ORIGINAL RESEARCH PAPER

Cardiology

ST SEGMENT ELEVATION IN aVR AS A PROGNOSTIC INDICATOR IN PATIENTS OF NON ST SEGMENT ELEVATION ACS

KEY WORDS: ST elevation in aVR, LM/LM equivalent, TVD, non ST elevation ACS

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ABSTRACT

Objectives: To identify and screen patients of non ST segment elevation acute coronary syndrome (NSTE-ACS) for presence of significant LM stenosis or TVD on the basis of ST segment elevation ≥ 0.5 mm in aVR lead so that management of patients should be planned for better outcome.

Methodology: This study conducted in a tertiary cardiac care center in Northern India and enrolled 400 patients of NSTE – ACS. A 12 lead ECG was analyzed for presence or absence of ST segment elevation in aVR lead and ST segment depression in other leads. On the basis of their coronary angiographic findings, all enrolled patients divided into four groups. Patients with severe LM disease with or without TVD comprises group I, patients with severe LM equivalent disease in group II, patients with severe TVD in group III and patients with severe proximal LCX or severe ostio-proximal LAD disease in group IV. The angiographic findings of all patients correlated retrospectively with their respective ECG.

Results: Among patients of NSTE-ACS a statistical significant association (P value < 0.05) was found between ST segment elevation of ≥ 0.5 mm in aVR lead and severe LM/LM equivalent disease and severe TVD as compared to no ST segment elevation in aVR lead. Age and gender was not found to have significant association with severe LM/LM equivalent disease or severe TVD. While prevalence of CAD risk factors such as diabetes, hypertension, smoking and dyslipidemia were significantly higher in severe LM/TVD patients (P value<0.05).

Conclusion: ST segment elevation of ≥ 0.5 mm in aVR lead can be used to identify or screen patients of NSTE-ACS for presence of significant LM/LM equivalent disease or severe triple vessel disease and also for selection of correct management plan to improve their outcomes.

INTRODUCTION:

The prevalence of acute coronary syndrome (ACS) is continuously rising with the increase in prevalence of associated significant risk factors such as diabetes mellitus, obesity, dyslipidemia, smoking and hypertension. Across the world ACS is the leading cause of mortality and morbidity.[1] Prognosis of patients with non–ST-segment elevation acute coronary syndrome (NSTE-ACS) vary in severity based on size of the infarction, and the area of myocardium at ischemic risk. As patients with severe LM or LM equivalent/TVD disease found to have bad prognosis because of ischemic risk to large portion of myocardium, so an early identification of these NSTE-ACS patients is an important factor in the prognosis and selection of the management plan to improve their outcomes.[2] Total left main thrombosis usually leads to sudden cardiac death and affected patients generally die before arriving at hospital. Taglieri et al[3] found that patients with subtotal left main occlusion may present with NSTE-ACS and with ECG pattern of widespread ST depression in the anterior and inferior leads and ST elevation in aVR lead. Kühl et al[4] showed that ST elevation in aVR may represent a proximal LAD artery lesion and that this ECG sign is useful to differentiate proximal from more distal lesion in the setting of acute coronary syndrome. Lead aVR is electrically opposite to leads I, II, aVL, and V3–V6, and therefore an ST depression in these leads produces reciprocal ST elevation in aVR lead; in addition, lead aVR directly reflects the electrical activity of the right upper portion of the heart, including the basal portion of the interventricular septum and consequently, a transmural infarction in this area theoretically produces ST elevation in aVR. Accordingly, significant LM/LM equivalent disease or severe TVD can lead to diffuse antero-lateral subendocardial ischemia and ECG pattern of widespread ST depression in inferior and anterior leads and ST elevation in aVR lead. Transmural infarction of the basal portion of the heart also result in ST elevation in aVR lead.[5]

METHODOLOGY:

This observational study was conducted in a tertiary cardiac care center in Northern India. Patients admitted to the cardiology department from January 2019 to december 2019, who fulfilled the criteria, were included in the study. Informed consent was obtained from all enrolled patients. All enrolled patients were having age between 20 to 80 years. In this study total 400 patients of NSTE - ACS who presented with typical chest pain having duration > 20 minutes or chest pain attributed to cardiac ischemia and occurs at rest, or had unstable pattern now or had increased in duration or severity and had fully assessable 12 lead ECG and coronary angiography (CAG) data were included. Patients with LBBB, RBBB, LVH or any pre-excitaion pattern on ECG, patients having cardiomyopathy, structural or valvular heart disease, patients with persistent or transient ST segment elevation in leads other than aVR lead, and patients having history of recent PCI (within 6 months) or CABG were excluded from the study. All the patients underwent full history and clinical examination. Laboratory evaluation was done for all patients that included plasma glucose, lipid profile, renal function tests and cardiac troponin T levels. A 12 lead ECG was looked for ST segment elevation 0f ≥0.5 mm in aVR lead with ST segment depression in all other leads or ST segment depression in all 12 leads.[6] On the basis of coronary angiographic findings, all the enrolled patients (n = 400) were divided into four groups. A stenosis of ≥ 50% in Left main stem and ≥ 70% in other coronaries on CAG is considered as severe coronary artery disease. Patients with severe LM disease with or without TVD placed in group I, patients with severe LM equivalent disease (severe stenosis of proximal LAD and proximal LCX before the origin of any major branch, and no or mild LM disease) in group II, patients with severe TVD in group III and patients

having only severe proximal LCX or severe ostio-proximal LAD disease in group IV. The angiographic findings of all patients correlated statistically with respective ECG for any significant association with ST segment elevation in aVR lead. Data of all patients collected and entered in Microsoft excel and analysed by using SPSS16 version. P value <0.5 considered statistically significant.

RESULTS:

A total of 400 patients were included in the study. The prevalence of various CAD risk factors in the study population is shown in Table 1. The prevalence of smoking was 53%, while 57% had hypertension, 70% had dyslipidemia and 51.75% had Diabetes Mellitus. These were the most common risk factors among patients with NSTE-ACS in this study. In each group the mean age, sex ratio and prevalence of various CAD risk factors shown in Table 2. Out of total 400 patients; 52 patients (13%) had severe LM disease with or without TVD (group I), 75 patients (18.75%) had severe LM equivalent disease (group II), 110 patients (27.5%) had severe TVD (group III) and 163 patients (40.75%) were of group IV i.e. with only severe proximal LCX disease or severe ostio-proximal LAD disease.

Table1: Prevalence Of Risk Factors In The Study Population

Risk Factors	Number	Percentage (%)
Smoking	212	53.0
Dyslipidemia	280	70
Renal dysfunction	51	12.75
Hypertension	228	57.0
Family history of CAD	35	8.75
Diabetes	207	51.75

Table 2: Prevalence Of Various CAD Risk Factors In Each Group

Risk factors	Group I (Severe LM disease with or without TVD) (n=52)	Group II (Severe LM equivalent disease) (n=75)	Group III (Severe TVD) (n=110)	Group IV (Severe proximal LCX disease or ostio-proximal LAD disease) (n=163)
Mean Age (Years ± SD)	61.4±7.94	64.2±8.2	63.9±5.6	58.7±8.3
Gender Male (n=229)	30	41	62	88
Female (n=171)	22	34	48	75
Smoking	40 (76.92%)	52 (69.33%)	86 (78.18%)	34 (20.85%)
Dyslipidemia	43 (82.69%)	58 (77.33%)	82 (74.54%)	97 (59.50%)
Renal Dysfunction (CKD)	9 (17.30%)	5 (6.66%)	27 (24.54%)	10 (6.13%)
Hypertension	31 (59.61%)	39 (52.00%)	82 (74.54%)	76 (46.62%)
Family history of CAD	3 (5.76%)	5 (6.66%)	13 (11.81%)	14 (8.58%)
Diabetes	44 (84.61%)	40 (53.33%)	78 (70.90%)	45 (27.60%)

The association of ST segment elevation in aVR lead with the angiographic findings is shown below in table 3. Among 52 patients with severe LM disease with or without TVD, ST elevation of ≥0.5 mm in aVR lead was present in 78.84% (41) patients and absent in 21.15% (11) patients. This difference was statistically significant (P=0.002). Out of 75 patients with severe LM equivalent disease, ST elevation of ≥0.5 mm in aVR lead was present in 74.66% (56) patients and absent in 25.33% (19) patients (P<0.0018). Among 110 patients with severe TVD, ST elevation of ≥0.5 mm in aVR lead was present in 71.81% (79) patients and absent in 28.18% (31) patients. This difference was found to be statistically significant (P=0.001). ST segment elevation ≥0.5 mm in aVR lead was present in only 36.19% (59) patients and absent in 63.80% (104) patients out of total 163 patients having either severe proximal LCX disease or severe ostio-proximal LAD disease (P<0.001). The prevalence of ST segment elevation in aVR lead was significantly higher in patients with severe LM/LM equivalent disease or severe TVD compared to patients having either severe proximal LCX disease or severe ostio-proximal LAD disease (P<0.001) as shown below in table 4.

Table 3: Correlation Of ST Segment Elevation In aVR Lead With Coronary Angiography Findings In Each Group

	Group I (Severe LM disease with or without TVD) (n=52)	Group II (Severe LM equivalent disease) (n=75)	Group III (Severe TVD) (n=110)	Group IV (Severe proximal LCX disease or ostio-proximal LAD disease) (n=163)
NSTE-ACS patients with ST elevation ≥0.5 mm in aVR lead	41 (78.84%)	56 (74.66%)	79 (71.81%)	59 (36.19%)
NSTE-ACS patients with no ST elevation in aVR lead	11 (21.15%)	19 (25.33%)	31 (28.18%)	104 (63.80%)
P value	0.002	<0.0018	0.001	<0.001

In our study age and gender were not found to have any statistically significant relation with the incidence of LM/TVD in studied population. Prevalence of risk factors such as hypertension, diabetes mellitus, smoking, CKD and dyslipidemia was proximal LCX disease or severe ostio-proximal LAD disease significantly higher (P<0.05) in patients with severe LM/LM equivalent disease or severe TVD (group I, II and III patients) compared to group IV patients having only severe proximal LCX disease or severe ostio-proximal LAD disease (Table 4).

Table 4: Comparison Among Patients With Severe LM/LM Equivalent Disease Or TVD and Patients With Only Severe Proximal LCX Disease Or Severe Ostio-proximal LAD Disease

Variables	Patients with severe LM/LM equivalent disease or severe TVD (N=237)	Patients with severe proximal LCX disease or severe ostio-proximal LAD disease (N=163)	P value
Mean age(y±sd)	63.16±7.24	58.7±8.3	0.632
Gender	133 (M) 104 (F)	88 (M) 75 (F)	0.750
Smoking	178	34	0.0001

Dyslipidemia	183	97	0.0001
Renal dysfunction	41	10	0.002
HTN	152	76	0.0001
Diabetes	162	45	0.0001
Patients with ST elevation >0.5mm in aVR	176(74.26%)	59(36.20%)	<0.001
Patients with no ST elevation in aVR	61(25.73%)	104(63.80%)	

DISCUSSION:

Various studies have shown that ST elevation in aVR lead along with widespread ST segment depression in all other ECG leads is an important predictor of severe LM or TVD. Our study shown that prevalence of ST elevation of ≥0.5 mm in aVR lead is significantly higher in patients with severe LM/LM equivalent disease or severe TVD compared to patients having either severe proximal LCX disease or severe ostio-proximal LAD disease (P<0.001). Hence ST segment elevation of ≥0.5 mm in aVR lead in NSTE-ACS patients predicts severe LM or TVD. Masami et al.[6] also concluded in their study that this electrographic finding was the strongest predictor of severe LM stenosis or severe TVD and adverse outcome at 90 days in patients with ACS. Hengrussamee et al.[7] also found ST elevation in aVR as a predictor of left main disease. Rostoff et al.[8] conducted study on 150 patients with ACS to assess the value of ST segment elevation in lead aVR and lead V1 for the detection of left main stenosis and found that in patients with LMCAS, ST segment elevation in lead aVR was two times more frequent than in remaining patients (69.6% vs 34.6% p=0.0001) whereas there were no differences in lead V1. The assessment of lead aVR in patients with NSTE-ACS may indicate LMCAS. Additional analysis of lead V1 does not improve diagnostic accuracy. Both the above studies concluded that in patients with acute coronary syndrome, ST segment elevation in lead aVR is associated with the culprit left main coronary lesion.

In our study, we found that ST elevation in aVR lead can also occur due to severe stenosis in proximal LAD or proximal LCX, but prevalence of this ECG finding in these patients is not significantly high when compared to patients with severe LM/TVD (P<0.001). Kühl et al[9] showed that ST elevation in aVR may represent a proximal LAD artery lesion and that this ECG sign is useful to differentiate proximal from more distal lesion in the setting of NSTE ACS. Along with ST elevation in aVR, ST elevation in V1 may be observed in proximal LAD stenosis and this finding depends on the coronary anatomy.[10] Lead V1 reflects the right basal septal area, which is supplied by septal branches from the LAD artery alone or together with the conal branch of the right coronary artery (dual circulation). Accordingly, ST elevation in aVR and in V1 lead predict LAD lesion proximal to the first septal branch, along with insufficient or absent flow from the conus branch. Gaitonde et al. proposed that significant proximal LCx stenosis should cause ST-segment elevation in both lead aVR and V1, reflecting posterior wall ischemia. Using vectorcardiology, they proposed ECG changes in the posterolateral wall to be reflected in lead aVR.[11]

As discussed above, we can say that NSTE-ACS patients with severe LM/LM equivalent disease or severe TVD have significantly higher prevalence of ST segment elevation in aVR lead, while some of these patients may present without ST elevation in aVR lead (P<0.001). Conversely, patients of NSTE-ACS with either severe proximal LAD disease or severe proximal LCX disease usually present without ST elevation in aVR lead, but few patients can have presentation with ST elevation in aVR lead (P<0.001) (table 4).

Age and gender were not found to be predictors of significant LM/TVD in our study. This result is similar to that in the study of Gary et al., who conducted a study on 200 patients and did not find age to be a predictor of LM/TVD.[12] On the other hand Masami et al.[6] observed that patients with LM/TVD were older. Adamus et al[13] also did not find gender to be a predictor of LM/TVD.

Diabetes mellitus was significantly associated with severe LM/TVD in our study. Similar association with diabetes was found in studies by Masami et al[6] and Claver et al.[14] In our study a statistical significant association was seen between prevalence of hypertension, dyslipidemia, smoking and renal dysfunction risk factors and the incidence of significant LM/TVD. While Masami et al.[6] and Hubbard et al.[15] had similar findings, Claver et al[14] found a significant association between renal impairment and risk of significant LM/TVD.

Study limitations: a) non randomized study, b) small sample size, data derived from a single hospital, c) long term clinical follow up of enrolled patients is not available.

CONCLUSION:

We can conclude that ST segment elevation of ≥0.5 mm in aVR lead is an important predictor of severe LM/LM equivalent disease or severe TVD in NSTE-ACS patients. Patients with severe LM disease or severe TVD found to have a worse outcomes because of ischemic risk to large portion of myocardium, hence ST segment elevation in aVR lead can be used to identify or screen these patients in emergency room and for selection of early management plan and intervention to improve their outcomes.

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