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Effect of sequential respiratory training on patients with stable chronic obstructive pulmonary disease: a randomized controlled clinical trial

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Abstract

Objective: To explore the effect of sequential respiratory training rehabilitation methods on the pulmonary function of patients with stable chronic obstructive pulmonary disease.

Methods: This is a randomized controlled clinical trial. A total of 200 cases of stable chronic obstructive pulmonary disease patients were recruited from June 2014 to May 2015 in the respiratory medicine clinic, which were randomly divided into sequential breathing training group and control group. Forced expiratory volume in the first second (FEVI%), British Medical Research Council (mMRC) questionnaire, Chronic Obstructive Pulmonary Disease Assessment Test (CAT) score, the number of acute exacerbation frequency were and 6-minute walk test (6MWT) were assessed after treatment for 3, 6 and 12 months.

Results: During the 12-month follow-up period, a total of 170 patients had complete follow-up information. There were 85 patients both in sequential breathing training group and control group. In the experimental group, there were 59 males and 26 females, with an average age of (65.02 ± 7.84) years. In the control group, there were 64 males and 21 females, with an average age of (64.96 ± 7.02) years. After treatment for 3, 6 and 12 months, FEVI%, mMRC score, CAT score, the number of acute exacerbation frequency and 6MWT were all significantly improved in the experimental group than control group ($p<0.05$).

Conclusion: Sequential breathing training therapy can better improve the pulmonary function of stable chronic obstructive pulmonary disease patients and distinctly reduce the incidence of acute exacerbation of chronic obstructive pulmonary disease, which provides a basis for clinical rehabilitation.

Trial registration: This study was registered in the Chinese Clinical Trials Registry Platform (ChiCTR-OPC-14005290).

Abbreviations: mMRC: British Medical Research Council; CAT: COPD Assessment Test; 6MWT: 6-minute walk test; SD: standard deviation; BMI: body mass index.

Introduction

Chronic obstructive pulmonary disease is one of the most common respiratory system diseases worldwide (approximately 11.7% prevalence), characterized by small airway obstruction and emphysema [1]. The most common risk factors for chronic obstructive pulmonary disease are smoking and other environmental factors [2]. The main method of controlling stable chronic obstructive pulmonary disease is to inhale long-acting bronchodilators [3]. In addition to quitting smoking, there are currently no effective methods to slow down the progress of chronic obstructive pulmonary disease [3,4]. Thus, there is a need to develop novel therapies for chronic obstructive pulmonary disease [5].

Pulmonary rehabilitation training has been considered as the main recommended therapy in the non-pharmacological treatment of chronic obstructive pulmonary disease prevention and treatment [6,7]. The methods involved mainly include exercise therapy, social psychological support, behavioral intervention, and publicity and education, and the core is respiratory training [8-10]. Studies have shown that lung rehabilitation can improve the exercise capacity and life quality of chronic obstructive pulmonary disease patients, including dyspnea, fatigue, and mood [11-13]. Its curative effect evaluation index is relatively comprehensive, basically covering the control of symptoms, daily activity ability, exercise ability, hospital admission rate and utilization of social health resources [14,15]. Nevertheless, these studies also have problems such as incomplete rehabilitation methods and lack of systemicity [16]. Also, there is still a big gap between the current status of domestic lung rehabilitation and the multidisciplinary team of lung rehabilitation. In this study, we proposed a practical, effective, and convenient method for patient application, effective sequential respiratory rehabilitation treatment of chronic obstructive pulmonary disease patients and evaluation of rehabilitation efficacy, which can provide a basis for better rehabilitation treatment for clinical chronic obstructive pulmonary disease patients.

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Key words: *stable chronic obstructive pulmonary disease; sequential respiratory training; 6-minute walk test; pulmonary function; respiratory rehabilitation*

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Materials and methods

Participates

According to the diagnosis and classification standards of the revised guidelines of the 2014 Global Initiative for Chronic Obstructive Pulmonary Disease, a total of 200 chronic obstructive pulmonary disease patients (aged 45-65 years) with pulmonary grades II-III grade and in stable phase were included in this study between June 2014 to May 2016 in the Jinhua People's Hospital. The exclusion criteria were as follows: patients with hypertension, diabetes, coronary heart disease, severe bronchial asthma, cardiomyopathy, malignant tumors, allergic disease, bronchiectasis, severe liver and kidney disease and other infectious, trauma, hematopoietic system diseases, nervous system diseases, mental system diseases, autoimmune system diseases, active tuberculosis, gout, stroke, pregnant women, lactating women and so on. This study was approved by the ethics committee of School of Medicine, Jinhua Polytechnic (2014035). This study was registered in the Chinese Clinical Trials Registry Platform (ChiCTR-OPC-14005290).

Treatment and assessment

All patients were comprehensively evaluated before enrollment, including CAT questionnaire, 6-minute walk test, pulmonary ventilation function assessment, and acute exacerbation risk assessment. These patients were randomly divided into sequential breathing training group (experimental group) and control group. The sequential breathing training group was given sequential breathing training based on conventional medicine, while the control group was given single breathing training based on conventional medicine. The CAT questionnaire score, 6-minute walking distance test, acute exacerbation risk assessment, and pulmonary ventilation function assessment were performed on the two groups of patients at 3, 6, and 12 months after the experiment. During the 12-month follow-up period, the patient returned to the hospital for further treatment if the symptoms worsened again. During the follow-up period, the frequency of acute chronic obstructive pulmonary disease exacerbation of the two groups of patients was counted. Finally, a total of 170 patients completed follow-up and 30 were lost to follow-up. The indicators monitored during training were as follows: target heart rate; fingertip blood oxygen SpO_2>90%; blood pressure<200/100mmHg; Borg index<5 (more severe shortness of breath). The frequency of sequential breathing training was 3 times a week and lasted for 12 weeks.

Sequential breathing training methods were as follows: (1) Abdominal breathing: patient was taken a supine position; hip and knee joints were slightly bent, and the whole body was in a comfortable position. Patient put his right hand on his abdomen and his left hand on his chest. He took a deep breath, concentrated his thoughts, and allowed the patient to feel the hand change during inhalation and exhalation. The training time was 15 minutes, twice a day. (2) Contract lips after reaching the previous goal: during abdominal breathing, patient inhaled and exhaled with the nose and closed the lips slightly, and gently exhaled the gas. The ratio of inhalation to exhalation was from 1:2. The goal of exhalation ratio was 1: 4, the training time was 15 minutes, twice a day. (3) After reaching the previous goal, the abdominal weight-bearing method was used to strengthen the training of respiratory muscles: the abdominal breath was used to resist the abdominal heavy objects. The patient was still knee flexion and supine position, added a small sandbag on the upper abdomen, the weight of the sandbag was to target the load that could complete 10 abdominal breaths, and gradually increased the amount, 10 times per process and lasted for 15 minutes twice a day. (4) After reaching the previous goal, upper limb muscle training was performed: lifting weights (small sandbags 250-500g) each group lift 15 times, 3 groups each time, twice a day. (5) Lower limb muscle training after reaching the previous goal: level walking training for 15 minutes, twice a day.

Statistical analysis

All statistical analysis was implemented using SPSS21.0 software. Normally distributed data were expressed as mean ± standard deviation (SD), and non-normally distributed data were presented as median (interquartile range). Normally distributed data were compared with the student's t test, while non-normally distributed data were compared with the non-parametric test. Count data was evaluated using χ^2 test. $P<0.05$ indicated statistical significance.

Results

General characteristics of participants

There were 85 patients in sequential breathing training group (experimental group), including 59 males and 26 females, with an average age of (65.02 ± 7.84) years. There were 85 patients in the control group, including 64 males and 21 females, with an average age of (64.96 ± 7.02) years. Before the experiment, there were no statistical differences in the average age, gender, body mass index (BMI), pulmonary function assessment (FEV1% predicted value), CAT score, mMRC score, 6-minute walk test (6MWT), and the number of acute exacerbations within one year between the two groups (Table 1).

Comparison of pulmonary function between the experimental and control groups before and after treatment

There was no significant difference in FEVI% between experimental and control groups before treatment. After 3 months, 6 months and 12 months of treatment, the FEVI of patients in experimental or control groups was significantly higher compared to before treatment. Compared with the control group, patients in the sequential breathing training group had significantly higher FEVI% after treatment for 3 months, 6 months and 12 months in Table 2. Thus, sequential breathing training could improve pulmonary function of patients with chronic obstructive pulmonary disease.

Comparison of 6MWD between the experimental and control groups before and after treatment

Before treatment, there was no significant difference in the 6MWD between experimental and control groups. After treatment for 3, 6 and 12 months, the 6MWD of the two groups of patients was significantly higher compared to before treatment. Compared with the control group after treatment, the 6MWD of the sequential breathing training group was significantly improved, as listed in Table 3.

Comparison of CAT and mMRC scores of between the experimental and control groups before and after treatment.

The CAT and mMRC scores of the experimental and control groups of patients before and after treatment were compared. The results showed that the CAT scores of the two groups of patients were distinctly decreased with time. Compared with before treatment, there were statistical significances in CAT scores after treatment for 3, 6 and 12 months both in the two groups (Figure 1). The experimental group had a significantly lower CAT scores than the control group. Moreover, both in the two groups after treatment for 3, 6 and 12 months had notably higher mMRC scores than before treatment. There were significantly higher mMRC scores in experimental group compared to control group after treatment for 3, 6 and 12 months (Figure 2).

Table 1. General characteristics of participants in the experimental and control groups

Characteristics	Experimental group (n=85)	Control group (n=85)	P-value
Sex			>0.9999
Male (%)	59 (69.41)	64 (75.29)	
Female (%)	26 (30.59)	21 (24.71)	
BMI (x ± s, kg/m^2)	21.55 ± 3.17	21.13 ± 2.26	0.3213
FEVI (x ± s, %)	58.70 ± 6.12	58.43 ± 5.15	0.7560
CAT score (x ± s)	27.40 ± 2.61	27.32 ± 3.13	0.8566
mMRC score (x ± s)	2.32 ± 0.10	2.25 ± 0.21	0.0062
6MWT (x ± s, m)	278.25 ± 8.13	275.95 ± 9.34	0.0887
Number of acute exacerbations within 1 year (x ± s)	1.96 ± 0.20	1.85 ± 0.40	0.0791

Table 2. Comparison of pulmonary function between the experimental and control groups before and after treatment

	FEVI		P-value
	Experimental group (n=85)	Control group (n=85)	
Before treatment	1.01 ± 0.08	1.03 ± 0.19	0.75
3-months treatment	1.15 ± 0.23	1.07 ± 0.21	0.04
6-months treatment	1.32 ± 0.26	1.12 ± 0.22	<0.01
12-months treatment	1.37 ± 0.27	1.14 ± 0.23	<0.01
P-value	<0.01	0.007	—

Table 3. Comparison of 6MWD between the experimental and control groups before and after treatment

	6MWD		P-value
	Experimental group (n=85)	Control group (n=85)	
Before treatment	375.07 ± 21.72	377.19 ± 24.61	0.65
3-months treatment	409.07 ± 33.17	392.93 ± 28.34	0.01
6-months treatment	439.52 ± 32.32	397.49 ± 26.95	<0.01
12-months treatment	467.30 ± 27.98	402.15 ± 24.06	<0.01
P-value	<0.01	<0.01	—

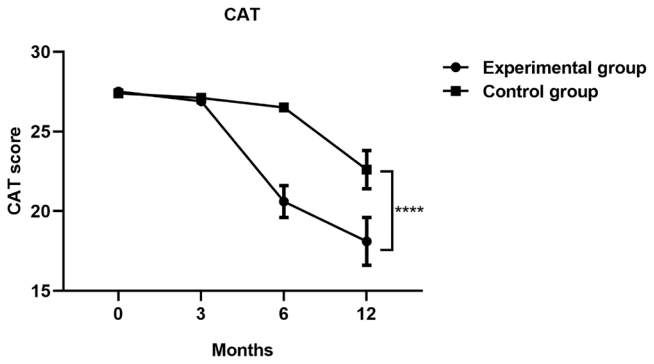

Figure 1. Comparison of CAT scores of between the experimental and control groups before and after treatment

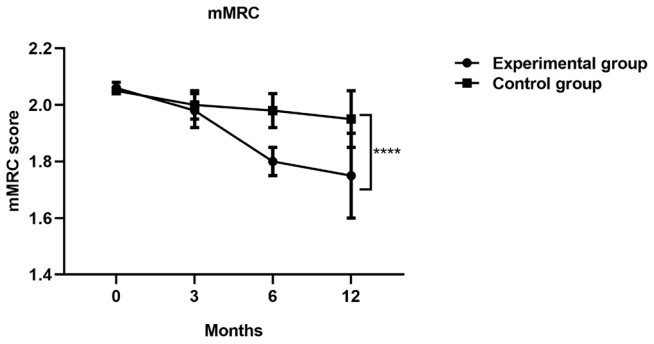

Figure 2. Comparison of mMRC scores of between the experimental and control groups before and after treatment

Discussion

Pulmonary rehabilitation has gradually been utilized to treat chronic obstructive pulmonary disease patients with dyspnea and exercise endurance, which has become one of the important means for the treatment of chronic obstructive pulmonary disease in the stable period [17-19]. The clinical application of lung rehabilitation has achieved considerable results [20]. For example, studies have found that lung rehabilitation can not only delay chronic obstructive pulmonary disease patients' illness and relieve symptoms of dyspnea, but also restore lung function and improve motor function [21-23]. However, at present, a unified standard for rehabilitation therapy has been not established. Moreover, physicians engaged in respiratory specialties have not yet recognized the role of rehabilitation therapy in improving lung function and quality of life in patients with chronic obstructive pulmonary disease [24]. In this study, we performed a randomized controlled clinical trial to investigate the effect of sequential respiratory training on stable chronic obstructive pulmonary disease. Our results suggested that sequential respiratory training can significantly improve FEVI%, mMRC score, CAT score, the number of acute exacerbation frequency and 6MWT for stable chronic obstructive pulmonary disease. Thus, sequential respiratory training could become a potential therapy for pulmonary rehabilitation.

Many studies have confirmed that mMRC and CAT can well reveal the characteristics of chronic obstructive pulmonary disease [25-27]. However, mMRC score is a one-dimensional measurement that can only quantify dyspnea. The CAT score is a multi-dimensional method that can evaluate 8 items; not only dyspnea, but also other symptoms and health conditions. Moreover, it has the advantage of being easy to implement and can be associated with clinically important variables

such as FEVI% and acute exacerbation. Therefore, utilization of CAT to evaluate the quality of life of patients with chronic obstructive pulmonary disease can help doctors judge the patient's condition, which is scientific and reliable [28-30]. In our study, we compared the difference between the effects of sequential respiratory training and basic conventional methods on the lung function and quality of life scores of patients with stable chronic obstructive pulmonary disease. We selected CAT and mMRC scores as evaluation criteria for chronic obstructive pulmonary disease. The results showed that the sequential breathing training method can effectively improve the FEVI% level of lung function in chronic obstructive pulmonary disease patients after treatment for 3, 6 and 12 months. Previous studies have demonstrated the correlation between CAT and 6MWT [31]. 6MWT has been considered to be a crucial indicator of exercise tolerance in chronic obstructive pulmonary disease patients, which is in significant association with mortality [11]. In this study, 6MWT was examined to assess functional walking ability as well as the treatment response of sequential breathing rehabilitation training of chronic obstructive pulmonary disease. Our results suggested that sequential breathing training can increase the patient's six-minute walking distance, thereby improving their exercise tolerance.

In summary, sequential breathing training strategy for chronic obstructive pulmonary disease is not only limited to the rehabilitation of patients' lung function, but can also be extended to improve the patient's motor function and quality of life, which is worthy of clinical application.

Conclusion

Our findings revealed that sequential breathing training therapy can distinctly improve FEVI%, mMRC score, CAT score, the number of acute exacerbation frequency and 6MWT for stable chronic obstructive pulmonary disease compared to basic routine treatment. Thus, sequential breathing training therapy can better improve the pulmonary function as well as acute exacerbation incidence for stable chronic obstructive pulmonary disease patients, which is worthy of further clinical exploration.

Declarations

Acknowledgements

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Availability of data and material

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

Mingxing Ding conceived and designed the study. Xiaobing Wang, An Guo conducted most of the experiments and data analysis, and wrote the manuscript. Honggang Wang, Wei Huang participated in collecting data and helped to draft the manuscript. All authors reviewed and approved the manuscript.

Ethics approval and consent to participate

The study was approved by the Ethics Committee of School of Medicine, Jinhua Polytechnic (2014035).

Consent for publication

All subjects were informed consent.

Conflicts of Interest

The authors declare no conflicts of interest.

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