The correlation of deceleration capacity of rate with the cardiac function and micro-inflammatory state in patients with both primary hypertension and type 2 diabetes mellitus

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ABSTRACT

Objective: To study the correlation of deceleration capacity of rate with the cardiac function and micro-inflammatory state in patients with both primary hypertension and type 2 diabetes mellitus. Methods: A total of 60 patients with both primary hypertension and type 2 diabetes mellitus who were treated in our hospital between May 2012 and February 2016 were collected as the observation group, and 50 patients with primary hypertension who were treated in our hospital during the same period were selected as the control group. According to the median of deceleration capacity of rate (DC), the observation group of patients were further divided into high DC group and low DC group (n=30). The 24 h dynamic electrocardiogram of the included patients were obtained to calculate the DC value; color Doppler diasonograph was used to measure the echocardiogram of the two groups, and obtain the left cardiac function indexes and strain rate indexes; enzyme-linked immunosorbent assay (ELISA) was used to detect the contents of serum pro-inflammatory factors and anti-inflammatory factors. Results: The DC value of observation group was lower than that of control group; left cardiac function indexes IVSTd, LVIDd and LVIDs levels of low DC group and high DC group were higher than those of control group, strain rate indexes SRs, SRe and Sra levels were lower than those of control group, and serum pro-inflammatory factors CRP, IL-6, IL-18 and PCT contents were higher than those of control group while anti-inflammatory factors IL-10 and IL-13 levels were lower than those of high DC group. Conclusion: DC value is lower in patients with both primary hypertension and type 2 diabetes mellitus, and can intuitively reflect the cardiac function and systemic micro-inflammatory state.

1. Introduction

Primary hypertension and diabetes are the most common diseases of clinical cardiovascular system and endocrine system respectively, and both can damage vascular endothelial function, and accelerate the occurrence of target organ damage and cardiovascular events[1,2]. The cardiac systolic and diastolic function in patients with primary hypertension accompanied by type 2 diabetes mellitus continues to reduce, and the two interact as both cause and effect and prompt the condition deterioration. Deceleration capacity of rate (DC) is a new test item on the basis of the dynamic electrocardiogram, it can reflect the strength of the vagus nerve function independently, and it has been confirmed that the DC level has strong warning value for sudden death[3,4]. A study shows that the DC value reduces the senile patients with hypertension and patients with diabetes, but there is not much research on the analysis of DC value in patients with primary hypertension accompanied by type 2 diabetes mellitus and its judgment value for target organ damage. In the study, DC levels in patients with primary hypertension accompanied by type 2 diabetes were detected, and the internal relation of DC value with cardiac function and micro-inflammatory state was further analyzed.
2. Information and methods

2.1 Clinical information

A total of 60 patients with both primary hypertension and type 2 diabetes mellitus who were treated in our hospital between May 2012 and February 2016 were included in the observation group, and 50 patients with primary hypertension who were treated in our hospital during the same period were selected as the control group. Observation group included 34 male cases and 26 female cases, they were 50-78 years old, the primary hypertension course was 5-18 years, and the body weight was 48-82 kg and (63.29±8.11) kg in average; control group included 26 male cases and 24 female cases, they were 48-79 years old, the primary hypertension course was 4-16 years, and the body weight was 47-83 kg and (64.18±9.05) kg in average.

2.2 Inclusion and exclusion criteria

Inclusion criteria: (1) conforming to the diagnosis for primary hypertension and type 2 diabetes in the "Internal Medicine"; (2) taking blood pressure-lowering/blood sugar-regulating drugs regularly; (3) no history of hypertensive cerebral hemorrhage; (4) participating in the whole study, and with complete clinical data. Exclusion criteria: (1) associated with primary aldosteronism and other causes of secondary hypertension; (2) associated with systemic infectious diseases; (3) associated with severe liver and kidney dysfunction; (4) associated with hypertrophic heart disease, infective endocarditis, viral myocarditis and other basic heart diseases.

2.3 Deceleration capacity of rate

Both groups of patients received 24 h dynamic ECG recordings examination to ensure the total effective dynamic electrocardiogram recording time ≥18 h. The deceleration cycle and the sorting of the heart rate segment length were determined, and the deceleration capacity of rate was calculated (DC).

2.4 Cardiac function index detection methods

Color Doppler diasonograph (Jiangsu Jiahua Electronics Co., LTD., the article number JH-930) was applied for echocardiography of two groups of patients to obtain (1) the left cardiac function indexes: left atrial interventricular septum thickness at end-diastole (IVSTd), left ventricular inner diameter at end-diastole (LVIDd) and left ventricular inner diameter at end-systole (LVIDs). (2) Strain rate indexes: Qlab software was started to measure the mean peak systolic strain rate (SRs), early diastolic strain rate (SRe) and advanced diastolic strain rate (Sra) of middle left ventricular anterior wall.

2.5 Micro-inflammatory state index detection methods

2 mL of fasting cubital venous blood was extracted from two groups of patients, anti-coagulated, then let stand at room temperature and centrifuged at low speed to collect supernatant and then freeze it at -20℃ for test. Enzyme-linked immunoabsorbent assay (ELISA) was used to determine the serum pro-inflammatory factor contents, including C-reactive protein (CRP), interleukin-6 (IL-6), interleukin-18 (IL-18) and procalcitonin (PCT). Anti-inflammatory factor contents were determined, including interleukin-10 (IL-10) and interleukin-13 (IL-13).

2.6 Statistical methods

Specially-assigned person was used to input the data obtained in the study into software SPSS 21.0, measurement data was in terms of mean±SD, comparison among three groups was by variance analysis, pair-wise comparison between groups was by LSD method, and \( P<0.05 \) was set as the standard of statistical significance in differences.

3. Results

3.1 Deceleration capacity of rate

DC value of observation group was (4.15±0.48) ms, DC value of control group was (5.9±0.67) ms, the DC value of observation group was significantly lower than that of control group, and differences between groups were statistically significant \( (P<0.05) \). The median of DC value of observation group was (4.71±0.63) ms and used as boundary to divide the observation group into high DC group and low DC group, 30 cases in each group.

3.2 Left cardiac function indexes

Comparison of left cardiac function indexes IVSTd, LVIDd and LVIDs levels among three groups of patients was as follows: the differences in IVSTd, LVIDd and LVIDs levels were statistically significant among low DC group, high DC group and control group \( (P<0.05) \). IVSTd, LVIDd and LVIDs levels of low DC group and high DC group were higher than those of control group, IVSTd, LVIDd and LVIDs levels of low DC group were higher than those of high DC group, and differences between groups were statistically significant \( (P<0.05) \), shown in Table 1.

### Table 1.

Comparison of left cardiac function index levels (mm).

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>IVSTd</th>
<th>LVIDd</th>
<th>LVIDs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low DC group</td>
<td>30</td>
<td>13.76±1.94*</td>
<td>67.82±7.19*</td>
<td>57.58±6.02*</td>
</tr>
<tr>
<td>High DC group</td>
<td>30</td>
<td>11.05±1.74*</td>
<td>63.05±6.74*</td>
<td>52.64±5.89*</td>
</tr>
<tr>
<td>Control group</td>
<td>50</td>
<td>9.12±0.98</td>
<td>61.28±6.97</td>
<td>49.27±5.13</td>
</tr>
<tr>
<td>( F ) value</td>
<td></td>
<td>8.293</td>
<td>7.197</td>
<td>10.673</td>
</tr>
<tr>
<td>( P ) value</td>
<td></td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

Note: compared with control group, *\( P<0.05 \); compared with high DC group, *\( P<0.05 \).

3.3 Strain rate indexes

Comparison of strain rate indexes SRs, SRe and Sra among three groups of patients was as follows: the differences in SRs, SRe and Sra were statistically significant among low DC group, high DC group and control group \( (P<0.05) \). SRs, SRe and Sra levels of low
DC group and high DC group were lower than those of control group, SRs, SRe and Sra levels of low DC group were lower than those of high DC group, and differences between groups were statistically significant (P<0.05), shown in Table 2.

Table 2.
Comparison of stain rate index levels.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>SRs</th>
<th>SRe</th>
<th>Sra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low DC group</td>
<td>30</td>
<td>0.76±0.08^a</td>
<td>1.02±0.12^a</td>
<td>0.51±0.06^b</td>
</tr>
<tr>
<td>High DC group</td>
<td>30</td>
<td>0.85±0.09^a</td>
<td>1.16±0.13^b</td>
<td>0.59±0.06^b</td>
</tr>
<tr>
<td>Control group</td>
<td>50</td>
<td>0.94±0.09</td>
<td>1.29±0.15</td>
<td>0.67±0.07</td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

Note: compared with control group, ^aP<0.05; compared with high DC group, ^bP<0.05.

3.4 Pro-inflammatory factor contents

Comparison of serum pro-inflammatory factors CRP (mg/L), IL-6 (mg/L), IL-18 (pg/mL) and PCT (ng/mL) contents among three groups of patients was as follows: differences in serum CRP, IL-6, IL-18 and PCT contents were statistically significant among low DC group, high DC group and control group (P<0.05). Serum CRP, IL-6, IL-18 and PCT contents of low DC group and high DC group were higher than those of control group, serum CRP, IL-6, IL-18 and PCT contents of low DC group were higher than those of high DC group, and differences between groups were statistically significant (P<0.05), shown in Table 3.

Table 3.
Comparison of serum pro-inflammatory factor levels.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>CRP</th>
<th>IL-6</th>
<th>IL-18</th>
<th>PCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low DC group</td>
<td>30</td>
<td>8.15±0.93^a</td>
<td>12.4±1.76^a</td>
<td>115.7±14.05^a</td>
<td>9.16±0.95^b</td>
</tr>
<tr>
<td>High DC group</td>
<td>30</td>
<td>4.09±0.45^a</td>
<td>7.19±0.85^a</td>
<td>79.6±9.12^a</td>
<td>5.38±0.64^a</td>
</tr>
<tr>
<td>Control group</td>
<td>50</td>
<td>1.27±0.15</td>
<td>4.28±0.56</td>
<td>45.2±5.09</td>
<td>2.17±0.25</td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

Note: compared with control group, ^aP<0.05; compared with high DC group, ^bP<0.05.

3.5 Anti-inflammatory factors

Comparison of serum anti-inflammatory factors IL-10 and IL-13 contents among three groups of patients was as follows: differences in serum IL-10 and IL-13 contents were statistically significant among low DC group, high DC group and control group (P<0.05). Serum IL-10 and IL-13 contents of low DC group and high DC group were lower than those of control group, serum IL-10 and IL-13 contents of low DC group were lower than those of high DC group, and the differences between groups were statistically significant (P<0.05), shown in Table 4.

Table 4.
Comparison of serum anti-inflammatory factor levels (pg/mL).

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>IL-10</th>
<th>IL-13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low DC group</td>
<td>30</td>
<td>11.76±1.82^a</td>
<td>36.8±4.07^a</td>
</tr>
<tr>
<td>High DC group</td>
<td>30</td>
<td>17.53±1.94^a</td>
<td>51.67±6.05^b</td>
</tr>
<tr>
<td>Control group</td>
<td>50</td>
<td>25.48±3.01</td>
<td>75.38±8.19</td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

Note: compared with control group, ^aP<0.05; compared with high DC group, ^bP<0.05.

4. Discussion

DC is obtained after the judgment of general tendency and deceleration capability of 24 h heart rate, it can quantitatively evaluate the vagus nerve tension, and it is a new popular noninvasive ECG technology[5,6]. Diabetic patients can be associated with autonomic nerve function lesion, and are mostly with decreased DC value; it has been approved in studies at home and abroad that DC value also reduces in elderly patients with hypertension[7]. In the study, DC levels in patients with both primary hypertension and type 2 diabetes mellitus were detected, and it was found that compared with control group, the observation group of patients were with lower DC value. Both cardiac afterload and myocardial contraction work increase in patients with essential hypertension, and the risk of long-term ventricular remodeling and heart failure is higher than that in normal people. There is autonomic nervous system imbalance in diabetic patients, characterized by the increased sympathetic nervous tension and the inhibited pressure sensors and cardiac vagus nerve tension[8]. The above heart load and nerve function disorder are worse in patients with both primary hypertension and type 2 diabetes mellitus, so the DC value decreases.

Many studies confirm that abnormal cardiac function is the most important complication of hypertensive patients with diabetes mellitus, and with the extension of the course of disease, the blood pressure and blood sugar fluctuation increase, and the cardiac function gradually deteriorates[9,10]. Echocardiogram is one of the most reliable ways to judge cardiac function, but the inspection process is complex, the ejection fraction and other common parameters are not quite sensitive to the early cardiac function change, and it can't become a convenient way to monitor condition changes. DC value represents the deceleration capacity of vagus nerve for heart rate adjustment, it is a kind of heart protection mechanism, and the risk of sudden death is doubled when DC is too low [11]. In the study, analysis of the cardiac function between patients with different DC values showed that compared with high DC group, low DC group of patients were with higher left cardiac function indexes LVSTd, LVIDd and LVIDs levels. Under LVSTd, LVIDd and LVIDs systolic and diastolic state, the left ventricular inner diameter and interventricular septum thickness, the values increase, the incidence of congestive heart failure is rising, and the above results show that in patients with both primary hypertension and type 2 diabetes, the DC value is positively correlated with ventricular systolic ability. Strain rate technique is a new method to evaluate cardiac function, it reflects the myocardial deformation after the exogenic action, and ischemic myocardial systolic strain rate and early diastolic strain rate significantly reduce or are even reversed[12,13]. In the study, comparison of the myocardial strain rate between primary hypertensive and type 2 diabetic patients with different DC levels showed that compared with high DC group, low DC group of patients were with lower strain rate indexes SRs, SRe
and Sra levels, indicating that DC value is negatively correlated with the degree of myocardial ischemia and cardiac dysfunction.

There is a big relationship between inflammatory reaction and the occurrence as well as development of diabetes, and the sustained release of inflammatory mediators can increase insulin resistance and aggravates the diabetes condition[14,15]. The endothelial injury increases in patients with both primary hypertension and type 2 diabetes mellitus, which prompts the generation of local inflammatory factors and forms the micro-inflammatory state. The micro-inflammatory state is a feature in patients with type 2 diabetes, and the increased inflammation levels is one of the signs of poor control of diabetes[16,17]. In the study, the inner link between the DC value and the body’s micro-inflammatory state was discussed, and it was found that compared with high DC group, the low DC group of patients were with higher serum pro-inflammatory factors CRP, IL-6, IL-18 and PCT contents as well as lower anti-inflammatory factors IL-10 and IL-13 contents. The pro-inflammatory/anti-inflammatory imbalance is the essence of micro-inflammation, blood pressure and blood glucose fluctuations may induce pro-inflammatory mediator generation, IL-10, IL-13 and other anti-inflammatory factors are also reactively generated to control the overall inflammation level, and when the inflammatory state persists, IL-10 and IL-13 are massively consumed and at low levels[18]. The above results show that the DC value of patients with both primary hypertension and type 2 diabetes mellitus is negatively correlated with the systemic micro-inflammatory state.

Based on the analysis of above clinical data, the deceleration capacity of rate significantly reduces in patients with both primary hypertension and type 2 diabetes mellitus, it is related to the degree of cardiac function change and inflammatory response, thus it is believed that the inflammatory response activation is one of the pathological factors that lead to the decreased deceleration capacity of rate in patients with both primary hypertension and type 2 diabetes mellitus, and the abnormally decreased deceleration capacity of rate will lead to the change of cardiac function.

References


