Case report: acute inferior myocardial infarction with single-lead ST segment elevation

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This article illustrates a patient who presented with acute inferior myocardial infarction with only isolated ST segment elevation in Lead III. Brief review on the electrocardiographic interpretation was discussed. Early recognition and management is the key to prevent morbidity and mortality. (Hong Kong J Emerg Med. 2002;9:154-158)

Keywords: Right ventricular infarction, right-sided chest lead, single-lead ST segment elevation, thrombolytic therapy

Case summary

A 54-year-old gentleman attended our Accident and Emergency department complaining of central chest pain one hour earlier. On arrival, he was conscious, alert and was able to locate the site of chest pain. Examination of cardiovascular system showed bradycardia, blood pressure of 100/66 mmHg; pulse rate of 50 beats per minute. Other systemic review did not reveal any abnormality. ECG showed bradycardia, AV dissociation, and ST segment elevation in only Lead III, T-wave inversion over V3-V6. (Figure 1)

Figure 1. ST elevation in lead III.
Presumptive diagnosis was acute inferior myocardial infarction (AIMI) complicated with complete heart block. Aspirin, streptokinase was given with transcutaneous pacing on standby. Blood pressure was 104/54 mmHg upon transfer to Coronary Care Unit in Ruttonjee Hospital.

However, physician in Coronary Care Unit stopped the streptokinase infusion because the criteria according to Gusto studies (1 mm ST segment elevation in 2 limb leads) were not fulfilled. Instead, he started low molecular weight heparin infusion and monitored patient's progress. Right-sided chest leads showed 1 mm ST segment elevation over V5R-V6R and the complete heart block subsided spontaneously. (Figure 2)

Creatine phosphokinase peak 1,120 IU/L at 16 hours after admission. Mass CPK-MB was 58 ng/ml and CK-MB/CK index 48.0 ng/U. (A Mass CK-MB concentration of >10 ng/ml and a CK-MB/CK index >40 ng/U supports a diagnosis of myocardial injury.) Clinical diagnosis was acute occlusion of distal branch of right coronary artery with reperfusion. Subsequent ECG 22 hours after admission showed sinus rhythm, Q-wave & ST segment elevation in Lead III only, T-wave inversion over V4-V6. (Figure 3)
Transthoracic oesophageal echocardiogram did not reveal any systolic or diastolic dysfunction. He was discharged with aspirin, metoprolol and sublingual glyceryl trinitrate.

**Journal discussion**

1) **Single-lead ST segment elevation AMI**

GUSTO multi-centre studies set up guidelines for management of acute myocardial infarction in 1993. Thrombolytic therapy should only be given when >1 mm ST segment elevation was noted over 2 limb leads. Most hospitals still follow this guideline strictly. Actually Sanders documented AIMI can occur even with only one single-lead ST segment elevation in 1930. David et al published their report in 1995 further evaluating this clinical problem. He found that 7.8% (31 out of 394 patients) AIMI patients had ST segment elevation in Lead III only in their initial ECG. Vectorial term explains this ECG feature since maximal ST segment changes towards the infarcted area. Lead III is looking through an angle of +120 degrees on the right inferior wall whereas Lead II is looking through an angle of +60 degrees on left inferior wall. Once the occlusion is proximal to right coronary artery causing right ventricular wall infarction, the ST segment elevation looks upon Lead III. On the other hand, if the occlusion occurs in circumflex artery or periphery of a dominant branch of right coronary artery, the ST changes looks upon Lead II. This also indicates that only a small area of or even no involvement of the right ventricle. Hence myocardial infarction could occur even when ST elevation was noted over a single lead.

As shown in the Figure 4, right ventricular wall involvement is likely especially if the magnitude of ST segment elevation over Lead III is greater than that of Lead II.

![Figure 4. Normal ECG axis.](image)

2) **Lead III/II ratio >1 versus right-sided chest lead V4R**

Right ventricular infarction occurs in 30% to 50% of AIMI. It carries different treatment regime, morbidity and mortality. This was well documented in the review article by Kinch in the New England Journal of Medicine. Emergency physician frequently orders right-sided chest lead V4R to check any right ventricular involvement since the treatment was different. Anderson et al evaluated this ECG feature and published their data in American Heart Journal in 1989. They found that both the positive predictive value and specificity were higher in right-sided chest lead than Lead III/II ratio. But right-sided chest lead carried poor sensitivity and negative predictive value. It values were as follows:

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<th>Positive predictive value</th>
<th>Specificity</th>
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<tr>
<td>Lead III/II ratio</td>
<td>91%</td>
<td>88%</td>
</tr>
<tr>
<td>Right-sided chest lead</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
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Jacqueline et al compared the statistics between III > II versus V4R in 136 patients suffering from right ventricular myocardial infarction. By using the chi-square test, they had found similar results:

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<th>III &gt; II</th>
<th>V4R</th>
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<tbody>
<tr>
<td>Sensitivity</td>
<td>97%</td>
<td>65%</td>
</tr>
<tr>
<td>Specificity</td>
<td>56%</td>
<td>78%</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>69%</td>
<td>75%</td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>95%</td>
<td>69%</td>
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The low negative predictive value in V4R could not exclude RVMI even if there is no ST segment elevation. Kosuge et al\textsuperscript{7} explained that the reason for this is because of concomitant posterior wall involvement. ST segment elevation could be found over V7-V9 rather than V4R. Hence additional posterior leads up to V9 should be performed as well as the standard 12-lead ECG in order to rule in RVMI.

3) Clinical importance
Fifty percent of acute myocardial infarction will present with normal initial ECG.\textsuperscript{8} Moreover ECG is not sensitive (28\% to 50\%) in the first 12 hours.\textsuperscript{9,10} Biochemical marker tests are not diagnostic and their low negative predictive value could not rule out infarction.\textsuperscript{10} David et al\textsuperscript{3} stratified three groups of patients among the 394 AIMI patients with only ST segment elevation in Lead III in the initial ECG tracing i.e. all of them did not meet the GUSTO criteria:

- Type 1: ST segment depression of \(<1\text{ mm}\) in all precordial leads.
- Type 2: ST segment depression \(\geq 1\text{ mm}\) in one or more precordial leads with the sum of ST segment depression in leads V1-V3 \(\geq\) the sum of V4-V6.
- Type 3: ST segment depression \(\geq 1\text{ mm}\) in one or more precordial leads with the sum of ST segment depression in leads V4-V6 \(\geq\) the sum of V1-V3.

<table>
<thead>
<tr>
<th>Type</th>
<th>Number of patient</th>
<th>Thrombolytic given</th>
<th>Congestive heart failure</th>
<th>Death</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>Died of Cardiogenic shock</td>
</tr>
<tr>
<td>3</td>
<td>21</td>
<td>4</td>
<td>13</td>
<td>4</td>
<td>No death in patient receiving thrombolytic therapy</td>
</tr>
</tbody>
</table>

David et al found that Type 3 patients developed more serious cardiac complications including severe heart failure and even cardiogenic shock more commonly than Type 1 and Type 2 patients. Angiography showed global ischaemia due to multivessel coronary artery disease in Type 3 patients. David et al showed that patients presenting with only single-lead ST segment elevation may have a grave prognosis because the diagnosis might be overlooked due to the non-specific, subtle change in the inferior leads.\textsuperscript{3} Worse still, the effect of thrombolytic agent decreases after 12 hours\textsuperscript{10} and may even develop post-treatment cardiac complications.\textsuperscript{3} David concluded that early interventional therapy should be started to arrest the clinical complications.

4) Lesson to learn
AMI can occur in single-lead ST segment elevation. Emergency physician should recognize this ECG feature. Worse still, 50\% of initial ECG was normal in AMI patient.\textsuperscript{8} Hence many clinical trials had been conducted to improve the sensitivity and specificity in the diagnosis of AMI; shorten the door-to-needle time; decrease the complications. This include serial ECG; serial biochemical markers e.g. myoglobin; troponin or even set up a Chest Pain Evaluation Observation Unit.\textsuperscript{8} GUSTO guideline was set up 8 years ago but it can hardly fulfill the rapidly changing cardiac medicine today. Would it be the time for the protocol to be redesigned?

Most studies evaluate the precordial infarction rather inferior one.\textsuperscript{6} Not much data could be found concerning the benefit of giving thrombolytic agent to AMI patients with single-lead ST segment elevation. It would be rather difficult for emergency physician to balance between violating the thrombolytic guideline versus shortening the door-to-needle time. Most of the physicians are still using dogmatic approach to care for patient with myocardial infarction.

Hence we suggest:
1) to gather more AIMI patients' data and analyse the number of patients suffering from single-lead ST segment elevation.
2) combine international data.
3) revise the thrombolytic protocol for AMI patients with single-lead ST segment elevation.
4) find out whether thrombolytic treatment is helpful or not by using multi-centre data analysis.
5) evaluate morbidity and mortality.

No perfect test exist. Anyhow, one should combine clinical information, ECG findings and biochemical results in order to make their presumptive diagnosis. Thrombolytic therapy should be initiated as soon as possible if the diagnosis is confirmed since AIMI carries higher incidence of complications including higher degree of conduction blockade and haemodynamic instability. Early reperfusion or even angioplasty is the key to prevent such complications and in-hospital mortality especially in patients with right ventricular involvement.

References