronary angiograms were analyzed and 48 patients were shown to have coronary bifurcation lesions. The period study was from December 2013 to February 2014. This was a prospective observational study. The patients undergoing angiogram had three modes presentation which includes chronic stable angina, unstable angina/ non-ST elevation myocardial infarction, ST elevation myocardial infarction. Based on the angiographic analysis, patients were given treatment options including guideline-directed medical management and invasive approach either percutaneous coronary intervention/ coronary artery bypass surgery.

Results: Acute coronary syndrome contributed 32 cases out of a total of 48 cases. ST-elevation myocardial infarction (STEMI) constituted 22 cases (46%). Anterior wall STEMI constituted 18 cases (38%) and Inferior wall STEMI had 4 cases (8%). Unstable Angina /Non-ST elevation myocardial infarction (UA/ NSTEMI) had constituted 10 cases which contribute about 21% of the total number of patients. Those patients with bifurcation lesions in the STEMI group was presented with cardiogenic shock had significant left main and ostial LAD lesions which were seen in 6 cases out of 22 cases and

contributes 27% of the total number of patients with significant bifurcation lesions. Patients with stable angina with significant LMCA and LAD lesions had Canadian Cardiovascular Society class III angina and NYHA functional class III. Heart failure was in 7 STEMI patients who were taken angiogram and showed significant disease in LMCA and LAD, which constitutes about 32% of the total number of patients showing bifurcation lesions.

Conclusion: Diabetes was a major risk factor noted in 65% of study groups and 100% incidence of bifurcation lesions among them. Smoking and Hypertension were the other two risk factors noted. The incidence of bifurcation lesions was higher in smoking cohorts. Acute coronary syndrome was the dominant group in the study population. Of which STEMI contributes 46% and UA 21%. Cardiogenic shock and heart failure noted in STEMI subsets, in which the majority had triple vessel disease with the left main disease. Single vessel disease was noted in 24 patients and triple vessels in 21 patients. The most common coronary artery involved was Left Anterior Descending artery.

Key words

Coronary Bifurcation Lesions, Single Vessel, Double Vessels, Angiogram Changes, Dyslipidaemia, smoking, Diabetes mellitus.

Introduction

Coronary artery narrowing is involving adjacent to and or involving the origin of a significant side branch. True bifurcation lesion should have significant ostial involvement of a side branch with or without the involvement of the main vessel. A significant side branch means a branch that shouldn't get occluded in the global purview while treating a particular patient [1]. The clinical significance of coronary bifurcation lesion relies on the presence of a side branch. These branches gain importance in the development of atheroma owing to altered hemodynamics and also remain a predictive factor for periprocedural myocardial infarction when percutaneous coronary intervention is performed [2]. The normal flow in coronary artery bifurcations is pulsatile with the antegrade flow during diastole and retrograde during systole with a nonlinear parabolic transverse speed profile [3]. The flow is linear and rapid in carinae at bifurcation points and slow, turbulent along the walls opposite to carina. Endothelial shear stress is the tangential force on the endothelial surface from the friction of flowing blood. Pulsatile laminar flow in straight segments produces high endothelial shear stress in geometrically irregular stress areas as in bifurcations it produces low/oscillatory endothelial shear stress lateral wall at

bifurcations [4]. Low endothelial shear stress is sensed by endothelial mechanoreceptors which in turn triggers intracellular pathways and activates transcription factor, which finally induces pro-atherogenic gene expression. Carina has high endothelial shear stress and henceforth non-atherogenic but develops atherosclerosis through circumferential progression [5]. The clinical significance of a side branch depends on its diameter which in turn strongly correlated with its flow and muscle mass that it supplies a particular territory. There is a negative correlation between endothelial shear stress and intimal thickness. The major stimulus for atherosclerosis is low endothelial shear stress, which leads to the plaque of high-risk morphology [6].

Materials and methods

The study was conducted in the department of cardiology, Rajiv Gandhi Government General Hospital. In this study, 300 coronary angiograms were analyzed and 48 patients were shown to have coronary bifurcation lesions. The period study was from December 2013 to February 2014. This was a prospective observational study.

Inclusion criteria: All the patients undergoing coronary angiogram either elective or following acute coronary syndrome.

Exclusion criteria: Not willing for an angiogram, Hypersensitivity to radiocontrast agent, Chronic Renal Disease, Valvular heart disease, Cardiomyopathy, Congenital Heart Disease. All the patients were evaluated before taking for an angiogram which includes complete blood count, blood group and typing, urea, creatinine, serum lipid, electrolytes, chest X-Ray, electrocardiogram, echocardiogram using PHILIPS HD 7. The patients undergoing angiogram had three modes presentation which includes chronic stable angina, unstable angina / non-ST elevation myocardial infarction, ST elevation myocardial infarction. The study population was analyzed for a risk factor for coronary artery disease which includes Smoking – duration, no. of packs per day, reformed smoker Hypertension duration, drugs, compliance, complications. Diabetes – Type I / II, duration of OHA, insulin, HbA1C, compliance, complications. Dyslipidemia – duration, serum lipid levels, on drugs. Family history premature coronary heart disease, sudden cardiac death Personal history includes alcohol intake, the occupation was recorded. Detailed clinical examination was conducted in all the patients undergoing coronary angiogram which include general examination, recording pulse, blood pressure, cardiovascular examination. Based on the angiographic analysis, patients were given treatment options including guideline-directed medical management and invasive approach either percutaneous coronary intervention/ coronary artery bypass surgery.

Clinical presentation

Among the patients taken for coronary angiogram showing bifurcation lesions, Acute coronary syndrome contributed 32 cases out of a total 48 cases.

ST-elevation myocardial infarction (STEMI) constituted 22 cases (46%). Anterior wall STEMI constituted 18 cases (38%) and Inferior wall STEMI had 4 cases (8%). Unstable angina/ Non-ST elevation myocardial infarction (UA/ NSTEMI) had constituted 10 cases which contribute about 21% of the total number of

patients. Stable angina was the clinical presentation in about 16 patients out of 48 patients who had bifurcation lesions in the coronary angiogram. Stable angina constituted about 33% of patients with bifurcation lesions. Those patients showing bifurcation lesions in the STEMI group presented with cardiogenic shock had significant left main and ostial LAD lesions which were seen in 6 cases out of 22 cases and contributed 27% of the total number of patients with significant bifurcation lesions. Patients with stable angina with significant LMCA and LAD lesions had Canadian Cardiovascular Society class III angina and NYHA functional class III. Heart failure was in 7 STEMI patients who were taken angiogram and showed significant disease in LMCA and LAD, which constitutes about 32% of the total number of patients showing bifurcation lesions.

Exercise stress test (EST): Among 48 patients showing bifurcate lesions, 11 patients had a positive exercise stress test which contributes 23% of the total number of cases,

Statistical analysis

Independent t-test was used to examine differences in age; Fischer's exact test for sex; and chi-square test for etiology were used. A “p” value of less than 0.05 was considered to be statistically significant. Data analysis was performed using SPSS software.

Results

Table - 1 showed among 48 cases, age group above 60 had the highest incidence (21 cases). Among the 48 patients showing bifurcation lesions, LAD was involved in 24 cases and constitutes about 49%. LMC A involved in 7 cases (15%), LCX in 13 cases (27%), RCA involved in 4 cases and constituted 9% respectively.

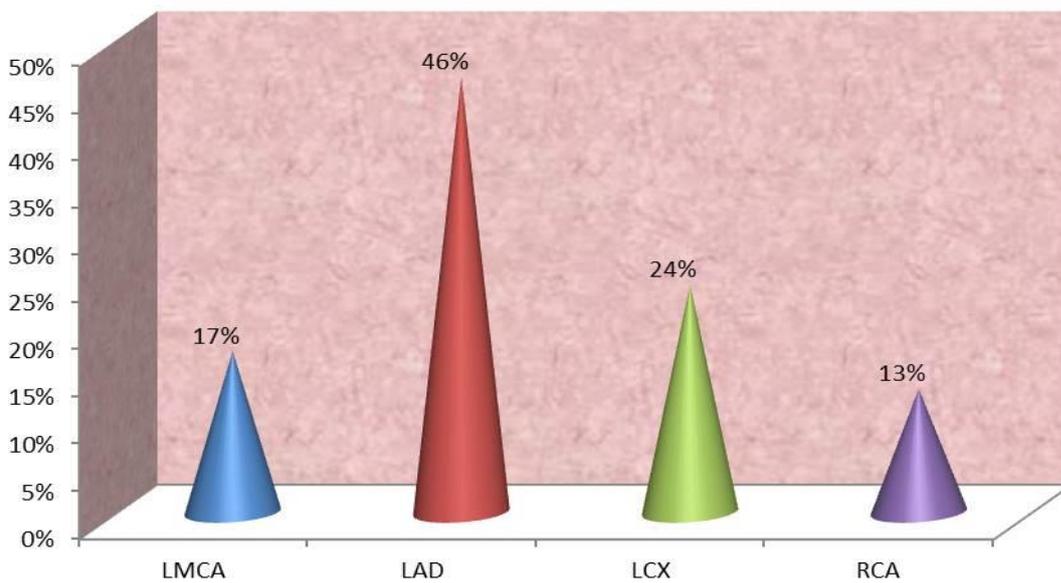
Graph - 1 showed out of the total number of patients with bifurcation lesions, patients with Diabetes Mellitus constitute 65% (i.e.) 31 patients had diabetes out of a total of 48 cases.

Among the 31 patients who had diabetes, the distribution of coronary bifurcation lesions was as follows: $\frac{3}{4}$ LMCA involved in 10 cases (17%), $\frac{3}{4}$ LAD involved in 27 cases (46%), $\frac{3}{4}$ LCX involved in 14 cases (24%), $\frac{3}{4}$ RCA involved in 8 cases (13%).

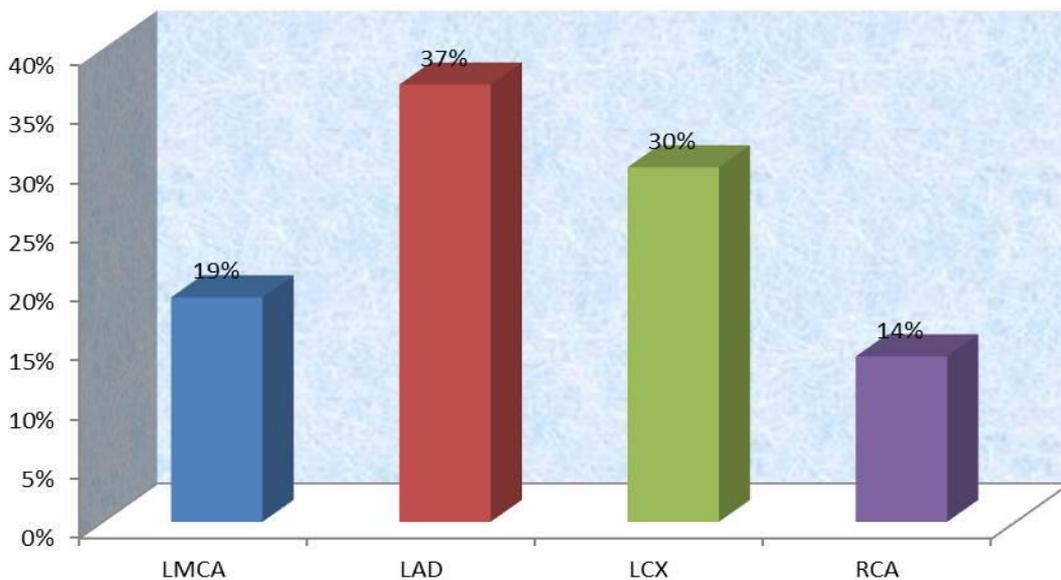
Table - 1: Age distribution.

Age of patients	No of patients
> 60 years	21 (44%)
50- 60 years	10 (21%)
40- 50 years	12 (25%)
< 40 years	5 (10%)
Total	48(100%)

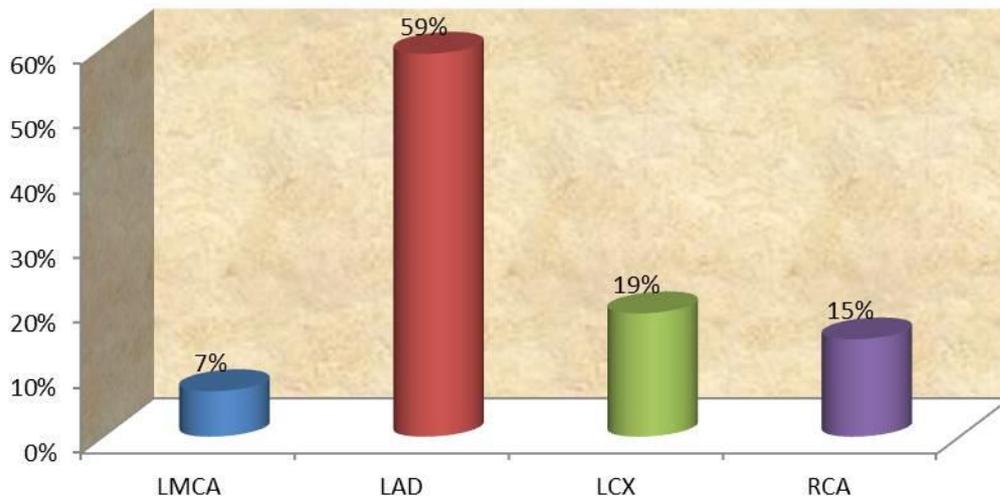
Graph – 1: Correlation of diabetes with site of bifurcation lesion.



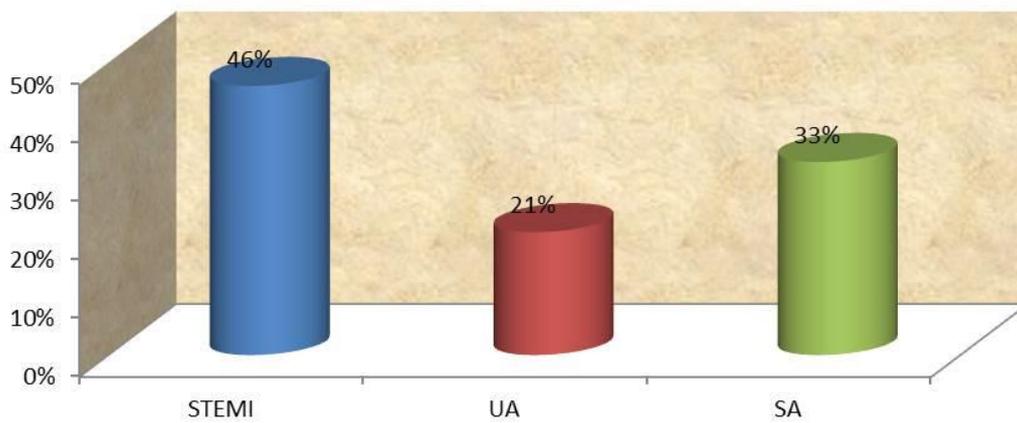
Graph – 2: Correlation of hypertension with site of bifurcation lesion.



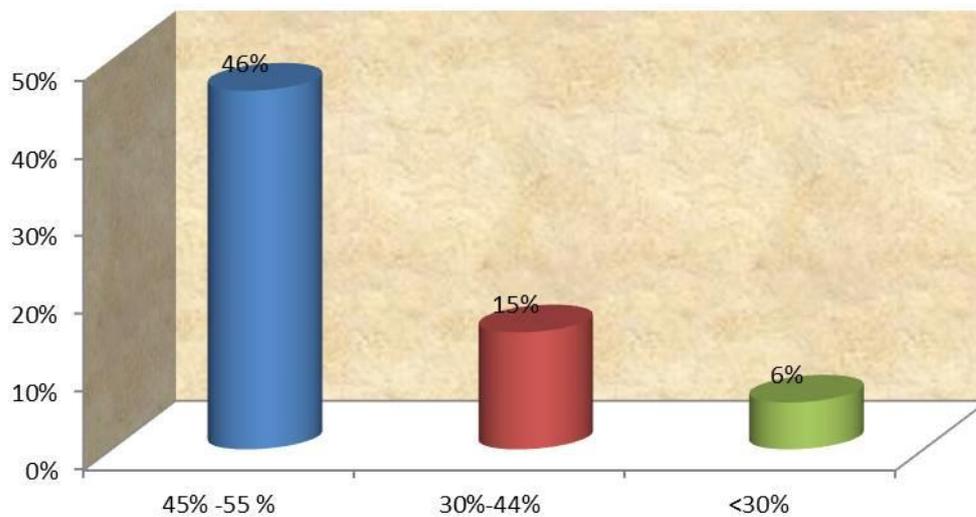
Graph – 3: Correlation of smoking with site of bifurcation lesion.



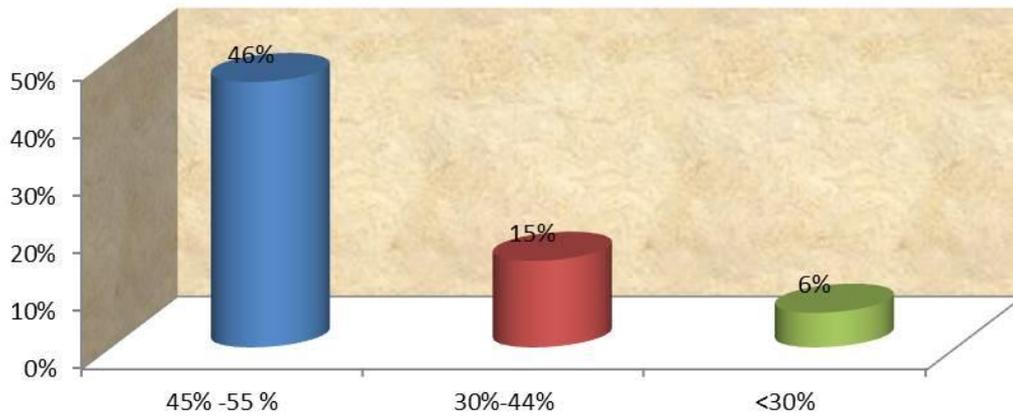
Graph – 4: Clinical presentation.



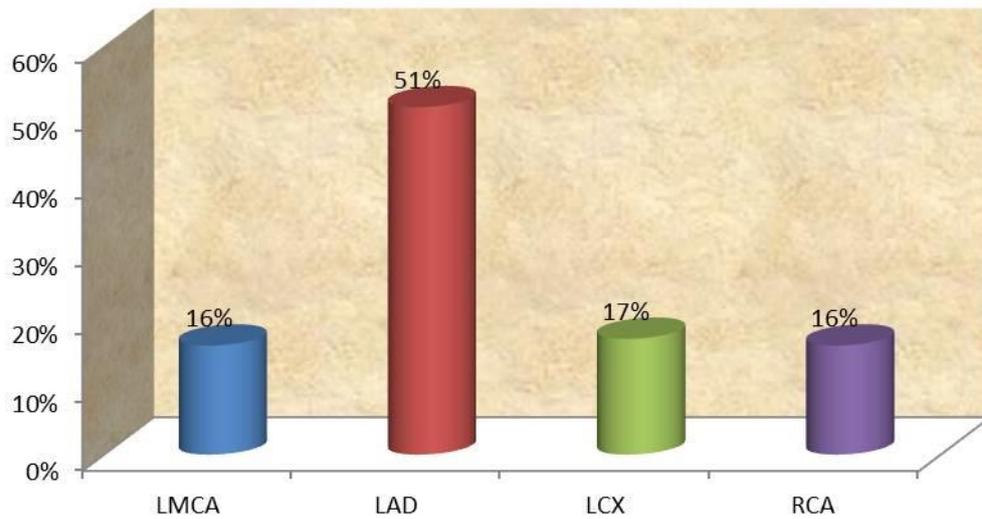
Graph – 5: Exercise stress test (EST).



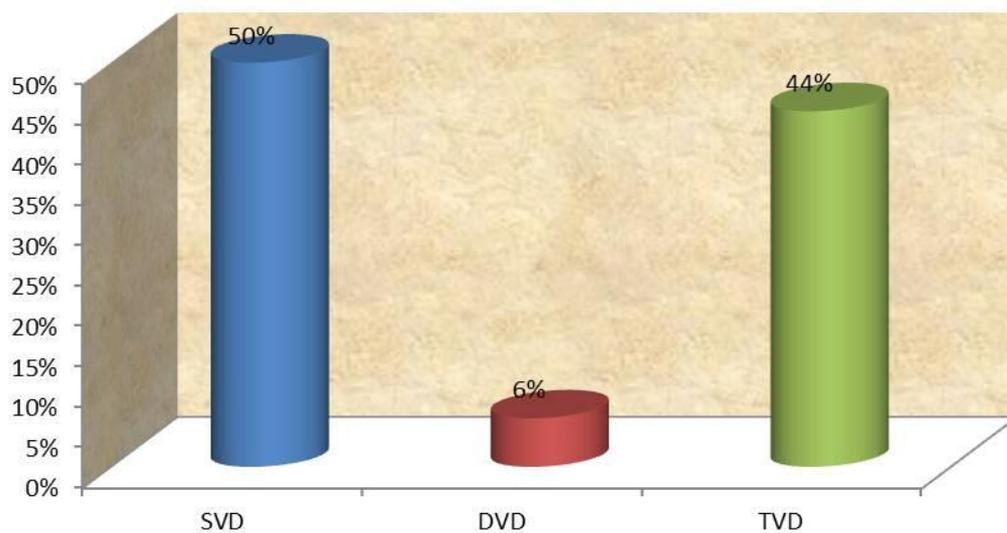
Graph – 6: Echocardiographic changes.



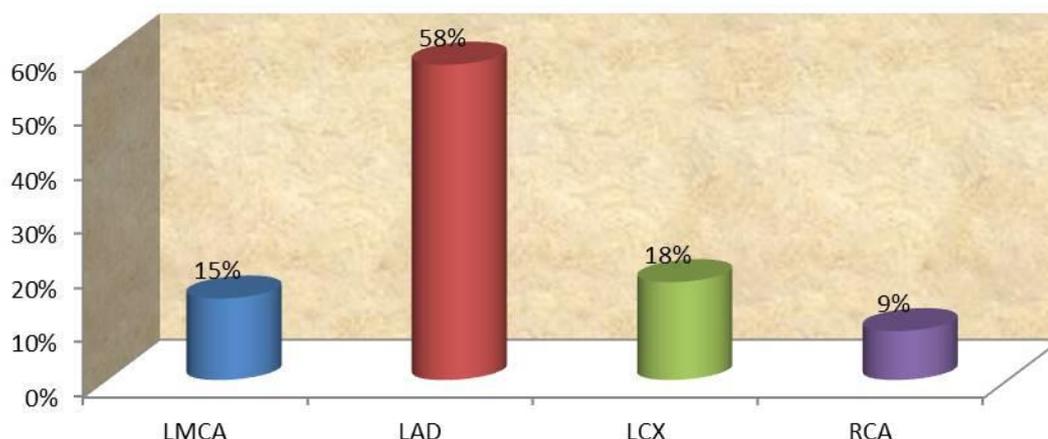
Graph – 7: Coronary angiogram.



Graph – 8: No. of vessel involved.



Graph – 9: Pattern of involvement.



Graph - 2 showed among the total number of patients showing bifurcation lesions, hypertension was present in 21 cases which constitute about 44% of the total number of cases. Among the 21 patients who had hypertension, the distribution of coronary bifurcation lesions was as follows: LMCA involved in 8 cases (19%), LAD involved in 16 cases (37%), LCX involved in 13 cases (30%), RCA involved in 6 cases (14%).

Among the total number of patients showing bifurcation lesions, history of smoking was present in 21 cases which constitute about 48% of the total number of cases. All the patients who had a smoking history were males and none of them were females. Among the patients who had history of smoking, the distribution of coronary bifurcation lesions was as follows, LMCA involved in 2 cases (7%), LAD involved in 16 cases (59%), LCX involved in 5 cases (19%), RCA involved in 4 cases (15%) as per **Graph – 3**.

Graph - 4 showed among the patients taken for coronary angiogram showing bifurcation lesions, Acute coronary syndrome contributed 32 cases out of a total of 48 cases. ST-elevation myocardial infarction (STEMI) constituted 22 cases (46%). Anterior wall STEMI constituted 18 cases (38%) and Inferior wall STEMI had 4 cases (8%). Unstable Angina /Non-ST elevation myocardial infarction (UA/ NSTEMI) had

constituted 10 cases which contribute about 21% of the total number of patients. Those patients showed bifurcation lesions in the STEMI group presented with cardiogenic shock had significant left main and ostial LAD lesions which were seen in 6 cases out of 22 cases and contributes 27% of the total number of patients with significant bifurcation lesions. Patients with stable angina with significant LMCA and LAD lesions.

Graph - 5 showed among the 48 patients showing bifurcation lesions, 11 patients had a positive exercise stress test which contributed 23% of the total number of cases. Patients with multiple vessel disease and diabetes showed a positive result at low workloads during the stress test, which involved multiple leads and persisted in recovery.

Graph - 6 showed regional wall motion abnormalities confined to LAD territory was seen in 18 patients who had Anterior wall STEMI and LCX / RCA territory seen in 4 patients with Inferior wall STE MI. Hypokinesia in area corresponding to LAD and LCX territories were seen in 4 patients with Unstable Angina. Normal Left ventricular systolic function was seen in about 16 patients (33%). Mild LV systolic dysfunction – EF 45-55% - 22 patients (46%) Moderate LV systolic dysfunction – EF 30-44% - 7 patients (15%)

Severe LV systolic dysfunction – EF <30% - 3 patients (6%).

Graph - 7 showed a coronary angiogram was performed by the femoral route in 30 patients (63%) and radial route in 18 patients (37%). For those patients with suspected LMCA lesions, only minimal views were taken. All other patients had standard angiographic views. The coronary bifurcation lesions were analyzed using Medina's scoring system and bifurcation angles were noted. The pattern of involvement in coronary bifurcation lesion as follows: LMCA – 9 patients (16%) LAD – 29 patients (51%) LCX – 10 patients (17%) RCA – 9 patients (16%).

True bifurcation lesion was seen in 42 patients out of the total number of 48 patients with bifurcation lesions, which constituted around 87.5%. Single vessel disease was present in 24 number of patients (50%), Three patients had double vessel disease (6%), Triple vessel disease was present in 21 number of patients (44%). Among the patients showing bifurcation lesions, LAD dominates the pattern of involvement and constitutes 58% of the total number of patients (**Graph – 8**).

Graph - 9 showed among the patients with bifurcation lesions, obstructive coronary involvement was seen in 21 patients (44%) who had a history of smoking compared to non-smokers. Among the patients with bifurcation lesions, obstructive coronary involvement was seen in 31 number of patients who had Diabetes mellitus. Among the patients with bifurcation lesions, obstructive coronary involvement was seen in 21 patients who had Hypertension.

Complications

During the procedure, 4 cases out of 48 patients had angina along with transient ST T changes and was disappeared after the procedure. No other complications were noted during the procedure. None of the patients had post-procedure complications.

Discussion

This study was undertaken to correlate clinical risk factors and angiographic characteristics in patients with coronary bifurcation lesions. Coronary bifurcation lesions are often seen in cardiac interventional practice and pose challenges in terms of management. The treatment of bifurcation lesions by percutaneous coronary intervention accompanies low success and high restenosis rates compared to those without bifurcation lesions. High success rate in percutaneous coronary intervention may be comprehended by well-defined bifurcation anatomy [7]. In this study, 300 coronary angiograms were analyzed and 48 patients were shown to have coronary bifurcation lesions, which contributes to an overall incidence of 16%. This result is consistent with various studies that showed an overall incidence of 15-20% in coronary angiograms. The most frequent coronary artery involved in our study was the left anterior descending artery in 29 cases (51%). The left main coronary artery was involved in 9 cases (16%). The left circumflex artery was involved in 10 cases (17%) and Right coronary artery in 9 cases (16%). The Medina classification was used in our study to delineate the bifurcation lesion. The most common Median score noted in our study was 1,1,1 which was found in 37 patients (77%) and occurred in greater frequency [8]. True bifurcation lesions which indicate significant (>50%) ostial disease of side branch with either a proximal or distal main vessel was seen in 42 patients which constitute around 87.5% in the study population. Patients with diabetes mellitus contribute to 61% of our study population and it is the most common risk factor. The predominant mode of presentation was Acute coronary syndrome [9]. The most common clinical presentation in our study was STEMI (46%). Of which Anterior wall STEMI was seen in 38% cases and Inferior wall in 8% cases. Among STEMI patients, the incidence of bifurcation lesion was 52% in LAD, LMCA – 13%, LCX- 22%, RCA- 14%. The second most common presentation was stable angina, seen in 33% of patients. LAD was the

most artery of involvement and seen in 38% of cases. LMCA in 17%, LCX in 35% and RCA in 10% cases respectively [10]. Unstable angina was seen in 21% of patients. The true bifurcation lesion was seen in 78% of cases in LAD, LMCA, and LCX together 11%. No RCA involvement was seen in this group. Among the clinical features, heart failure was seen in 7 patients (15%) [11]. All the patients who had heart failure were STEMI. Three patients had triple vessel disease, one had double vessel disease and three had triple vessel disease. Cardiogenic shock was in STEMI patients only and contributes 13% of the study group. Coronary angiogram showed triple vessel disease in 4 patients, one each had the double and single-vessel disease [12]. The exercise stress test was done in stable angina patients and was positive in 11 patients which constitute around 23%. Those patients who had a positive stress test at low workloads had significant bifurcation lesion involving the left main was seen [13]. There were no specific

electrocardiographic changes were noted. Echocardiogram showed normal ejection in 16 patients (33%). Mild left ventricular systolic dysfunction was noted in 22 patients and constitutes (46%) the majority in the study population [14]. Moderate left ventricular systolic dysfunction was seen in 7 patients (15%) and severe in 3 patients (6%). Regional wall motion abnormalities were seen in all patients who had ST-elevation myocardial infarction [15]. Coronary angiogram showed True bifurcation lesions in 42 patients which constitute around 87.5% in our study. The overall incidence of bifurcation lesions seen in our study is 16% out of a total of 300 angiograms, which is consistent with the incidence of other major studies. The Medina classification was to assess the morphology of bifurcation lesions. The most common pattern of involvement was 1, 1, 1 and the coronary artery most frequently was Left anterior descending artery [16].

Table - 2: Medina classification.

Medina score	1 1 1	1 1 0	1 0 1	0 0 1	0 1 1	0 1 0	1 0 0	Total
Patients	37	3	1	1	2	3	1	48

As per Medina's score, the commonest pattern of involvement is 1, 1, 1 was in 37 patients and constitutes around 77% (**Table – 2**). This study results were consistent with other major studies in terms of coronary artery involvement and also the pattern of involvement as per Medina's score. Left Anterior Descending artery is the artery of involvement in 58% cases, Left Circumflex around 17%, Left Main 15% and Right coronary artery in 10% cases [17]. The commonest bifurcation angle noted was < 70 degrees in 37 patients which gives an overall incidence of 77% in our study patients. Diabetes and smokers had a higher incidence of bifurcation lesions [18]. LAD was the commonest artery to be involved. Among the study population, 50% had single-vessel disease, 44% had triple vessel disease and 6% had double vessel disease [19]. More than one coronary artery bifurcation lesion was seen in 16 patients who come around 33% of

incidence. No significant post-procedural complications noted after the coronary angiogram. Four patients had transient ECG changes during procedure [20].

Conclusion

The incidence of coronary bifurcation lesions in this study was 16%. The incidence of true bifurcation lesion was seen in 42 patients in a total of 48 patients which gives an overall incidence of 87.5% in our study. The major study population was above 50 years constitutes nearly 65%. The incidence of bifurcation lesions was higher in smoking cohorts. Acute coronary syndrome was the dominant group in the study population. Of which STEMI contributes 46% and UA 21%. Shock and heart failure noted in STEMI subsets, in which the majority had triple vessel disease with the left main disease. Single vessel disease was noted in 24 patients and triple

vessels in 21 patients. The most common coronary artery involved was the Left Anterior Descending artery. Left main disease was seen in 15% of patients. There is a higher incidence of bifurcation lesions noted in patients with triple and double vessel disease. The most common coronary bifurcation lesion pattern noted in Medina's classification was 1, 1, 1 in 37 patients among a total of 48 patients. 77% of study patients had a bifurcation angle < 70 degrees.

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