

Angiographic Assessment of Coronary Arteries Involvement in Cases of Ischemic Heart Disease

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Abstract:

Aim of study: To find out pattern of arterial involvement in cases of Ischemic Heart Disease .

Materials and methods: Angiography report of 225 patients was studied to find out spectrum of coronary artery involvement . Data obtained was analyzed to draw inferences and conclusion .

Observations : Out of 225 patients , 58 had single vessel involvement , 47 had double vessel involvement while 76 had triple vessel involvement. 25 patients had angiographic finding suggestive of nonobstructive coronary artery disease (CAD) , while 19 presented with angiographically normal coronaries .

Discussion and conclusion: Triple vessel involvement of coronary arterial system was most common finding followed by single vessel involvement . Left anterior descending artery was most frequently affected vessel followed by right coronary artery. Left main coronary artery involvement is almost always associated with multi vessel disease and more severe disease spectrum .

Keywords: Coronary angiography, double vessel disease , nonobstructive coronary artery disease , single vessel disease , triple vessel disease.

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I. Introduction

Ischemic Heart Disease typically occurs when there is imbalance between myocardial oxygen supply and demand ¹. Most common cause of myocardial ischemia is atherosclerotic disease of an epicardial coronary artery (arteries)¹ . Atherosclerotic plaques reduce the luminal diameter as well as cross sectional area of the affected vessel and thus decrease the flow of blood , leading to inadequate perfusion of myocardium supplied by the involved coronary artery .

The incidence of Ischemic heart disease is rising throughout the world , more so in developing countries like India and it is likely to become the most common cause of death worldwide by 2020¹ . This has lead to many innovative researches throughout the world but there main focus is on preventive and management aspect of the disease . We thought of focusing on the anatomical aspect i.e. the coronary arteries which are the center point of this disease spectrum . We target to study the pattern of coronary artery involvement in ischemic heart disease patients and to find there correlation with disease severity .

II. Materials And Methods

Our study is based on angiography report of 225 patients who presented either in emergency / cardiology section of medicine department of our College with chest pain / chest discomfort and whose ECG and echocardiography suggested ischemic changes in myocardium and hence they were selected to undergo coronary angiography to assess the degree of coronary artery involvement .

Angiography was done in Cath lab of Cardiology section of Medicine Department of Narayan Medical College and Hospital , and based on angiographic findings patients were grouped into those with angiographically normal coronaries , patients with nonobstructive coronary artery disease , patients with single vessel disease , patients with double vessel disease and patients with triple vessel disease .

The criteria used for the grouping was luminal diameter of coronary arteries , cutoff level for considering it as significant narrowing was decrease in luminal diameter by 50% or more² . Patients with less than 50% reduction in luminal diameter were considered to have subcritical stenosis and they were grouped as non-obstructive coronary artery disease cases ².

The criteria for single , double and triple vessel description is involvement of either one , two or three of the major epicardial coronary arteries and their 2nd or 3rd order branches . Using this basic information we categorized the available data and prepared the tables and charts used in our study . We analyzed the data obtained to draw inferences and come to conclusion .

III. Observations

Our observation is based on the angiographic reports of the 225 patients that we got from cardiology department. As per the description above patients were categorized as those having angiographically normal coronaries , those with nonobstructive coronary artery disease , those with single , double and triple vessel disease . Single vessel disease patients were further broken up into group with involvement of left main coronary artery(LMCA) or left anterior descending(LAD)artery or left circumflex(LCx) artery or ramus intermedius(RI) branch of left main coronary artery and those with involvement of right coronary artery(RCA) . Double vessel disease group was also broken into those with involvement of LAD artery and LCx artery or their major branches ; those with involvement of LAD artery and RCA or their major branches ; those with involvement of LCx artery and RCA or their major branches ; those patients having LMCA and RCA as the affected vessel . The data was further categorized based on coronary dominance . Following tables and charts depict the data we acquired .

Table 1. Coronary artery involvement pattern (n – 225)

Type	Number of patients	Percentage of total (%)
Normal coronaries	19	8.44
Non obstructive CAD	25	11.11
Single Vessel Disease	58	25.78
LMCA	0	0
LAD	40	17.78
LCx	9	4.00
RI	1	0.44
RCA	8	3.56
Double Vessel Disease	47	20.89
Triple Vessel Disease	76	33.78

Note : CAD – coronary artery disease , LAD – left anterior descending artery , LCx – left circumflex artery , LMCA – left main coronary artery , n - total number of patients , RCA – right coronary artery, RI – ramus intermedius artery .

Out of 225 patients , dominance pattern was not clear in 5 patients as they presented with triple vessel disease wherein there was subtotal / total occlusion of both right coronary artery and left circumflex artery , which prevented filling of posterior interventricular and posterolateral ventricular branches and thus dominance pattern could not be made out in them . Out of remaining 220 patients 151 had right dominance , 46 had left dominance and 23 presented with balanced / codominant circulation . Following tables depict pattern of coronary involvement in different dominance category .

Table 2. Coronary artery involvement in cases with right dominant circulation (n – 151)

Type	Number of patients	Percentage (%)
Normal coronaries	13	8.61
Non obstructive CAD	15	9.934
Single Vessel Disease	41	27.152
LMCA	0	0
LAD	28	18.543
LCx	5	3.311
RI	0	0
RCA	8	5.298
Double vessel disease	28	18.543
Triple Vessel Disease	54	35.761

Note : CAD – coronary artery disease , LAD – left anterior descending artery , LCx – left circumflex artery , LMCA – left main coronary artery , n - total number of patients , RCA – right coronary artery, RI – ramus intermedius artery .

Table 3. Coronary artery involvement pattern in cases with left dominant circulation (n-46)

Type	Number of patients	Percentage (%)
Normal coronaries	6	13.043
Nonobstructive CAD	6	13.043
Single Vessel Disease	11	23.913
LMCA	0	0
LAD	7	15.22
LCx	3	6.52
RI	1	2.173
RCA	0	0
Double Vessel Disease	13	28.261
Triple Vessel Disease	10	21.74

Note : CAD – coronary artery disease , LAD – left anterior descending artery , LCx – left circumflex artery , LMCA – left main coronary artery , n - total number of patients , RCA – right coronary artery, RI – ramus intermedius artery.

Table 4. Coronary artery involvement pattern in co-dominant circulation (n-23)

Type	Number of patients	Percentage (%)
Normal coronaries	0	0
Non obstructive CAD	4	17.39
Single Vessel Disease	6	26.09
LMCA	0	0
LAD	5	21.74
LCx	1	4.35
RI	0	0
RCA	0	0
Double vessel disease	6	26.09
Triple Vessel Disease	7	30.43

Note : CAD – coronary artery disease , LAD – left anterior descending artery , LCx – left circumflex artery , LMCA – left main coronary artery , n - total number of patients , RCA – right coronary artery, RI – ramus intermedius artery.

Following tables and chart depict coronary artery involvement in cases of double vessel disease . Out of 225 patients 47 presented with double vessel disease , we further grouped them based on dominance pattern , 28 had right dominance , 13 left dominance and 6 patients had codominant circulation .

Table 5. Arterial involvement pattern in double vessel disease (n – 47)

Type	Number of patients	Percentage (%)
LAD + LCx	18	38.30
LAD + RCA	20	42.55
LCx + RCA	8	17.02
LMCA + RCA	1	2.13

Note : LAD – left anterior descending artery , LCx – left circumflex artery , LMCA – left main coronary artery, n - total number of patients , RCA – right coronary artery .

Table 6 : Arterial involvement pattern in double vessel disease cases with right dominance (n – 28)

Type	Number of patients	Percentage (%)
LAD + LCx	8	28.57
LAD + RCA	15	53.57
LCx + RCA	4	14.29
LMCA + RCA	1	3.57

Note : LAD – left anterior descending artery , LCx – left circumflex artery , LMCA – left main coronary artery , n - total number of patients , RCA – right coronary artery .

Table 7: Arterial involvement pattern in double vessel disease cases with left dominance (n – 13)

Type	Number of patients	Percentage (%)
LAD + LCx	9	69.23
LAD + RCA	2	15.385
LCx + RCA	2	15.385
LMCA + RCA	0	0

Note : LAD – left anterior descending artery , LCx – left circumflex artery , LMCA – left main coronary artery , n - total number of patients , RCA – right coronary artery.

Table 8: Arterial involvement pattern in double vessel disease cases with co-dominant circulation (n – 6)

Type	Number of patients	Percentage (%)
LAD + LCx	1	16.67
LAD + RCA	3	50.00
LCx + RCA	2	33.33
LMCA + RCA	0	0

Note : LAD – left anterior descending artery , LCx – left circumflex artery , LMCA – left main coronary artery , n - total number of patients , RCA – right coronary artery.

IV. Discussion

Coronary angiography can visualize major epicardial arteries and their second and third order branches. The network of smaller intramyocardial branches generally is not seen because of their size , cardiac motion and limitations in resolution of angiographic system .² Coronary Artery Surgery Study (CASS) Investigators established the nomenclature most commonly used to describe coronary anatomy , defining 27 segments in 3 major arteries . The Bypass Angioplasty Revascularization Investigators(BARI) modified these criteria by addition of 2 more segments (One for Ramus Intermedius and other one for Third Diagonal branch)^{2,3}. The segments are :

In Right coronary artery –

1. Proximal RCA , 2. Mid RCA , 3. Distal RCA , 4. Posterior descending artery (PDA) , 5. Right posterior atrioventricular (RPAV) , 6. First posterolateral ventricular (PL) , 7. Second PL , 8. Third PL , 9. Inferior septal (posterior descending septal) , 10. Acute marginal

In left coronary artery territory –

11. Left main coronary artery (LMCA) , 12. Proximal left anterior descending (LAD) , 13. Mid LAD , 14. Distal LAD , 15. First Diagonal(D1) , 16. Second Diagonal(D2) , 17. Anterior septal , 18. Proximal circumflex , 19. Middle circumflex , 19a. Distal circumflex , 20. First obtuse marginal(OM1) , 21. Second obtuse marginal (OM2) , 22. Third obtuse marginal(OM3) , 23. Left atrioventricular , 24. First left posterolateral , 25. Second left PL , 26. Third left PL , 27. Left PDA , 28. R I (ramus intermedius) , 29. Third diagonal(D3) . [24,25,26 present in left dominance(LD) and balanced circulation, 27 in LD]

In this system the 3 major arteries are LAD , LCx , RCA . Dominance is determined by PDA and PL branches , artery which gives them is dominant while in balanced circulation PDA comes from RCA while PL branches are given by LCx.^{2,3}

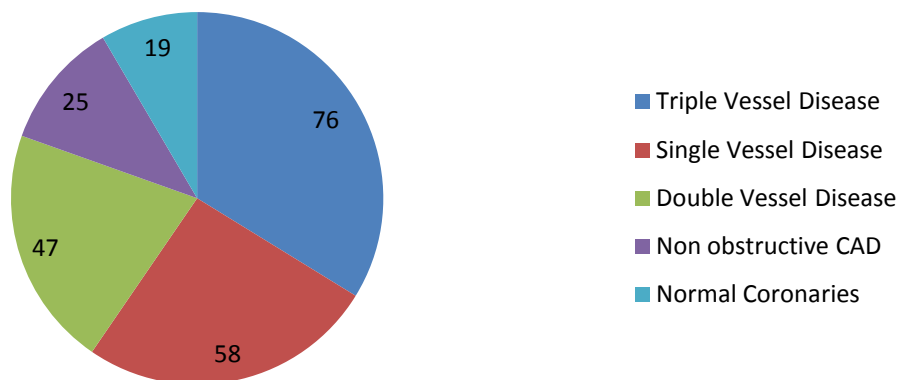
Coronary artery disease(CAD) is defined as a 50% or greater diameter stenosis in one or more of these vessels .

Stenosis of less than 50% diameter is called subcritical stenosis and such cases are characterized as nonobstructive coronary artery disease . Obstructive CAD is classified as one , two or three vessel disease . Even subcritical stenosis are important because they can lead to plaque rupture and acute coronary syndromes .² Having discussed the basic criteria for classifying coronary artery diseases we come back to our data .

Table 9. Comparison of percentages of different categories

Type	Collective(n-225) (%)	In right dominance (%)	In left dominance (%)	In co-dominance (%)
Normal coronaries	8.44	8.61	13.043	0
Non obstructive CAD	11.11	9.934	13.043	17.39
Single vessel disease	25.78	27.152	23.913	26.09
LMCA	0	0	0	0
LAD	17.78	18.543	15.22	21.74
LCx	4.00	3.311	6.52	4.35
RI	0.44	0	2.173	0
RCA	3.56	5.298	0	0
Double vessel disease	20.89	18.543	28.261	26.09
Triple vessel disease	33.78	35.761	21.74	30.43

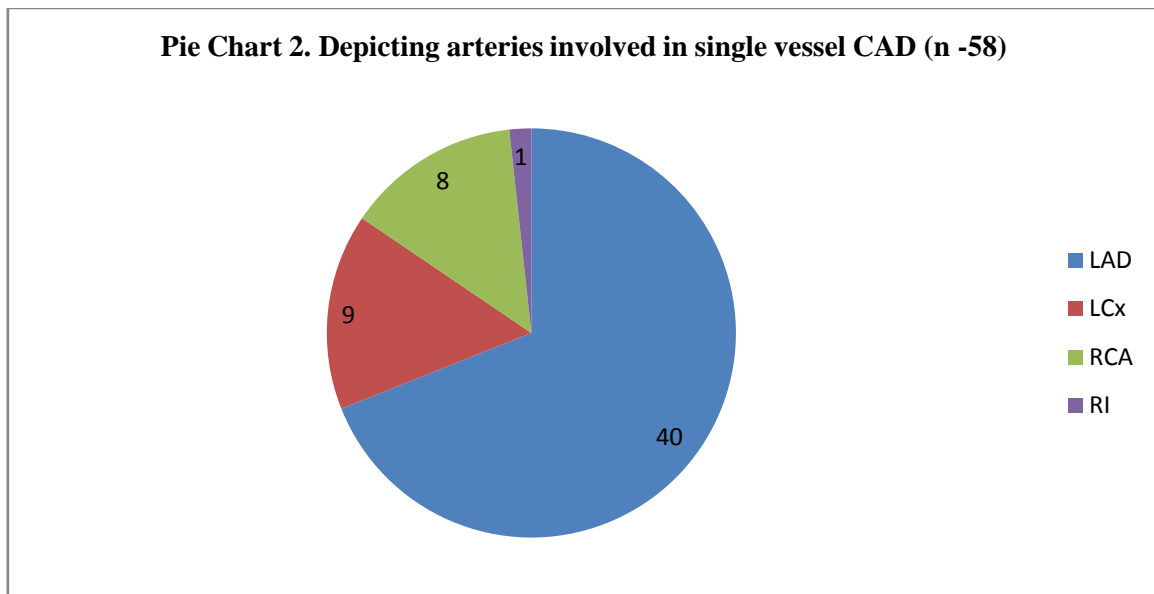
Pie Chart 1. Depicting coronary artery involvement pattern (n - 225)



Our data suggests triple vessel disease(TVD) is most common pattern of vascular involvement overall (33.78%), it is also the most common presentation in right dominant (35.76%) and co-dominant(30.43%) cases. However in left dominant circulation patients , double vessel disease (28.261%) is most common presentation followed by single vessel disease(23.913%) , triple vessel disease is found in only 21.74% of them.

If we club double vessel disease and triple vessel disease together we get the multivessel disease cases . Multivessel disease patients outnumber the other categories , 123/225 patients (54.67%) overall , 84/151(55.63%) patients with right dominance , 23/46(50%) patients with left dominance , 13/23(56.52%) patients with codominant circulation and 5/5 (100%) patients with unclear dominance pattern .

Single vessel disease(SVD) is second most common presentation overall (25.78%), it is also second most common presentation in right dominant (27.152%) and left dominant(23.913%) patients , however codominant people show equal incidence of single and double vessel disease both being 26.09% each .

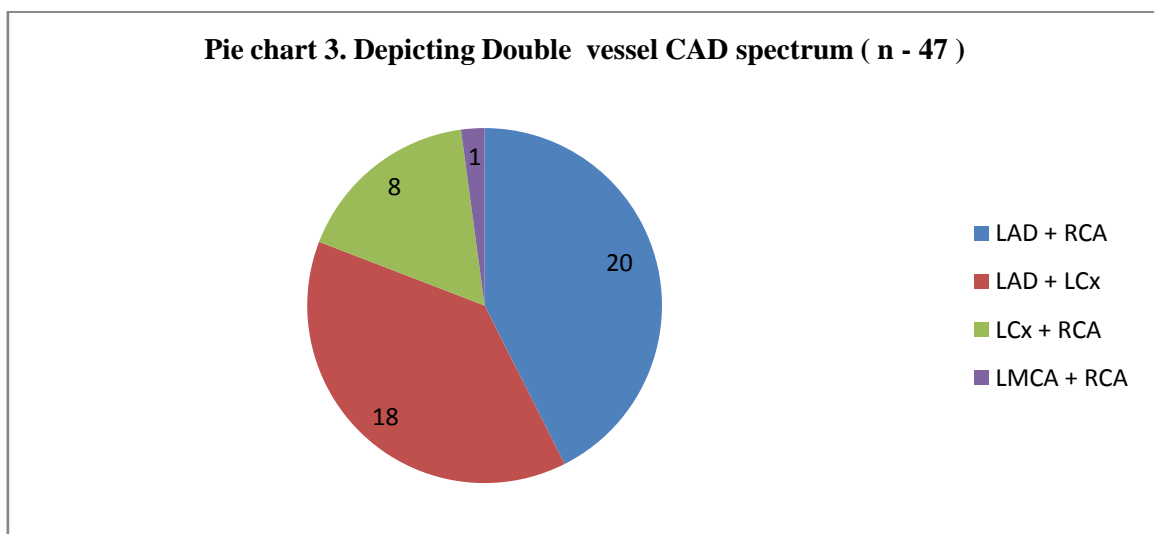


Among the SVD cases left anterior descending (LAD) is most frequently diseased vessel (40 out of total 58 cases of SVD are LAD cases) . LAD is also the most common vessel to show solitary involvement in all dominance types (28 out of 41SVD in right dominant , 7 out of 11SVD in left dominant and 5 out of 6SVD case in co dominant circulation patients) .

Left main coronary artery(LMCA) is never affected alone (no cases of SVD with LMCA as culprit artery) . Ramus Intermedius (a branch arising from LMCA between LAD and LCx artery in cases of trifurcation of LMCA) is another branch that is not commonly affected as single vessel involvement (only one case found in our study and the patient had left dominant circulation) .

RCA involvement as single vessel was found only in right dominance people in our study , there was no case of solitary involvement of RCA in left dominant and balanced circulation patients .

LCx as a single vessel involved was found most commonly in left dominant circulation (6.52%) followed by codominant (4.35%) and right dominant (3.31%) patients .



Among double vessel disease cases , involvement of LAD + RCA (20/47, 42.55%) is most common finding followed by LAD +LCx(18/47 , 38.30%) . LAD +RCA involvement is also most common double vessel CAD in right dominant (15/28 ,53.57%) and codominant(3/6 , 50%) , while in left dominant circulation LAD +LCx (9/13 , 69.23%) are the most frequently afflicted vessels .

Table 10 . Depicting LMCA involvement in various categories of CADs(n-225)

Type	Number	LMCA (critical stenosis)	LMCA (subcritical stenosis)
Normal coronaries	19	0	0
NO CAD	25	0	1
SVD	58	0	7
DVD	47	1	2
TVD	76	15	20
TOTAL	225	16	30

Note : CAD – coronary artery disease , DVD – double vessel disease , LMCA – left main coronary artery , n – total number of patients , NO CAD – non obstructive coronary artery disease , SVD – single vessel disease , TVD – triple vessel disease .

Out of 225 patients 46 showed LMCA involvement , 16 had critical stenosis while 30 presented with subcritical stenosis indicating nonobstructive involvement of artery . Out of 16 cases of critical stenosis 15(93.75%) were associated with triple vessel disease , similarly out of 30 subcritical stenosis cases 20(66.67%) are associated with triple vessel disease , thus we can say involvement of LMCA in CAD usually indicates more severe disease presentation .

When we take a overall picture LAD is most commonly affected vessel . LAD artery involvement (either in single, double or triple vessel disease and nonobstructive CAD) was found in 167out of 225(74.22%) of patients we studied , while RCA was affected in 125 of 225(55.56%) of patients and LCx artery was involved in 121of 225 patients (53.78%) .

Now we would briefly discuss observations of some other researchers who have also focused on our area of study .

Peng L et al⁴ in their study on data of 2225 patients undergoing coronary angiography found that patients with right dominant circulation had a higher prevalence of triple vessel coronary artery disease and significant stenosis in RCA . They suggested that right dominance may act as a risk factor for triple vessel CAD and more effective measures should be taken in right dominant patients to prevent fatal cardiovascular events . In our study also we have found triple vessel CAD to be more frequently associated with right dominant circulation(35.76%) compared to codominance (30.43%) or left dominance(21.74%) .

R J Weiss et al⁵ in their study on 50 patients found single vessel disease in 16 cases(7 with LAD involvement , 5 with RCA involvement and 2 with LCx involvement) and multivessel disease in 34 patients . There criteria for angiographic labeling of multivessel disease was presence of two or more major coronary arteries with atleast 70% intraluminal diameter narrowing . In our study we found multivessel CAD (double and triple vessel disease) in 123 out of 225 patients (56.67% cases) while single vessel disease was present in 58 out of 225 (25.78%) cases , Out of 58 SVD cases 40 were of LAD involvement , 9 of LCx , 8 with RCA and 1 with RI involvement) . Our finding that multivessel diseases are more common compared to single vessel disease and among single vessel disease LAD is most frequently affected is corroborated by findings of Weiss et al.

H L Abrams⁶ in his observation found that single vessel CAD has better survival at 5and 10 years than double or triple vessel disease , however if LAD is the solitary vessel involved then mortality is doubled . Stenosis of RCA alone has a favorable prognosis , resting hemodynamics may be similar to those with normal coronaries , however in cases with marked stenoses or chronic total occlusion , MI may occur . In patients with symptoms of angina about 30% have triple vessel disease , 30% have double vessel disease , 30% have single vessel disease and 10% may have normal coronaries . We got triple vessel disease in 33.78% , double vessel disease in 20.89% and single vessel involvement in 25.78% while normal coronaries were present in 8.44% , we had one more group of patients , patients with nonobstructive CAD and this group formed 11.11% of whole patient database , this group has not been mentioned in this particular study of Abrams .

S Jianping et al⁷ studied luminal stenosis of coronary arteries on the basis of % of cross sectional area stenosis and categorized them into 4 groups – those with 1-25% decrease , 26-50% , 51 – 75% and 76-100% decrease in cross sectional area . They studied 97 patient , 77 arteries showed 75% or more stenoses . In 39 patients LMCA + LAD were involved , in 27 LCx was involved , in 31 RCA was involved , thus they had 39 cases with DVD and 58 cases with SVD , however our patients spectrum ranged from normal coronaries to triple vessel disease and TVD was the most common presentation of all . May be population base in Jianping study is more aware of cardiac symptoms and they are reporting to hospitals early while our rural and semiurban population base is not so much health and in particular cardiac health conscious and they are not aware of initial

symptoms of cardiac problems, hence they neglect the initial symptoms and report to hospital late with more severe coronary involvement.

Limitations of angiographic assessment – evaluation of stenosis is done by assessing % reduction in diameter of narrowed vessel site in relation to adjacent unobstructed vessel. Now this angiographically normal vessel may have diffuse atherosclerotic disease which is not being detected and hence underestimation of stenosis can occur in such cases. There can be overestimation in some cases where the normal luminal diameter of the vessel with which comparison is being done is more than the normal caliber of the affected vessel segment being considered. The assessment is subjective, hence there can be +/- 20% variation between readings of two or more experienced angiographers especially for lesions narrowed by 40 – 70%. Different angiographers may interpret the same angiographic image differently and same angiographer may render a different interpretation at a time remote from first reading.⁸ Also reduction in cross sectional area(CSA) of stenosis is always greater than reduction in diameter of stenosis site - decrease in luminal diameter by 50%, 70% and 90% correspond to reduction in CSA of 75%, 90% and 99% respectively.^{3,9}

Despite the above mentioned pitfalls coronary angiography still remains the primary investigation to assess coronary arterial system involvement in cases of coronary artery diseases.

V. Conclusion

Multivessel disease (double and triple vessel disease taken together) patients outnumber other categories, 123/225 patients (54.67%) overall, 84/151 (55.63%) patients with right dominant circulation, 23/46 (50%) patients with left dominant circulation, 13/23 (56.52%) patients with codominant circulation and 5/5(100%) patients with unclear dominance pattern.

If we consider individual categories, triple vessel disease(TVD) is the most common pattern of vascular involvement overall (33.78%) followed by single vessel disease in 25.78% and then double vessel disease in 20.89%.

Left anterior descending(LAD) artery is the most common artery affected overall (in 74.22%), right coronary artery(RCA) is the next (in 55.56%) followed by left circumflex(LCx) artery(in 53.78%) cases.

Our center is located in rural area of the country and population base of our patient source is rural to semi-urban. People in such remote areas may not be aware of significance of mild/transient chest discomfort/uneasiness that they may be facing for long and come to hospital only when the symptoms become worse and debilitating, this may be one of reason for higher prevalence of multivessel disease in our database.

To reduce the burden of coronary artery diseases we need to develop community sensitization program aimed at making people aware of early presentations of coronary artery diseases, so that if any one faces such symptoms they come to hospital for screening at the earliest, thus making it possible to detect CAD cases in initial stages and thus improve treatment outcome and prognosis. Apart from this approach of early detection and treatment of patients we need to teach people about primordial preventive measures like the importance of healthy habits regarding diet, exercise, weight control etc. that can be taken to avoid development of coronary artery diseases.

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