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A study of changes in lead aVR in acute coronary syndrome

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Abstract
The objective of our study was to determine the significance of changes in lead aVR in patients with acute coronary syndromes, its role in predicting adverse prognosis and the occurrence of complications in these patients.
The study contained 120 study participants in a tertiary care hospital presenting with acute coronary syndrome. Standard 12-lead ECG was taken on admission, after thrombolysis (if required), six hour after admission, twenty four hours after admission and daily till the patient remained in the ICCU. The relevant history regarding chief complaints, risk factors for atherosclerosis were taken and each patient examined for vital signs and signs of cardiac failure.
ST elevation in lead aVR was found in 17% of patients of Anterior wall STEMI. ST depression was seen in lead aVR in patients of Inferior wall STEMI. Complications like Left Ventricular Failure, Hypotension and Death were significantly more in groups having changes in lead aVR in patients of Acute Coronary Syndrome. Death was significantly higher in patients of Anterior wall STEMI who had changes in lead aVR.

Keywords: lead aVR, acute coronary syndrome, left ventricular failure

1. Introduction
India has the highest burden of ACS in the world. The rising incidence of ACS in Indians may be related to the changes in the lifestyle, the westernization of the food practices, the increasing prevalence of diabetes mellitus and probably genetic factors.
Acute coronary syndromes comprise the spectrum of unstable cardiac ischemia from Unstable Angina (UA) to Acute Myocardial Infarction. They are classified based on the presenting ECG as either "ST segment elevation myocardial infarction" (STEMI) or "Non–ST-segment elevation acute coronary syndrome." Non–ST-segment elevation acute coronary syndrome is further divided into Non–ST-Elevation Myocardial Infarction (NSTEMI) or Unstable Angina (UA), based primarily on presence or absence of elevation of cardiac biomarkers. This allows for immediate classification and guides determination of whether patients should be considered for acute reperfusion therapy. The evolution of cardiac biomarkers then allows determination of whether myocardial infarction has occurred.
The ECG is the main diagnostic and triage tool and serves as the center of the decision pathway for management by differentiating patients presenting with ST-segment elevation from those presenting without ST- segment elevation.
In evaluating the ECG, lead aVR is a very valuable, which unfortunately is often neglected. The augmented limb leads give more localised information than the bipolar leads. So from the existing limb electrodes, new leads aVR, aVF and aVL were developed, 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, lead aVR is thought to give reciprocal information from the left lateral side, which is already represented by the leads aVL, II, V5 and V6. This has been the reason that lead aVR has become largely ignored.
Lead aVR can be very useful in identifying left main coronary artery (LMCA) obstruction. Ischaemia of the basal part of the inter ventricular septum is the reason for the occurrence of ST segment elevation in this lead.
However there is a paucity of data when short term prognostic value of changes in lead avR in patients with acute coronary syndrome is considered and hence the purpose of this study.

2. Material and Methods
2.1 Study Population
This study of 120 patients was carried out at SSG Hospital & Baroda Medical College in year December 2013 - November 2014.
All patients between age 18 to 75 admitted in Intensive Cardiac Care Unit with clinical history/examination compatible with an Acute Coronary Syndrome and ECG changes and/or Cardiac enzyme elevation suggestive of Acute Coronary Syndrome were included in the study.
The diagnosis of ACS is defined by at least one of the following: (1) Occurs at rest or minimal exertion and usually lasts > 20 minutes (if nitroglycerin is not administered) (2) Being severe and described as frank pain and of new onset (i.e., within 1 month) (3) Occurs with a crescendo pattern (more severe, prolonged, or increased frequency than previously).
The study protocol was approved by the institutional ethics committee and a signed informed consent was obtained from every enrolled patient.
2.2 Methods
In all the patients presenting with symptoms/signs suggestive

of acute coronary syndrome a relevant history regarding chief complaints, risk factors(like smoking, alcoholism, OCPs),occupation, income were taken and each patient examined for vital signs especially noting the pulse rate and blood pressure on admission and signs of cardiac failure. A detailed respiratory and cardiovascular examination was done specifically looking for S-3 and/or S-4 and basal rales so as to classify the patients into various Killip's classes of left ventricular failure and to rule out clinically, mechanical complications like MR, VSD etc.

The provisional diagnosis of acute coronary syndrome was made. Every patient undergone routine hematological, biochemical (including CPK-MB) and urine examination for detecting associated illnesses eg. Diabetes, infections, renal failure etc. Standard 12-lead electrocardiographic recordings were performed at randomization (and at 90 min if streptokinase is to be given) at a paper speed of 25 mm/s and were standardized at 1.0 mV to 1.0 cm. Patients were classified as having STEMI (Anterior Wall STEMI in case of ST-segment elevation in I, aVL and V1-V6; Inferior Wall STEMI in case of ST-segment elevation in II, III, aVF) or NSTEMI/UA.

ST-segment changes (elevation or depression) were measured manually at 60 ms after the J point, and a magnitude of 1 mm was considered significant. The lead aVR was specifically analysed for any changes (especially ST segment changes).The magnitude of ST segment changes in lead aVR was relative to the TP segment as a baseline.

3. Statistical Analysis

The data was expressed as the mean + SD for continuous variables and as percentages for categoric variables. Comparisons were done by McNemar's test for continuous variables, and the statistical significance of differences were calculated by using Chi2test. Chi2 analysis was used to compare categoric variables.

The variables used for analysis include age, sex, absence of previous angina within 24 h before ACS, Killip class on hospital admission, time from symptom onset to hospital admission, and the changes in lead aVR. A two-tailed p value of <0.05 was considered to indicate statistical significance.

4. Results

This study of 120 patients was carried out at SSG Hospital & Baroda Medical College in year December 2013 - November 2014. Out of 120 patients 98 were male (81.7%) and 22 were female (18.3%).Anterior wall STEMI occupied 59.2% of acute coronary syndromes. Inferior wall STEMI were 24.2 % and NSTEMI/UA were 16.6%.

16.9% of Anterior wall STEMI patients had ST segment elevation in lead aVR.ST segment depression in lead aVR was seen in 24.1% of Inferior wall STEMI, 4.2% of Anterior wall STEMI and 10% of NSTEMI/UA.That makes 20% of the total number of patients with changes in lead aVR. Significantly higher no. of Anterior wall STEMI cases had ST elevation in lead aVR (P=0.0024).

Most of the complications LVF, Hypotension and Death were significantly more in the groups having changes in lead aVR. P value for LVF was 0.016. It shows that more LVF is seen with changes in lead aVR. P value for hypotension was 0.0015; So more hypotension is seen with changes in lead aVR. Mortality was also higher in the groups with changes in lead aVR.(P value <0.001)

22.1% of patients of Anterior wall STEMI with changes in lead aVR had LVF. Similarly 29.9% of patients had hypotension and 23.4% of patients had arrhythmias in the group having Anterior wall STEMI with changes in lead aVR. 77.8% of Anterior wall STEMI patients who died had changes in lead aVR. P value for hypotension and death were significant: 0.002 and <0.0001 respectably, indicating that they were more in groups with changes in lead aVR.

8.3% of patients developing LVF had Inferior wall STEMI with ST depression in lead aVR as compared to 13.8% in the group without changes in lead aVR. Likewise arrhythmias, conduction blocks and hypotension were 23.5%, 57.1% and 16.6% in group without changes in lead aVR in Inferior wall STEMI patients. P values for LVF, arrhythmias, hypotension, conduction block and death were not significant.

Complications like LVF, arrhythmias, conduction block and hypotension were less common in the NSTEMI/UA group. P values for LVF was 0.046; So, LVF was more seen in NSTEMI/UA patients having changes in lead aVR. P values for arrhythmias, hypotension, conduction block and death were not significant.

5. Discussion

In our study 59.2% patients of Acute coronary syndrome had anterior wall affection, 24.2% patients had inferior wall involvement (i.e a total of 83.3% of ST elevation acute coronary syndromes) and 16.7% of patients had NSTEMI/UA. Raihanathul Misiriya *et al*. [1] reported 1865 cases of ACS that qualified the inclusion criteria of which 56% had STEMI and 44% had NSTEMI/UA. Among the patients with STEMI, 522 (50%) had inferior wall and 459 (43.97%) had anterior wall infarctions. Of the remaining 63 (6.03%) cases, 54 were lateral wall and nine were isolated posterior wall infarctions.

Barrabés *et al*. [2] showed that lead aVR on the admission ECG contains valuable short-term prognostic information among patients with a first non–ST-segment elevation AMI. ST- segment elevation in lead aVR was closely associated with the rates of in-hospital death, recurrent ischemic events, and heart failure and was more efficient than ST-segment depression elsewhere in predicting these complications.

Similarly in our study percentage of complications is more in the group with changes in lead aVR as compared to other group. In our study 16.9% of Anterior wall STEMI patients had ST segment elevation in lead aVR. ST segment depression in lead aVR was seen in 24.1% of Inferior wall STEMI, 4.2% of Anterior wall STEMI and 10% of NSTEMI/UA. That makes 20% of the total number of patients with changes in lead aVR. P value for LVF was 0.016. It shows that more LVF is seen with changes in lead aVR. P value for hypotension was 0.0015; So more hypotension is seen with changes in lead aVR.

In our study, mortality was also higher in the groups with changes in lead aVR (58.3%; P value <0.001) as also observed in study by Barrabés *et al*. [2] (19.4% mortality in group with changes in aVR).

22.2% of patients of Anterior wall STEMI with changes in lead aVR had LVF. Similarly 29.9% of patients had

hypotension and 23.4% of patients had arrhythmias in the group having Anterior wall STEMI with changes in lead aVR. 77.8% of anterior wall STEMI patients who died had changes in lead aVR. P value for hypotension and death were significant: 0.002 and <0.0001 respectably, indicating that they were more in groups with changes in lead aVR. Abbase *et al*. [3] reported ST- segment elevation in aVR in acute anterior myocardial infarction had more complications including more patients developed shock, post myocardial angina, heart failure, tachy or bradyarrhythmia than without ST- elevation in lead aVR.

In our study, 8.3% of patients developing LVF had Inferior wall STEMI with ST depression in lead aVR as compared to 13.8% in the group without changes in lead aVR. Likewise arrhythmias, conduction blocks and hypotension were 23.5%, 57.1% and 16.6% in group without changes in lead aVR in Inferior wall STEMI patients. However, P values for LVF, arrhythmias, hypotension, conduction block and death were not significant. These findings were against Kosuge *et al.* [4] who reported congestive heart failure during hospitalization was more frequent in group with ST segment depression in lead aVR of >1.0 mm.(P value <0.001)

Similarly, in the study by Piotr Kukla *et al.* [5] the percentage of patients with ST segment elevation, ST segment depression, and with no ST segment change who reached the composite end-point (death or cardiogenic shock) was 31.9%, 27.0%, and 3.2%, respectively ($p < 0.001$).The in-hospital mortality rates of patients with ST segment elevation, ST segment depression, and no ST segment changes were 27.7%, 16.5%, and 1.0%, respectively ($p < < 0.001$).

In our study LVF was more seen in NSTEMI/UA patients having changes in lead aVR. [P value 0.046] However, P values for arrhythmias, hypotension, conduction block and death were not significant. In the study by Barrabés *et al.* [2] ST-segment elevation in lead aVR was associated with older age, a higher risk profile, and a higher prevalence of previous angina as well as with an increased heart rate and systolic blood pressure on admission and with a higher Killip class.

6. Conclusion

Following conclusions were drawn:

1. ST elevation in lead aVR was found in 17% of patients of Anterior wall STEMI.
2. ST depression was seen in lead aVR in patients of Inferior wall STEMI.
3. Complications like Left Ventricular Failure, Hypotension and Death were significantly more in groups having changes in lead aVR in patients of Acute Coronary Syndrome.
4. Death was significantly higher in patients of Anterior wall STEMI who had changes in lead aVR.
5. Incidence of Arrythmias or Conduction disturbances were not significantly different in relation to changes in lead aVR.

7. References

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