Reciprocal Changes in 12-Lead Electrocardiography Can Predict Left Main Coronary Artery Lesion in Patients With Acute Myocardial Infarction

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SUMMARY

Acute left main coronary artery (LMCA) occlusion may result in acute myocardial infarction (AMI) or sudden death. ST elevation in the aVR and V1 leads is reported to be valuable in recognizing LMCA occlusion. Early recognition of electrocardiogram (ECG) changes, such as reciprocal ST depression in other leads, is helpful in averting this disaster. This study aimed to determine the reciprocal ST segment depression of 12-lead ECGs associated with acute LMCA occlusion. From January 2000 to December 2004, 61 patients who underwent emergency percutaneous coronary intervention in 3 hospitals due to AMI associated with LMCA (n = 18) and a left anterior descending coronary artery (LADCA) (n = 43) proximal lesion were selected. Reciprocal ST segment depression occurred in leads aVF, V2, V3, V4, V5, and V6 with significantly higher incidence in the LMCA group than in the LADCA group. Stepwise linear multivariate discriminant analysis indicated that ST segment depression in leads aVF, V2, and V4 could distinguish the LMCA group from the LADCA group. We concluded that reciprocal ST segment depression in leads V2, V4, and aVF of a 12-lead ECG is an important predictor of acute LMCA occlusion. (Int Heart J 2006; 47: 13-20)

Key words: Reciprocal change, ST segment depression, Acute left main occlusion, Acute myocardial infarction

ACUTE LMCA occlusion is a serious clinical condition. Despite its low incidence, the prognosis is often poor. The condition is usually discovered too late for surgery to be initiated, therefore, vessel patency is usually obtained by percutaneous coronary intervention.1,2) Unfortunately, this modality is associated with a high mortality rate. Early recognition and faster percutaneous coronary intervention may decrease the mortality rate.3-5)

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The best and most readily available noninvasive modality in the emergency room (ER) is the ECG. However, an ECG may be normal or present findings compatible with acute anterior wall myocardial infarction, but be unable to distinguish an LM coronary artery occlusion from the proximal lesion of a left anterior descending coronary artery occlusion. Over the past few years, many reports have shown that ST segment elevation in leads aVR and V₁ is an important predictor of acute LMCA occlusion. However, there have been no reports on reciprocal ST segment depression or whether the relationship between ST segment depression differs between acute LMCA and LADCA proximal lesions. Therefore, we undertook this study to compare reciprocal ST segment depression in patients with acute LMCA occlusion with that in patients with acute LADCA occlusion.

**METHODS**

**Study patients:** From January 2000 to December 2004, 61 patients who underwent emergency percutaneous coronary intervention at 3 hospitals due to acute myocardial infarction (AMI) associated with LMCA (n = 18) and LADCA (n = 43) proximal lesions were selected. The diagnosis of AMI was based on elevations of serum cardiac enzymes and the presence of symptoms and ST segment elevation in more than 2 leads on ECG (at least ST segment elevation in leads aVR and V₁). An ST segment shift was determined as the mean value of 3 successive beats measured at 60 ms after the J point of the QRS complex. ST segment elevation was defined as a rise of more than 0.05 mV in the limb leads and 0.1 mV in the precordial leads. Only patients with complete medical histories, available ECG, and coronary angiograms were included.

**Measurements:** Patients were grouped according to the infarct-related artery (IRA). Patients with an IRA of the LMCA were characterized as group A, while patients with an IRA of the LADCA proximal lesion were categorized as group B. The 12-lead ECGs were obtained in the ER a few minutes after arrival. Reciprocal change was defined as an ST segment depression of more than 0.05 mV in the limb leads and 0.1 mV in the precordial leads, except leads aVR and V₁. ST segment depression data were subjected to statistical analysis.

**Coronary angiography:** Coronary angiography was performed immediately on all patients upon diagnosis of AMI at the ER. A stenosis of more than 50% in diameter of one or more major epicardial arteries was considered significant. The infarct-related artery was defined as 1) total occlusion; 2) the most severe lesion; and 3) thrombus formation in the coronary artery. An LADCA proximal lesion was defined as a culprit lesion proximal to the dominant first septal and diagonal arteries.

Initially, interobserver and intraobserver differences were investigated by
analyzing 20 randomly selected ECG samples from the two groups. Measurements were then calculated by two observers who were blinded to any of the angiographic findings.

**Statistics:** Continuous variables are presented as the mean ± SD and were compared using the unpaired Student t-test. Categorical or discrete variables are presented as frequencies and percentages. When appropriate, they were compared by the Fisher exact test or chi-square test. ST segment depression in limb and precordial leads is presented as a quantitative variable, and was subjected to univariate analysis. Stepwise linear multivariate discriminant analysis was later used to determine the predictors of acute LM occlusion. A $P$ value of less than 0.05 was considered significant.

**RESULTS**

After evaluating the sample ECGs, the interobserver and intraobserver differences in the limb leads averaged $0.02 ± 0.02$ mV and $0.02 ± 0.03$ mV, respectively. Similarly, the interobserver and intraobserver differences in the precordial leads averaged $0.01 ± 0.02$ mV and $0.02 ± 0.04$ mV, respectively. Therefore, interobserver and intraobserver variations were acceptably small and did not affect the validity of the results.

There were no significant differences in the clinical characteristics of the patients between the two groups, except for a higher incidence of smoking and more Killip IV patients in the LMCA group than in the LADCA group. The clinical characteristics are shown in Table I.

Figure 1 shows representative 12-lead ECGs in one patient from each group. The incidence of reciprocal ST segment depression on the 12-lead ECG, except for leads aVR and V1, is summarized in Figure 2. Lead V2 showed ST segment depression in 56% (10/18) of patients in the LMCA group; ST segment depres-

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**Table I.** Baseline Clinical Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Group A ($n = 18$)</th>
<th>Group B ($n = 43$)</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>62 ± 14</td>
<td>60 ± 16</td>
<td>0.621</td>
</tr>
<tr>
<td>Male (%)</td>
<td>14 (78)</td>
<td>33 (77)</td>
<td>0.930</td>
</tr>
<tr>
<td>Hypertension (%)</td>
<td>10 (56)</td>
<td>20 (47)</td>
<td>0.519</td>
</tr>
<tr>
<td>Diabetes mellitus (%)</td>
<td>4 (22)</td>
<td>11 (26)</td>
<td>0.781</td>
</tr>
<tr>
<td>Smoking (%)</td>
<td>14 (78)</td>
<td>20 (47)</td>
<td>0.025</td>
</tr>
<tr>
<td>Dyslipidemia (%)</td>
<td>3 (17)</td>
<td>15 (35)</td>
<td>0.155</td>
</tr>
<tr>
<td>Killip classification</td>
<td></td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>I (%)</td>
<td>4 (22)</td>
<td>31 (72)</td>
<td></td>
</tr>
<tr>
<td>II (%)</td>
<td>1 (6)</td>
<td>6 (14)</td>
<td></td>
</tr>
<tr>
<td>III (%)</td>
<td>3 (17)</td>
<td>3 (7)</td>
<td></td>
</tr>
<tr>
<td>IV (%)</td>
<td>10 (56)</td>
<td>3 (7)</td>
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</tr>
</tbody>
</table>
Figure 1. Typical ECG from LMCA group (A) and LADCA group (B).

Figure 2. The incidence of ST depression in each lead, except V1 and aVR, in LMCA group and LADCA group. * $P < 0.05$, ** $P < 0.01$. 
Similar incidences were seen in leads V3 and V4. Only lead aVF, an inferior lead, revealed a significantly different incidence of ST segment depression in the LMCA group [100%, (18/18)] than in the LADCA group [70%, (30/43)]. There were no differences in the other inferior limb leads between the two groups.

Univariate analysis revealed that leads II, III, aVF, V2, V3, V4, V5, and V6 were significant predictors of acute LM occlusion (Table II). Stepwise linear multivariate discriminant analysis identified leads aVF, V2, and V4 as leads in which ST segment depression significantly contributed to distinguishing the LMCA group from the LADCA group (Table III).

**DISCUSSION**

This study shows that the higher incidence of reciprocal ST segment depression in leads V2, V4, and aVF, the more useful it is for predicting the LM coronary artery as the culprit lesion in patients with AMI. In acute LMCA occlusion, except for ST segment elevation in leads aVR and V1, reciprocal ST segment depression also could be used to predict the lesion site. Thus, the present results are clinically useful for early recognition of acute LMCA occlusion in patients
Several reports have shown that ST segment elevation in leads aVR and V₁ was related to acute LMCA occlusion.³,⁴ We also found one report which stated that reciprocal ST segment depression in a 12-lead ECG can predict an acute LMCA lesion. Only two case reports have shown that diffuse ST depression over the inferior and anterior leads are typical ECG manifestations of AMI secondary to an LM occlusion.⁶,⁷ ECG is only one of many diagnostic modalities used in detecting AMI from an LMCA occlusion in the early stages. Early recognition of the significant ST segment depression on the 12-lead ECG followed by immediate cardiac revascularization will reduce the mortality rate.

Reciprocal ST segment depression on the 12-lead ECG in the wall opposite the infarcted territory is frequently observed during AMI. ST segment depression may reflect subendocardial ischemia, infarction, or reciprocal changes secondary to infarction at a remote site.⁸⁻¹⁰ This is seen frequently in acute LAD, right coronary artery, and left circumflex coronary occlusion, but rarely in acute LMCA occlusion. One can easily assume that acute LMCA occlusion, but not acute LADCA occlusion, is associated with posterior wall ischemia. Reciprocal ST segment depression in the precordial leads in acute LMCA occlusion may differ from that found in acute LADCA occlusion due to concomitant posterior wall ischemia, which produces reciprocal changes in the precordial leads.

LMCA disease is usually not an isolated coronary artery event, but is associated with individual LAD, left circumflex, right coronary artery, or even triple-vessel disease. Co-occurrence with one or more coronary arteries may alter the ECG manifestations, as the magnitude of ST depression in the precordial leads may change in relation to the inferior leads. A total of 34 patients with acute LMCA occlusion have been described in 11 reports.⁵,⁷,¹¹⁻¹⁹ ST segment depression in the precordial leads was reported in 12 patients. According to Sclarovsky, et al, manifestation of LMCA stenosis is diffuse ST segment depression over the inferior leads and the precordial leads except V₂ and V₃ on ECG, as in this series.²⁰

An important finding in our study is that the ST depression of V₂ and V₃ in the LMCA group can predict acute LMCA occlusion. Only two case reports have reported similar results. Schulman⁶ and Frierson, et al⁷ concluded that patients with acute LMCA occlusion will have diffuse ST segment depression in leads V₂⁻V₆ (including leads V₂ and V₃).

The presence of a reciprocal ST segment depression in the inferior leads in the setting of an anterior AMI is a parameter that in previous studies²¹⁻²³ predicted the existence of an occlusion proximal to the dominant first septal and diagonal arteries. In our study, a reciprocal ST segment depression only in lead aVF proved to be an excellent predictor for discriminating acute LMCA from an LADCA
proximal lesion. This parameter has never been reported.

Many reports have shown that ST segment elevation in leads aVR and V1 was related to acute LMCA occlusion. In our study, reciprocal ST segment depression in leads aVF, V2, and V4 strongly suggests a significant LMCA lesion. However, if accompanied by ST elevation in leads aVR and V1, the specificity of an LM lesion acting as the culprit vessel increases.

**Study limitations:** Two limitations in this study need to be emphasized. First, this was a retrospective and descriptive study in three hospitals over a period of four years. Also, the sample size was small because acute LM occlusion is not common, so caution must be exercised in interpreting our data. Second, since there was great variation in the time from the start of symptoms until arrival at the ER, it was not possible to have uniformity with respect to the timetable for conducting the 12-lead ECG. This factor can not be standardized since the time at which the patient decided to consult an ER physician could not be controlled. This may have affected our results because changes in ECG patterns are associated with the duration of ischemia.

**Conclusions:** The results of the present study show that in patients with acute MI- reciprocal ST depression in leads aVF, V2, and V4, there is a high probability of left main coronary artery occlusion.

**REFERENCES**


