Limitations of Electrocardiography in the Diagnosis of Acute Myocardial Infarction – Comparison with Two-Dimensional Echocardiography –

Chisato Izumi, Kanji Iga, Takahisa Kuima, Yoshihiro Himura, Hiromitsu Gen and Takashi Konishi

In order to assess the sensitivity of the initial electrocardiogram (ECG) in diagnosing the first attack of acute myocardial infarction (AMI), we compared the findings on ECG and two-dimensional echocardiogram (2-D echo) in 74 patients with single vessel coronary artery disease. Group A consisted of 41 patients with infero-posterior AMI while group B consisted of 33 patients with antero-septal AMI. In group A, 12 patients showed normal ECGs, while 2-D echo failed to reveal abnormal left ventricular wall motion in only 2 patients. In those two patients, the quality of the echocardiogram was poor. In group B, only one patient showed a normal ECG, and all patients showed abnormal left ventricular wall motion on 2-D echo. We conclude that electrocardiography has limitations in diagnosing infero-posterior myocardial infarction especially during the acute phase, but 2-D echo is an additional useful diagnostic procedure.

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Key words: sensitivity, coronary artery disease

Introduction

ST segment elevation associated with severe chest pain is a characteristic finding on electrocardiogram (ECG) in patients with acute myocardial infarction (AMI) and ECG has been an important diagnostic procedure for AMI. However, normal ECG does not always deny AMI (1).

We compared the findings of ECG with those of two-dimensional echocardiogram (2-D echo) in patients with AMI and discuss the limitations of ECG and usefulness of 2-D echo in diagnosing AMI.

Subjects and Methods

Subjects consisted of 74 consecutive patients with the first attack of AMI involving single vessel coronary artery disease who were admitted to our hospital between April 1987 and September 1993. We define single vessel coronary artery disease as the stenosis of more than 90% in only one of the main coronary arteries. We divided these subjects into two groups; group A was composed of 41 patients with infero-posterior AMI (32 males and 9 females, mean age 63 years), while group B of 33 patients with antero-septal AMI (24 males and 9 females, mean age 62 years).

Diagnosis of infero-posterior AMI was made when all the following criteria were fulfilled, 1) typical chest pain continuing for more than 30 minutes, 2) creatine kinase (CK) elevation of more than 500 IU, and 3) more than 90% stenosis of the right coronary or the left circumflex artery in the acute or chronic phase in coronary angiography.

Diagnosis of antero-septal AMI was made when all the following criteria were fulfilled, 1) typical chest pain continuing for more than 30 minutes, 2) CK elevation of more than 500 IU, and 3) more than 90% stenosis of the left anterior descending artery in the acute or chronic phase in coronary angiography.

The ECGs were performed within 24 hours from the onset of chest pain and interpreted by two cardiologists without knowledge of the clinical findings. Based on the Minnesota Code, positive ECG criteria for infero-posterior AMI included either more than 0.1 mV of ST segment elevation in leads II, III or aVF, or horizontal ST segment depression of more than 0.1 mV in V1 or V2 leads. Similarly, positive ECG criteria for antero-septal AMI included more than 0.1 mV ST segment elevation in one or more of the anterior chest leads.

2-D echo was performed within 24 hours after onset of AMI, by Toshiba SSH 140A (Toshiba Corporation, Tokyo, Japan) equipped with a 3.75 MHz or 2.5 MHz transducer and
was interpreted by two cardiologists without knowledge of the clinical findings. Those patients who showed abnormal left ventricular wall motion in the infarct area were regarded as 2-D echo-positive, while those who did not, including the subjects with poor quality echocardiograms, were regarded as 2-D echo-negative.

In group A, we also compared the ECG of the acute phase with that of the chronic phase (3 months after the onset of AMI). Old infero-posterior myocardial infarction (OMI) was defined as demonstrating either 1) abnormal Q waves or coronary T waves in the II, III or aVF leads, or 2) tall R waves (defined as R/S >1) or symmetrical tall T waves (defined as more than 1.5 mV) in the V1 or V2 leads.

Statistical evaluation was performed by the Mann-Whitney method and p<0.05 was considered to be significant. Data were expressed as mean±SE.

Results

Among the 41 patients in group A, 29 patients were ECG-positive, 12 were ECG-negative and 39 patients were 2-D echo-positive, 2 were 2-D echo-negative (Fig. 1). Both patients who were 2-D echo-negative demonstrated poor quality echocardiograms.

The culprit lesions were distal to Segment 3 or Segment 15 in 3 of the ECG-negative patients (25%), and in 5 patients in the ECG-positive group (17%) (Table 1). The average peak CK value in group A was 2,341±351 IU, 2,869±483 IU in the ECG-positive group and 1,232±103 IU in the ECG-negative group (p<0.05). The initial ECGs were taken 6.1±2.3 hours after the onset of chest pain in the ECG-negative group and 5.6±1.3 in the ECG-negative group (NS).

Seven of 12 patients in the ECG-negative group became ECG-positive in the chronic phase, while 3 of 29 patients in the ECG-positive group became ECG-negative (Fig. 2).

Among the 33 patients in group B, 32 were ECG positive and only one patient was ECG-negative (Fig. 1). All of the patients showed abnormal wall motion on 2-D echo. The average peak CK value was 3,252±324 IU. The initial ECGs were taken 4.0±0.9 hours after the onset of chest pain.

Discussion

In the present study, although all the patients except one with antero-septal AMI showed abnormal ECG, about 30% of the patients with infero-posterior AMI showed normal ECG on the initial visit. Approximately half of these ECG-negative patients became ECG-positive during the chronic phase. There was no tendency for ECG-negative patients to demonstrate stenosis in the distal segments, but the average peak CK value of the ECG-positive group was significantly higher than that of the ECG-negative group (2,869 vs 1,232, p<0.05), and none of the

Table 1. Culprit Lesions in Group A

<table>
<thead>
<tr>
<th></th>
<th>ECG-positive</th>
<th>ECG-negative</th>
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</thead>
<tbody>
<tr>
<td>Segment 1</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Segment 2</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Segment 3</td>
<td>3</td>
<td>2</td>
</tr>
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<td>Segment 11</td>
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<td>Segment 13</td>
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<td>2</td>
</tr>
<tr>
<td>Segment 15</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>total</td>
<td>29</td>
<td>12</td>
</tr>
</tbody>
</table>

Figure 1. Comparison of the ECG findings with 2-D echo in patients from infero-posterior AMI and antero-septal AMI groups. AMI: acute myocardial infarction, ECG: electrocardiogram, 2-D echo: two-dimensional echocardiogram.
ECG Limitations in the Diagnosis of AMI

Table 1. ECG findings during the chronic phase in patients from infero-posterior AMI group.

<table>
<thead>
<tr>
<th></th>
<th>Total cases</th>
<th>41</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>positive</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>negative</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>positive</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>negative</td>
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</tr>
<tr>
<td></td>
<td>positive</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>negative</td>
<td>3</td>
</tr>
</tbody>
</table>

Patients in the ECG-negative group revealed a peak CK of more than 2,000 IU. Therefore, patients with infero-posterior AMI who demonstrate normal ECGs might have a smaller infarct area. There was no significant difference between the average peak CK value in group A and in group B, while ECG-negative patients were more common in group A than in group B. This suggested that the ECG leads revealing the infero-posterior region are rather limited compared with the antero-septal region, which may be the reason for the limitations of ECG in the diagnosis of infero-posterior AMI.

Some previous reports concern the sensitivity of ECG in diagnosing AMI. Merrill and Pearce (2) compared ECG findings with autopsy findings; most of the patients who showed myocardial infarction at autopsy had typical abnormal ECG. However, this report was based on postmortem data and might select patients with extensive myocardial infarction, who were more likely to be associated with abnormal ECG. In other reports (3–7) discussing the initial ECG in cases of AMI, the probability of normal ECG in AMI varied (ranging from 3% to 35%). These differences might be due to different definitions and ECG criteria for myocardial infarction. In some reports regarding ECG changes during percutaneous transluminal coronary angioplasty (8, 9), complete occlusion of the left circumflex coronary artery was less likely associated with ST segment change than that of the left anterior descending coronary artery.

2-D echo detected localized abnormal ventricular wall motion in 39 of 41 patients in group A. Only 2 patients did not show abnormal left ventricular wall motion on 2-D echo; both patients demonstrated poor quality echocardiograms. All of the patients in group B showed localized wall motion abnormalities on 2-D echo. Therefore, 2-D echo was a useful method to detect abnormal left ventricular wall motion as in a previous report (10).

In conclusion, initial ECG has some limitations in diagnosing acute infero-posterior myocardial infarction and 2-D echo is an additional useful diagnostic procedure. 2-D echo should be performed whenever AMI is suspected, regardless of normal ECG.

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References