

Prognostic Value of ST Segment Changes in aVR Lead in Patients with Non-STEMI or Anterolateral STEMI

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ABSTRACT

Background: ST segment changes in aVR lead may effectively predict early mortality in patients with acute myocardial infarction (MI). We aimed to assess the value of ST segment changes in aVR lead to predict outcome in patients with anterolateral MI or with non-ST segment elevation MI (STEMI). Methods: The hospital recorded files of 200 consecutive patients with one of the two diagnoses of anterolateral MI or non-STEMI were retrospectively assessed. Four subgroups were defined as the group with ST elevation > 0.5 mV in aVR lead (n = 53), 2) ST depression > 0.5 mV in aVR lead (n = 34), 3) without ST change in aVR (n = 87), and 4) with any ST change in aVR (n = 26). Results: In-hospital mortality rate was 30.2% in the group with ST elevation, 23.5% in those with ST depression, 9.2% in those without ST change, and 11.5% in those with any ST change in aVR that was higher two former groups. The prevalence of repeated MI was 17%, 2.9%, 2.3%, and 3.8% respectively indicating higher in-hospital MI in the group suffered ST-segment elevation MI. The rate of revascularization and length of hospital stay did not also differ across the groups. In multivariate regression model, both ST elevation and ST depression in aVR predicted in-hospital death. Main predictor for in-hospital MI included the presence of as ST elevation in aVR lead. Conclusion: A significant change of ST segment in aVR lead predicts both in-hospital mortality and recurrence of MI within hospitalization in patients with anterolateral MI or with non-STEMI.

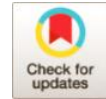
Keywords: Electrocardiography, aVR lead, Outcome, Myocardial infarction

Introduction

The initial prognosis of acute myocardial infarction is significantly associated with myocardial reservation following appearance of ischemic event, scar zone caused by previous infarcts, and also arterial branches in different zones of myocardium. In patients without history of myocardial infarction or without additional coronary lesions, the prognosis of disease is directly associated with the size of ischemic tissue that supplied by culprit arteries distal to coronary stenosis [1-3]. However, among those patients with a limited myocardial reserve or with diffuse fibrosis, even a minor infarction can be important and decisive. Therefore, in addition to diagnosis of disease, determining the size of infarction and also the rate of myocardial reservation is required. In this line, electrocardiography (ECG) can be very helpful to assessing size of ischemia, differentiation of transmural

and subendocardial infarction as well as determining old infarction events [4]. Moreover, some pattern in ECG can manifest the presence of diffuse coronary disease or progression of myocardial ischemia. Regarding pathophysiological mechanisms of myocardial infarction, size of infarction and the level of defected myocardium may have heterogeneous pattern. The assessment of the level of risk and also prognostic condition of patients include a major part of management and treatment of disease [5]. In this regard, designing and interpreting ST segment changes on admission is one of powerful factors to predict adverse cardiac events in patients with acute myocardial infarction [6-8].

Although aVR lead in ECG usually marks involvement of Right upper part of the heart muscle, it may be ignored in interpretation of ECG [9]. ST elevation in



aVR with some other repolarization changes indicates occurrence of severe lesions in coronary arteries in patients suffered unstable angina or STEMI [10-15]. Some studies also showed that ST elevation in this lead can effectively predict early mortality in those patients with inferior myocardial infarction with a high sensitivity [11,16,17,18]. However, it remains controversial the prognostic value of ST changes in aVR lead to predict outcome especially in patients with non-STEMI. Hence, the present study aimed to assess the value of ST changes in aVR to predict mortality and morbidity in patients with anterolateral MI or with non-STEMI.

Patients and Methods

In a cross-sectional study the hospital recorded files of 200 consecutive patients with one of the two diagnoses of anterolateral MI or with non-STEMI were retrospectively assessed. Initial 12-lead ECG assessment was performed at emergency ward. All changes in ECG leads especially ST segment changes were reviewed by a single cardiologist. In this study, all patients with typical manifestations of MI that undergoing diagnostic examinations including ECG assessment and cardiac enzymes measurement led to the diagnosis of non-STEMI or anterolateral MI within 24 hours of symptoms appearance were included. Those with previous history of MI, history of hospitalization in CCU ward, inferior wall MI, or presence of incorrect records were excluded from the study. All baseline characteristics including demographics, medical history, medication, and history of cardiac interventions were collected by the review of recorded files. The patients were divided into four

subgroups according to ST change as 1) ST elevation > 0.5 mV in aVR lead, 2) ST depression > 0.5 mV in aVR lead, 3) without ST change in aVR, and 4) with any ST change in aVR. The main study endpoint in this study as the patients' outcome were in-hospital mortality, repeated MI in hospital, and cerebrovascular accident. Results were presented as mean \pm standard deviation (SD) for quantitative variables and were summarized by frequency (percentage) for categorical variables. Continuous variables were compared using ANOVA test or Non-parametric Kruskal-Wallis H test whenever the data did not appear to have normal distribution or when the assumption of equal variances was violated across the study groups. Categorical variables were, on the other hand, compared using chi-square test. The multivariate regression model was used to determine main predictors of in-hospital outcomes. For the statistical analysis, the statistical software SPSS version 16.0 for windows (SPSS Inc., Chicago, IL) was used. P values of 0.05 or less were considered statistically significant.

Results

In this study, four subgroups were defined as the group with ST elevation > 0.5 mV in aVR lead (n = 53), 2) ST depression > 0.5 mV in aVR lead (n = 34), 3) without ST change in aVR (n = 87), and 4) with any ST change in aVR (n = 26). The groups were comparable in mean age and also sex distribution so the mean age of participants was 65.38 ± 11.38 years, 64.35 ± 12.69 years, 64.08 ± 14.17 years, and 62.04 ± 13.85 years ($p = 0.770$) with male frequency of 69.8%, 58.8%, 71.3%, and 80.8%, respectively ($p = 0.317$). Among different coronary risk factors (Table 1).

Table 1
Baseline characteristics of study population in different subgroups of ST change

| Item | ST segment elevation | ST segment depression | Without ST change | With ST change | p-value |
|-----------------------|----------------------|-----------------------|-------------------|-------------------|---------|
| Male gender | 37 (69.8) | 20 (58.8) | 62 (71.3) | 21 (80.8) | 0.317 |
| Age, year | 65.38 ± 11.38 | 64.35 ± 12.69 | 64.08 ± 14.17 | 62.04 ± 13.85 | 0.770 |
| Current Smoking | 12 (22.6) | 7 (20.6) | 27 (31.0) | 7 (26.9) | 0.542 |
| Diabetes | 34 (64.2) | 22 (64.7) | 34 (39.1) | 11 (42.3) | 0.008 |
| Hypertension | 26 (49.1) | 26 (76.5) | 40 (46.0) | 11 (42.3) | 0.014 |
| Family history of CAD | 6 (11.3) | 6 (17.6) | 14 (16.1) | 6 (23.1) | 0.593 |
| Dyslipidemia | 30 (56.6) | 15 (44.1) | 50 (57.5) | 11 (42.3) | 0.355 |
| CVA | 8 (15.1) | 2 (5.9) | 3 (3.4) | 2 (7.7) | 0.086 |
| DVT | 1 (1.9) | 1 (2.9) | 1 (1.1) | 1 (3.8) | 0.818 |
| PVD | 4 (7.5) | 0 (0.0) | 2 (2.3) | 1 (3.8) | 0.242 |
| LVEF, % | 33.02 ± 11.28 | 31.47 ± 12.71 | 36.90 ± 14.17 | 36.92 ± 14.36 | 0.119 |

The overall prevalence of diabetes mellitus was considerably higher in those with ST elevation or ST depression in aVR lead compared to other subgroups. Also, hypertension was more prevalent in those patients with significant ST depression than in other

patients' subgroups. There was also no difference in mean left ventricular ejection fraction across the four subgroups ($p = 0.119$). Regarding in-hospital mortality (Table 2).

Table 2
Outcome in study population in different subgroups of ST change

| Item | ST segment elevation | ST segment depression | Without ST change | With ST change | p-value |
|--------------------------|----------------------|-----------------------|-------------------|----------------|---------|
| In-hospital mortality | 16 (30.2) | 8 (23.5) | 8 (9.2) | 3 (11.5) | 0.009 |
| Myocardial infarction | 9 (17.0) | 1 (2.9) | 2 (2.3) | 1 (3.8) | 0.004 |
| Cerebrovascular accident | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (3.8) | 0.041 |
| Revascularization | 37 (69.8) | 30 (88.2) | 56 (64.4) | 18 (69.2) | 0.080 |
| Type | | | | | |
| Fibrinolytic | 15 (28.3) | 14 (41.2) | 28 (32.2) | 7 (26.9) | 0.807 |
| PCI | 11 (20.8) | 6 (17.6) | 15 (17.2) | 6 (23.1) | 0.939 |
| Primary PCI | 2 (3.8) | 3 (8.8) | 4 (4.6) | 0 (0.0) | 0.470 |
| CABG | 9 (17.0) | 7 (20.6) | 9 (10.3) | 5 (19.2) | 0.551 |
| Length of hospital stay | 4.85 ± 4.33 | 5.88 ± 4.97 | 5.55 ± 3.71 | 7.15 ± 9.60 | 0.318 |

This rate was 30.2% in the group with ST elevation > 0.5 mV in aVR lead, 23.5% in those with ST depression > 0.5 mV in aVR lead, 3) 9.2% in those without ST change in aVR, and 11.5% in those with any ST change in aVR, that was higher two former groups (p = 0.009). Also, the prevalence of repeated MI was 17%, 2.9%, 2.3%, and 3.8% respectively indicating higher in-hospital MI in the group suffered ST-segment elevation MI (p = 0.004). The rate of in-hospital revascularization in four groups was 86.9%, 88.2%,

64.4%, and 69.2% with no significant difference (p = 0.080). Cerebrovascular accident was revealed only in one patient in the group with any ST change in aVR. The mean length of hospital stay was 4.55 ± 4.33 days in the group with ST elevation > 0.5 mV in aVR lead, 5.88 ± 4.97 days in those with ST depression > 0.5 mV in aVR lead, 5.55 ± 3.71 days in those without ST change in aVR, and 7.15 ± 9.60 days in those with any ST change in aVR with no significant difference (p = 0.318). In multivariate regression model (Table 3).

Table 3
Main predictors of in-hospital mortality

| Item | Beta | Odds Ratio | p-value |
|-----------------------------|--------|------------|---------|
| ST change | 0.606 | 1.833 | 0.016 |
| Male gender | 0.046 | 1.047 | 0.935 |
| Age | 0.105 | 1.111 | < 0.001 |
| LVEF | -0.083 | 1.086 | < 0.001 |
| Diabetes | 1.879 | 6.536 | 0.002 |
| Hypertension | -0.144 | 0.866 | 0.786 |
| Family history of CAD | -0.598 | 0.550 | 0.402 |
| Cerebrovascular event | -1.445 | 0.236 | 0.092 |
| Deep vein thrombosis | 17.642 | 4.588 | 0.999 |
| Peripheral vascular disease | -0.476 | 0.621 | 0.719 |
| Dyslipidemia | -0.676 | 1.965 | 0.164 |
| Current smoking | 0.175 | 1.191 | 0.621 |

Both ECG changes as ST elevation > 0.5 mV in aVR or ST depression > 0.5 mV in aVR could effectively predict in-hospital death with the Odds Ratio of 1.8. Other predictors for in-hospital death were advanced

age, low LVEF, and history of MI. Also, main predictors for in-hospital MI included the presence of as ST elevation > 0.5 mV in aVR, male gender, and history of peripheral vascular disease (Table 4).

Table 4
Main predictors of in-hospital repeated MI

| Item | Beta | Odds Ratio | p-value |
|-----------------------|--------|------------|---------|
| ST change | 0.843 | 2.324 | 0.026 |
| Male gender | 2.810 | 16.614 | 0.021 |
| Age | -0.020 | 0.980 | 0.527 |
| LVEF | 0.058 | 1.060 | 0.058 |
| Diabetes | -0.931 | 0.394 | 0.201 |
| Hypertension | -0.541 | 0.582 | 0.468 |
| Family history of CAD | 0.250 | 1.284 | 0.833 |
| Cerebrovascular event | -0.318 | 0.727 | 0.755 |

| | | | |
|-----------------------------|--------|-------|-------|
| Deep vein thrombosis | 21.372 | 1.913 | 0.999 |
| Peripheral vascular disease | -2.778 | 0.062 | 0.024 |
| Dyslipidemia | 0.021 | 1.021 | 0.975 |
| Current smoking | 0.053 | 1.054 | 0.897 |

In addition, in another regression model, neither ST change in in aVR lead nor other baseline parameters could predict in-hospital revascularization.

Discussion

Despite the development of improved diagnostic strategies, the ECG remains an essential clinical tool for diagnosis, evaluation, and management of acute coronary syndrome. In this group of patients early risk stratification is crucial for appropriate management and for deciding whether early invasive strategy should be adopted. Recent evidences emphasize the central role of ST changes in different leads to risk stratification and determine outcome of patients who suffered MI. In this context, our study attempted to determine the role of ST change in aVR lead to predict in-hospital outcome in patients who experienced either non-STEMI or anterolateral MI. In our study, significant ST elevation or ST depression was shown to be predictive for early mortality in these groups of patients. Furthermore, ST segment elevation in aVR lead could predict repeated MI within hospitalization. However, ST changes in this lead could not predict in-hospital revascularization or cerebrovascular accident. On the other hand, ST segment changes in aVR lead could well predict mortality and MI in both groups of patients with STEMI or non-STEMI that was consistent with the previous studies. In Wong et al. (19) study, ST elevation at least 1 mm in aVR lead has been shown to be predictive for 30-day mortality in both anterior and inferior MI. In fact, each 0.5 mm elevation in ST was accompanied with 30% increase in early mortality. In another study by Kukulka et al. [20] a change in ST segment in aVR was indicated in 42.2% of patients. Also, in their study, mortality rate in patients with ST-elevation, ST depression, and those without ST change was 27.7%, 16.5%, and 1.0% with a significant difference. Alherbish et al. [21] also showed that the appearance of ST change in aVR lead was accompanied with higher mortality rate so ST change in this lead led to higher 3-month mortality in those with inferior MI. Barrabés et al. [22] also indicated that in-hospital mortality in patients without ST change in aVR lead, in patients with ST change less than 0.1 mV and in those with ST change more than 0.1 mV was 1.3%, 8.6%, and 19.4% with the increased risk for mortality in the latter groups with the Odds Ratios of 4.2 and 6.6, respectively. Taglieri et al. [23] revealed that the occurrence of ST depression in aVR lead resulted in increased risk for left main lesion (with odds ratio of 4.7) and for in-hospital mortality (with odds ratio of

5.6). Also, Raymond et al. [24] showed that each 1 mm increase in ST-depression could highlight the role of this change for predicting early mortality.

Thus, accordant to these information and results of our study, we can suggest ST change in aVR, both segment elevation and depression, is a valuable marker which can predict in hospital mortality and recurrent MI in patients with anterolateral MI or with non-STEMI. It can be useful to improve risk stratification beyond other risk predictors and it can help for selection of optimal management strategy.

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