Detection and significance of blood rheology and coagulation function index in elderly patients with type 2 diabetes mellitus complicated with cerebral infarction

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Abstract

Objective: To investigate the level of blood rheology and coagulation function in elderly patients with type 2 diabetes mellitus (T2DM) and cerebral infarction and its significance. Methods: A total of 81 elderly patients with T2DM and cerebral infarction were selected as the observation group, 80 cases of T2DM patients without cerebral infarction were selected as T2DM group, and 80 healthy elderly people as control group. According to the Adama classification, the patients in the observation group were divided into three groups: lacunar infarction group (n=28), small infarction group (n=39) and large infarction group (n=14). The blood rheology and coagulation function indexes levels among the groups were compared. Results: The single factor variance analysis showed that the differences of the high shear whole blood viscosity, plasma viscosity, low shear whole blood viscosity, APTT, PT, FIB and D-D levels among the control group were significant, T2DM group and observation group were statistically significant. Compared with the control group, the high shear whole blood viscosity, plasma viscosity, low shear whole blood viscosity, FIB and D-D levels in the T2DM group and observation group were significantly increased, PT and APTT were decreased sharply, and in the observation group high shear whole blood viscosity, plasma viscosity, low shear whole blood viscosity, FIB and D-D levels were significantly higher than that of T2DM group APTT, and PT were significantly lower than those of T2DM group. Lacunar infarction group, small infarction group and large infarction group with increased infarct size, with high shear whole blood viscosity, plasma viscosity, low shear whole blood viscosity, FIB and D-D levels were significantly increased, while APTT and PT were significantly decreased. Conclusion: T2DM and cerebral infarction patients with abnormal blood rheology and coagulation function, the index examination has important clinical value for cerebral infarction area evaluation.

1. Introduction

The occurrence of diabetic cerebrovascular complications is one of the main factors contributing to the dysfunction and death of diabetic patients. The risk of cerebral infarction in diabetic patients is significantly increased compared with non-diabetic patients[1,2]. Studies have shown that vascular wall lesions, hemorheological changes and thrombosis were closely related to cerebral infarction, persistent hyperglycemia is its independent risk factor[3,4]. In physiological hypercoagulable state and thrombotic disease process, coagulation function indicators were significantly increased, there are significant differences in the coagulation function in stable and progressive cerebral infarction in patients, which confirmed that coagulation function played an important role in the pathogenesis of cerebral infarction[5,6]. This study aimed to investigate the relationship between hemorheology and coagulation and type 2 diabetes mellitus (T2DM) with cerebral infarction.

2. Data and methods

2.1 Research data

From April 2016 to August 2017, 81 elderly patients with T2DM and cerebral infarction admitted to the First affiliated hospital of Chengdu Medical College were enrolled in this study. 80 patients with pure T2DM were selected as T2DM group. In the same period,
80 persons with healthy examination were chosen as the control group. All subjects were enrolled in the following principles (1) all meeting the diagnostic criteria of T2DM and cerebral infarction\[7,8\]; (2) admission within 72 h after cerebral infarction; (3) admission within 1 month without angiotensin converting enzyme inhibitors, antiplatelet and anticoagulant therapy history; (4) Excluded patients with acute and chronic infections, autoimmune diseases and malignancies; All subjects and/or relatives were informed of the study and signed informed consent. In the observation group, the patients were 62 to 79 years old, 50 were male and 31 were female. The age of patients in T2DM group was 60-80 years old, 47 were male and 33 were female. The age of patients in the control group was 61-80 years old, 50 males and 30 females. There was no significant difference in age and gender among the three groups.

According to the Adama classification standard[9], patients in the observation group were divided into lacunar infarction group (brain anatomical site diameter <1.5 cm, 28 cases), small infarction group (diameter range 1.5 cm to 3.0 cm, 39 cases), large infarction group (diameter 3.0 cm and more than two brain anatomical focal sites, 14 cases). The study was approved by the ethics committee and all processes met the ethics committee’s standards.

### 2.2 Index detection

The detection indexes included hemorheology (high shear whole blood viscosity, plasma viscosity, low shear whole blood viscosity) and coagulation related indexes [partial prothrombin time (APTT), prothrombin time (PT), fibrinogen FIB) and D-dimer (DD)], detection equipment of all indicators was the ACL-TOP700 automatic coagulation instrument, selected corresponding kits, all operations were strictly in accordance with the operating instructions.

### 2.3 Statistical processing

In the study, SPSS 17.0 software was used for data processing. Hemorheology and coagulation function indexes were conformed to the normal distribution through normalized validation. The expression method was Mean ± SD. The single factor analysis of variance was used to compare the indexes among multiple groups. LSD test was used for comparison of each other, \(P<0.05\) indicated that the difference was statistically significant.

### 3. Results

#### 3.1 Comparison of blood rheology between groups

Blood rheology indicators level in the control group, T2DM group and observation group were shown in Table 1. The results of one-way ANOVA showed that there was significant difference in high shear whole blood viscosity, plasma viscosity, low shear whole blood viscosity among the three groups\(P<0.05\). High shear whole blood viscosity, plasma viscosity, low shear whole blood viscosity in T2DM group and observation group were significantly higher than the control group, the difference was significant \(P<0.05\); compared with the high shear whole blood viscosity, plasma viscosity, low shear whole blood viscosity in T2DM group ((15.49±1.01) mPa-s, (16.77±2.96) mPa-s, (1.74±0.47) μg/L), theses levels in observation group were significantly increased (17.8±1.46) mPa-s, (21.38±4.59) mPa-s, (1.99±0.38) μg/L), the difference was statistically significant \(P<0.05\).

#### 3.2 Comparison of coagulation function between groups

The results of one-way ANOVA showed that the differences of APTT, PT, FIB and DD between control group, T2DM group and observation group were statistically significant \(P<0.05\); Compared with the control group, the levels of APTT and PT in T2DM group and observation group were significantly lower than those in control group \(P<0.05\), moreover observation group level \((28.6±4.27)\) s, \((11.18±0.82)\) s was obviously lower than T2DM group \((31.4±4.18)\) s, \((12.33±0.93)\) s the difference was significant \(P<0.05\). The levels of FIB and DD in T2DM group and the observation group were significantly higher than those in the control group \(P<0.05\), moreover, \((5.2±0.98)\) g/L, \((1.5±0.47)\) μg/L in

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**Table 1.** Comparison of hemorheology (mPa • s)

<table>
<thead>
<tr>
<th>Group</th>
<th>(n)</th>
<th>High shear whole blood viscosity</th>
<th>Low shear whole blood viscosity</th>
<th>Plasma viscosity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>80</td>
<td>4.67±0.78</td>
<td>13.27±2.44</td>
<td>1.42±0.27</td>
</tr>
<tr>
<td>T2DM group</td>
<td>80</td>
<td>5.49±1.01(^a)</td>
<td>16.77±2.96(^b)</td>
<td>1.74±0.32(^c)</td>
</tr>
<tr>
<td>Observation group</td>
<td>81</td>
<td>7.08±1.46(^d)</td>
<td>21.38±4.59(^e)</td>
<td>1.99±0.38(^f)</td>
</tr>
<tr>
<td>(F) value</td>
<td></td>
<td>93.954</td>
<td>153.070</td>
<td>63.565</td>
</tr>
<tr>
<td>(P) value</td>
<td></td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Note: \(^a\) \(P<0.05\) compared with control group; \(^b\) \(P<0.05\) compared with T2DM group.

**Table 2.** Comparison of coagulation function between groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>(n)</th>
<th>APTT (s)</th>
<th>PT (s)</th>
<th>FIB (g/L)</th>
<th>D-D (μg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>80</td>
<td>34.73±2.89</td>
<td>12.95±0.48</td>
<td>3.18±0.61</td>
<td>0.26±0.08</td>
</tr>
<tr>
<td>T2DM group</td>
<td>80</td>
<td>31.4±4.18</td>
<td>12.33±0.93</td>
<td>3.74±1.14</td>
<td>0.34±0.12</td>
</tr>
<tr>
<td>Observation group</td>
<td>81</td>
<td>28.6±4.27(^b)</td>
<td>11.18±0.82(^e)</td>
<td>5.23±0.98(^ab)</td>
<td>1.51±0.47(^bc)</td>
</tr>
<tr>
<td>(F) value</td>
<td></td>
<td>56.880</td>
<td>92.322</td>
<td>90.975</td>
<td>479.584</td>
</tr>
<tr>
<td>(P) value</td>
<td></td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Note: \(^a\) \(P<0.05\) compared with control group; \(^b\) \(P<0.05\) compared with T2DM group.
found that blood glucose of some patients with acute cerebral circulation disorders resulting in hypoxia, ischemia. Related research has shown that blood glucose continues to rise after the disease onset, highlighting its importance in the management of acute cerebral infarction.

### 3.3 Comparison of blood rheology in different infarct sizes

As shown in Table 3, high shear whole blood viscosity, plasma viscosity, low shear whole blood viscosity in patients with diabetes mellitus were significantly different compared to those in the control group. This indicates that diabetes mellitus might be related to increased shear/low shear whole blood viscosity and plasma viscosity levels.

### 3.4 Comparison of coagulation function in different infarct sizes

The results of one-way ANOVA showed that the differences of APTT, PT, FIB and DD between different infarct sizes were statistically significant ($P<0.05$). Compared with lacunar infarction group, the levels of APTT and PT in small infarction group and large infarction group were significantly decreased, coagulation abnormalities. At the same time, continuing hyperglycemia can lead to vascular endothelial damage, increase platelet aggregation, generate hypercoagulable state, thereby promoting cerebral atherosclerosis [12,13]. In this research, hemorheology and coagulation function were studied in order to clarify its relationship with diabetes mellitus combined with cerebral infarction.

Long-term hyperglycemia, intravascular red blood cell morphology changes, increase of aggregation tendency, leading to increased plasma and whole blood viscosity. Abnormal blood rheology can lead to vascular wall damage, and thus speed up the occurrence of microvascular complications and promote blood hypercoagulability and form thrombus, which is one of the important risk factors diabetes mellitus combined with cerebral infarction [14,15]. The results of this study indicated that compared with the control group, high shear/low shear whole blood viscosity and plasma viscosity levels in T2DM patients and T2DM with cerebral infarction patients were significantly increased, and hemorheological parameters of patients combined cerebral infarction increased most obviously, the findings were consistent with previous reports [16,17], confirming the abnormal changes in hemorheology in patients with T2DM and T2DM with cerebral infarction. In addition, this study also compared with blood rheology in different infarct sizes, the results showed that with the increase of infarct size, hemorheological levels in patients increased significantly, the difference between groups was statistically significant, the results revealed that hemorheological indexes were related to infarct sizes, so the detection of hemorheological indicators was of great value for infarction area evaluation of T2DM with cerebral infarction.

Body coagulation and fibrinolysis disorders are one of the main

### Table 3.

Comparison of blood rheology in different infarct sizes (mPa s).

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>High shear whole blood viscosity</th>
<th>Low shear whole blood viscosity</th>
<th>Plasma viscosity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lacunar infarction group</td>
<td>28</td>
<td>5.59±0.41</td>
<td>14.79±1.03</td>
<td>1.56±0.32</td>
</tr>
<tr>
<td>Small infarction group</td>
<td>39</td>
<td>6.82±0.66</td>
<td>20.11±1.59</td>
<td>1.85±0.37</td>
</tr>
<tr>
<td>Large infarction group</td>
<td>14</td>
<td>8.65±0.69</td>
<td>27.12±1.84</td>
<td>2.51±0.24</td>
</tr>
</tbody>
</table>

F value 152.981  P value 0.000

Note: Compared with lacunar infarction group, *P*<0.05; compared with small infarction group, †*P*<0.05.

### Table 4.

Comparison of coagulation function in different infarct sizes.

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>APTT (s)</th>
<th>PT (s)</th>
<th>FIB (g/L)</th>
<th>D-D (μg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lacunar infarction group</td>
<td>28</td>
<td>31.06±2.52</td>
<td>12.19±0.62</td>
<td>3.92±0.85</td>
<td>0.94±0.52</td>
</tr>
<tr>
<td>Small infarction group</td>
<td>39</td>
<td>29.56±2.37</td>
<td>11.65±0.41</td>
<td>4.70±1.01</td>
<td>1.28±0.47</td>
</tr>
<tr>
<td>Large infarction group</td>
<td>14</td>
<td>26.61±2.19</td>
<td>9.47±0.30</td>
<td>5.44±0.73</td>
<td>1.63±0.46</td>
</tr>
</tbody>
</table>

F value 19.766  P value 0.000

Note: Compared with lacunar infarction group, *P*<0.05; compared with small infarction group, †*P*<0.05.
factors of thrombosis and bleeding[18]. Previous studies have shown that D-D levels in patients with progressive cerebral infarction were significantly higher than those in patients with stable cerebral infarction, and their levels correlated with the outcome of cerebral infarction[19,20]. The results of this study pointed out that coagulation function in T2DM and T2DM with cerebral infarction patients was abnormal compared with normal control subjects, the clinical manifestations were APTT, PT shortened, FIB and DD levels increased, APTT, PT levels decreased revealed that patients with higher coagulation activity[21], FIB is an important marker of thrombosis, the increase in its concentration promotes platelet aggregation and leads to changes in blood rheology, that is a sensitive indicator of the body's blood hypercoagulability[22]. The risk of death and other complications in patients with large cerebral infarction was significantly higher than that in patients with small infarcts. The results of this study showed that there was a significant difference in patients with large infarct and lacunar infarction with small infarct, The results revealed that there was a certain correlation between coagulation function indexes and infarct sizes in patients and can be used as an indicator of disease diagnosis and severity evaluation.

In summary, pathogenesis of T2DM with cerebral infarction was more complicated, early diagnosis and treatment were important for reducing disease disability and mortality. Hemorheology and coagulation abnormalities existed in patients with T2DM and cerebral infarction. The range of the index changes was related to the size of cerebral infarction, which can be used as an auxiliary index in disease diagnosis, disease severity and prognosis evaluation, and has important clinical value.

References