Effects of aerobic exercise and medical nutrition intervention on endothelial injury and placental blood perfusion in patients with preeclampsia

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ABSTRACT

Objective: To study the effects of aerobic exercise and medical nutrition intervention on endothelial injury and placental blood perfusion in patients with preeclampsia. Methods: 72 cases of patients diagnosed with preeclampsia in Department of Obstetrics and Gynecology of Zigong Third People’s Hospital between January 2013 and August 2016 were selected randomly divided into two groups, the observation group received aerobic exercise, medical nutrition combined with routine intervention, and the control group received routine intervention. Before and after intervention, serum endothelial injury markers were detected. After delivery, the expression of apoptosis molecules and the contents of stress molecules caused by hypoxia in placenta were detected. Results: After intervention, serum AnnexinV, vWF, ET-1 and oxLDL contents of both groups were lower than those before intervention while NO, PLGF and ABCA1 contents were higher than those before intervention and serum AnnexinV, vWF, ET-1 and oxLDL contents of observation group were lower than those of control group while NO, PLGF and ABCA1 contents were higher than those of control group; after delivery, Bax, Fas, Fasl and Caspase-3 mRNA expression as well as MDA, AOPP, CHOP and GRP78 protein contents in placenta of observation group were lower than those of control group. Conclusion: Aerobic exercise and medical nutrition intervention can reduce the endothelial injury and improve the placental hypoxia of preeclampsia.

1. Introduction

Pre-eclampsia is a common complication of pregnancy, it is clinically characterized by hypertension and kidney injury, and it will increase maternal and newborn mortality. At present, the pathogenesis of preeclampsia is not entirely clear, maternal endothelial injury and insufficient placental blood perfusion are the important characteristic of patients with preeclampsia, and protecting endothelial function and improving the placental blood flow perfusion are the intervention targets of preeclampsia treatment[1]. Persistent aerobic exercise during pregnancy can enhance the ability to carry oxygen, improve mitochondrial oxidative respiratory function and increase myocardial blood pump to provide adequate blood perfusion for placental tissue[2]; medical nutrition intervention guides pregnant women to set up a prenatal diet to balance their nutritional intake and avoid the endothelial injury caused by glycolipid metabolism disorder[3]. In the following study, aerobic exercise combined with medical nutritional intervention was used for patients with preeclampsia, and the endothelial damage degree and the placental blood perfusion in patients with preeclampsia were specifically analyzed.

2. Subjects and methods

2.1 Research subjects

72 cases of patients diagnosed with preeclampsia in Department of Obstetrics and Gynecology of Zigong Third People’s Hospital between January 2013 and August 2016 were selected, they were
all consistent with the diagnostic criteria for preeclampsia, and the patients associated with pregnancy complications such as gestational diabetes mellitus, placenta previa and placental abruption were excluded. The included patients were divided into observation group and control group according to random number table, 36 cases in each group. The observation group received aerobic exercise, medical nutrition combined with routine intervention, they were 24-35 years old, 22 cases were primiparous and 14 cases were multiparous; the control group received routine intervention, they were 24-36 years old, 20 cases were primiparous and 16 cases were multiparous. There was no significant difference in general information between the two groups of patients (P>0.05).

2.2 Intervention methods

Both groups of patients received routine care during pregnancy as well as maternal psychological health and health knowledge education, and observation group of patients received aerobic exercise and medical nutrition intervention on the basis. Aerobic exercise intervention method was as follows: first, the heart rate in resting state was detected, the heart rate reserve was referred to calculate the target heart rate at exercise, the patients were instructed do walking aerobic exercise once every day and detect the heart rate during exercise themselves, and the time reaching target heat rate for 30 min was the aerobic exercise time each time; medical nutrition intervention method was as follows: the same group of nutritionists continuously recorded patients' 24 h food intake, the nutrient solution was made according to the pregnant women's body mass index and weight gain during pregnancy as well as fetal growth and development, and low calorie, high quality protein, low sodium and low fat were the basic requirements in order to ensure that pregnancy weight gain was within reasonable range.

2.3 Serum index detection methods

Before intervention and 2 weeks after intervention, 5-8 mL of cubital venous blood was collected from two groups of patients and centrifuged to separate serum, and enzyme-linked immunosorbent assay kits were used to determine the content of endothelial injury molecules AnnexinV, vWF, ET-1 and oxLDL as well as endothelial protection molecules NO, PLGF and ABCA1.

2.4 Placenta index detection methods

Within 30 min after childbirth, right amount of central placenta tissue was collected and divided into two, one was used for the extraction of RNA, fluorescence quantitative PCR kit was used to determine apoptosis molecules Bax, Fas, FasL and Caspase-3 mRNA expression, the other was use for the extraction of protein, and enzyme-linked immunosorbent assay kits were used to determine the stress molecules MDA, AOPP, CHOP and GRP78 protein content.

2.5 Statistical methods

SPSS 19.0 software was used to process serum indexes and placenta indexes, analysis between two groups as well as before and after treatment was by t test, and P<0.05 indicated statistical significance in differences.

3. Results

3.1 Serum endothelial injury marker levels

Before intervention and 2 weeks after intervention, analysis of serum levels of endothelial injury molecules AnnexinV, vWF, ET-1 and oxLDL as well as endothelial protection molecules NO (μmol/L), PLGF (pg/mL) and ABCA1 (pg/mL) between two groups of patients was as follows: before intervention, serum AnnexinV, vWF, ET-1, oxLDL, NO, PLGF and ABCA1 levels were not significantly different between two groups of patients (P>0.05); after intervention, serum AnnexinV, vWF, ET-1 and oxLDL contents of both groups were lower than those before intervention while NO, PLGF and ABCA1 contents were higher than those before intervention (P<0.05), and serum AnnexinV, vWF, ET-1 and oxLDL contents of observation group were lower than those of control group while NO, PLGF and ABCA1 contents were higher than those of control group (P<0.05).

Table 1.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Time</th>
<th>AnnexinV</th>
<th>vWF</th>
<th>ET-1</th>
<th>oxLDL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation group</td>
<td>36</td>
<td>Before intervention</td>
<td>1.29±0.19</td>
<td>132.48±17.57</td>
<td>42.94±6.41</td>
<td>58.92±7.81</td>
</tr>
<tr>
<td></td>
<td></td>
<td>After intervention</td>
<td>0.48±0.07*</td>
<td>79.35±10.24*</td>
<td>20.39±2.21*</td>
<td>34.52±4.26*</td>
</tr>
<tr>
<td>Control group</td>
<td>36</td>
<td>Before intervention</td>
<td>1.32±0.16</td>
<td>134.21±17.59</td>
<td>44.12±6.79</td>
<td>59.41±8.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>After intervention</td>
<td>0.78±0.10*</td>
<td>105.57±14.28*</td>
<td>31.25±5.48*</td>
<td>46.21±7.25*</td>
</tr>
</tbody>
</table>

*: compared between observation group and control group, P<0.05; *: compared between before intervention and after intervention, P<0.05.

Table 2.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Time</th>
<th>NO</th>
<th>PLGF</th>
<th>ABCA1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation group</td>
<td>36</td>
<td>Before intervention</td>
<td>56.51±7.84</td>
<td>224.58±31.25</td>
<td>48.49±6.83</td>
</tr>
<tr>
<td></td>
<td></td>
<td>After intervention</td>
<td>93.42±11.25*</td>
<td>378.76±52.14*</td>
<td>106.84±15.72*</td>
</tr>
<tr>
<td>Control group</td>
<td>36</td>
<td>Before intervention</td>
<td>55.94±7.56</td>
<td>226.12±34.67</td>
<td>50.14±8.12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>After intervention</td>
<td>70.54±8.39*</td>
<td>289.41±36.37*</td>
<td>76.85±9.35*</td>
</tr>
</tbody>
</table>

*: compared between observation group and control group, P<0.05; *: compared between before intervention and after intervention, P<0.05.
3.2 Placenta hypoxia-induced apoptosis and stress molecule levels

After delivery, analysis of placenta apoptosis molecules Bax, Fas, FasL, and Caspase-3 expression as well as stress molecules MDA (μmol/L), AOPP (μmol/L), CHOP (ng/L) and GRP78 (ng/L) levels between two groups of patients was as follows: Bax, Fas, FasL and Caspase-3 mRNA expression as well as MDA, AOPP, CHOP and GRP78 protein contents in placenta of observation group were significantly lower than those of control group. Differences were statistically significant in Bax, Fas, FasL and Caspase-3 mRNA expression as well as MDA, AOPP, CHOP and GRP78 protein contents in placenta between two groups of patients (P<0.05).

Table 3.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Bax</th>
<th>Fas</th>
<th>FasL</th>
<th>Caspase-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation group</td>
<td>36</td>
<td>0.42±0.07</td>
<td>0.37±0.05</td>
<td>0.26±0.05</td>
<td>0.34±0.08</td>
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<tr>
<td>Control group</td>
<td>36</td>
<td>1.02±0.15</td>
<td>1.05±0.17</td>
<td>0.98±0.11</td>
<td>1.03±0.12</td>
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<tr>
<td>T</td>
<td>13.824</td>
<td>17.372</td>
<td>22.372</td>
<td>15.687</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>&lt;0.05</td>
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<td>&lt;0.05</td>
<td>&lt;0.05</td>
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</tr>
</tbody>
</table>

Table 4.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>MDA</th>
<th>AOPP</th>
<th>CHOP</th>
<th>GRP78</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation group</td>
<td>36</td>
<td>3.27±0.52</td>
<td>2.31±0.35</td>
<td>10.32±1.26</td>
<td>4.54±0.66</td>
</tr>
<tr>
<td>Control group</td>
<td>36</td>
<td>8.67±0.93</td>
<td>5.52±0.79</td>
<td>28.49±5.21</td>
<td>12.15±1.69</td>
</tr>
<tr>
<td>P</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td></td>
</tr>
</tbody>
</table>

4. Discussion

Maternal endothelial injury and insufficient placental blood perfusion are the important characteristics of patients with preeclampsia, and taking effective interventions to reduce endothelial injury and increase the placental blood perfusion is of important value for improving the condition and pregnancy outcomes of patients with preeclampsia. Aerobic exercise combined with medical nutrition intervention can increase the body’s ability to carry oxygen, increase myocardial blood pump and improve glucolipid metabolism at the same time in order to reduce endothelial injury and increase the placental blood perfusion[4,5]. NO, PLGF and ABCA1 are the important molecules involved in the protection of maternal endothelial function. NO is a type of gas signaling molecule that can relax the blood vessels and protect the endothelial function through a variety of signaling pathways downstream[6]; PLGF is a member of the vascular endothelial growth factor family, which has the function of promoting endothelial cell growth and is the important protective factor for endothelial function[7]; ABCA1 can promote the intracellular free cholesterol to swim out, start the process of reverse cholesterol transport and reduce the lipid deposition and foam cell formation damage to maternal endothelium[8]. In the study, analysis of serum endothelial protective molecule levels before and after the intervention showed that serum NO, PLGF and ABCA1 contents of both groups after intervention were higher than those before intervention, and serum NO, PLGF and ABCA1 contents of observation group after intervention were higher than those of control group. This means that aerobic exercise combined with medical nutrition intervention can significantly increase the levels of endothelial protective molecules to improve the endothelial function in patients with preeclampsia.

In the development and change of preeclampsia, maternal endothelial function injury is not only associated with the reduction of endothelial protective molecules, but also closely related to the excessive generation of AnnexinV, vWF, ET-1, oxLDL and other endothelial injury molecules. AnnexinV is a type of calcium-dependent membrane protein that can promote coagulation, promote apoptosis and other ways to cause maternal endothelial cell function injury[9]; VWF is a kind of polysaccharide highly expressed in the endothelial cells, it is mainly stored in Weibel-Palade globule, and endothelial injury can cause vWF to be released into the blood plasma and involved in the activation of platelet, thus affecting the placental blood perfusion; ET-1 is the most powerful vasoconstrictive active substance in the body, and excessive secretion of ET-1 will not only cause vasoconstriction and affect the placental blood perfusion, but can also cause endothelial function damage[10]; ox-LDL is an oxidative product of LDL, which can not only be directly involved in the formation of foam cells and arterial plaques, but also has the effect of damaging endothelial function[11]. In the study, the analysis of serum endothelial injury molecule levels showed that serum AnnexinV, vWF, ET-1 and oxLDL contents of both groups after intervention were lower than those before intervention and serum AnnexinV, vWF, ET-1 and oxLDL contents of observation group after intervention were lower than those of control group. This means that aerobic exercise combined with medical nutrition intervention can significantly reduce endothelial injury molecule generation so as to mitigate endothelial damage in patients with preeclampsia.

The reduction of placental blood perfusion of pre-eclampsia will cause local tissue hypoxia, which is characterized by the exacerbation of hypoxia-induced apoptosis and stress. Mitochondrial apoptosis and death receptor apoptosis are two ways to regulate cell apoptosis, Bax is the key molecule to promote the mitochondrial apoptosis and can promote the mitochondrial cytochrome C release into the cytoplasm and launch cascade activation of a variety of Caspase molecules; Fas/FasL are the key molecules that promote death receptor apoptosis and can be combined in the ligand-receptor way to initiate the cascade activation of the downstream Caspase molecules; Caspase-3 is a common downstream molecule of mitochondrial apoptosis and death receptor apoptosis, and also
the executor of apoptosis[12,13]. Oxidative stress and endoplasmic reticulum stress are the two forms of hypoxia-induced stress, the former is mainly characterized by increased generation of oxygen free radicals, and the excessively generated oxygen free radicals can oxidize lipids and proteins into MDA and AOPP free radicals, and the excessively generated oxygen free radicals former is mainly characterized by increased generation of oxygen [12,13] the executor of apoptosis

References


