ST Segment Elevation in Lead aVR: Clinical Significance in Acute Coronary Syndrome

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ABSTRACT

Objective: We sought to determine the electrocardiographic (ECG) features associated with acute left main coronary artery (LMCA) obstruction.

Study Design: Descriptive observational study.

Place and duration: The study was conducted at Faisalabad Institute of Cardiology Faisalabad from August 2015 to March 2016.

Materials and Methods: Total 70 consecutive patients of age≥ 30 years, of any gender who fulfills the inclusion and exclusion criteria were enrolled in the study. We enrolled 70 patients who presented in the emergency department of Faisalabad Institute of cardiology, Faisalabad with non-ST elevation acute coronary syndrome. Demographic characteristics of all patients were obtained. A 12 leads ECG of all patients were done to observe any ST segment elevation or depression especially ST elevation in lead aVR. H/O risk factors for CAD like hypertension, diabetes mellitus, family H/O ischemic heart disease and hyperlipidemia was noted.

Results: Total 70 patients were enrolled in the study. 52 (74.3%) were male and 18 (25.7%) were female. Mean age was 55.94±7.44 years. Troponin-I (Trop-I) was positive in 45 (64.3%) patients. Hyperlipidemia was documented in 40 (57.1%), 37 (52.9%) were smokers, 31 (44.3%) were hypertensive and 32 (45.7%) were diabetics. Significant LMCA stenosis was found in 52 (74.3%) and out of this 39 (75%) were male and 13 (72.22%) were female. 52 (74.2) patients with ACS had significant LMS disease. 37 (82.8%) patients with positive Trop. I had significant LMS disease. Significant LMS disease was observed in 26 (81.25%) diabetics.

Conclusion: ST-segment elevation ≥ 0.5mm in aVR lead of ECG identifies significant LMCA stenosis in patients presenting with ACS, especially in male, elderly and with raised cardiac markers. It also contributes to predict patient’s clinical outcome.

Key words: Acute coronary syndrome (ACS), Left main coronary artery (LMCA) disease. Electrocardiography; Non-ST-segment MI.

Introduction

Coronary artery disease (CAD) is one of the leading causes of mortality worldwide with same similar prevalence in Pakistan.1,2,3 and acute coronary syndrome is still the leading cause of morbidity and mortality worldwide. Due to increased prevalence of diabetes mellitus and obesity incidence of CAD will continue to rise. Patients suffering from LMS/ TVD in acute coronary syndrome setting had a very bad prognosis. To have a best treatment option for these patients early identification of these patients by bed side electrocardiography is...
important. By observing QRS duration of P90 ms and an ST segment elevation of P0.5 mm in lead aVR may help us to choose optimal treatment option for these patients. The major manifestation of ACS is an acute myocardial infarction that results from occlusive thrombus. The left main coronary artery supplies the largest area of myocardium, so patients with the disease of this artery are at very high risk for myocardial infarction and its related complications. In the modern era, there is improvement in the prognosis of LMCA disease with surgery or Percutaneous coronary intervention in selected cases but this requires early diagnosis of this disease. ECG rapidly interprets the manifestations of ACS in emergency department; however ECG findings in lead aVR are mostly neglected. These findings are related to LMCA stenosis in ACS. The most common ECG findings related to LMCA stenosis are ST segment elevation in lead aVR with widespread ST-segment depression, especially in anterior and lateral leads. The ST segment elevation of 0.1 mV or more in lead aVR on ECG suggests high probability of left main coronary artery disease or severe CAD with associated worse prognosis. Rationale of this study is to identify and screen patients of ACS for presence of significant LMCA stenosis on basis of ECG findings of ST segment elevation ≥ 0.5 mm in lead aVR so that management of patients should be planned for better outcome.

**Methodology**

This study was conducted at Faisalabad Institute of Cardiology (FIC) Faisalabad from August 2015 to March 2016.

**Inclusion Criteria:** Following patients were included in the study:

1. Any patient of either gender of age 30-70 years.
2. Patients presented with typical chest pain having duration > 20 minutes or chest pain attributed to cardiac ischemia and occurs at rest, or have unstable pattern now or have increased in duration or severity.
3. Patients with ST elevation ≥ 0.5mm in limb lead aVR and presenting with ACS.
4. Patients having fully assessable ECG and angiographic data on admission.

**Exclusion Criteria:**

1. On ECG patients having LBBB, RBBB pattern.
2. Patients with LVH, patients on TPM/PPM.
3. Patients having cardiomyopathy, pre-excitation on ECG or on any antiarrhythmic drugs.
4. Patients having persistent or transient ST segment elevation in leads other than AVR.
5. ST segment elevation MI.
6. H/O recent (<6 months) PCI.
7. H/O previous CABG.
8. Patients with any valvular or structural heart disease.
9. Patient having serum creatinine ≥ 2 mg/dl, INR (International Normalization Ratio) ≥ 1.5.

**Sample Size:** Sample size was calculated by using WHO sample size calculator:

\[ P = 77\% \]

Absolute precision required = 10%
Confidence level = 95%
Sample size = 70

In all patients before angiography, Lab. investigations including complete blood count, fasting blood sugar, fasting lipid profile, blood urea and serum creatinine levels were obtained. Cardiac markers (cardiac enzymes/Troponin I level) were measured for each patient. In all patients Coronary angiography was performed to detect left main stem disease. Left main stem disease was considered significant if stenosis was ≥ 50% with or without significant disease (≥ 70%) in other vessels. Total 70 consecutive patients of age ≥ 30 years, of any gender who fulfills the inclusion and exclusion criteria were enrolled in the study. Before enrollment in the study, informed consent was taken from all patients and the study protocol was approved by the local Hospital Ethical Committee. We enrolled 70 patients who presented in the emergency department of Faisalabad Institute of cardiology, Faisalabad with non-ST elevation acute coronary syndrome. Demographic characteristics of all patients were obtained. Detailed medical history including past history was taken. A detailed physical examination with special emphasis on CVS was performed. History of any drug allergy especially to contrast was obtained. A 12 leads ECG of all patients were done to observe any ST segment elevation or depression especially ST elevation in lead aVR. A base line echocardiography was performed to identify any valvular or structural heart disease. H/O risk factors for CAD like history of hypertension, diabetes mellitus, family H/O ischemic heart disease and hyperlipidemia was noted. Diabetes was identified on the basis of hospital record or if patient was taking anti diabetic medications (Insulin/ OHGA) or fasting blood sugar was ≥ 126 mg/dl. Patient was labeled hypertensive on the basis of hospital record or if patient was taking
antihypertensive medications or his/her BP was ≥ 140/90 mmHg. Dyslipidemia was defined if total serum cholesterol was≥ 180 mg/ dl in fasting state or patient was on statin therapy for it. In all patients before angiography, Lab. investigations including complete blood count, fasting blood sugar, fasting lipid profile, blood urea and serum creatinine levels were obtained. Cardiac markers (cardiac enzymes/ Troponin I level) were measured for each patient. Patients were considered smokers if still they were smoking (Huqa and/ or Cigarettes). Body mass index (BMI) was calculated by weight in kilogram divided by body surface area in m² (kg/m²).

All patients were treated according to ACC/ AHA guidelines. ECG analysis was done to know degree of ST segment elevation in aVR or other leads or ST segment depression in other leads or to know QRS duration. Acute coronary syndrome was defined on basis of ECG changes with any one of the following:

1. Chest pain
2. Raised cardiac enzymes (Trop I > 0.30ng/ml)

In all patients Coronary angiography was performed to detect left main stem disease. Left main stem disease was considered significant if stenosis was ≥ 50% with or without significant disease (≥ 70%) in other vessels.

All the data was analyzed by SPSS (Statistical Package for Social Sciences) Version 23 for Windows. Categorical variables like gender, hypertension, Diabetes, hyperlipidemia, smoking, Troponin-I levels and angiographic findings (LMCA stenosis) were documented by frequency and percentage and continues variables were presented as means±SD (Standard Deviation).P value≤ 0.05 was taken as significant. All tests applied were two tailed.

**Results**

Total 70 patients were enrolled in the study. 52 (74.3%) were male and 18(25.7%) were female. Out of 70 patients 32(45.7%) patients were between 51-60 years of age, 19(27.1%) were below 51 years and 19(27.1%) above 60 years of age. Minimum age was 42 years and maximum 70 years and mean age was 55.94±7.44 years. Troponin-I (Trop-I) was positive in 45(64.3%) patients. Hyperlipidemia was documented in 40(57.1%), 37(52.9%) were smokers, 31(44.3%) were hypertensive and 32(45.7%) were diabetics. Table 1, Fig 1.

52(74.2) patients with ACS had significant LMS disease but 22(66.66) non smokers were also suffering from significant LMS disease.19 (27.1%) patients were above 60 years of age and out of this 16 (84.21%) patients had significant LMS disease. 32(71.87%) patients who had significant LMS disease were between 51-60 years of age, and 13 (68.42%) patients with LMS disease were below 50 years. 37 (82.8%) patients with positive Trop. I had significant LMS disease. Significant LMS disease was observed in 26(81.25%) diabetics. Table II.

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<tr>
<td>Mean Age in years</td>
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<tr>
<td>Gender</td>
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**Table I: Demographic Characteristics Of Study Population**
Discussion

ECG is an appropriate bedside tool used for diagnosis of ACS.11, 12 Changes in Lead aVR are ignored frequently however the ST-segment changes in this lead can predict LMCA disease.

In this study, 74.2% patients presented with ACS had significant left main coronary artery disease. The significant LMCA stenosis was more common in male and elderly. These findings are similar to study conducted by Yamaji et al.13 This study also documented that the patients with raised cardiac markers and elevated ST-segment in aVR are high risk for significant LMCA disease. Similarly Kosuge et al14 reported high incidences of significant LMCA disease in patients with raised troponin level and elevated ST-segment in aVR.

On univariate analysis diabetes was found a significant predictor for LMS disease and this coincides with the results of Masami et al. and Claver et al., who studied 102 patients. Masami et al. and Hubbard et al15 reported in their study that hypertension and positive family history had no significant relationship with LMS disease and our results coincide with study.

Hyperlipidemia is a well documented risk factor for CAD.16 Higher incidences of LMCA disease in hyperlipidemic patients is documented in different studies.17, 18 Diabetics have several fold increased risk of future cardiovascular events.16 In this study 50% diabetic had significant LMCA disease. Similar findings were documented in other studies17, 18. However the incidence of LMCA stenosis (44.3%) in hypertensive patients was lower in our study in comparison with other studies17, 18, 19. This study suggests that smokers were high risk for left main artery stenosis. Similar findings were reported by Hussain A.20

On univariate analysis we found that there is strong association with positive Troponin T and LMS disease and these results are supported by the Masami et al. and Jurlander et al 15,21 results. Jurlander et al. conducted a study on 117 patients. Positive Trop T may occur with critical single or two vessel disease; it is not exclusively associated with LMS or TVD.22

In our study, it was observed that LMS disease had strong association with positive Troponin T and LMS disease and these results coincide with Jimenez-Candil et al. study, who conducted a study on 502 patients to examine the QRS duration.23 It has been demonstrated in different studies that the specificity of ST segment changes and QRS prolongation to detect myocardial ischemia is same but sensitivity of QRS is higher24.
Murkofsky et al. in his study reported that on resting 12 lead ECG, a QRS duration of >100 ms was a strong predictor of decreased left ventricular function. In our study, 52 (74.2%) patients presenting with non ST elevation ACS had significant LMS disease and this coincides with Masami et al. results.

He conducted a study on 501 patients to evaluate the correlation of different non-invasive predictors with significant multi-vessels and/or left main disease. They found that on univariate analysis many variables were associated with LM/3VD but in multivariate analysis only positive Trop T, QRS durationP90 ms and ST elevation in lead aVR P0.5 mm were strong predictors of LM/3VD, these results are similar to Rostoff et al. study who in 150 patients with ACS studied the accuracy of ST segment elevation in lead aVR and V1 to detect LMS disease. Hengrussamee et al., conducted a study on 26 patients with ACS and observed the same results.

Results of above both studies concluded that ST elevation in lead aVR in acute coronary syndrome is associated with the culprit left main coronary lesion.

We documented significant LMCA stenosis in 74.28% of ACS patients with elevated ST-segment in aVR. This correlation was reported in different studies. Hengrussamee et al, reported this correlation in 80% of patients. Rostoff et al documented that the significant LMCA disease is two times more common in patients with elevated ST segment in ECG lead aVR. Kosugeet al documented that ST segment elevation≥0.5 mm in aVR is a strongest predictor of LMCA stenosis.

Masami et al. conducted a study on 333 patients presenting with NSTE-ACS, in which he documented that ST-segment elevation in lead aVR was the strongest predictor of adverse outcomes at 90 days but on the other hand raised cardiac markers other than positive Trop T and ST-segment depression in other leads were found to carry independent prognostic information when entered into a multivariate analysis with ST-segment elevation in lead aVR.

**Conclusion**

Based on the results of the current study we can conclude that elevated ST-segment in aVR lead of ECG identifies significant LMCA stenosis in patients presenting with ACS, especially in male, elderly and with raised cardiac markers.

In acute coronary syndrome useful predictors for Left Main stem disease/ or three vessel coronary artery disease are ST-segment elevation in lead aVR of P0.5 mm and maximal QRS duration of P90 ms.

**LIMITATIONS OF STUDY**

The presence of collateral circulation may affect the ECG findings suggestive of LMCA disease and may be difficult to interpret. This issue was not addressed properly in our study.

In our study number of patients was relatively less because acute significant LMCA disease is not common but careful patient selection and by using different methods of analysis (i.e., univariate and multivariate analyses) partly we compensate this limitation.

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