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Correlation of ST Segment Elevation in the Lead aVR During tmt with Coronary Angiogram

Medical Science

KEYWORDS : Treadmill Test, Lead aVR, Left Main Coronary Artery disease, ST Segment Elevation.

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ABSTRACT

***BACKGROUND**:- Treadmill testing (TMT) is the most widely used method for evaluating patients with coronary artery disease, predicting the left main coronary artery (LMCA) disease before invasive procedure is very important in risk assessment because of its severe clinical outcome. Lead aVR can be very useful in identifying LMCA obstruction, it is also valuable lead not only in diagnosis but also in predicting the prognosis.*

***AIM**:-To examine whether ST elevation in lead aVR during TMT may suggest LMCA disease since the lead aVR is the reciprocal lead of LMCA .*

***METHOD**:- In this study, 50 patients with positive TMT were included. The study group consisted of 30 patients with ST elevation of >1 mm in lead aVR. 20 patients also having positive TMT, but with <1mm of ST elevation in lead aVR comprised the control group. All patients underwent coronary Angiography.*

***RESULTS**:-Coronary angiography in the study group revealed significant LMCA disease in 19(63%) patients, whereas no LMCA disease in the control group. 6(20%) patients had ostioproximal LAD lesions in study group, 2(10%)patients in the control group. Tripple vessel disease in 5(17%)patients in study group, 3(15%)patients in the control group. Significant "P" value indicates ST segment elevation in lead aVR during TMT which strongly predicts the presence of LMCA disease.*

***CONCLUSION**:-ST segment elevation in the lead aVR of >1 mm during Treadmill testing(TMT)is a strong predictor of LMCA disease.*

INTRODUCTION :-

Lead aVR, one of the 12 electrocardiographic leads, is frequently ignored in clinical medicine . Infact, many clinicians refer to the 12-lead electrocardiogram (ECG) as the 11-lead ECG, noting the commonly held belief that lead aVR rarely offers clinically useful information.[1]

The augmented limb leads were developed to derive more localised information than the bipolar leads I, II and III could offer. For this purpose from the existing limb electrodes, new leads aVR, aVF and aVL were constructed, being unipolar leads looking at the right, left and lower part of the heart with the reference electrode constructed from the other limb electrodes. Thus, the purpose of lead aVR was to obtain specific information from the right upper side of the heart, such as the outflow tract of the right ventricle and the basal part of the septum. In practice, however, most electrocardiographers consider lead aVR as giving reciprocal information from the left lateral side, being already covered by the leads aVL, II, V5 and V6. This has been the reason that lead aVR has become largely ignored.[2,3]

Lead aVR can be very useful in identifying Left Main Coronary Artery (LMCA) obstruction.[4]

Ischaemia of the basal part of the interventricular septum is the electrocardiographic explanation for the occurrence of ST-segment elevation in this lead. In this situation, owing to the dominance of the basal ventricular mass, the ST-segment vector in the frontal plane points in a superior direction, leading to ST-segment elevation in leads aVR and ST depression in the inferior leads.[5]

Lead aVR also helps in differentiating between LMCA and proximal Left Anterior Descending artery(LAD) disease. ST elevation in aVR more than in V1 is suggestive of LMCA disease and vice versa is suggestive of proximal LAD disease.[6]

Coronary artery disease (CAD) is the world's leading cause of mortality.[7]

Treadmill testing (TMT) is the most widely used and widely available method for investigating the presence of CAD. The TMT is used to determine the likelihood of CAD, to determine functional capacity and to assess the effects of therapy. The TMT may also be used to assess the likelihood of anatomic severe disease that may be of prognostic importance.[8]

During TMT, the ST-segment and T wave changes, arrhythmias and decreases in blood pressure may indicate myocardial ischaemia. The ST-segment elevation in leads reflecting the ischaemic region of the heart demonstrate significant stenosis in the coronary artery supplying this region.

The lead aVR is infrequently used in clinical practice. Because it is the reciprocal lead of the basal interventricular septum, aVR is affected by the perfusion changes of this region.[9]

Likewise,Engelen et al,[6] reported that ST elevation at the lead aVR during the acute phase of anterior myocardial infarction (MI)indicates left anterior descending artery (LAD) occlusion before the first septal branch.

Other studies have also revealed that ST segment elevation in lead aVR may identify patients with the left main coronary artery (LMCA);[10,11] that ST segment depression at aVR is a sign of reduced (35%)ejection fraction;[12] and that ST segment elevation in aVR is associated with increased in-hospital mortality rates among non ST elevation MI patients.[9]

Nevertheless, there are insufficient data concerning TMT role and the aVR assessment in predicting severity of CAD. In this study, we hypothesised that ST segment elevation in lead aVR is a sign for LMCA disease in the TMT-positive patients.

METHODS :-

STUDY GROUP:-Study conducted from October-2013 to March-2014 over a period of 6 months at Sri Jayadeva Institute of cardiovascular sciences and Research, Bangalore. We included 30 successful patients who had ST segment elevation of more than 1 mm in the aVR lead and positivity criteria during TMT (aVR group). 20 age-matched patients who had positiveTMT with less than 1mm of ST elevation in aVR served as control group. All patients underwent TMT due to complaining of angina on exercise. All patients gave written informed consent before inclusion, and this study had the approval of our local ethics committee. Participants underwent complete history and physical examination, resting ECG, transthoracic echocardiography and measurement of serum cholesterol and blood glucose levels.

EXCLUSION CRITERIA WERE:-known CAD; previous percutaneous coronary intervention; pericardial disease; valvular heart disorders; cardiomyopathy; mitral valve prolapse and abnormal resting ECG.

Because of their positive TMT, all participants underwent diagnostic coronary angiography. The LMCA disease was considered present when there was stenosis of ≥ 50%.

EXERCISE TEST:-

Nitrates, beta-blockers and calcium blockers were stopped 48 hours before TMT. Exercise ECG was performed using Quinton 4500 (CA, USA) according to the standard Bruce protocol, aiming for the attainment age-adjusted target heart rates of 85% of predicted maximal response. Exercise was terminated when necessary for fatigue, significant angina, ischaemic ST-segment depression > 1 mm, significant ventricular ectopy, systolic blood pressure ≥ 250 mm Hg or decreased by 15 mm Hg or more during exercise.

Exercise ECG was considered positive when ≥ 1 mm ST segment depression occurred at 80 ms after J point. The TMT was considered negative when no ST depression occurred in a patient who achieved ≥ 85% of maximal age-predicted heart rate.

The ST-segment elevation in aVR was detected when ≥ 1 mm ST elevation occurred at 80 ms after J point. The results of coronary angiography and TMT were evaluated .

STATISTICAL METHODS:- Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5 % level of significance. The following assumptions on data is made, **Assumptions: 1.**Dependent variables should be normally distributed, 2.Samples drawn from the population should be random, Cases of the samples should be independent

Analysis of variance (ANOVA) has been used to find the significance of study parameters between three or more groups of patients , Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups Inter group analysis) on metric parameters[22-25]

Significant figures :-

+ Suggestive significance (P value: 0.05<P<0.10)

* Moderately significant (P value:0.01<P ≤ 0.05)

** Strongly significant (P value : P≤0.01)

RESULTS :-

Table-1.CLINICAL AND DEMOGRAPHIC CHARACTERISTICS OF THE aVR AND COTROL GROUP:-

SL.NO	PARAMETERS	aVR GROUP(n=30)	CONTROL GROUP(n=20)	P value
1	AGE(years)	47-76	44-78	1.000
2	SEX	M-26, F-04	M-14, F-06	0.149
3	EFFORT ANGINA	30	20	1.000
4	PAST HISTORY OF MI	0	0	-
5	PAST HISTORY OF CAD	0	0	-
6	DIABETES MELLITUS	24	17	0.652
7	HYPERTENSION	20	12	0.630
8	HYPERCHOLESTERELEMIA	25	15	0.470
9	SMOKING	18	12	1.000
10	ST SEGMENT ELEVATION IN LEAD aVR (mm)	2-5mm	<1mm	-
11	LMCA DISEASE	19	0	<0.001**
12	OSTIO PROXIMAL LAD DISEASE	6	2	1.000
13	LCX LESIONS	0	7	<0.001**
14	RCA DISEASE	0	8	<0.001**
15	TRIPPLE VESSEL DISEASE	5	3	0.875
16	SVD	25	17	0.875
17	DVD	0	0	1.000

Table-1 shows, total number of patients included in the study were 50, 30 in study group, 20 in the control group, in the range of 44-78 years. In study group-male-26, female-04. In control group-male-14, female-06. History of effort angina present in all the 50 patients. Diabetes mellitus in 24 (study group), 17(control group)patients. Hypertension in 20(study group), 12(control group)patients. Hypercholesterelemia in 25(study group), 15(control group)patients. History of Smoking in 18(study group), 12(control group)patients. ST segment elevation in lead aVR(>1mm)—2 to5 mm seen in 30 patients(study group), <1mm seen in 20 patients(control group).

Coronary angiography in the study group revealed significant LMCA disease in 19(63%) patients, whereas no LMCA disease in the control group . 6(20%)patients had ostio-proximal LAD lesions in study group , 2(10%)Patients in the control group.Tripple vessel disease in 5(17%)patients in study group ,3(15%)patients in the control group. Significant “P” value (<0.001)indicates ST segment elevation in lead aVR during TMT which strongly predicts the presence of LMCA disease.

DISCUSSION:-

Our study demonstrates that the elevation of ST segment in lead aVR may indicate the presence of LMCA disease with high sensitivity and specificity. Lead aVR of a standard 12-lead ECG depicts changes in electrical activation of the upper right part of the heart, including right ventricular outflow tract and the basal part of the interventricular septum.[9]

In the presence of LMCA or proximal LAD stenosis, especially the basal part of the left ventricle is subject to ischaemia. Ischaemia of the basal part results in a superior deviation of the net vector in the left ventricle. This finding is reflected in the ECG as elevation of ST segment in the leads aVR and V1 and ST segment depression in leads V5, V6 as well as inferior leads. In contrast to that, during LAD disease after the first septal branch, there is ischaemia of inferoapical left ventricle. In this case, due to the inferior deviation of net vector, ST segment elevation is present in inferior and V4, V5 and V6 leads and ST segment depression in aVR lead.

Rostoff et al,[13] reported that assessing lead aVR in patients with acute coronary syndrome (ACS) can indicate LMCA disease and that analysing lead V1 does not improve diagnostic accuracy. In our study, similar to their results, we observed that ST segment elevation in lead aVR demonstrated LMCA disease. There was no significant finding in lead V1 during TMT.

Data from literature suggest a significant relationship between the amplitude of ST segment elevation in lead aVR and the presence of hypertension, mean systolic blood pressure,diabetes mellitus, cigarette smoking, male gender and advanced age of patients with first acute MI without ST segment elevation in other leads.[9]

In the study of Rostoff et al,[13] only the incidence of hypertension was significantly higher in patients with LMCA disease than in those without it. The prevalence of hypertension was high in both groups and reached 70% in patients with LMCA disease and 60% in patients without it.

Michaelides et al,[14] have shown that during TMT, ST elevation in lead V1, and ST depression in lead V5, predicted significant LAD stenosis as single-vessel disease or significant stenoses of LAD and circumflex arteries. In our study, ST segment depression in leads V2, V3, V4, V5 and V6 occurred concurrently with ST segment elevation in lead aVR.

Another study reported that the sensitivity of isolated exercise-induced ST elevation in lead aVR in detecting LMCA disease was 85.0%, specificity 50.0%, positive predictive value 25.8%, and negative predictive value 94.2%.[15]

Tuna Katircibasi et al,[16] showed that exercise-induced ST-segment elevation in lead aVR had a sensitivity of 92.9% and a specificity of 48.6% and ST segment elevation in lead aVR accompanied by ST segment elevation in lead V1 had a sensitivity of 85.7% and a specificity of 81.6% in predicting LMCA disease. The results of these two studies are similar to our findings.

In a separate study, Michaelides et al,[17] reported that exercise-induced ST depression in V5, and concomitant ST elevation in aVR, predicted significant isolated LAD lesion.

Six of our patients had ostioproximal LAD lesions in addition to LMCA lesions. Interestingly, none of the patients had RCA lesions. It has been shown that ST segment elevation in lead aVR during acute inferior MI is a useful predictor of impaired myocardial reperfusion.[18]

There are also data showing that ST segment deviation in lead aVR does not indicate infarct-related artery during acute inferior MI.[19]

A study performed by Kasuge et al,[20] showed that > 0.5 mm ST elevation of aVR in ACS, together with positive troponin value, is a useful predictor of LMCA disease or triple vessel coronary artery stenosis.

There were no ACS or recent MI patients in our study population. Our study is different as it reveals LMCA disease via exercise-induced ischaemia.

According to literature, ischaemia of the basal part of the interventricular septum causes ST segment elevation in lead aVR. Owing to the dominance of the basal ventricular mass, ST segment vector in the frontal plane points in superior directions, leading to ST segment elevation in lead aVR.[1,5]

Chenniappan M et al, in their article(JAPI) reports that ST elevation of ≥1mm in aVR during exercise stress testing predicts LMCA or ostial LAD stenosis.[21]

LIMITATIONS OF THE STUDY:-This is a case control study with inherent limitation , although consequitive patients with ST elevation of more than 1 mm were enrolled. This study performed at tertiary centre which may lead to selection biass and sample size is also less.

CONCLUSIONS:-
ST segment elevation in the lead aVR of >1 mm during Treadmill testing (TMT) is a strong predictor of LMCA disease.

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