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Clinical Efficacy Evaluation of Salt Rock Aerosol Therapy in Patients with Chronic Obstructive Pulmonary Disease Complicated with Silicosis

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Abstract: Chronic obstructive pulmonary disease (COPD) seriously affects patients' health and daily life. Its coexistence with silicosis leads to an extremely critical clinical situation and serious death. In this article, a randomized controlled trial design was used to evaluate the clinical efficacy of salt rock aerosol in the treatment of COPD and silicosis. The treatment group received salt aerosol treatment, while the control group received routine treatment. The assessment mainly involved lung function, quality of life and inflammatory markers. The lung function, St. George's Breathing Questionnaire (SGRQ) score and high-sensitivity C-reactive protein level were evaluated in all patients. The results showed that the salt rock aerosol treatment effectively improved the forced vital capacity (FVC) of COPD patients with silicosis. The maximum FVC values of the treatment group and the control group were 2.99 liters and 2.47 liters respectively. In addition, the average total score of SGRQ decreased significantly in the treatment group, indicating that the quality of life was improved. The level of inflammatory marker C-reactive protein was also low in the treatment group, and the level did not exceed 6.4mg/L in any treatment group, but reached 14.7mg/L in the control group, which proved the anti-inflammatory effect of salt rock aerosol therapy.

1. Introduction

COPD is one of the main causes of death and disease burden worldwide, and when co occurring with silicosis, it further exacerbates respiratory dysfunction in patients and increases treatment difficulty. Although some progress has been made in current treatment methods, including drug therapy, oxygen therapy, and rehabilitation training, the treatment of COPD patients with silicosis still faces many challenges.

This study focuses on salt rock aerosol therapy, an emerging non pharmacological therapy that improves respiratory symptoms by inhaling salt rock particles. This study aims to evaluate the clinical efficacy of salt rock aerosol therapy in COPD patients with silicosis, and explore its impact

on lung function, inflammation levels, and quality of life. In addition, this study also evaluates the safety of salt rock aerosol therapy, providing preliminary evidence for clinical application.

At first, the article introduces the disease background of COPD complicated with silicosis, the limitations of existing treatment methods and the research prospect of salt rock aerosol therapy. The second part summarizes the research progress in the field of COPD and silicosis treatment. The third part describes the method of this study, including the mechanism of action, research design, patient screening criteria, treatment plan and efficacy evaluation index of salt rock aerosol therapy. Results and discussion show the clinical effect of salt rock aerosol therapy on COPD patients complicated with silicosis, and evaluate its safety. Finally, the main findings of this study are summarized, and the clinical application prospect of salt rock aerosol therapy is prospected.

2. Related Work

With the deepening of medical research, people's understanding of COPD is also expanding. Chen Jialiang explored the effect of nobiletin on airway mucus hypersecretion in rats with chronic obstructive pulmonary disease (COPD), and clarified its molecular mechanism of regulating endoplasmic reticulum stress signal pathway [1]. Wang Wenxing studied and analyzed the incidence, illness, death, disability-adjusted life years, premature death life years and disability life years of chronic obstructive pulmonary disease in China from 1990 to 2019 [2]. Wu Linke conducted a prospective study on 112 stable stage patients with chronic obstructive pulmonary disease (COPD) who were visited in the outpatient department of Nanjing First Hospital from June 2021 to June 2022, to explore the application effect of the case management model of behavior staged transformation theory in stable stage patients with COPD [3]. Zhang Jing selected 82 elderly patients with COPD complicated with respiratory failure admitted to Beijing Friendship Hospital affiliated with Capital Medical University from February 2022 to February 2023 to explore the clinical effect of budesonide nebulization inhalation combined with non-invasive mechanical ventilation in the treatment of COPD complicated with respiratory failure in elderly patients [4]. Wan Yin retrospectively selected 60 COPD patients admitted to the Respiratory and Critical Care Medicine Department of Jiangxi Chest Hospital from January 2022 to February 2023 as the research subjects to explore the correlation between serum interleukin and pulmonary arterial pressure in COPD patients with concomitant pulmonary hypertension [5].

Not only that, Blanco-Pérez J J conducted a prospective observational study on all patients who visited specialized silicosis clinics in the pulmonary department from 2009 to December 2017 [6]. Zhou M used liquid chromatography-mass spectrometry to analyze the plasma of 30 cases of silicosis, 30 cases of asbestosis, and 20 healthy controls, and explored the correlation between metabolic networks and identified metabolic disorders [7]. Huo X divided patients with systemic sclerosis admitted to Guangxi Workers' Hospital and Guangxi Zhuang Autonomous Region People's Hospital from January 2000 to December 2020 into a group with systemic sclerosis accompanied by silicosis and a group without systemic sclerosis, and explored the clinical characteristics of systemic sclerosis complicated with silicosis [8]. Ruan Q carried out an evaluation aimed at studying the efficacy and safety of weekly use of rifapentine and isoniazid as preventive measures against tuberculosis in Chinese silicosis patients, providing valuable data on the use of these drugs for tuberculosis prevention, and helping guide clinical practice [9]. Govindagoudar M B revealed the serious burden of silicosis among mining workers in North India by reviewing the implementation of compensation and rehabilitation policies for miners in the state of Haryana [10]. Although the above studies have made progress in exploring treatment methods and disease management for COPD, more research is still needed to explore more personalized and effective treatment strategies for specific subgroups, such as COPD patients with silicosis. Based on these considerations, this

study aims to evaluate the clinical efficacy of salt rock aerosol therapy in patients with chronic obstructive pulmonary disease complicated with silicosis, and provide more precise treatment options for this special patient group.

3. Methods

3.1 Mechanism of Salt Rock Aerosol Therapy

Salt rock aerosol therapy is a non pharmacological treatment for chronic respiratory diseases. Its sodium chloride particles can remove dust and pathogens from the air through physical adsorption, reducing the risk of irritation and infection to the respiratory tract. These particles decompose into aerosols with a diameter less than 5 microns under mechanical action, which are easy to enter the bronchioles and even alveoli. They are evenly distributed on the surface of the mucosa and attach to the positively charged mucosa through the action of charges, promoting the dilution and excretion of mucus and alleviating respiratory obstruction symptoms:

$$F_e = k \cdot \frac{q_1 q_2}{r^2} \tag{1}$$

F_e is the charge force; k is the Coulomb constant; q_1 and q_2 are the charges of two charged particles; r is the distance between them.

In addition, the high osmotic pressure environment of salt rock aerosols helps to reduce congestion and edema of the airway mucosa, improve local blood circulation, promote the clearance of inflammatory mediators, and have anti-inflammatory and anti allergic effects:

$$\Pi = \gamma \cdot (C_o - C_i) \tag{2}$$

Π is osmotic pressure; γ is the permeability coefficient; C_o and C_i are the external and internal solute concentrations, respectively.

Research has shown that this therapy can regulate the body's immune response by increasing levels of immunoglobulin A and decreasing levels of immunoglobulin E, enhancing the body's defense against pathogens, while reducing the occurrence of allergic reactions:

$$I_gA = I_gA_0 + \Delta I_gA \tag{3}$$

$$I_gE = I_gE_0 - \Delta I_gE \tag{4}$$

Among them, I_gA and I_gE refer to the levels of immunoglobulin A and E, respectively; I_gA_0 and I_gE_0 are the initial levels; ΔI_gA and ΔI_gE are the changes after treatment, reflecting the regulation of immune response.

In terms of improving lung function, salt rock aerosol therapy improves respiratory distress and exercise tolerance by reducing airway resistance and improving alveolar ventilation function, increasing lung capacity and oxygen exchange efficiency in patients:

$$V_A = V_{A0} + \Delta V_A \tag{5}$$

V_A is the lung capacity after treatment; V_{A0} is the initial lung capacity; ΔV_A is the increase in lung capacity after treatment.

Long-term adherence to the use of salt rock aerosol therapy can delay the rate of decline in lung function, reduce acute exacerbation events, and improve quality of life.

3.2 Design

In this study, a randomized controlled trial is used to evaluate the clinical efficacy of salt rock aerosol in the treatment of COPD patients with silicosis [11-12]. In the experimental design, patients are randomly assigned to the treatment group and the control group. The treatment group receives salt aerosol treatment, while the control group receives routine treatment.

The research needs to carefully screen the research population to ensure the accuracy of the experimental results. The patient must be diagnosed with COPD complicated with silicosis, aged between 40 and 75, regardless of gender, with GOLD grade of moderate to severe COPD, at least one acute exacerbation in the past year, with the ability of baseline lung function test, the ability to participate in 6-minute walking test, and a stable living environment in order to complete the treatment. Exclusion criteria include patients with severe cardiovascular disease, liver or kidney failure, mental illness or dementia, allergic to salt rock aerosol components, and patients who need other major medical treatment during the study period.

The stratified randomization strategy is stratified based on the patient's age, gender, severity of the condition, and pulmonary function test results, ensuring that the proportion of patients in each layer remains consistent between the treatment group and the control group, thereby reducing the impact of confounding factors.

Detailed baseline data is collected before the start of the experiment, such as patient demographic characteristics, medical history, smoking history, lung function test results, blood gas analysis results, 6-minute walk test results, etc., as shown in Table 1:

Table 1: Patient baseline data

ID	Age	Gender	Smoking History	Medical History	FEV1 (L)	FVC (L)	pO2 (mmHg)	pCO2 (mmHg)	6-Minute Walk Test Distance (m)
001	55	Male	20 years	Chronic Obstructive Pulmonary Disease	1.0	2.5	65	45	350
002	48	Female	Non-smoker	No Chronic Disease	2.5	3.0	85	38	450
003	62	Male	30 years	Lung Cancer	0.8	1.5	60	50	300
004	45	Female	15 years	Asthma	1.2	2.0	70	40	400
005	35	Male	5 years	No Chronic Disease	3.0	3.5	90	35	500
006	60	Male	40 years	Chronic Bronchitis	0.9	1.8	55	55	320

Table 1 provides a standardized baseline data collection method for medical research and clinical practice by recording the patient's ID, age, gender, smoking history, medical history, lung function

indicators, blood gas analysis results, and 6-minute walking test distance, in order to comprehensively evaluate the patient's health status and guide personalized treatment strategies.

During the treatment process, the patient's lung function, symptom score, quality of life score, and any adverse events are regularly monitored. After treatment, follow-up is conducted to evaluate the persistence and safety of the therapeutic effect.

3.3 Specific Implementation Methods of Salt Rock Aerosol Therapy

Salt rock aerosol therapy uses unique rock salt and mechanical grinding until the size of salt particles is 1 to 5 microns. These salt particles have high surface energy and negative charge. Salt particles can be inhaled by patients and can penetrate deep into respiratory system, thickness and glass [13-14].

The patient enters a specially designed treatment room and receives halo therapy. The purpose of the treatment room is to ensure a certain concentration of salt rock aerosol and allow patients to inhale particulate matter by natural breathing. The function of salt particles in respiratory tract is to absorb and remove harmful particles, pathogenic microorganisms and allergens. At the same time, they use high osmotic pressure to break bacterial cell walls to kill pathogens, activate alveoli or macrophages, and finally enhance the body's immune response.

When salt rock aerosol therapy is used to treat mild silicosis and/or chronic obstructive pulmonary disease complicated with bronchitis, it can reduce cough sputum and improve patients' breathing difficulties, which is helpful to improve patients' health and quality of life by regulating the immune response and reducing inflammation [15].

The specific scheme of salt rock aerosol treatment, including the frequency and duration of treatment, is determined by the patient's reaction and illness, and must be carried out under professional guidance to ensure the safety and effectiveness of treatment. Based on the patient's tolerance and reaction, the trajectory should be gradually increased. At the beginning of treatment, it should be several times a week, and each cycle should be 20 to 30 minutes. During the whole treatment process, patients' reactions and the risk of adverse reactions must be monitored to ensure that the treatment is personalized and optimized.

4. Results and Discussion

4.1 Clinical Efficacy of Salt Rock Aerosol Therapy

In order to verify the specific therapeutic effect of salt rock aerosol therapy on patients with chronic obstructive pulmonary disease complicated with silicosis, a comparative experiment is conducted, focusing on the improvement of lung function, changes in quality of life, and changes in inflammatory markers in patients.

The improvement of lung function is shown in Figure 1:

As shown in Figure 1, the maximum forced lung capacity of the treatment group using salt rock aerosol therapy reaches 2.99L, while the control group using conventional treatment has a maximum forced lung capacity of only 2.47L. The increase in forced lung capacity in the treatment group indicates that salt rock aerosols may help reduce airway inflammation, lower airway resistance, and promote the discharge of airway secretions, thereby improving respiratory function.

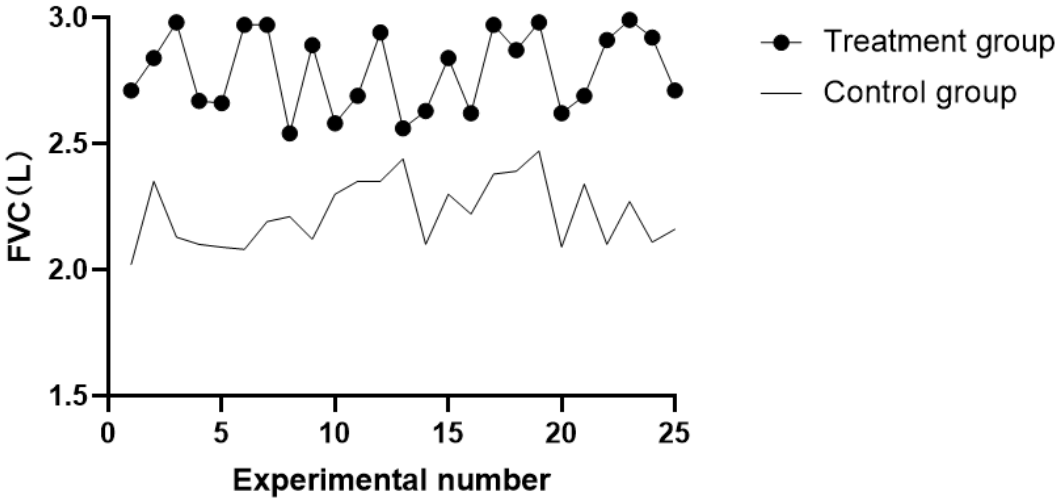

Figure 1: Forced lung capacity

This article uses the total score of the St. George's Respiratory Questionnaire to measure changes in patient quality of life. A higher score indicates poorer quality of life, as shown in Figure 2:

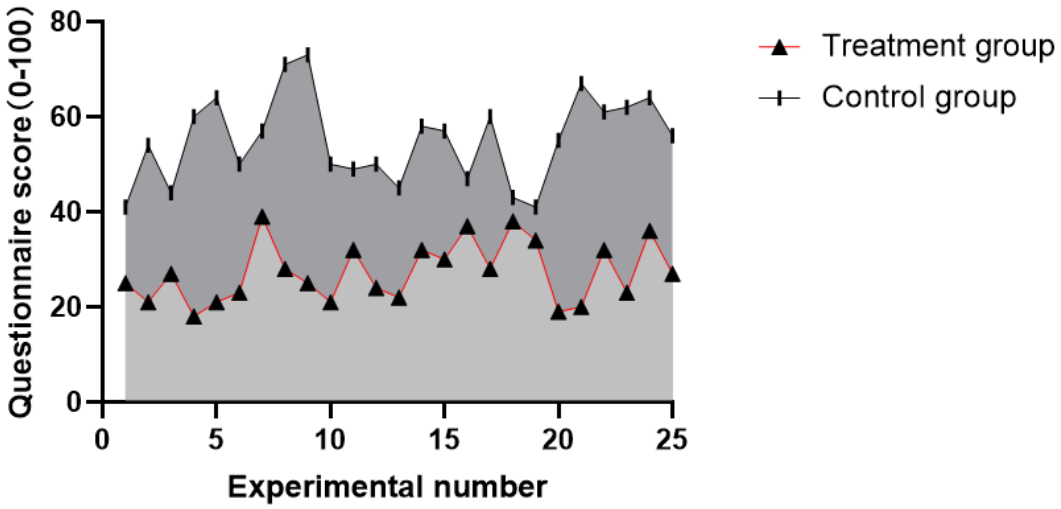

Figure 2: Total score of the St. George's Respiratory Questionnaire

According to the total score data of the St. George's Respiratory Questionnaire in Figure 2, it can be seen that the treatment group has the lowest score of 18, while the control group has the lowest score of 41, indicating that the quality of life of patients in the treatment group is much higher than that of the control group. This difference is related to the improvement of respiratory system symptoms in patients with salt rock aerosol therapy, which reduces breathing difficulties, reduces airway reactivity, and improves respiratory efficiency, all of which directly affect their daily activity ability and psychological state.

As shown in Figure 3, inflammatory markers are measured using C-reactive protein in this study:

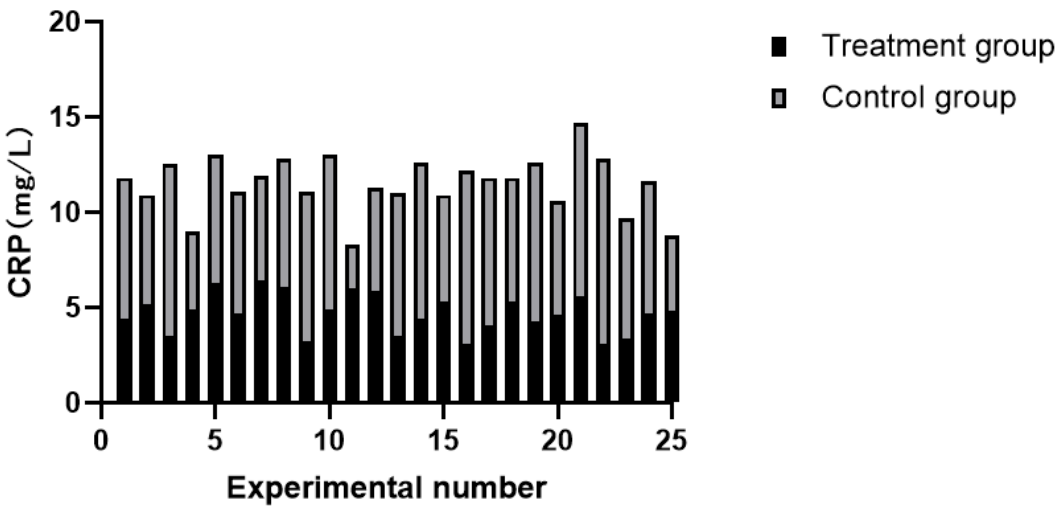

Figure 3: C-reactive protein

Analyzing the data in Figure 3, this article finds that the highest level of C-reactive protein in the treatment group is only 6.4mg/L, while the highest level in the control group is 14.7mg/L. This indicates that particles in salt rock aerosols exert anti-inflammatory effects through various mechanisms, including neutralizing inflammatory mediators, regulating immune cell activity, and promoting the discharge of secretions in the airways, thereby reducing the inflammatory burden on the airways and alveoli.

4.2 Security Assessment

In clinical studies on the application of salt rock aerosol therapy in patients with chronic obstructive pulmonary disease complicated with silicosis, safety assessment focuses on recording and analyzing adverse events that occur during the treatment process. The medical team closely monitors the physical reactions of each patient during treatment, records the time, nature, severity, and duration of all abnormal symptoms, and records the measures taken to address them. These records provide basic data for safety analysis, which involves statistical evaluation of adverse events, including calculating event incidence rates, assessing their correlation with treatment, and exploring possible influencing factors.

In addition, safety analysis also includes a trade-off analysis between treatment risk and efficacy, ensuring the overall safety and effectiveness of treatment. Through this approach, healthcare professionals can make wiser decisions based on data, adjust treatment plans to reduce risks, and ensure treatment outcomes.

4.3 Discussion

Through the above theoretical research and specific experimental verification, it is found that the maximum inspiratory capacity of the treatment group is significantly higher than that of the control group, and the decrease of C-reactive protein level indicates that this therapy has the potential to reduce systemic inflammation. Salt rock aerosol therapy can improve the lung function of patients with salt-rock aerosol by reducing respiratory inflammatory reaction, improving sputum defecation, reducing dyspnea and increasing daily activities. This result is consistent with the positive results of salt rock aerosol therapy found in other studies, so it provides a supplementary understanding of the current research results. However, the study has some limitations, including a relatively small

sample size, which may limit universality.

Based on the limitations of the above research, future research should increase the sample size and carry out randomized controlled and double-blind research to improve the credibility and rigor of the research and conclusions. In addition, further research is being conducted on the long-term efficacy and safety of salt rock aerosol therapy in clinical practice.

5. Conclusions

The purpose of this study is to explore the clinical application value of salt rock aerosol therapy in COPD patients with silicosis. In this article, a randomized controlled trial was conducted to evaluate the changes of lung function, quality of life and inflammation in patients with salt rock aerosol therapy, and a comprehensive safety assessment was made. Studies have confirmed that the treatment of salt rock aerosol is related to the significant improvement of forced vital capacity, the reduction of St. George's respiratory questionnaire score and C-reactive protein level, the improvement of respiratory function and quality of life, and the anti-inflammatory effect of COPD patients with silicosis. Finally, it is concluded that salt rock aerosol therapy is an effective treatment for COPD patients with silicosis. Although the research has produced favorable results in the curative effect of salt rock aerosol on COPD patients with silicosis. However, limitations still exist. First, the sample size is small, which affects the universality and efficacy of the results. In addition, this study uses a relatively short follow-up time to follow up COPD patients with silicosis, and long-term research is needed to evaluate the long-term efficacy and safety of salt rock aerosol treatment. Due to the limitations of current research, future research should expand the sample size, adopt a randomized double-blind controlled design, and try to improve the rigor of the research and the reliability of the results. In addition, the follow-up time is extended to evaluate the long-term efficacy and safety of salt rock aerosol treatment.

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