Assessment of myocardial injury markers and neurohumoral indicators in serum after STEMI patients received percutaneous coronary intervention combined with thrombus aspiration

Ling Gong

Department of Cardiology, Zigong Third People’s Hospital of Sichuan Province, Zigong City, Sichuan Province, 643020

ARTICLE INFO

Objective: To study the myocardial injury markers and neurohumoral indicators in serum after STEMI patients received percutaneous coronary intervention combined with thrombus aspiration.

Methods: Patients with acute ST-segment elevation myocardial infarction who received percutaneous coronary intervention in our hospital from May 2010 to December 2015 were selected for study, 48 cases of patients who received PCI combined with thrombus aspiration and 50 cases of patients who received direct PCI were screened and included in experimental group and control group respectively. The degree of myocardial injury and neurohumoral indicators of two groups were compared.

Results: Intraoperative TIMI grade of experimental group was significantly higher than that of control group, peak values of CK-MB, cTnT and cTnI 24 h after operation were significantly lower than those of control group, and ST-segment fallback ratio within 1h after operation was significantly higher than that of control group; 24h after operation, serum renin, angiotensin II, aldosterone, sodium and endothelin-1 content of experimental group were significantly lower than those of control group, potassium and nitric oxide content were significantly higher than those of control group, and the number of CD31+/CD42b- EMPs in peripheral blood was significantly lower than that of control group.

Conclusion: Percutaneous coronary intervention combined with thrombus aspiration treatment of STEMI can improve coronary perfusion, reduce myocardial cell injury, inhibit RAS system activation and protect endothelial function.

1. Introduction

ST-segment elevation myocardial infarction (STEMI) is the most severe clinical type of coronary heart disease, and the pathological basis of the disease is coronary artery atherosclerotic plaque rupture, blood coagulation pathway activation, arterial thrombosis and lumen obstruction. Irreversible damage may occur in myocardial cells in hypoxic-ischemic environment, and opening obstructed coronary arteries and restoring blood supply to ischemic myocardium as soon as possible is the key to clinical treatment of STEMI. At present, percutaneous coronary intervention (PCI) is the preferred myocardial reperfusion therapy for patients with STEMI, which can effectively recanalize coronary arteries and restore myocardial perfusion. However, mortality in patients with STEMI after PCI still reaches 4%-6%. Related study shows that the leading cause of death in patients with STEMI after PCI treatment is that in the treatment process, the thrombus within coronary artery breaks, moves and leads to distal angiembryxis[1]. Therefore, in the process of PCI therapy, correctly treating thrombus within coronary artery and avoiding the occurrence of distal angiembryxis helps to improve the prognosis of patients with STEMI. Thrombus aspiration is the way to treat intravascular thrombosis in recent years, and joint treatment with PCI can improve the prognosis of patients with STEMI[2,3], but neurohumoral changes after STEMI patients received PCI combined with thrombus aspiration have not been
reported. In the following research, the myocardial injury markers and neurohumoral indicators in serum after STEMI patients received percutaneous coronary intervention combined with thrombus aspiration were analyzed.

2. Research subjects and methods

2.1. Research subjects and groups

Patients with acute ST-segment elevation myocardial infarction who received percutaneous coronary intervention in our hospital from May 2010 to December 2015 were selected for study, including criteria: (1) those who met the diagnostic criteria for STEMI; (2) those with myocardial infarction for the first time; (3) those who were hospitalized within 12 h after chest pain; (4) those who received direct PCI treatment or thrombus aspiration combined with PCI; (5) those with complete clinical information and available serum myocardial injury markers and neurohumoral indicators; excluding criteria: (1) those who received coronary artery bypass grafting before; (2) those who received thrombolytic therapy before PCI treatment; (3) those with myocardial infarction before. Case information of included patients was followed up, and 48 cases of patients who received PCI combined with thrombus aspiration and 50 cases of patients who received direct PCI were screened and included in experimental group and control group respectively.

2.2. Emergency treatment

Patients chewed aspirin 300 mg and clopidogrel 300 mg immediately after admission, received subcutaneous injection of low molecular heparin calcium 6 125 U, received subcutaneous injection of unfractionated heparin 100 U/kg before surgery and received extra unfractionated heparin 1 000 U per hour during surgery. Emergency interventional therapy was performed by the same group of doctors, routine right radial artery puncture was done and angiography catheter was sent in along the sheath, selective coronary angiography was performed to determine the site of coronary artery with infarction, and stent was implanted directly or after balloon dilation in control group; for experimental group, the guide wire of thrombus aspiration catheter was inserted and passed through the lesion part, then the thrombus aspiration catheter was stretched into to the proximal lesion, thrombus aspiration was repeated in the lesion part for several times, and then stent was implanted for treatment. Patients received subcutaneous injection of low molecular heparin calcium 6 125 U every 12 h after operation for 1 week; they received oral administration of aspirin 100 mg/d and clopidogrel 75 mg/d for 1 year.

2.3. Evaluation of myocardial injury degree

TIMI grading standard was referred to judge the recovery of coronary artery blood flow during operation, there were a total of four grades: 0, 1, 2 and 3, and the higher the grade, the more ideal the coronary artery blood flow filling; within 24 h after operation, venous blood was collected once every six hours, automatic biochemical analyzer was used to determine creatine kinase isoenzyme (CK-MB), troponin T (cTnT) and troponin I (cTnI), the myocardial enzyme spectrum at different points in time were compared and the peak were recorded; atlas of electrocardiograms 1 h before and after operation were selected, the degree of ST-segment elevation was evaluated and the ratio of ST-segment fallback (sumSTR) was calculated.

2.4. Evaluation of neurohumoral indicators

24 h after surgery, serum was collected and radioimmunoassay kit was used to determine renin, angiotensin II and aldosterone levels, chemiluminescence immunoassay kit was used to determine sodium and potassium content, and enzyme-linked immunosorbent assay kit was used to determine endothelin-1 and nitric oxide content; peripheral blood was collected, platelet-poor plasma was separated, CD31-PE and CD42b-FITC antibodies were incubated, flow cytometer was used to determine the content of CD31+/CD42b-, and particle number was expressed by pieces/μl.

2.5. Statistical methods

SPSS 21.0 software was used to input and analyze data, measurement data analysis between two groups was by t test, and differences were considered to be statistically significant at a level of P<0.05.

3. Results

3.1. Assessment results of myocardial injury degree

(1) During the operation, TIMI grade of coronary artery perfusion of two groups was as follows: TIMI grade of experimental group was significantly higher than that of control group; (2) within 24 h after operation, comparison of myocardial enzyme spectrum peak between two groups was as follows: peak values of CK-MB, cTnT and cTnI of experimental group were significantly lower than those of control group; (3) before operation and 1 h after operation, comparison of myocardial infarction-related lead ECG and ST-segment fallback ratio between two groups was as follows: sumSTR of experimental group was significantly higher than that of control group.

3.2. RAS system function

24 h after operation, analysis of renin, angiotensin II and aldosterone content in RAS system showed that serum renin, angiotensin II and aldosterone content of experimental group were significantly lower than those of control group; aldosterone can retain sodium and discharge potassium, and analysis of blood electrolyte test results showed that serum potassium content were higher than those of control group, and sodium content was lower than that of control group.
3.3. Endothelial injury degree

24 h after operation, analysis of the number of CD31+/CD42b-EMPs in peripheral blood was as follows: the number of CD31+/CD42b-EMPs in peripheral blood of experimental group was significantly lower than that of control group. Analysis of serum vasoconstrictor factor endothelin-1 and vasodilator factor nitric oxide content was as follows: serum endothelin-1 content of experimental group was lower than that of control group, and nitric oxide content was higher than that of control group.

Table 1
Assessment results of myocardial injury degree of two groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>TIMI grade of coronary artery perfusion</th>
<th>Myocardial enzyme spectrum peak 24 h after operation</th>
<th>sumSTR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CK-MB peak (ng/mL)</td>
<td>cTnT peak (ng/mL)</td>
<td>cTnI peak (ng/mL)</td>
</tr>
<tr>
<td>Experimental</td>
<td>145.4±20.6</td>
<td>3.9±0.5</td>
<td>3.1±0.4</td>
</tr>
<tr>
<td>Control</td>
<td>325.6±41.3</td>
<td>6.2±0.8</td>
<td>5.5±0.7</td>
</tr>
<tr>
<td>P</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>

Table 2
Comparison of RAS system function between two groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>RAS system levels</th>
<th>Electrolyte</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rennin (ng/mL/h)</td>
<td>Angiotensin II (pg/mL)</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.96±0.62</td>
<td>42.39±6.13</td>
</tr>
<tr>
<td>Control</td>
<td>5.38±0.73</td>
<td>60.45±8.78</td>
</tr>
<tr>
<td>P</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>

Table 3
Comparison of endothelial injury degree between two groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>CD31+/CD42b-EMPs number (pcs/μL)</th>
<th>Endothelin-1 (ng/L)</th>
<th>Nitric oxide (μmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>3 486.2±645.9</td>
<td>67.66±9.33</td>
<td>51.35±7.97</td>
</tr>
<tr>
<td>Control</td>
<td>7 576.2±1034.6</td>
<td>89.48±12.49</td>
<td>33.57±5.58</td>
</tr>
<tr>
<td>T</td>
<td>12.922</td>
<td>6.595</td>
<td>8.695</td>
</tr>
<tr>
<td>P</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>

4. Discussion

Percutaneous coronary intertention (PCI) is the primary method for clinical treatment of STEMI, which can effectively recanalize the obstructed coronary artery and restore blood flow perfusion to the ischemic myocardial. A study shows that in the process of emergency PCI, the incidence of "slow flow/no reflow" is 5%-50% and the proportion of postoperative TIMI flow grade that reaches 3 is less than 30%[4]. "Slow flow/no reflow" in patients with STEMI during PCI treatment will affect the therapeutic effect of PCI[5]. Thrombus aspiration is a treatment method for coronary thrombosis rising in recent years, which can reduce the load of intravascular thrombus and reduce the risk of distal vessel embolization in PCI process, thus preventing coronary "slow flow/no reflow"[6,7]. TIMI flow grade can directly reflect coronary artery perfusion after PCI treatment, obstruction with no flow in the distal was judged as grade 0, and the higher the TIMI grade, the more ideal the recovery of coronary perfusion. Analysis of TIMI grade in the research showed that TIMI grade of experimental group was significantly higher than that of control group. It confirmed that thrombus aspiration combined with PCI therapy could improve coronary artery perfusion and avoid "slow flow" or "no reflow" in distal arteries.

Current studies about the causes of "slow flow/no reflow" in distal vessels during PCI treatment suggest that the main cause of "slow flow/no reflow" in treatment process is distal vascular embolization caused by the fragments of thrombus or plaque movement towards distal coronary artery[8,9]. "Slow flow" or "no reflow" caused by distal vascular obstruction will further aggravate the condition of myocardial infarction and expand the area of infarction, then lead to sustained damage to myocardial cells and the constant release of macromolecular substances into the blood, and will also cause that the corresponding ECG ST segment can't fall back[10]. Creatine kinase isoenzyme (CK-MB), troponin T (cTnT) and troponin I (cTnI) are highly-specific of macromolecular substances in myocardial cells, and serum levels of corresponding molecules can reflect the degree of myocardial cell injury; ECG ST-segment fallback can reflect the restoration of myocardial perfusion. Analysis of serum indexes and ECG parameters in the research showed that peak values of CK-MB, cTnT and cTnI of experimental group were significantly lower than those of control group, and sumSTR was significantly higher than that of control group. It indicated that after thrombus aspiration combined with PCI treatment, the restoration of coronary blood flow was more ideal and the degree of myocardial cell injury was less.

The development of myocardial infarction is associated with dysfunction of myocardial contractility and will further lead to changes of neurohumoral system. Weakened myocardial contractility and deficient heart pumping can cause enhanced sympathetic nervous activity, thus increasing the secretion of aldosterone; moreover, with the decrease of cardiac output, renal vascular blood flow also reduces accordingly, thus activating the renin-angiotensin-aldosterone (RAS) system and increasing the corresponding body fluid and hormone levels within the system[11]. Renin is first activated humoral factor in...
the RAS system and is able to act on angiotensinogen and generate angiotensin I, the latter is converted to angiotensin II under the action of angiotensin converting enzyme, which, on the one hand, exerts intense vasoconstrictor effect, and on the other hand, increases the secretion of aldosterone and exerts the effect of retaining sodium and discharging potassium[12]. In the research, analysis of RAS system activity after myocardial patients received treatment confirmed that serum renin, angiotensin II, aldosterone and sodium content of experimental group were significantly lower than those of control group, and serum potassium content was higher than that of control group. It confirmed that after thrombus aspiration combined with PCI treatment, RAS system activation of STEMI patients was less and the effect of retaining sodium and discharging potassium of aldosterone was weaker.

Neurohumoral change in patients with STEMI is not only characterized by the activation of RAS system and the enhancement of aldosterone function, but will also show disorder of vasodilator factor and vasoconstrictor factor proportion as well as endothelial dysfunction[13]. In the occurrence and development of myocardial infarction, endothelial cells lose the protection of vasodilator factors, and under the constant effect of vasoconstrictor factor, will be injured and release a large amount of endothelial microparticles (EMPs). CD31+/CD42b- is the surface sign of endothelial microparticles, and our analysis showed that the number of CD31+/CD42b- EMPs in peripheral blood of experimental group was significantly lower than that of control group[14]. Endothelin-1 and nitric oxide is the most important pair of vascular constriction and relaxation factors in the body, the former has the clear vasoconstrictor effect and is used as a marker molecule of endothelial injury, and the latter can activate guanylate cyclase and exert the vasodilator effect[15,16]. In the research, analysis of serum endothelin-1 and nitric oxide content showed that serum endothelin-1 content of experimental group was lower than that of control group, and nitric oxide content was higher than that of control group. Thus it confirmed that thrombus aspiration combined with PCI treatment could reduce endothelial injury of STEMI patients.

To sum up, percutaneous coronary intervention combined with thrombus aspiration treatment of STEMI can improve coronary perfusion, reduce myocardial cell injury, inhibit RAS system activation and protect endothelial function.

References


