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Frequency of Left Main Coronary Artery Disease in Patients with ST Segment Elevation in aVR Lead

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Abstract

Introduction: *Studies have demonstrated the predictive value of ST segment elevation in lead aVR on resting ECG and three vessel diseases in the setting of ACS. These studies have indicated that ST elevation in lead aVR is a strong predictor of left main coronary artery (LMCA) occlusion when used in isolation or in conjunction with other leads. Studies have indicated that the presence of simultaneous ST-segment elevation (STE) in leads aVR + aVL or the presence of ST–segment elevation in aVR that exceeds the amount of STE in lead V1 is highly specific for LMCA occlusion in patients with ACS.*

Objective: *To determine the frequency of left main coronary artery disease in patients with ST-segment elevation in aVR lead*

Duration, Study design & Setting: *It was a Cross-section study conducted in Cardiology Department BMC, Quetta, from January 2023 to December 2023*

Methods: *The study was performed in Cardiology Department BMC, Quetta. Patients were selected according to inclusion criteria. Ninety five patients of acute coronary syndrome with ST-segment elevtion in aVR lead were included in this study. They underwent coronary angiography for left main coronary artery disease.*

Result: *Out of 95 patients 42 patients had left main coronary artery disease, while 53 patients had no left main disease. So according to our study the frequency of left main disease in patients with ST-segment elevation in aVR lead is 44%.*

Conclusion: *Elevation of ST segment in aVR in the setting of Acute Coronary Syndrome Identifies patients with severe coronary artery disease.*

Keywords: Acute coronary syndrome, Left main coronary artery disease, aVR lead, ECG.

INTRODUCTION

In the developed countries coronary artery disease (CAD) is the major cause of mortality, including sudden cardiac death, both in females and males.

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Despite the enormous development of non-invasive diagnostic methods, especially imaging techniques, electrocardiography remains one of the most valuable diagnostic and prognostic tools that may be used by clinicians for the evaluation of patients with angina at rest [1]. Precordial (chest) leads and limb leads I, II, III, aVF and aVL have undeniable clinical value, but the electrocardiographic changes in lead aVR and their interpretation in the setting of acute coronary syndrome (ACS) have not been conclusively investigated and are currently the subject of many clinical studies [2]

Elevation of the ST segment in aVR, which may be accompanied by ST segment depression in leads I, II, and V4-V6, indicates the possibility of 60% of significant left main coronary artery stenosis (LMCAS)[3]. In previous studies frequency of left main coronary artery disease was found to be 55.6% among patients with ST-segment elevation in aVR lead[1].

The aim of this study was to evaluate the predictive value of ST segment elevation in lead aVR on resting ECG, recorded in patients with anginal pain in the diagnosis of significant LMCAS, LMCASE(left main coronary artery stenosis equivalent) and three-vessel disease in the setting of ACS.

Studies have demonstrated the predictive value of ST segment elevation in lead aVR on resting ECG and three vessel diseases in the setting of ACS. These studies have indicated that ST elevation in lead aVR is a strong predictor of left main coronary artery (LMCA) occlusion when used in isolation or in conjunction with other leads.

Studies have indicated that the presence of simultaneous ST-segment elevation (STE) in leads aVR + aVL or the presence of ST –segment in aVR that exceeds the amount of STE in lead V1[4,5] is highly specific for LMCA occlusion in patients with ACS. Other studies have discussed STE in lead aVR in less specific terms, simply citing that this finding is indicative of either LMCA occlusion or left anterior artery occlusion or indicative of either LMCA occlusion or triple-vessel disease[6] The magnitude of STE in lead aVR that is considered significant is inconsistent among these articles; some articles have evaluated any STE in aVR, whereas others have focused on STE greater than 1 mm. This difference may account for the varying specificities for LMCA involvement.

Regardless, the literature continues to show with increasing consistency that STE in lead aVR in patients with ACS is associated with more ominous coronary occlusions. Patients with LMCA occlusions, left anterior artery occlusions, or triple-vessel occlusions have a worse prognosis, requiring more aggressive immediate therapy and often bypass surgery. Emergency physicians who find ECG predictors of any of these 3 conditions in their patients with ACS (whether ST-segment elevation myocardial infarction[STEMI]or non -ACS) would be prudent to mobilize resources for rapid invasive therapy . [3,4]

Lead aVR of standard electrographic recordings, commonly underestimated in clinical practice, enables the recording of electrical potential from the right superior part of the heart[7,9]. Although it has been assumed that ECG abnormalities in aVR reflect only changes in the ventricular lateral wall, i.e. in leads II, aVL, V5 and V6, the results of clinical trials, as well as our observation, seem to contradict.

Elevation of ST segment in aVR, which may be accompanied by ST segment depression in lead I,II and V4, V6, indicate the possibility of left main coronary artery stenosis or, as reported in the literature three vessel disease[4,6,10,].Despite the fact that several studies have proven the association between electrocardiographic changes in aVR and the risk of LMCAS and three vessel diseases, the clinical relevance of ST

segment elevation in aVR as an independent predictor LMCAS ,left main coronary artery stenosis equivalent(LMCASE).and three vessel disease in patients with ACS remains unknown.

This study is undertaken to determine the magnitude of left main coronary artery disease, so that this data can be utilized to formulate for management and preventive strategies.

MATERIAL AND METHODS

left-main coronary artery disease: more than 50% stenosis in left main stem observed on coronary angiography
ST-segment elevation: ST-segment elevation of >0.05mv above the isoelectric line

This Cross-section study was conducted at Bolan Medical College/BMCH, Quetta from March 2022 to April 2023. The patients meeting inclusion criteria (Either sex age more then 18 who presents with chest pain within 24 hours) were enrolled from all medical wards of NICVD. Prior to enrollment consent was taken for enrollment in study and intervention. Coronary angiography was done by consultant having more than ten years post fellowship experience. Presence of stenosis of left main coronary artery of >50% was considered as left main coronary artery disease. Exclusion criteria was applied Patients with chest pain not ready or fit for intervention This information was collected and entered in the proforma for further work up.

Data was analyzed by SPSS version 12. The frequency and percentages were calculated for left main coronary artery disease and gender.Mean ,+,_, SD, were calculated for age of patient and duration of chest pain. Stratification was done with regard to age, gender, history of hypertention, smoking, and duration of chest pain to see the effect of these on outcome.

RESULTS

There were 76 males and 19 females in my study with M:F 4:1 (Figure -1)

The average age of the patients was 55.27 (ranging from 35 to 75) years (Figure 2).

Hypertention was the commonest risk factor that was observed in 50(53.6%) patients followed by smoking in 39(41.1%), diabetes in 28 (29.5%) patients. Left main coronary artery disease was found among 42 (44.2%) patients (Figure 3).

Among 95 patients, 74 (77.8%) patients presented within 12 hrs, while 21 patients (22.10%) patients after 12 hrs.(Table).

Out of 42 patients who had left main coronary artery disease 31 (73%) patients were males and 11 (26.19%) patients were females. 9 (21.4%) were diabetics and 33 (78.5%) were non diabetics, 19 (45.23%) were hypertensive and 23 (54.76%) were non-hypertensive, 19 (45.23%) were smokers and 23 (54.76%) were non-smokers, 29 (69.04%) presented within 12 hrs and 13 (30.95%) in more than 12 hrs.

Fig.1

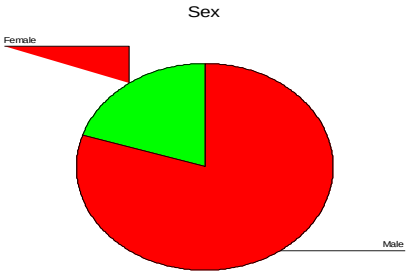

Fig.2

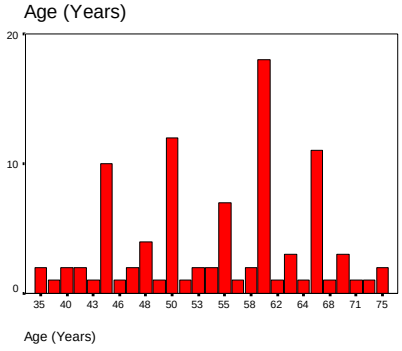

Fig.3

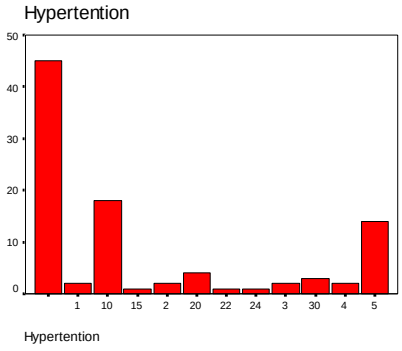

Table 1. Left Main Coronary Artery Diseases with age

Left Main Coronary Artery Diseases			
Age	**Yes**	**No**	**Total**
35	0	2	2
39	0	1	1
40	1	1	2
42	1	1	2
43	0	1	1
45	5	5	10
46	0	1	1
47	1	1	2
48	3	1	4
49	0	1	1
50	5	7	12
52	0	1	1
53	1	1	2
54	2	0	2
55	2	5	7
56	0	1	1
58	2	0	2
60	10	8	18
62	0	1	1
63	2	1	3
64	1	0	1
65	2	9	11
68	1	0	1
70	1	2	3
71	0	1	1
72	0	1	1
75	2	0	2
Total	42	53	95

DISCUSSION

Left main coronary artery (LMCA) occlusion is a serious clinical condition. Despite its low incidence, the prognosis is grave. It may present as sudden death, complete heart block, shock or acute coronary syndrome (ACS). Surgery is usually too late to initiate, so that percutaneous coronary intervention (PCI) is utilized to obtain immediate vessel patency. However, this modality is associated with a high mortality and restenosis rate.[109.110]Early recognition and emergent PCI may be lifesaving.

The best and easiest available noninvasive modality in the emergency room (ER) is an electrocardiogram (ECG).However, ECG may be normal or may present with findings compatible with ACS, but be unable to distinguish an LMCA from other coronary artery occlusion. For the past few years, reports have shown that the ST segment elevation in lead aVR is an important predictor of acute LM occlusion, and is valuable in its prognosis. Also, an ST elevation of more than 0.05 mV in lead aVR is indicative of LM occlusion in patients with acute myocardial infarction (AMI).[11, 12]

We therefore undertook this study to determine if we could obtain similar findings. According to available data the mechanism of ST segment elevation in aVR in ACS patients is not entirely clear .Currently it is assumed that it reflects transmural ischaemia of the basal segment of the interventricular septum, where the current is directed towards the right shoulder [6].The clinical analyses showed that electrocardiographic changes in aVR were common in patients with ACS. First

observations indicating the association between ST segment elevation in aVR in ACS patients and the severity of coronary artery atherosclerosis, LMCAS and three vessel disease were reported by Gorgels et al. [4, 7]

They found that elevation of the ST segment in lead aVR with concomitant ST segment depression in leads I, II, and V4-V6 in patients with UA was typical of LMCAS, and for three-vessel disease.[4] In the study of Gorgels et al. the above-mentioned electrocardiographic abnormalities, called left main electrocardiogram by the authors, indicated the presence of LMCAS and three-vessel disease with sensitivity of 90% and 50%, respectively. To compare, the rate of such ECG changes in one-vessel disease was significantly lower and was merely 21%.

The analysis of ST segment changes in aVR in AMI patients, particularly in the setting of anterior wall infarction, is clinically relevant. According to the studies of Engelen et al., ST segment elevation in aVR was observed in resting ECG recordings in patients with LAD as the infarct-related artery that was occluded proximal to the main septal branch [(5)]. Yamaji et al. convincingly documented that ST segment elevation in aVR and concomitant lower ST segment elevation in V1 in resting ECG was indicative of acute occlusion of LM [6]. In this study, ST segment elevation in aVR was observed in 55.6% of patients with LM occlusion.

In my study,42% patients had ST segment elevation in aVR lead which is comparable with that of reported in other studies supporting our hypothesis regarding direct and strong association of ST segment elevation in aVR lead and left main coronary artery disease.

Interestingly, the authors observed a significant correlation between ST segment elevation in aVR and mortality of their patients. AMI survivors had significantly lower ST segment elevation in aVR than individuals with a fatal outcome (0.09 mV±0.09 mV vs 0.23 mV±0.14 mV; $p < 0.05$). Such a prognostic value has not been shown for lead V1.[6]

Barrabes et al., who analysed the prognostic value of electrocardiographic abnormalities in aVR in patients with first non-ST segment elevation MI, demonstrated that ST segment elevation of 0.05-0.1 mV in aVR increased the risk of in-hospital death by over four times, whereas ST segment elevation in aVR of above 0.1 mV was an independent risk factor that increased the risk of death by almost seven times[8]

The studies involving patients with ACS have documented that only LMCAS, ST segment elevation in V1 lead and diabetus mellitus is independent predictors of ST segment elevation in aVR in resting ECG recorded during anginal pain.

However my study involving 95 patients with ACS have shown no such significant relation between diabetus mellitus and ST segment elevation in V1 lead with ST segment elevation in aVR lead. However strong association was found between LMCAS, hypertension and ST segment elevation in aVR lead.

Although three-vessel disease has been associated with LMCAS in many cases, our results have not indicated that three vessel disease was associated with ST segment elevation in aVR. This finding adds to our understanding of the clinical value of aVR electrocardiogram analysis in patients with ACS and may influence the indications for coronary angiography [4, 6, 8].

The results of our studies and published data show that the evaluation of underestimated lead aVR tracings is an important element of complete clinical workup in patients with ACS.

This study shows that the higher the ST elevation in lead aVR, the more useful it is for predicting LMCAS as culprit lesion in patients with ACS. Patients with significant LM disease, even if LM was not the culprit lesion of ACS, also exhibited ST elevation in lead aVR. However, in these cases, the ST elevation was lower in magnitude. There is no cutoff level as to the magnitude of ST elevation in lead aVR in predicting LMCA lesions.

The aVR on a 12-lead ECG provides valuable information on the right upper side of the heart. However, it is not usually used in clinical practice, and is commonly seen and interpreted as reciprocal information from the left lateral leads, or for observing endocardial electrographic changes. During the 1980's, ST elevation in lead aVR was reported to be associated with LM occlusion.[13,14] But even up till the late 1990's, ECG interpreters often ignored the aVR.[15] For the past few years, reports have proven that ST elevation in lead aVR was not only related to a LM occlusion, but also indicated an anterior wall infarction. As was mentioned earlier, and as proven in our data, ST elevation in lead aVR strongly suggests a significant LM lesion. However, if accompanied by ST elevation in lead V1, the specificity of an LM lesion acting as the culprit vessel increases. Assuming that both leads aVR and V1 have ST elevations, a higher magnitude of ST elevation in lead aVR compared to lead V1 is very specific for LM occlusion.[11.14.16.19]

According to Yamaji et al,[12] the incidence of ST elevation in lead aVR of lower magnitude or less than that of V1 in AMI from LM occlusion is less than 20%, as in this series.

Patients who present with total LM occlusion associated with RBBB, ST elevation in lead aVR, shock an cardiac arrest are known as "left main shock syndrome.[20] Patients with this condition have a high mortality rate, as in this series. Therefore, a high index of suspicion, with accompanying symptoms and aforementioned new ECG findings, are helpful to arrive at a diagnosis early.

LM disease is usually not an isolated coronary artery event, but is associated with individual LAD, LCX, RCA or even triple-vessel disease.

Co-occurrence with 1 or more coronary arteries may alter ECG manifestations, as the magnitude of ST elevation in lead aVR may change in relation to V1. Diffuse ST depression over the inferior and anteriolateral leads with ST elevation in leads aVR, aVL, V1 and V2 are typical ECG manifestations of AMI secondary to an LM occlusion.[18,21,22,23,24]

ECG is only 1 of the many diagnostic modalities used in detecting myocardial infarction from an LM occlusion. Therefore, recognizing the significance of ST elevation in lead aVR and subjecting the patient to emergent cardiac catheterization are lifesaving.

In my study, patients with ST-segment elevation in lead aVR were older and had a higher baseline risk profile than the remaining patients, but the association of this variable with mortality was independent of baseline clinical predictors. Not surprisingly, ST-segment elevation in lead aVR was also related to ST-segment depression in other leads, a finding with well-known adverse prognostic implications.[24,25] Because lead aVR points at -150 degrees in the frontal plane (or inverted lead aVR at -30 degrees), ST-segment elevation in this lead was especially associated with lateral or to a minor extent inferior ST-segment depression. However, ST segment elevation in lead aVR was superior to ST-segment depression elsewhere in predicting the risk of death even after adjusting for the location of ST-segment

depression, which had incremental prognostic value in our previous study. The particular orientation of inverted lead aVR falling between leads I and II and not matching exactly the lateral or the inferior leads may help explain these results.[26]

Hypertension was the commonest risk factor that was observed in 50 (53.6%) patients followed by smoking in 39 (41.1%) and diabetes 28 (29.5%). Our results are comparable in this aspects that LMCAS in found among old patients with multiple risk factors.

Accordingly and in view of its association with severe coronary artery disease, ST-segment elevation in lead aVR could be used, if the results of the present study are confirmed in the large databases now available, as a readily available tool for an early selection of patients for coronary angiography and revascularization.

CONCLUSION

- Significant stenosis of the left main coronary artery is an independent factor associated with ST segment elevation in lead aVR in patients with acute coronary syndromes.
- Three-vessel disease and the left main coronary artery stenosis equivalent are not independent factors responsible for ST segment elevation in lead aVR of standard ECG recorded in patients with acute coronary syndromes.
- ST segment elevation in lead aVR of resting ECG in patients with acute coronary syndrome identifies patients with severe coronary artery disease on angiography.
- The analysis of electrocardiographic abnormalities in lead aVR of widely available standard ECGs is of importance in the global assessment of patients with acute coronary syndrome**.**

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