Evaluation of the intraoperative trauma degree and postoperative speech function of low-temperature plasma radiofrequency surgery treatment of children with OSAHS

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ABSTRACT

Objective: To evaluate the intraoperative trauma degree and postoperative speech function of low-temperature plasma radiofrequency surgery treatment of children with obstructive sleep apnea-hypopnea syndrome (OSAHS). Methods: A total of 118 children with OSAHS were divided into the control group (n=59) who received general surgery and the observation group (n=59) who received the low-temperature plasma radiofrequency surgery according to the random number table. Before operation and 24 h after operation, serum levels of stress hormones, acute phase proteins and inflammatory markers of two groups of children were determined, and the speech function parameter levels were assessed. Results: Before operation, differences in serum contents of stress hormones, acute phase proteins and inflammatory factors as well as speech function parameter levels were not statistically significant between two groups of patients. 24 h after operation, serum stress hormones adrenocorticotropic hormone (ACTH), angiotensin-2 (Ang-2), norepinephrine (NE), cortisol (Cor) contents of observation group were lower than those of control group, serum acute phase proteins haptoglobin (HP), ceruloplasmin (CER), and prealbumin (PA) contents were lower than those of control group, and serum inflammatory factors interleukin-1 (IL-1), interleukin-4 (IL-4), interleukin-27 (IL-27), tumor necrosis factor α (TNF-α) contents were lower than those of control group; speech function parameters NNE and NHR levels of observation group were higher than those of control group. Conclusion: Compared with routine surgery, low-temperature plasma radiofrequency surgery treatment of children with OSAHS causes less surgical trauma and more greatly improves the postoperative speech level.

1. Introduction

Obstructive sleep apnea hypopnea syndrome (OSAHS) is that the airway collapse obstruction during sleep causes apnea and hypoventilation, specifically characterized by snoring, daytime sleepiness, frequent oxygen desaturation, etc., [1,2]. Incidence of OSAHS in children is increasing year by year, it is closely related to the anatomical abnormalities, obesity, etc., the disease can seriously affect the normal growth and development of children, and even can lead to cardiovascular system disease, and early surgery is needed[3]. Uvulopalatopharyngoplasty (UPPP) is a traditional way to treat children with OSAHS, it has been proven to be able to effectively relieve the clinical symptoms, but some studies have shown that its curative effect is not obvious for children with severe illness, and there are the circumstances of much surgical bleeding and damage to surrounding normal tissues. Low-temperature plasma radiofrequency is a new minimally invasive technology that decompose the target tissue cells into water and oxide in a 40–70 °C environment so as to achieve therapeutic purposes[4,5]. Low-temperature plasma radiofrequency is quite popular in clinic practice for its high efficacy, minimal invasion and other characteristics, and it was used to treat children with OSAHS in the study and elaborated from surgical trauma, postoperative speech function and other aspects.
2. Materials and methods

2.1. Diagnostic criteria for OSAHS

(1) with daytime sleepiness, severe snoring, repeated apnea and other clinical manifestations; (2) with upper airway stenosis after instrumental examination; (3) polysomnography showed that the apnea or hypopnea number 30 (7 h of sleep, for example); (4) with abnormal upper airway structure confirmed by imageological examination; (5) central sleep apnea syndrome, acromegaly, laryngospasm, vocal cord paralysis and other diseases were ruled out.

2.2. Case information

A total of 118 children with OSAHS who were treated in our hospital between February 2013 and January 2016 were selected as research subjects, and the families of children signed informed consent. According to the random number table, the included children were divided into the control group (n=59) who received general surgery and the observation group (n=59) who received low-temperature plasma radiofrequency surgery. The control group 30 male cases and 29 female cases, they were 2–11 years old, and the OSAHS course was 3 months to 2 years; observation group 31 male cases and 28 female cases, they were 1–11 years old, and the OSAHS course was 2 months to 2 years. The two groups of children were not statistically different in the distribution of gender, age and course of disease (P>0.05), and the research was discussed and approved by the hospital ethics committee.

2.3. Operation methods

Both groups of children received general anesthesia and appropriate-diameter endotracheal tube placement, the control group received UPPP therapy, which was as follows: conventional resection of hypertrophic tonsil and adenoid body, hemostasis, suturing tonsillar fossa and soft palate mucosa, and conventional tongue base processing. Observation group received low-temperature plasma radiofrequency surgery, which was as follows: endoscopic exposure of proliferous hypertrophic tonsil and adenoid, using plasma radiofrequency knife (American Arthrocare Company) for ablation from shallow to deep, keeping tonsil tissue in the capsule, and making residual tonsil free edge in line with pharyngopalatine arch level. The operation should keep residual tonsil edge smooth to prevent postoperative adhesion. Endoscope and suction tube were inserted respectively in both sides of nasal cavity, electric aspirator and cutter was placed in the mouth for cutting and aspirating from the bottom of adenoids, the ostium tubae auditivae adenoids were treated until they were smooth and flat. Postoperative breathing and wound bleeding were closely observed after operation.

2.4. Trauma-related indexes

Before operation and 24 h after operation, peripheral venous blood was extracted from two groups of children at same point in time, added in the anticoagulant and centrifuged at low speed to get supernatant and freeze it in medical cryogenic refrigerator (Jinan Bohua Instrument Co., LTD., the article number MDF-1156ATN) for test. Specific detection trauma indexes were as follows: (1) stress hormones: enzyme-linked immunosorbent assay (ELISA) was used to determine serum levels of adrenocorticotropic hormone (ACTH), angiotensin-2 (Ang-2), norepinephrine (NE), cortisol (Cor) and other stress hormones. (2) Acute phase proteins: RIA method was used to detect serum levels of haptoglobin (HP), ceruloplasmin (CER), prealbumin (PA) and other acute phase proteins. (3) Inflammatory factors: ELISA was used to detect serum levels of interleukin-1 (IL-1), interleukin-4 (IL-4), interleukin-27 (IL-27), tumor necrosis factor (TNF-α) and other inflammatory factors.

2.5. Speech function parameters

Before operation and 1 month after operation, two groups of children received acoustic detection with computer. Children sat in a quiet room with the mouth 5 cm away from the microphone, and naturally pronounced vowel "a" and consonant "ji" for 5 s. The speech spectrum software was used to analyze and get the levels of fundamental frequency (F0), normalized noise energy (NNE), noise to harmonic ratio (NHR) and other speech function parameters.

2.6. Statistical analysis

Statistical software was SPSS 21.0 and the personnel with professional (1-2) statistical knowledge was selected for calculation. Measurement data was in terms of (x±s) and the comparison between groups was by paired t test. P<0.05 was the standard of statistical significance in differences.

3. Results

3.1. Stress hormones

Before operation and 24 h after operation, comparison of serum stress hormones ACTH, Ang-2, NE and Cor contents between two groups of children was as follows: before operation, differences in serum ACTH, Ang-2, NE and Cor contents were not statistically significant between two groups of patients (P>0.05); 24 h after
operation, serum ACTH, Ang-2, NE and Cor contents of both groups were higher than those before operation, and differences within group were statistically significant before operation and 24 h after operation ($p<0.05$). 24 h after operation, serum ACTH, Ang-2, NE and Cor contents of observation group were lower than those of control group, and differences between groups were statistically significant 24 h after operation ($p<0.05$), shown in Table 1.

### 3.2. Acute phase proteins

Before operation and 24 h after operation, comparison of serum acute phase proteins HP, CER and PA contents between two groups of children was as follows: before operation, differences in serum HP, CER and PA contents were not statistically significant between two groups of patients ($p>0.05$); 24 h after operation, serum HP, CER and PA contents of both groups were higher than those before operation, and differences within group were statistically significant before operation and 24 h after operation ($p<0.05$). 24 h after operation, serum HP, CER and PA contents of observation group were lower than those of control group, and differences between groups were statistically significant 24 h after operation ($p<0.05$), shown in Table 2.

### 3.3. Inflammatory factors

Before operation and 24 h after operation, comparison of serum inflammatory factors IL-1, IL-4, IL-27 and TNF-α contents between two groups of children was as follows: before operation, differences in serum IL-1, IL-4, IL-27 and TNF-α contents were not statistically significant between two groups of patients ($p>0.05$); 24 h after operation, serum IL-1, IL-4, IL-27 and TNF-α contents of both groups were higher than those before operation, and differences within group were statistically significant before operation and 24 h after operation ($p<0.05$). 24 h after operation, serum IL-1, IL-4, IL-27 and TNF-α contents of observation group were lower than those of control group, and differences between groups were statistically significant 24 h after operation ($p<0.05$), shown in Table 3.

### 3.4. Speech function parameters

Before operation and 24 h after operation, the comparison of speech function parameters F0, NNE and NHR levels between two groups of children was as follows: before operation, differences in F0, NNE and NHR levels were not statistically significant between two groups of patients ($p>0.05$); 24 h after operation, NNE and NHR levels of both groups were higher than those before operation, and differences within group were statistically significant before operation and 24 h after operation ($p<0.05$). 24 h after operation, NNE and NHR levels of observation group were higher than those of control group, and differences between groups were statistically significant 24 h after operation ($p<0.05$). Before and after operation, differences in F0 levels were not statistically significant between groups of children ($p>0.05$), shown in Table 4.

### Table 1

Comparison of serum stress hormone contents before and after operation ($n=59, \text{SDs}$).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Time point</th>
<th>ACTH (pg/mL)</th>
<th>Ang-2 (pg/mL)</th>
<th>NE (pg/mL)</th>
<th>Cor (nmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>Before operation</td>
<td>2.47±0.39</td>
<td>5.83±0.69</td>
<td>20.18±2.54</td>
<td>78.28±9.12</td>
</tr>
<tr>
<td></td>
<td>24 h after operation</td>
<td>5.93±0.61</td>
<td>11.17±2.12</td>
<td>41.66±5.49</td>
<td>141.28±19.34</td>
</tr>
<tr>
<td>Observation group</td>
<td>Before operation</td>
<td>2.52±0.35</td>
<td>5.81±0.64</td>
<td>20.42±2.73</td>
<td>79.64±9.52</td>
</tr>
<tr>
<td></td>
<td>24 h after operation</td>
<td>3.71±0.43</td>
<td>8.03±0.95</td>
<td>29.84±4.51</td>
<td>98.52±10.17</td>
</tr>
</tbody>
</table>

Compared with same group before operation, $^*p<0.05$; compared with control group 24 h after operation, $^#p<0.05$.

### Table 2

Comparison of serum acute phase protein contents before and after operation ($n=59, \text{SDs}$).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Time point</th>
<th>HP (mg/dL)</th>
<th>CER (mg/L)</th>
<th>PA (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>Before operation</td>
<td>53.91±6.78</td>
<td>231.27±29.34</td>
<td>29.36±4.11</td>
</tr>
<tr>
<td></td>
<td>24 h after operation</td>
<td>103.27±15.88</td>
<td>312.46±38.52</td>
<td>64.82±7.12</td>
</tr>
<tr>
<td>Observation group</td>
<td>Before operation</td>
<td>53.85±6.49</td>
<td>230.85±25.47</td>
<td>29.47±4.05</td>
</tr>
<tr>
<td></td>
<td>24 h after operation</td>
<td>71.27±8.59</td>
<td>270.36±30.45</td>
<td>42.65±6.19</td>
</tr>
</tbody>
</table>

Compared with same group before operation, $^*p<0.05$; compared with control group 24 h after operation, $^#p<0.05$.

### Table 3

Comparison of serum inflammatory factor contents before and after operation ($n=59, \text{pg/mL}$).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Time point</th>
<th>IL-1</th>
<th>IL-4</th>
<th>IL-27</th>
<th>TNF-α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>Before operation</td>
<td>0.17±0.03</td>
<td>1.27±0.18</td>
<td>31.27±4.52</td>
<td>4.28±0.59</td>
</tr>
<tr>
<td></td>
<td>24 h after operation</td>
<td>0.32±0.04</td>
<td>3.15±0.46</td>
<td>49.27±5.42</td>
<td>9.05±0.98</td>
</tr>
<tr>
<td>Observation group</td>
<td>Before operation</td>
<td>0.16±0.03</td>
<td>1.25±0.19</td>
<td>30.98±4.24</td>
<td>4.23±0.52</td>
</tr>
<tr>
<td></td>
<td>24 h after operation</td>
<td>0.23±0.03</td>
<td>1.94±0.27</td>
<td>38.62±4.52</td>
<td>6.17±0.74</td>
</tr>
</tbody>
</table>

Compared with same group before operation, $^*p<0.05$; compared with control group 24 h after operation, $^#p<0.05$.
postoperative rehabilitation and the body is in a severe consumption state, which is bad for and accelerates the protein decomposition process in the body, ACTH, Ang-2, NE and Cor after receiving intense stimulation, the central nervous system releases a large amount of stress hormones. Surgery-induced tissue damage is the most direct stressor, the trauma and postoperative speech function were compared. Used in the treatment of children with OSAHS, and the surgical UPPP and low-temperature plasma radiofrequency surgery were used in the treatment of children with OSAHS, and this is directly because that the operation causes serious consequences, so early active therapeutic measures should be taken. UPPP has been successfully applied in the treatment of children with OSAHS, but some children have severe postoperative pain, and the incidence of wound tear hemorrhage and other side effects under intense struggle is high. Low-temperature plasma radiofrequency is a new minimally invasive technology that was originally used in orthopaedic arthroscopic surgery and then gradually promoted in OSAHS treatment, and the treatment principle is that the bipolar radiofrequency probe releases radiofrequency current, releases energy and produces voltage in tissue space, converts the electrolyte between tissues into ion thin layer, accelerates charged particle movement, transfers the energy to the target tissue and then disintegrates the molecular link into carbohydrates at low temperature, thus realizing tissue resection. Low-temperature plasma radiofrequency surgery is performed under relatively low temperature of 40–70°C, and the action range of charged particles is only 100 μm, which reduces the damage to the surrounding normal muscle nerve to the lowest. In the study, both UPPP and low-temperature plasma radiofrequency surgery were used in the treatment of children with OSAHS, and the surgical trauma and postoperative speech function were compared.

Surgery-induced tissue damage is the most direct stressor, the central nervous system releases a large amount of stress hormones ACTH, Ang-2, NE and Cor after receiving intense stimulation, and accelerates the protein decomposition process in the body, catabolism > anabolism can appear in those with severe stress, and the body is in a severe consumption state, which is bad for postoperative rehabilitation. In the study, early postoperative stress hormone levels were compared between two groups of children, and it was found that serum ACTH, Ang-2, NE and Cor contents of observation group 24 h after operation were lower than those of control group (P < 0.05), it directly shows that low-temperature plasma radiofrequency surgery causes less stress injury to the children, and this is directly because that the operation causes less damage to the surrounding normal tissue, and the operation is performed at relatively low temperatures. Stress may also directly trigger the increased acute phase protein synthesis by the liver, and the specific increase level is directly related to the degree of the tissue damage and infection. HP, CER and PA are the acute phase proteins commonly studied at present, and can be directly involved in the immune defense and maintain the body’s homeostasis. In the study, serum HP, CER and PA contents of observation group 24 h after operation were lower than those of control group (P < 0.05), which is also the evidence that low-temperature plasma radiofrequency surgery causes less tissue damage and stress reaction. Acute phase proteins can be used as tissue repair materials, and they are consumed in the process of inflammation and repair, so the body’s inflammatory response is mostly consistent with the reactive increase of acute phase proteins. IL-1, IL-4, IL-27 and TNF-α are all involved in the body’s inflammation and repair, and their generation is not only directly related to the surgical trauma, but is also affected by intraoperative blood loss. In the study, early postoperative serum inflammatory factor levels were compared between two groups of children, and it was found that serum IL-1, IL-4, IL-27 and TNF-α contents of observation group 24 h after operation were lower than those of control group (P < 0.05), it confirms that the low-temperature plasma radiofrequency surgery causes lighter systemic inflammatory response, the results are not only related to the, lesser tissue damage under low-temperature operation, but also directly associated with the hemostatic/tissue contraction effect produced by the resistance heat effect of tissue, and it explains that the operation unites cutting, ablation, hemostasis and other functions.

At the same time of complete resection of hypertrophic tonsil and adenoid, the treatment of children with OSAHS should protect children’s speech function to the greatest extent, which is one of the most important standards to measure the effectiveness of surgical operation. The airway obstruction in children OSAHS leads to the narrowed oropharyngeal cavity volume and the decreased sound intensity and pitch. F0, NNE and NHR are the key indexes to evaluate children’s state of phonetics, F0 level can directly reflect the vocal cords function, and the NNE and NHR reflect the change of acoustic vibration amplitude and acoustic intensity. It was found in the study that NNE and NHR levels of observation group 1 month after operation were higher than those of control group (P < 0.05), and F0 levels were not significantly different between the

<table>
<thead>
<tr>
<th>Groups</th>
<th>Time point</th>
<th>F0 (f/Hz)</th>
<th>NNE (LP/dB)</th>
<th>NHR (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>Before operation</td>
<td>224.8±19.9</td>
<td>-9.4±1.15</td>
<td>0.22±0.04</td>
</tr>
<tr>
<td></td>
<td>24 h after operation</td>
<td>227.1±24.8</td>
<td>-8.4±0.97</td>
<td>0.31±0.03</td>
</tr>
<tr>
<td>Observation group</td>
<td>Before operation</td>
<td>223.0±26.7</td>
<td>-9.5±1.08</td>
<td>0.21±0.04</td>
</tr>
<tr>
<td></td>
<td>24 h after operation</td>
<td>226.6±28.7</td>
<td>-6.8±0.79</td>
<td>0.25±0.02</td>
</tr>
</tbody>
</table>

Compared with same group before operation, *P < 0.05; compared with control group 24 h after operation, **P < 0.05.

4. Discussion

The incidence of OSAHS is high in children, there is not only the frequent upper airway obstruction, but with the aggravation of illness and the extended course of disease, there may be memory deterioration, learning difficulties, growth retardation and other serious consequences, so early active therapeutic measures should be taken. Low-temperature plasma radiofrequency surgery is performed under relatively low temperatures. Stress may also directly trigger the increased acute phase protein synthesis by the liver, and the specific increase level is directly related to the degree of the tissue damage and infection. HP, CER and PA are the acute phase proteins commonly studied at present, and can be directly involved in the immune defense and maintain the body's homeostasis.

In the study, serum HP, CER and PA contents of observation group 24 h after operation were lower than those of control group (P < 0.05), which is also the evidence that low-temperature plasma radiofrequency surgery causes less tissue damage and stress reaction. Acute phase proteins can be used as tissue repair materials, and they are consumed in the process of inflammation and repair, so the body's inflammatory response is mostly consistent with the reactive increase of acute phase proteins. IL-1, IL-4, IL-27 and TNF-α are all involved in the body's inflammation and repair, and their generation is not only directly related to the surgical trauma, but is also affected by intraoperative blood loss. In the study, early postoperative serum inflammatory factor levels were compared between two groups of children, and it was found that serum IL-1, IL-4, IL-27 and TNF-α contents of observation group 24 h after operation were lower than those of control group (P < 0.05), it confirms that the low-temperature plasma radiofrequency surgery causes lighter systemic inflammatory response, the results are not only related to the, lesser tissue damage under low-temperature operation, but also directly associated with the hemostatic/tissue contraction effect produced by the resistance heat effect of tissue, and it explains that the operation unites cutting, ablation, hemostasis and other functions.

At the same time of complete resection of hypertrophic tonsil and adenoid, the treatment of children with OSAHS should protect children’s speech function to the greatest extent, which is one of the most important standards to measure the effectiveness of surgical operation. The airway obstruction in children OSAHS leads to the narrowed oropharyngeal cavity volume and the decreased sound intensity and pitch. F0, NNE and NHR are the key indexes to evaluate children’s state of phonetics, F0 level can directly reflect the vocal cords function, and the NNE and NHR reflect the change of acoustic vibration amplitude and acoustic intensity. It was found in the study that NNE and NHR levels of observation group 1 month after operation were higher than those of control group (P < 0.05), and F0 levels were not significantly different between the
two groups of children. Above results show that the low-temperature plasma radiofrequency surgery can more effectively remove the diseased tissue and expand oropharyngeal cavity, and the children with OSAHS do not involve the change of vocal cord function, so the operation has no effect on F0 levels.

To sum up, it is concluded as follows: low-temperature plasma radiofrequency surgery treatment of children with OSAHS can significantly reduce surgical trauma and furthest optimize children’s speech function, it is more ideal in minimal invasion and effectiveness of surgery than routine operation, and it’s worth popularization in clinical practice in the future.

References


