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Effect of Carbon Fiber Nanotubes Tracheotomy Under Swallowing Training Combined with Bronchoscopic Alveolar Lavage

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ABSTRACT

This study aimed to analyze the effect of carbon fiber nanotube tracheotomy (CFNT) under swallowing training (ST) combined with bronchofiberoscope alveolar lavage (BAL), so as to provide theoretical guidance for the clinical treatment of pulmonary infection. 40 patients with pulmonary infection were selected as the research objects, and the effects of ST combined with BAL were analyzed after CFNT. The patients were randomly divided into four groups: a control group (group A) and three observation groups (groups B, C, and D), with 10 cases in each group. Patients in group A received conventional treatment, patients in group B received conventional treatment + ST, patients in group C received conventional treatment + BAL, and patients in group D received conventional treatment + ST + BAL. The effect of ST + BAL was analyzed after CFNT. The results showed that compared with the group A, the number of lung infections and infection rates in groups C and D was reduced ($P< 0.05$); the use time and per capita cost of antibiotics in group A were much higher than those in the groups C and D ($P< 0.05$); and in group B and D, the number of successful extubation of tracheal catheters and the success rate were greatly increased ($P< 0.05$) and the average time of intubation was dramatically shortened ($P< 0.05$). The scores of the water swallow test (WST) in groups B and D were much lower than the score of group A ($P< 0.05$), and the scores for swallowing ability and swallowing dysfunction scores were much different from those of the group A ($P< 0.05$). In summary, after a CFNT, the lung infection and swallowing function of patients were effectively improved after ST + BAL.

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Introduction

Tracheotomy firstly appeared in a medical classic in India more than 4000 years ago, and it is an extremely ancient surgery (1). Researchers define tracheotomy as a stoma on the front wall of the trachea to establish an artificial airway (2). In the early stages of tracheotomy, people extremely lack surgical experience and knowledge of anatomy, leading to a high mortality rate of this operation, about 73% (3). The emergence of surgical tracheotomy in the early 20th century solved this dilemma. Researchers initially established surgical standards to ensure safety during the operation, and surgical tracheotomy is still used today (4, 5). With the development of medical technology, including the emergence of intensive care and mechanical ventilation, the scope of adaptation of tracheostomy has continued to expand, and it has gradually become the most commonly used surgical airway method (6-8). The early-stage tracheotomy is only used to relieve the acute airway obstruction and establish artificial airways. At present, its scope of use is expanding and can be applied to a variety of diseases in different fields. The main role is to help patients who cannot be intubated through the mouth or nose. The patency of the respiratory tract. It can be divided into six categories. The first category refers to the upper airway obstruction caused by trauma, foreign bodies in the respiratory tract, pharyngitis and other infections, angioedema, neck surgery, oropharyngeal tumors, and obstructive sleep apnea syndrome. The second category refers to the sputum dysfunction of the body caused by impairment of consciousness, cranial injury or peripheral nerve injury, tetanus, major chest and abdomen surgeries, aspiration burns, chronic pneumonia, bronchiectasis, and larynx dysfunction. The third category refers to the retention of secretions

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in the lower respiratory tract caused by coughing and the accumulation of a large number of secretions. The fourth category refers to the peripheral or central respiratory function depression caused by myelitis, poisoning, encephalitis, brain herniation, high fever, spinal cord trauma, bilateral vocal cord paralysis, and drug suppression. The fifth category refers to the cardiopulmonary function damage caused by multiple factors. The last category refers to the case when patients need to ensure the stability of the airway and facilitate drug delivery through the trachea. Patients who require preventive tracheotomy before major operations on multiple sites such as the oral and maxillofacial region, skull, and nasopharynx and neck (9-13).

As one of the important measures to rescue critically ill patients, tracheotomy has saved many patients' lives, but tracheotomy has many disadvantages and complications (14-16). When tracheotomy is performed, the respiratory barrier will be destroyed, and the airway will be directly exposed to the external environment. During this period, bacteria can directly enter the respiratory tract, resulting in a greatly increased probability of pulmonary infection (17-19). According to research statistics, the incidence of pulmonary infection after tracheotomy is in the range of 2.9% - 88.3%, and the highest value is close to 90%. It can be seen that pulmonary infection has become a great interference factor restricting the application of tracheotomy, and it is urgently needed to study and solve it (20, 21). In addition, studies have shown that the difficulty of extubation may occur after tracheotomy. According to statistics, about 2.0%-5.0% of all patients undergoing tracheotomy will face the problem of difficulty in extubation (22-24). Clinical studies have shown that most tracheostomy patients undergoing rehabilitation treatment and care have symptoms such as weakened or disappearing cough and swallowing reflex, decreased sputum excretion, lower respiratory tract obstruction, and atelectasis, which can cause alveolar hypoventilation (25-27). In addition, some severely ill patients undergo rehabilitation treatment and nursing due to severe pulmonary infection, excessive sputum, and difficulty in extubation (28, 29).

Reducing postoperative pulmonary infection in patients undergoing tracheotomy, restoring swallowing function, increasing extubation rate, reducing economic costs, and achieving faster and better recovery are important clinical issues that need to be resolved. Swallowing training (ST) and alveolar lavage are commonly used nursing treatments. Dysphagia is a manifestation of obstacles in the process of food transportation from the oral cavity to the stomach, and ST can effectively alleviate the dysphagia and restore the swallowing function (30-32). Alveolar lavage is also called lung lavage. It is mainly used to deliver normal saline to the distal bronchi and alveoli through a bronchoscope. After a period of deposition, the liquid is sucked out through the bronchoscope to achieve the effect of lavage (33). Alveolar lavage is an invasive operation method. Therefore, it is necessary to ensure that the operation process conforms to the specifications to avoid the risk of secondary infection and tracheal hemorrhage.

In order to analyze the effect of carbon fiber nanotube tracheotomy (CFNT) under ST combined with bronchofiberoscope alveolar lavage (BAL), a total of 40 tracheostomy patients were admitted to the Department of Rehabilitation Medicine of Hunan Provincial People’s Hospital from January 2019 to December 2021 were selected. The patients were randomly divided into four groups: a control group (group A) and three observation groups (groups B, C, and D), with 10 cases in each group. Patients in group A received conventional treatment, patients in group B received conventional treatment + ST, patients in group C received conventional treatment + BAL, and patients in group D received conventional treatment + ST + BAL. The effect of ST plus BAL after CFNT was analyzed in this study, so as to provide theoretical guidance for clinical treatment of pulmonary infection.

Materials and methods

Research objects

A total of 40 tracheostomy patients admitted to the Department of Rehabilitation Medicine of Hunan Provincial People’s Hospital from January 2019 to December 2021 were selected. The patients were randomly divided into four groups: a control group (group A) and three observation groups (groups B, C, and D), with 10 cases in each group. This study had been approved by the Medical Ethics Committee of Hunan Provincial People's Hospital, and all patients and their families signed the informed consent.

Patients in this study had to meet the following criteria: patients who underwent tracheotomy; patients with a clear mind and able to cooperate with rehabilitation nursing training; patients without other interventional treatment measures before the surgery; and patients without any checkup contraindications.

Patients meeting the below equations had to be excluded: patients in critical condition; patients with severe cardiopulmonary or liver and kidney diseases; patients with mental diseases who can't cooperate with rehabilitation nursing treatment; patients with contraindications to bronchoscopy alveolar lavage; and patients who disagreed with the consent form.

Routine rehabilitation nursing and treatment methods

Patients in groups A, B, C, and D underwent conventional rehabilitation care and treatment after tracheotomy according to the following content. Firstly, it shall strictly manage the ward, disinfect the ward every day, ventilate it in time, maintain the air circulation in the ward, and restrict family visits. Secondly, the management of the airway is mainly to strengthen humidification and standardize sputum suction operations, the time should not exceed 15 s, and it had to ensure the aseptic environment of the operation process. Professionals should closely observe the patient's sputum condition. When the patient was in the semi-recumbent position, it had to ensure the frequency of turning over and pat the back once every 2 hours, and perform ultrasonic atomization to inhale the diluted sputum medicine into the body at the same time as the sputum is discharged, so as to promote the normal implementation of sputum and basic care. It had to focus on the nutritional support and treatment of the patient, improve the patient’s immunity to strengthen the physical fitness. Finally, it should ensure the normal rehabilitation of the patient’s trunk and limb joints such as active and passive activities.

ST

Patients in groups B and D underwent ST after tracheostomy. Patients can choose to perform ST in a sitting or semi-sitting position. The patient's bilateral temporomandibular joints and the masticatory muscles were massaged for about 1 - 2 minutes. A long-frozen cotton swab was taken to massage the cheeks on both sides to ensure proper strength and press until the skin is slightly red, and the massage should last 2 - 3 times. Multiple acupoints were simulated, including Renzhong, Dicang, Chengjiang, Jiache, Lianquan, and Shangxiaguan, which should be repeated 5 times in total. A long-frozen cotton swab was extended into the mouth to stimulate the soft palate, isthmus, the base of the tongue, the back wall of the pharynx, and the Jinjinyuye point in the cold state. At this time, the patient had to cooperate with empty swallowing action. Above operations should be repeated 5 times. The complete process of lip exercises should be completed in the order of opening the mouth, closing the lips, inflating, gargling left and right, sucking the lips, licking the lips, grinning the lips, and rounding the lips, which should be repeated 5 - 10 times. The patient completed the whole process of tongue exercises in accordance with the tongue stretching, tongue shrinking, tongue swinging, tongue on stage, tongue flat, tongue left and right top cheeks, tongue popping, tongue stirring inside and outside, tongue licking the upper and lower lips, tongue swinging inside and out, repeating continuously 5-10 times. The speech-building training was carried out: the patient was required to open his mouth as required to pronounce "a", "ka", "ta", "pa", and "wu" in sequence, repeating 5 - 10 times in a row. Breathing training was about 35 minutes. The patient fully inhaled, held his breath, swallowed, and finally exhaled, repeating 3 - 8 times in total.

BAL

Patients in groups C and D underwent alveolar lavage following tracheotomy. Firstly, it could choose different lavage sites based on different types of lung diseases. If the patient had diffused interstitial lung disease, it can choose the left lingual segment or right middle lobe (B1 or B5) as the lavage site. While for localized lung disease, it is necessary to complete the BAL in the corresponding bronchopulmonary segment wash. The specific steps of BAL were as follows. Firstly, it should locally anesthetize the lavage site, and inject 1-2 mL lidocaine (2%) through the biopsy hole through a silicone tube. The top of the bronchoscope was wedged tightly at the opening of the segment or sub-segment bronchus and continued to deliver sterile saline (37°C) through the silicone tube, 25-50 mL/time, with about 100 - 250 mL in total. Immediately after the injection of physiological saline was completed, the lavage fluid was drawn and recovered with a negative pressure of 50 - 100 mmHg (1 mmHg = 0.133 kPa). Generally, the recovery rate is about 40% - 60%. The double-layer sterile gauze was adopted to filter and absorb the liquid and record the volume of the liquid. The filtered recovered liquid was placed in a silicon-coated sterilized glass container or a silicon-plastic bottle and then transported to the laboratory for inspection under the condition of ice insulation.

Observation indicators

After 30 days of rehabilitation care and treatment, the corresponding indicators were evaluated, including the number of cases of pulmonary infection, use time and per capita cost of antibiotics, number of successful extubation of tracheal catheters and extubation rate, and average time of indwelling tracheal tube of patients in different groups. The water swallow test (WST) was used to evaluate the swallowing function of the four groups of patients. The patients were in a sitting posture, drinking 30 mL of water at a suitable temperature so that the required time and coughing conditions can be observed, and the levels can be evaluated. There were 5 levels in total. Level 1 meant that 30 mL of water can be swallowed safely at one time, level 2 meant that all water can be swallowed twice without coughing, level 3 meant that 30 mL of water can be swallowed once with a cough, and level 4 meant drinking had to in 2 times and there was a cough, and level 5 meant that it can't swallow all, and it had to keep choking. The lower the level, the more normal and perfect your swallowing function was.

Statistical methods

SPSS was adopted to statistically analyze the data. Data that conformed to normal distribution were represented by mean ± standard deviation (mean ± S), using the t-test. The chi-square (χ^2) test was used to represent count data, and $P< 0.05$ indicated a statistical difference.

Results and discussion

Results on pulmonary infection of patients

The infection status and infection rate of patients in all groups were observed and calculated. It was found that the number of pulmonary infection cases in group A was 10, which was significantly different from that in groups C and D ($P< 0.05$). In addition, groups C and D showed the least number of infection cases, and the differences were significant compared with group B ($P< 0.05$). Compared with group A, the infection rates in group B and group D were much lower ($P< 0.05$). The specific results were shown in Figure 1

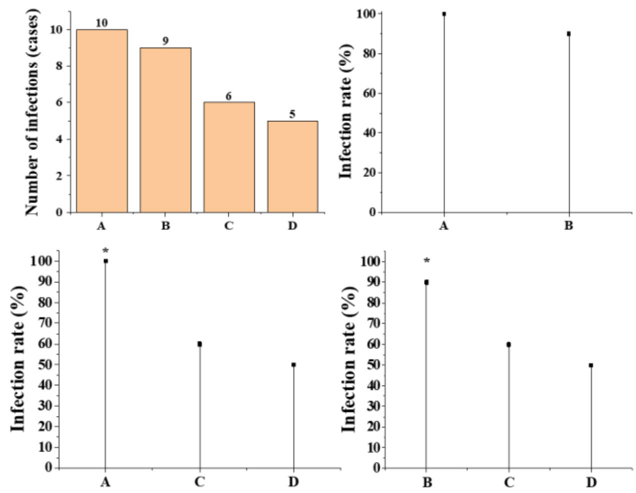

Figure 1. Comparison of the number of pulmonary infections and infection rate. Note: * suggested that the difference was statistically obvious ($P< 0.05$).

Antibiotic use results

The use of antibiotics of patients was recorded and compared. The results showed that the use time of antibiotics in group A was greatly higher than that of groups C and D ($P< 0.05$), and the per capita cost of antibiotics was higher than in group C and D, showing a statistical great difference ($P< 0.05$). The specific results were shown in Figure 2 and Figure 3.

The success rate of tracheal catheter extubation

The number of successful extubation of tracheal catheters and the success rate of extubation was recorded and calculated. It was found that the number of successful extubation of tracheal catheters was 7 in group A, and the extubation success rate was lower than that of groups B and D, showing statistically obvious differences ($P< 0.05$); and the extubation success rate of groups B and D was statistically different from that of group C ($P< 0.05$). The specific results were shown in Figure 4.

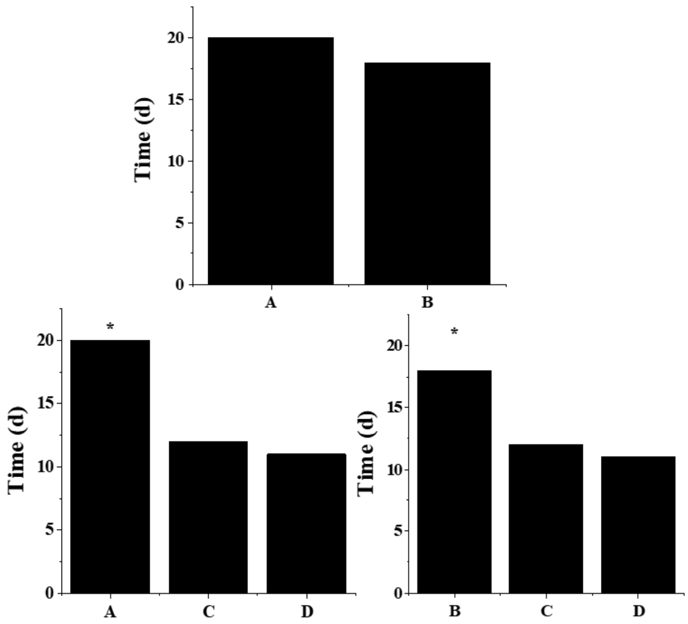

Figure 2. Comparison of use time of antibiotics.Note:*suggested that the difference was statistically obvious($P< 0.05$).

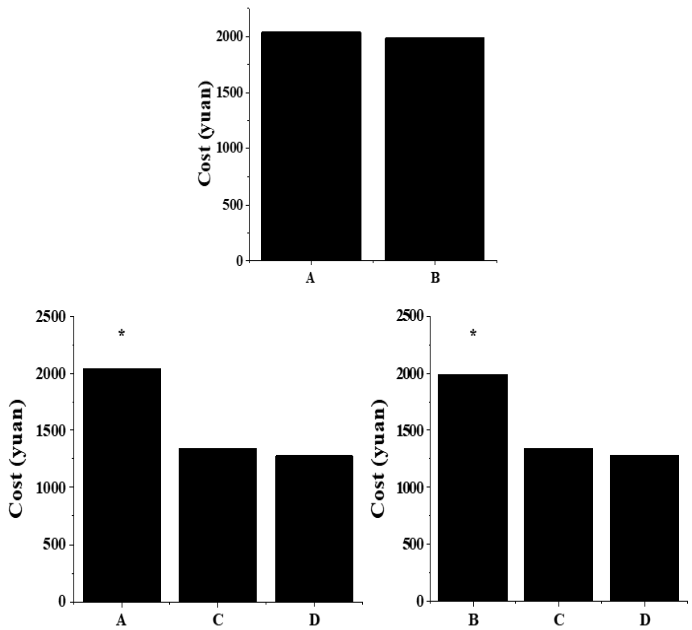

Figure 3. Comparison of per capita cost of antibiotics. Note: * suggested that the difference was statistically obvious ($P< 0.05$).

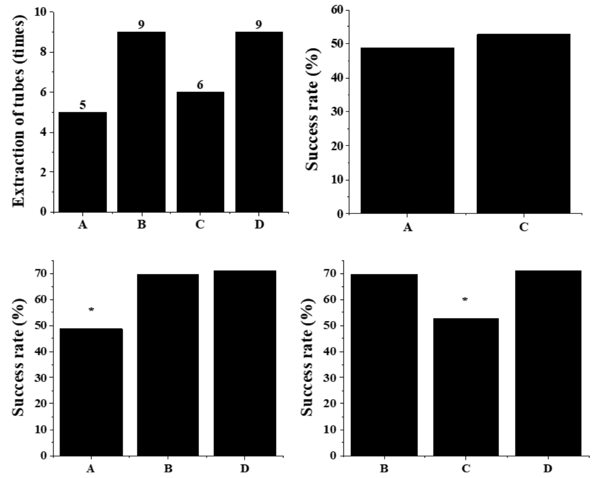

Figure 4. Comparison of the number of successful extubation of tracheal catheters and the success rate of extubation. Note: * suggested that the difference was statistically obvious ($P< 0.05$).

Calculation results of indwelling tracheal cannula time in each group

The average time of indwelling tracheal tube in each group was observed and recorded. The results showed that compared with group A, the average time of indwelling tracheal tube in group C and group D was much shorter ($P< 0.05$), and that in group B did not change greatly ($P> 0.05$). The specific results were shown in Figure 5.

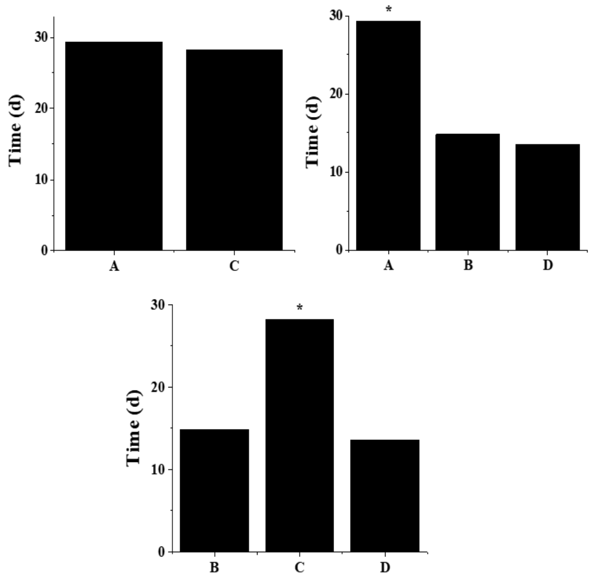

Figure 5. Comparison of indwelling tracheal cannula time. Note: * suggested that the difference was statistically obvious ($P< 0.05$).

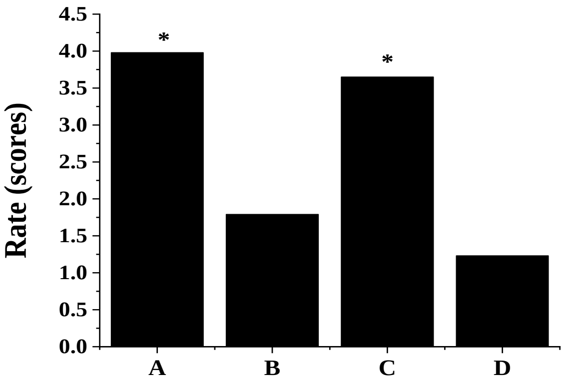

Figure 6. Comparison of WST scores of patients in each group. Note: * suggested that the difference was statistically obvious (P< 0.05).

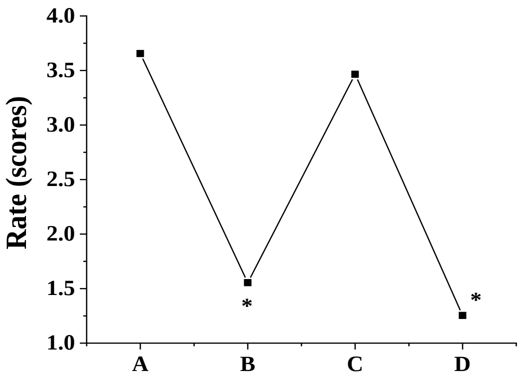

Figure 8. Comparison of swallowing dysfunction assessment method scores of patients in each group. Note: * suggested that the difference was statistically obvious (P< 0.05).

Evaluation results of swallowing function of patients in each group

WST was used to evaluate the swallowing function of the four groups of patients (P> 0.05). The results showed that compared with group A, the WST scores of group B and group D were much lower (P< 0.05), and the difference between group C and group A was not significant (P> 0.05). The specific results were shown in Figure 6. The results of swallowing ability assessment method and swallowing dysfunction assessment method both showed that the score in group A was significantly different from group B and group D (P< 0.05), and it was not statistically significant in group C (P> 0.05). The specific results were illustrated in Figure 7 and Figure 8.

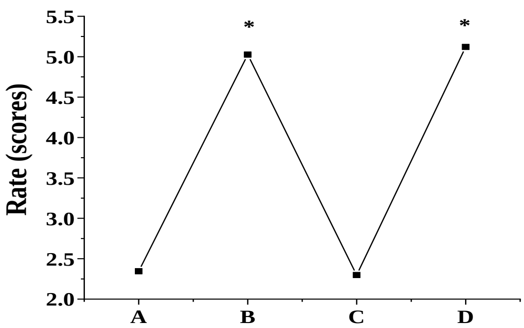

Figure 7. Comparison of swallowing ability scores of patients in each group. Note: * suggested that the difference was statistically obvious (P< 0.05).

At present, tracheotomy has become one of the important measures for the rescue of critically ill patients. It can promptly and effectively remove respiratory secretions, relieve respiratory obstruction, and increase respiratory gas exchange. However, tracheotomy has many disadvantages and complications, including postoperative pulmonary infection and dysphagia. During tracheotomy, the airway barrier will be destroyed, directly connecting the airway with the external environment. During this period, bacteria can directly enter the respiratory tract, leading to a greatly increased probability of pulmonary infection, which makes patients who are recovering from tracheotomy as a highly susceptible group to pulmonary infection. Therefore, it is extremely important for the postoperative rehabilitation nursing treatment of patients undergoing catheterotomy(34). With the rapid development and continuous attention of rehabilitation medicine, a variety of postoperative rehabilitation nursing treatment methods for tracheotomy have appeared in people's sight. Rehabilitation treatment has advanced medical concepts and treatment methods, which have penetrated and penetrated the entire treatment process of patients to achieve the purpose of helping patients heal better and faster and recover health. Relieving postoperative pulmonary infection, restoring swallowing function, increasing extubation rate, and reducing economic costs are important issues that need to be resolved in clinical rehabilitation care. ST and alveolar lavage are commonly used nursing treatments.

In order to analyze the effect of carbon fiber nanotube tracheotomy (CFNT) under ST combined with bronchofiberoscope alveolar lavage (BAL), a total of 40 tracheostomy patients were admitted to the Department of Rehabilitation Medicine of Hunan Provincial People's Hospital from January 2019 to December 2021 were selected. The patients were randomly divided into four groups: a control group (group A) and three observation groups (groups B, C, and D), with 10 cases in each group. Patients in group A received conventional treatment, patients in group B received conventional treatment + ST, patients in group C received conventional treatment + BAL, and patients in group D received conventional treatment + ST + BAL. After CFNT was performed, the effect of ST combined with BAL was analyzed. The results of postoperative pulmonary infection showed that the number of pulmonary infection cases in group A was 10, which was much higher than that in group C and group D (P< 0.05). The infection rate was the least, and the difference was significant compared with group B (P< 0.05). At the same time, the results showed that the use time and per capita cost of antibiotics in group A were greatly higher than those of group C and group D (P< 0.05), indicating that based on routine rehabilitation care, BAL can significantly improve postoperative pulmonary infection. In addition, the results revealed that the number of successful extubation of tracheal catheters was 7 in group A, and the success rate of extubation was lower than that of groups B and D, showing statistically significant differences (P< 0.05). The average time of indwelling tracheal catheters in group A was observably higher than that in groups B and D (P< 0.05). WST scoring results showed that the score in group A was much higher than group B and group D (P < 0.05), but not significantly different from group C (P> 0.05). The results of the swallowing ability assessment method and swallowing dysfunction assessment method both showed that the score in group A was significantly different from the scores in group B and group D (P< 0.05), but not statistically from group C (P> 0.05). It suggests that on the basis of routine rehabilitation care, post-ST can significantly improve patients' dysphagia after surgery. Some studies have added comprehensive rehabilitation training and care to patients after tracheotomy, which effectively reduces the occurrence of pulmonary infection, greatly shortens the time for patients to take the tube, and promotes better and faster recovery of patients. Such conclusions are in line with the results of this study (35, 36). At the same time, in this study, the treatment of ST had significantly improved the swallowing function of patients after surgery. Therefore, the application of ST combined with BAL in the rehabilitation care of CFNT showed a good therapeutic effect.

Conclusions

In order to analyze the effect of carbon fiber nanotube tracheotomy (CFNT) under ST combined with bronchofiberoscope alveolar lavage (BAL), a total of 40 tracheostomy patients were admitted to the Department of Rehabilitation Medicine of Hunan Provincial People's Hospital from January 2019 to December 2021 were selected. The patients were randomly divided into four groups: a control group (group A) and three observation groups (groups B, C, and D), with 10 cases in each group. Patients in group A received conventional treatment, patients in group B received conventional treatment + ST, patients in group C received conventional treatment + BAL, and patients in group D received conventional treatment + ST + BAL. The effect of ST combined with BAL after CFNT was analyzed to provide theoretical guidance for the clinical treatment of pulmonary infection. The results showed that the combined use of ST and BAL rehabilitation nursing treatment after trachelectomy can significantly reduce the occurrence of postoperative pulmonary infection, reduce the use time and cost of antibiotics, increase the success rate of tracheal catheter extubation, and shorten the patient's postoperative indwelling time. At the same time, the swallowing function of patients after tracheotomy was effectively improved. The ST and BAL combined nursing methods provided great help for the recovery process of patients after CFNT and had a significant nursing effect. The shortcomings of this study were that the research objects were of small size and simple source, which restricted the randomness and wide applicability of the results of this study. In subsequent studies, analysis and research of multiple locations, multiple types, and large sample sizes would be considered to provide a more practical and effective reference value for the application of ST combined with BAL after tracheotomy.

Acknowledgments

Not applicable.

Conflict interest

The authors declare that they have no conflict of interest.

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