Effect of bronchofiberscope airway lavage on respiratory function and inflammatory stress level in adults with severe pneumonia

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ABSTRACT

Objective: To study the effect of bronchofiberscope airway lavage on respiratory function and inflammatory stress level in adults with severe pneumonia. Methods: 80 adults with severe pneumonia treated in our hospital between July 2011 and March 2015 were collected, and after the treatment process and auxiliary examination results were retrospectively analyzed, they were divided into control group (n=45) who accepted conventional treatment and observation group (n=35) who accepted bronchofiberscope airway lavage. Before and after treatment, the spirometer was used to test the respiratory function of two groups of patients; ELISA method was used to detect serum inflammatory factor levels; RIA method was used to detect serum stress index levels. Results: Before treatment, differences in serum levels of inflammatory cytokines and stress indexes were not statistically significant between two groups of patients (P>0.05); after treatment, respiratory function parameters forced expiratory volume in 1 s (FEV$_1$), alveolar ventilation (VA), maximal mid-expiratory flow (FEF$_{25-75}$), instantaneous late-expiratory flow (FEF$_{50}$) and instantaneous late-expiratory flow (FEF$_{75}$) levels of observation group were higher than those of control group (P<0.05), serum high mobility group box B1 (HMGB1), interleukin-2 (IL-2), interferon $\gamma$ (IFN-$\gamma$), cortisol (Cor), adrenaline (ADR) and noradrenaline (NADR) levels were significantly lower than those of control group while interleukin-13 (IL-13) level was significantly higher than that of control group (P<0.05). Conclusions: Bronchofiberscope airway lavage can optimize the respiratory function and reduce systemic inflammatory and stress response in adults with severe pneumonia.

1. Introduction

Severe pneumonia is severe stage after common pneumonia is poorly controlled or progresses, it is with large lesion range or accompanied by myocarditis, respiratory failure, renal dysfunction and other severe complications, and early diagnosis and positive treatment is the key to optimizing the treatment outcome[1,2]. Symptomatic treatment and intravenous drip of antibiotics is the normal treatment of severe pneumonia, but the drug concentration is low after the drugs in the circulating blood enter into the local lesions in lungs, the killing effect on pathogenic bacteria is weak, and the application of broad-spectrum antibiotics could increase the incidence of body flora disorder. Drug use in local lesions is the best treatment for severe pneumonia, and with the development of endoscopic technique, bronchofibroscope has played an important role in the diagnosis and treatment of lung diseases[3,4]. In the study, bronchofiberscope airway lavage was used for the treatment of severe pneumonia in our hospital, and the effect of bronchofiberscope airway lavage on respiratory function and inflammatory stress level in adults with severe pneumonia was specifically analyzed.

2. Materials and methods

2.1. Clinical information
80 adults with severe pneumonia treated in our hospital between July 2011 and March 2015 were included, and after the treatment process and laboratory examination results were retrospectively analyzed, they were divided into control group (n=45) who accepted conventional treatment and observation group (n=35) who accepted bronchofiberscope airway lavage. Control group included 25 male cases and 20 female cases, they were 32–70 years old, and the course of disease was 3–11 d and (5.48±0.69) d in average; observation group included 19 male cases and 16 female cases, they were 34–71 years old, and the course of disease was 2–13 d and (5.71±0.72) d in average. Two groups of patients were not statistically different in the distribution of gender, age and course of disease (P>0.05), the patients themselves or families signed informed consent, and the research was approved by the hospital ethics committee.

2.2. Inclusion and exclusion criteria

Inclusion criteria: (1) in accordance with the diagnostic criteria for severe pneumonia; (2) 20–80 years old; (3) without lung surgery 3 months prior to admission; (4) receiving no systemic treatment before admission; (5) participating in the whole treatment process and with complete clinical data. Exclusion criteria: (1) associated with infectious diseases of other tissues and organs; (2) with severe heart, liver and kidney dysfunction; (3) with malignant tumor diseases; (4) pregnant or breastfeeding women.

2.3. Treatment methods

The control group of patients received routine medical treatment, including antibiotics, expectorant, nutritional support, mechanical ventilation, etc. Based on conventional treatment, observation group of patients received bronchofiberscope airway lavage, specifically as follows: the lesion location was identified by chest CT examination, lidocaine (Guangxi Nanning Baihui Pharmaceutical Group Co., LTD., approved by H45020569) was used for local anesthesia, then the fiber bronchoscope (Japanese Olympus Corporation, model BF-LTD., approved by H45020569) was used for local anesthesia, then the fiber bronchoscope (Japanese Olympus Corporation, model BF-3C40) was inserted through the nose to clearly suck out the airway secretions without suspending mechanical ventilation (single sucking time ≤15 s), and the removed secretions were used for etiological examination and drug sensitive test. Warm saline, 25 mL/time, was injected to rinse the lesions for several times until the removed liquid was not cloudy. If patients’ blood oxygen saturation <85% and (or) heart rate >120 times/min during operation, the operation was suspended for corresponding processing, and resumed after patients’ vital signs were stable. After the lavage, sensitive antibiotics were suspended for corresponding processing, and resumed after patients’ vital signs were stable. After the lavage, sensitive antibiotics were suspended for corresponding processing, and resumed after patients’ vital signs were stable. After the lavage, sensitive antibiotics were suspended for corresponding processing, and resumed after patients’ vital signs were stable. After the lavage, sensitive antibiotics were suspended for corresponding processing, and resumed after patients’ vital signs were stable. After the lavage, sensitive antibiotics were suspended for corresponding processing, and resumed after patients’ vital signs were stable.

Table 1

Comparison of respiratory function parameter levels after treatment (X±s).

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>FEV1 (L)</th>
<th>VA (L)</th>
<th>FEF25-75 (L/s)</th>
<th>FEF50% (L/s)</th>
<th>FEF75% (L/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation group</td>
<td>35</td>
<td>3.14±0.35</td>
<td>3.35±0.39</td>
<td>3.17±0.34</td>
<td>4.26±0.45</td>
<td>1.89±0.23</td>
</tr>
<tr>
<td>Control group</td>
<td>45</td>
<td>2.65±0.31</td>
<td>2.87±0.31</td>
<td>2.68±0.29</td>
<td>3.41±0.41</td>
<td>1.43±0.19</td>
</tr>
<tr>
<td>t</td>
<td></td>
<td>6.289</td>
<td>6.782</td>
<td>6.482</td>
<td>7.091</td>
<td>5.283</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

2.4. Observation indexes

2.4.1. Respiratory function

After treatment, spirometer (Beijing Tianzhuo Rufeng Medical Technology Co., LTD., model ML2525) was used to detect the respiratory function of two groups of patients, and the specific method was as follows: after 2 or 3 times of quiet breathing, patients slowly breathed out until couldn’t breathe out any more, then rapidly breathed in to the maximum extent and explosively fully breathed out (no stopping or taking a breath in the middle) until couldn’t breathe out any more. Specific detection indexes were as follows: forced expiratory volume in 1 s (FEV1), alveolar ventilation (VA), maximal mid-expiratory flow (FEF25-75), instantaneous late-expiratory flow (FEF35%), instantaneous late-expiratory flow (FEF35%).

2.4.2. Inflammatory stress indexes

Before and after treatment, 2 mL of fasting cubital venous blood was extracted from two groups of patients, put in anticoagulation EP tubes and centrifuged at low speed, and the supernatant was collected and cryopreserved in a -70 °C refrigerator for test. Detection indexes were as follows: (1) ELISA method was used to detect high mobility group box B1 (HMGB1), interleukin-2 (IL-2), interleukin-13 (IL-13) and interferon γ (IFN-γ) levels; (2) stress indicators: radioimmunossay method was used to measure cortisol (Cor), adrenaline (ADR) and noradrenaline (NADR) levels.

2.5. Statistical analysis

The obtained data was input in software SPSS18.0, measurement data was in terms of mean ± standard deviation (X±s), comparison before and after treatment was by paired t test, comparison between two groups after treatment was by group t test, and P<0.05 indicated statistical significance in differences.

3. Results

3.1. Respiratory function

After treatment, comparison of respiratory function parameters FEV1, VA, FEF25-75, FEF50% and FEF75% between two groups of patients is as follows: respiratory function parameters FEV1, VA, FEF25-75, FEF50% and FEF75% levels of observation group were higher than those of control group. Differences in respiratory function parameters FEV1, VA, FEF25-75, FEF50% and FEF75% levels were statistically significant between two groups of patients after treatment (P<0.05), shown in Table 1.
3.2. Inflammatory factors

Before and after treatment, comparison of serum inflammatory factors HMGB1, IL-2, IL-13 and IFN-γ levels between two groups of patients is as follows: before treatment, differences in serum inflammatory factors HMGB1, IL-2, IL-13 and IFN-γ levels were not statistically significant between two groups of patients (P>0.05); after treatment, serum HMGB1, IL-2 and IFN-γ levels of both groups were significantly lower than those before treatment while IL-13 levels were significantly higher than those before treatment, and differences within same group were statistically significant before and after treatment (P<0.05). After treatment, serum HMGB1, IL-2 and IFN-γ levels of observation group were significantly lower than those of control group while IL-13 level was significantly higher than that of control group, and differences between groups were statistically significant after treatment (P<0.05), shown in Table 2.

3.3. Stress indexes

Before and after treatment, comparison of serum stress indexes Cor, ADR and NADR between two groups of patients is as follows: before treatment, differences in serum stress indexes Cor, ADR and NADR levels were not statistically significant between two groups of patients (P>0.05); after treatment, serum stress indexes Cor, ADR and NADR levels of both groups were significantly lower than those before treatment, and differences within same group were statistically significant before and after treatment (P<0.05). After treatment, serum stress indexes Cor, ADR and NADR levels of observation group were significantly lower than those of control group, and differences between groups were statistically significant after treatment (P<0.05), shown in Table 3.

4. Discussion

After severe pneumonia, a large amount of secretions and pathogens accumulate in local lesion and even block the bronchus, and the intrapulmonary ventilation/blood flow is further out-of-balance, which prompts respiratory failure[5]. Many studies have shown that the key to the treatment of severe pneumonia is to completely clear the secretions in the lung lesions, improve ventilation function and apply sensitive antibiotics, but conventional intravenous medication can't make a lot of drugs reach the lesions, intrapulmonary dead space is even the blind spot of blood circulation, and therefore, the overall efficacy is not ideal[6]. The appearance of bronchofiberscope largely breaks the bottleneck of above treatment, which, under direct vision, identifies the areas with secretion, thoroughly sucks out the secretions and rinses the airway to improve the ventilation/gas exchange function and block the vicious cycle of "mucus-inflammation-mucus"[7]. At the same time, the sputum that is sucked out by bronchofiberscope can be used for bacteria culture and drug sensitive test, and then the sensitive antimicrobial drugs can be selected for local intrapulmonary injection to quickly and effectively control the infection. The overall effectiveness of the bronchofiberscope airway lavage has been recognized, but its influence on the specific respiratory function and serum indexes in patients with severe pneumonia was less covered.

Respiratory dysfunction is the main performance in patients with severe pneumonia, it is commonly caused by the blocking of secretions accumulated in airway, abnormal blood circulation in lungs and other reasons, and the patients may develop refractory hypoxemia and even respiratory failure[8,9]. The respiratory function of patients with severe pneumonia is closely related to the disease severity and treatment effect, FEV1, V A, FEF25-75, FEF50% and FEF75% are the most common clinical respiratory function indexes, and their levels can reflect the major airway function[10]. In the study, the ventilation function index levels of two groups of patients were detected after treatment, and it was found that compared with the control group of patients, the observation group of patients were with higher FEV1, VA, FEF25-75, FEF50% and FEF75% levels, confirming that bronchofiberscope airway lavage can significantly optimize the patients’ respiratory function. The primary role of bronchofiberscope is to remove the massively secreted mucus sputum in local airway, it can directly improve the patients’ ventilation function, optimize

Table 2
Comparison of serum inflammatory factor levels before and after treatment (T±s).

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>HMGB1 (μg/L)</th>
<th>IL-2 (pg/mL)</th>
<th>IL-13 (pg/mL)</th>
<th>IFN-γ (ng/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Before treatment</td>
<td>After treatment</td>
<td>Before treatment</td>
<td>After treatment</td>
</tr>
<tr>
<td>Observation group</td>
<td>35</td>
<td>162.48±19.93</td>
<td>32.17±4.09</td>
<td>34.27±4.11</td>
<td>5.89±0.67</td>
</tr>
<tr>
<td>Control group</td>
<td>45</td>
<td>165.27±18.53</td>
<td>79.26±8.51</td>
<td>35.09±4.12</td>
<td>11.17±1.64</td>
</tr>
<tr>
<td>t</td>
<td>0.172</td>
<td>8.293</td>
<td>&lt;0.05</td>
<td>0.55</td>
<td>0.018</td>
</tr>
<tr>
<td>P</td>
<td>&gt;0.05</td>
<td>&lt;0.05</td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

*: differences within same group were statistically significant before and after treatment, P<0.05; #: differences between groups were statistically significant after treatment, P<0.05.

Table 3
Comparison of serum stress index levels before and after treatment (T±s).

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Cor (nmol/L)</th>
<th>ADR (pg/mL)</th>
<th>NADR (pg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Before treatment</td>
<td>After treatment</td>
<td>Before treatment</td>
</tr>
<tr>
<td>Observation group</td>
<td>35</td>
<td>542.95±68.77</td>
<td>154.25±19.76</td>
<td>241.94±30.57</td>
</tr>
<tr>
<td>Control group</td>
<td>45</td>
<td>556.18±60.74</td>
<td>278.61±30.58</td>
<td>242.85±29.69</td>
</tr>
<tr>
<td>t</td>
<td>0.162</td>
<td>9.263</td>
<td>&gt;0.05</td>
<td>0.017</td>
</tr>
<tr>
<td>P</td>
<td>&gt;0.05</td>
<td>&lt;0.05</td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

*: differences within same group were statistically significant before and after treatment, P<0.05; #: differences between groups were statistically significant after treatment, P<0.05.
the blood circulation and ischemia hypoxia state in local lesion and eventually help the lesion absorption, and this is also the fundamental mechanism for the treatment to optimize patients’ respiratory function.

There is systemic inflammatory response in patients with severe pneumonia, pathogenic bacteria continuously proliferate and induce the production of pro-inflammatory factors, and pro-inflammatory factors can prompt the mononuclear macrophages to accumulate in local lesions, thus forming the inflammatory cascade reaction[11,12]. Anti-inflammatory factors are the important defense barriers of the body, they are reactively increasingly released in the early systemic inflammation to neutralize the inflammatory mediators and inhibit the inflammatory response, but the anti-inflammatory factor levels are generally low in the circulating blood of patients with severe pneumonia, which may be related to the continuing of inflammatory state and the massive consumption of anti-inflammatory factors[13,14]. HMGB1, IL-2 and IFN-γ are all pro-inflammatory factors, and HMGB1 is late inflammatory mediator, is actively secreted the activated mononuclear macrophages, and can prompt target cell movement and destruct epithelial barrier; IL-2 and IFN-γ can activate complement and aggravate the inflammatory response, and can also increase the antigen presenting ability of macrophages[15]. IL-13 is a typical anti-inflammatory factor, is produced by the Th2 cells, and can not only neutralize pro-inflammatory factors, but also adjust the mononuclear cell and B cell function and enhance the body’s immunity. In the study, the levels of above pro-inflammatory/anti-inflammatory factors were tested, and it was found that compared with the control group of patients, the observation group of patients were with lower serum pro-inflammatory factors HMGB1, IL-2 and IFN-γ levels as well as higher anti-inflammatory factor IL-13 level after treatment (P<0.05), which confirms the positive role of bronchofiberscope airway lavage in optimizing the pro-inflammatory/anti-inflammatory balance and alleviating systemic inflammatory response in patients with severe pneumonia, and this is also one of the important mechanisms to optimize patients’ respiratory function.

Inflammation is an important cause of stress state in the body, many studies have confirmed that patients with severe pneumonia are in a strong stress state, and the continuous release of massive stress hormones can further weaken the body’s immunity and accelerate protein decomposition in the body, which is unfavorable to inflammation control and disease improvement[16,17]. Cor, ADR and NADR are the hormones secreted by the hypothalamus-pituitary-adrenal axis, they are massively produced under infection and other stress states, and their levels can indirectly reflect the systemic infection severity[18,19]. In the study, serum levels of stress hormones were compared between two groups of patients after treatment, and it was found that compared with control group of patients, the observation group of patients were with lower serum Cor, ADR and NADR levels after treatment (P<0.05), which confirms that the systemic stress state in patients with severe pneumonia is relieved after bronchofiberscope airway lavage treatment, and this is the direct result of the infection control and can also further promote disease rehabilitation.

To sum up, it is concluded as follows: bronchofiberscope airway lavage can optimize the respiratory function and reduce systemic inflammatory and stress response in adults with severe pneumonia, and it’s worth popularization and application in clinical practice in the future.

References