Specific Findings of the Standard 12-Lead ECG in Patients With ‘Takotsubo’ Cardiomyopathy
--- Comparison With the Findings of Acute Anterior Myocardial Infarction ---

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The clinical course of ‘Takotsubo’ cardiomyopathy closely resembles that of acute myocardial infarction (AMI) and coronary angiography (CAG) is usually performed to distinguish the 2 conditions during the acute phase. The present study was designed to determine whether the standard 12-lead electrocardiogram (ECG) findings could help to distinguish ‘Takotsubo’ cardiomyopathy from anterior AMI. The study group comprised 13 patients with ‘Takotsubo’ cardiomyopathy and 13 consecutive patients with anterior AMI. Patients with ‘Takotsubo’ cardiomyopathy had abnormal Q waves less frequently than patients with anterior AMI (15% vs 69%, p=0.008). No reciprocal changes were seen in the inferior leads in patients with ‘Takotsubo’ cardiomyopathy (p=0.0003). The ratio of ST-segment elevation in leads V4 to V1-3 (STeV4-V1-3) was significantly higher in patients with ‘Takotsubo’ cardiomyopathy (1.55±0.53 vs 0.57±0.58, p=0.0004). The QTc interval was significantly longer in patients with ‘Takotsubo’ cardiomyopathy. The absence of reciprocal changes, absence of abnormal Q waves, and a STeV4-V1-3 ≥1 all showed a high sensitivity and specificity for diagnosing ‘Takotsubo’ cardiomyopathy. Furthermore, the combination of the absence of reciprocal changes and a STeV4-V1-3 ≥1 had a greater specificity (100%) and overall accuracy (91%) than either criteria. Therefore, the standard 12-lead ECG on admission can help to distinguish ‘Takotsubo’ cardiomyopathy from anterior AMI. (Circ J 2003; 67: 687–690)

Key Words: Cardiomyopathy; Electrocardiography; Myocardial infarction (acute)

‘Takotsubo’ cardiomyopathy1–8 is characterized by transient left ventricular (LV) dysfunction with chest symptoms and electrocardiographic (ECG) changes that mimic those of acute myocardial infarction (AMI) in patients with normal findings on coronary angiography (CAG). The entity was named because of the peculiar LV apical ballooning evident on left ventriculogram (ie, a round bottom and narrow neck), the shape of which looks like a ‘Takotsubo’, a vessel that is used in Japan for trapping octopi. Because the ECG findings of this syndrome are similar to those seen with anterior AMI in terms of ST-segment elevation in the precordial leads, emergency CAG is usually performed. In the present study, we determined whether the standard 12-lead ECG on admission could help to distinguish ‘Takotsubo’ cardiomyopathy from anterior AMI.

Methods

Study Population
Between May 2000 and September 2001, 13 patients

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Fig 1. Typical left ventriculogram from a patients with ‘Takotsubo’ cardiomyopathy demonstrating left ventricular apical ballooning.
Differences in the ratio of ST-segment elevation in leads V4–6 to V1–3 was significantly greater in patients with ‘Takotsubo’ cardiomyopathy (0.53 vs 0.57±0.58, p=0.0004). The QTc interval was significantly greater in patients with ‘Takotsubo’ cardiomyopathy (1.55±0.53 vs 1.57±0.58, p=0.0001). Abnormal Q waves, T wave inversions, and reciprocal changes, defined as ST-segment depressions ≥1 mm in 2 or more inferior leads, were also evaluated.

Cardiac Catheterization and Echocardiography

Coronary angiography and left ventriculography were performed by the femoral approach after heparin administration. The left ventriculogram was obtained in the 30-degree right anterior oblique projection. Informed consent for cardiac catheterization was obtained from all patients and/or their families before the procedure. Echocardiography was performed to determine the recovery of LV function in patients with ‘Takotsubo’ cardiomyopathy 2–3 weeks after the onset of symptoms.

ECG Analysis

At the time of admission, a standard 12-lead ECGs were recorded at a paper speed of 25 mm/s and an amplification of 10 mm/mV (Fig 2). A single observer who was unaware of the angiographic and clinical findings analyzed the ECGs. The degree of ST-segment deviation was measured in each lead to the nearest 0.5 mm at 80 ms after the J point. Measurements from 3 consecutive beats were averaged for each lead. We calculated the sum of the ST-segment elevations (STe) in leads V1–3 and V4–6, and determined the ratio of STeV4–6:STeV1–3 (STeV4–6/STeV1–3). The QT interval was measured as the interval from the beginning of the QRS complex to the end of the T wave. If U waves were present, the QT interval was measured to the nadir of the curve between the T and U waves. If U waves were present, the QT interval was measured to the nadir of the curve between the T and U waves. If U waves were present, the QT interval was measured to the nadir of the curve between the T and U waves.

Statistical Analysis

Continuous variables are expressed as the mean ± SD and compared with Student’s t test. Categorical variables were compared using the chi-square test. The ability of the ECG parameters to distinguish ‘Takotsubo’ cardiomyopathy from anterior AMI was assessed by determining the sensitivity, specificity, and accuracy, which were compared using the chi-square test. A probability value <0.05 was considered statistically significant.

Results

Clinical Characteristics (Table 1)

Patients with ‘Takotsubo’ cardiomyopathy were older than patients with anterior AMI (75±10 vs 57±16 years, p=0.002). The percentage of women was higher in the group of ‘Takotsubo’ cardiomyopathy patients (70% vs 15%, p=0.002). Patients with anterior AMI had a greater prevalence of hyperlipidemia and a history of smoking.

Findings on the Standard 12-Lead ECG

The ECG findings are summarized in Table 2. Patients with ‘Takotsubo’ cardiomyopathy had abnormal Q waves less frequently than patients with anterior AMI (15% vs 69%, p=0.008). T wave inversions in leads V1–6 were observed in 4 patients (31%) with ‘Takotsubo’ cardiomyopathy, but in none of the patients with anterior AMI (p=0.02). No reciprocal changes in the inferior leads were seen in patients with ‘Takotsubo’ cardiomyopathy (0 vs 69%, p=0.0003). The ST-segment was elevated primarily in leads V1–3 in patients with anterior AMI, whereas it was elevated primarily in leads V4–6 in patients with ‘Takotsubo’ cardiomyopathy. Therefore, the STeV4–6/STeV1–3 was significantly greater in patients with ‘Takotsubo’ cardiomyopathy (1.55±0.53 vs 0.57±0.58, p=0.0004). The QTc interval was significantly greater in patients with ‘Takotsubo’ cardiomyopa-

Table 1 Clinical Characteristics of Patients With Either Takotsubo Cardiomyopathy or Anterior Acute Myocardial Infarction (AMI)

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Takotsubo cardiomyopathy</th>
<th>Anterior AMI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>75±10</td>
<td>57±16</td>
<td>0.002</td>
</tr>
<tr>
<td>Women</td>
<td>9 (69%)</td>
<td>2 (15%)</td>
<td>0.006</td>
</tr>
<tr>
<td>ST-segment elevation</td>
<td>0.53±0.53</td>
<td>0.57±0.58</td>
<td>p=0.0004</td>
</tr>
<tr>
<td>QT dispersion (ms)</td>
<td>101±20</td>
<td>63±16</td>
<td>0.0006</td>
</tr>
<tr>
<td>QTc (s)</td>
<td>0.53±0.05</td>
<td>0.57±0.05</td>
<td>0.0004</td>
</tr>
<tr>
<td>Abnormal Q waves</td>
<td>2 (15%)</td>
<td>9 (69%)</td>
<td>0.008</td>
</tr>
<tr>
<td>T wave inversion</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
</tr>
<tr>
<td>Reciprocal changes</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
</tr>
<tr>
<td>RR interval (s)</td>
<td>0.69±0.04</td>
<td>0.75±0.13</td>
<td>0.25</td>
</tr>
<tr>
<td>QT (s)</td>
<td>0.44±0.05</td>
<td>0.39±0.02</td>
<td>0.0037</td>
</tr>
<tr>
<td>QTc (s)</td>
<td>0.54±0.05</td>
<td>0.46±0.05</td>
<td>0.0004</td>
</tr>
</tbody>
</table>

Table 2 ECG Findings for Takotsubo Cardiomyopathy and Anterior AMI

<table>
<thead>
<tr>
<th>ECG parameter</th>
<th>Takotsubo cardiomyopathy</th>
<th>Anterior AMI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST-segment elevation (mm)</td>
<td>4.33±1.20</td>
<td>10.04±2.73</td>
<td>0.008</td>
</tr>
<tr>
<td>STeV4–6/V1–3</td>
<td>6.44±4.69</td>
<td>7.73±10</td>
<td>0.56</td>
</tr>
<tr>
<td>STeV4–6/V1–3</td>
<td>0.55±0.53</td>
<td>0.57±0.58</td>
<td>0.0004</td>
</tr>
</tbody>
</table>
thy. Although QT dispersion was increased in both groups, the increase was greater in patients with ‘Takotsubo’ cardiomyopathy (101±30 vs 63±16 ms, p=0.0006).

Table 3 shows the sensitivity, specificity, and accuracy of the ECG findings for distinguishing ‘Takotsubo’ cardiomyopathy from anterior AMI. We found that the absence of reciprocal changes, absence of abnormal Q waves, and a STeV4–6/V1–3 ≥1 all showed high sensitivities and specificities. The overall accuracy of the diagnosis was ≥76% for any of these parameters. When these parameters were combined, the combined criteria of the absence of reciprocal changes and STeV4–6/V1–3 ≥1 had a better specificity (100%) and overall accuracy (91%) than any individual criteria alone.

**Discussion**

‘Takotsubo’ cardiomyopathy resembles anterior AMI in terms of chest symptoms and the ECG changes in the precordial leads. Therefore, emergency CAG is usually performed to distinguish ‘Takotsubo’ cardiomyopathy from anterior AMI during the acute phase. This is the first study to evaluate the usefulness of the standard 12-lead ECG findings in distinguishing ‘Takotsubo’ cardiomyopathy from anterior AMI. We found that the main ECG findings of ‘Takotsubo’ cardiomyopathy are: (1) greater ST-segment elevation in leads V4–6, (2) absence of reciprocal changes in the inferior leads, and (3) absence of abnormal Q waves.

Recently, Kurisu et al6 reported that ST-segment elevation in patients with ‘Takotsubo’ cardiomyopathy is most apparent in leads V4–5, which is quite different from that in anterior AMI. We found that a STeV4–6/V1–3 ≥1 had a specificity of 80%, sensitivity of 77%, and an accuracy of 76% for diagnosing ‘Takotsubo’ cardiomyopathy. Reciprocal changes in the inferior leads were seen in 9 patients with anterior AMI (69%), but in none of the patients with ‘Takotsubo’ cardiomyopathy (p=0.0003). Consequently, the absence of reciprocal changes strongly favors a diagnosis of ‘Takotsubo’ cardiomyopathy, with a sensitivity of 100%, specificity of 69%, and an accuracy of 84%. In addition, the absence of abnormal Q waves had a sensitivity of 83%, specificity of 69%, and accuracy of 76% for diagnosing ‘Takotsubo’ cardiomyopathy. Furthermore, we found that the combined findings of a STeV4–6/V1–3 ≥1 and the absence of reciprocal changes had a specificity of 100% and an overall accuracy of 91% for diagnosing ‘Takotsubo’ cardiomyopathy, which is superior to the individual criteria.

In patients with anterior AMI, high lateral wall infarction because of lesions in the proximal left anterior descending coronary artery has been shown to cause reciprocal changes in the inferior leads.10–12 In addition, Raitt et al13 postulated that acute ischemia in regions supplied by the proximal left anterior descending coronary artery can cause local intramyocardial conduction delays, resulting in early abnormal Q wave formation. On the basis of these observations, we postulate that the lack of reciprocal changes and abnormal Q waves in the setting of ‘Takotsubo’ cardiomyopathy might be explained by the fact that myocardial dysfunction is confined to the apical wall, and therefore the ST-segment elevations are greater in leads V4–6 than in leads V1–3. The absence of true myocardial necrosis, which is proved by minimal elevation of cardiac enzymes, might also be a reason for the lack of abnormal Q waves in patients with ‘Takotsubo’ cardiomyopathy.

In the present study, we evaluated the QTc interval and QT dispersion. Although, these ECG parameters were increased in both patient groups, the increase was greater in patients with ‘Takotsubo’ cardiomyopathy. It has been shown that prolongation of the QTc interval reflects delayed ventricular repolarization14–18 whereas QT dispersion reflects the heterogeneity of ventricular repolarization and electrical instability19–21 Greater variability in myocardial repolarization between an akinetic apical area and a hyperkinetic basal area in the setting of ‘Takotsubo’ cardiomyopathy might cause these differences.

**Study Limitations**

First, this was a retrospective study. Second, we were able to enroll only 13 patients because ‘Takotsubo’ cardiomyopathy is a relatively rare disorder. We found that the absence of reciprocal change was useful for distinguishing ‘Takotsubo’ cardiomyopathy from anterior AMI, but a previous report has shown that reciprocal changes are seen in ‘Takotsubo’ cardiomyopathy. The clinical value of these ECG criteria need to be evaluated in a large clinical study. Third, because assessment of the time of symptom onset was unusual in many patients (46%), we did not perform the ST-segment elevation from the onset to admission. Therefore, the time from the onset of symptoms to the recording of the ECG may have differed between the 2 groups. Finally, we compared only anterior AMI with ‘Takotsubo’ cardiomyopathy and comparison with other entities that have chest symptoms and ST-segment abnormalities, such as AMI in other coronary arteries, acute coronary syndrome and acute myocarditis, is necessary to prove the clinical relevance of this study.

**Conclusion**

We conclude that the standard 12-lead ECG on admission can help to distinguish ‘Takotsubo’ cardiomyopathy from anterior AMI.

**References**


