Assessment of Autonomic Function in Patients with Acute Myocardial Infarction or Diabetes Mellitus by Heart Rate Variability, Ventricular Late Potential and QT Dispersion

Ning GUO, Zhuoren LU, Xiaolin XUE, Juan SHU, and Shuyuan LIU

To compare the efficacy and sensitivity of heart rate variability (HRV), QT dispersion (QTd) and ventricular late potential (VLP) examination in judging autonomic function. Thirty three patients with acute myocardial infarction (AMI) and 33 patients with diabetes mellitus (DM), all of whom were diagnosed with autonomic neuropathy determined by a standard test of cardiovascular autonomic function, were examined by HRV (timing domain methods), QTd and VLP. Thirty three normal individuals served as controls. The mean SD of the normal R-R interval (SDNN) in both the AMI and DM groups was significantly less than that in the control group (p<0.01); and of course, the QTd of these groups was significantly greater than that of the controls (p<0.01). The VLP positive rate of the AMI and DM groups were much higher than that of the control group (p<0.001). SDNN was shown to be significantly negatively correlated to QTd (r= -0.45); and significantly negatively correlated to VLP (r= -0.47); QTd was shown to be positively, though not significantly, correlated to VLP (r=0.48). QTd could be looked as sieving index; HRV could be looked as routine examination of cardiovascular autonomic function, especially SDNN; the combination of HRV and VLP could improve the accuracy of diagnosis. (Hypertens Res 2000; 23: 367-370)

Key Words: acute myocardial infarction, diabetes mellitus, QT dispersion, ventricular late potential, heart rate variability

Introduction

In recent years, increasing attention has been paid to the involvement of the autonomic nervous system in acute myocardial infarction (AMI), cardiogenic sudden death and the complications of diabetes mellitus (DM) (1). Numerous studies have shown that heart rate variability (HRV) is the best index of autonomic function reference; QT dispersion (QTd), in turn, is used to indicate the dispersion of ventricular refractoriness; and ventricular late potential (VLP) is an electrophysiological index used to anticipate sudden death. For many years, a standard test of cardiovascular function was the only index of the presence or absence of autonomic neuropathy, especially in diabetic patients (3). However, this test is highly complicated to perform, and its reliability is relatively poor. Therefore, in order to determine a more accurate, sensitive and reliable method for evaluating cardiac autonomic function, we here compared the efficacy of HRV, QTd and VLP for evaluating autonomic function in patients with AMI or DM and normal controls.

Methods

Patients

The study involved 33 AMI patients (29 men and 4
women; mean age ± SD, 60 ± 10 years; range 39 to 88 years) who did not have DM. Thirty-three patients with DM diagnosed by the WHO standard were also enrolled (19 men and 14 women; mean age ± SD, 56 ± 11 years; range 33 to 76 years). Both groups of patients had autonomic neuropathy as determined by a standard test of cardiovascular autonomic function (3). In addition, 33 normal controls (20 men and 13 women; mean age ± SD, 49 ± 10 years; range 19 to 67 years) were recruited from the community. All patients and controls were examined by physical examination, heart X-ray, blood-sugar analysis, 12-lead electrocardiogram (ECG), VLP, QTd and long-term HRV (time domain methods). No patients or controls had taken any drugs capable of influencing the nervous or cardiovascular systems for at least one week prior to the study.

**HRV Tests**

HRV analysis was performed in accordance with recommended by the task force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (2). Those subjects for whom disturbance or premature beats surpassed the total heart beats by 20% were eliminated.

**QTd Tests**

In all patients and controls, ECGs were recorded at rest using a 12-lead ECG and paper speed of 25 mm/s. All ECGs were interpreted by a single observer who was unaware of the results of autonomic function tests. The QT interval was defined as the interval from the onset of the QRS complex to the end of the T wave, and as a return to the TP baseline. The QT dispersion was taken as the difference between the longest and shortest QT interval from any lead of the 12-lead ECG.

**VLP Tests**

VLP was detected using an ART-1200EPX instrument and Simson standards as follows: TOLQRS ≥ 120 ms, HFLA40 ≥ 40 ms, RMS40 ≤ 25 μV (4). Subjects who met two or more of these Simson conditions were considered positive for VLP.

**Statistical Analysis**

Patients were grouped according to the types of diseases, and comparisons were made using the Student's t test for analysis of continuous data. Chi-square analysis was used for discrete data. Correlational analysis was made by using standard linear regression methods with Spearman's rank correlation test. All data were expressed as mean value ± SD. The level of statistical significance was set at $p < 0.01$.

**Results**

The mean SD of the normal R-R interval (SDNN) in both the AMI and DM groups was significantly less than that in the control group; and of course, the QTd of these groups was significantly greater than that of the controls. The VLP positive rate of the AMI and DM groups was 72.73% and 42.42% respectively, which values were much higher than that (3.03%) of the control group (see Table 1). Table 2 shows the sensitivity and specificity of each of these three methods for judging autonomic function.

<table>
<thead>
<tr>
<th>Group</th>
<th>Numbers</th>
<th>SDNN (ms)</th>
<th>QTd (ms)</th>
<th>VLP positive (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control subjects</td>
<td>33</td>
<td>135.68±26.35</td>
<td>32.73±9.93</td>
<td>1</td>
</tr>
<tr>
<td>AMI group</td>
<td>33</td>
<td>76.61±29.39*</td>
<td>70.00±29.02*</td>
<td>24*</td>
</tr>
<tr>
<td>DM group</td>
<td>33</td>
<td>95.65±31.97*</td>
<td>57.00±17.49*</td>
<td>14*</td>
</tr>
</tbody>
</table>

* $p<0.01$, † $p<0.001$ vs. control subjects.

Youden's index indicates the validity of sensitivity and specificity.

<table>
<thead>
<tr>
<th>Index</th>
<th>Sensitivity %</th>
<th>Specificity %</th>
<th>Youden's index</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDNN &lt; 100 ms</td>
<td>87.16</td>
<td>86.36</td>
<td>0.74</td>
</tr>
<tr>
<td>QTd &gt; 50 ms</td>
<td>98.23</td>
<td>67.27</td>
<td>0.66</td>
</tr>
<tr>
<td>Positive VLP</td>
<td>76.09</td>
<td>85.00</td>
<td>0.61</td>
</tr>
</tbody>
</table>
Another important finding was that the SDNN of the VLP-positive group was less than that of the VLP-negative group. The SDNN of the QTd > 50 ms group was less than that of the QTd < 50 ms group, while the number of VLP-positive patients in the former group was greater than that in the latter (see Tables 3 and 4).

Discussion

HRV analysis is currently being applied in clinical practice, with decreases in HRV being proven indices of risk of mortality after AMI and risk of autonomic neuropathy of DM (5). Depressed HRV after myocardial infarction may reflect a decrease of vagal activity directed to the heart, which leads to prevalence of sympathetic mechanisms and to cardiac electrical instability. The mechanism by which HRV is transiently reduced after myocardial infarction and by which a depressed HRV is predictive of the neural response to AMI has not yet been defined, but it is likely to involve derangement in the neural activity of cardiac origin. In neuropathy associated with diabetes mellitus, a reduction in SDNN seems not only to carry negative prognostic value but also to precede the clinical expression of autonomic neuropathy. Here again, however, the mechanism of diabetic neuropathy is not very clear, although it may be related to the disturbance of metabolism, malnutrition of autonomic nerves, and so on (6). Partanen suggested that hyperinsulinemia may also be a cause of diabetic neuropathy (7).

QTd was first introduced in 1990 by Day as a possibly reliable index of non-equal ventricular refractoriness (8). In 1994, Zhang and Vincent reported that QTd, and especially T wave, was related to sympathetic activity (9). When the sympathetic nerves are active, the T wave returns to its peak value, and the QTd value is large. After MI the QTd in the infarction area is greater than that in the non-infarction area. A possible cause of the prolonged QTd in diabetic autonomic neuropathy is that the sympathetic nerves direct the heart with imbalance, resulting in an asynchronous ventricular refractoriness and an increase in QTd.

A positive VLP is often found in AMI patients, but in this study patients with DM also showed a more positive rate than controls. We hypothesize two reasons for this finding:
1) The sympathetic nerves of the heart are impaired non-equally in diabetic neuropathy, such that the ventricular refractoriness is not synchronous. As a result, the electro-potential difference of the myocardial cell membrane is increased. All these results would lead to a positive VLP.
2) Since there are more DM patients who suffer from MI or angina pectoris with no pain, the mingled existence of relatively living tissues and necrotic fibrous tissues leads to retardation of the speed of impulse conduction. As a result VLP becomes positive.

In view of the fact that the reliability of QTd is poor, but it is sensitive to judge autonomic function, so QTd could be as sieving index. Since the sensitivity, specificity and reliability of HRV are good, HRV could be used as a routine test of cardiac autonomic function. The combination of HRV, VLP and QTd could increase the accuracy of judging autonomic function.

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References


