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Effects of Staged Respiratory Rehabilitation Training on Pulmonary Function, Self-efficacy and Exercise Ability in Patients with COPD

Ruijian Cao [1,*], Hui Liu [1]

[1.] Xiaoshan Hospital of Traditional Chinese Medicine, Yucai Road No. 152, Xiaoshan District, 311201 Hangzhou, China

Keywords

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* **Correspondence**

Ruijian Cao

Xiaoshan Hospital of Traditional Chinese Medicine, Yucai Road No. 152, Xiaoshan District, 311201 Hangzhou, China

E-mail: caoruijian@126.com

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Abstract

Objective: To analyze the effects of staged respiratory rehabilitation training on pulmonary function, self-efficacy and exercise ability in patients with stable chronic obstructive pulmonary disease (COPD). **Methods:** 90 patients with stable COPD in our hospital from May 2018 to June 2019 were selected and divided into a control group and an observation group by the random number table method (45 cases/group). Routine respiratory rehabilitation training was adopted in patients in the control group while patients in the observation group were given staged respiratory rehabilitation training. The pulmonary function, quality of life, exercise ability and self-efficacy of the patients in two groups were compared. **Results:** After training, the levels of forced expiratory volume in the first second (FEV_1), six minute walking distance (6MWT) and maximum oxygen consumption (VO_2 max), the ratio of forced expiratory volume in the first second to forced vital capacity (FEV_1/FVC) as well as general self-efficacy scale (GSEs) score of patients in both groups were upregulated, and these indexes in the observation group were higher than those in the control group. Meanwhile, symptom score, impact score, activity score and total score of St George's respiratory questionnaire (SGQR), as well as the British Medical Research Council Dyspnea Scale (MMRC) in patients in both grops, were declined after treatment, and these indexes in the observation group were lower than those in the control group. **Conclusion:** Staged respiratory rehabilitation training can effectively improve the pulmonary function, exercise ability, self-efficacy and quality of life of COPD patients.

1 Introduction

Chronic obstructive pulmonary disease (COPD) is a common respiratory disease with high incidence and morbidity rates, which poses major threats to the life and health of people [1]. Recent studies [2] have found that respiratory rehabilitation training can effectively improve pulmonary function in stable COPD patients. However, its effect is seriously affected due to the poor compliance of some patients during respiratory rehabilitation training. In this case, it is necessary to modify respiratory rehabilitation training with an aim to improve the adherence of patients so as to increase the effects of respiratory rehabilitation training. Staged training is a targeted method with high patient compliance, and is hence widely adopted in the rehabilitation of various diseases [3]. Still, few studies have explored the effects of staged respiratory rehabilitation training in the treatment of patients with stable COPD patients. Therefore, this study aims to provide an insight into the rehabilitation treatment of patients with stable COPD by comparing the effects of conventional respiratory rehabilitation training and staged respiratory rehabilitation training on lung function, quality of life, exercise ability and self-efficacy in patients.

2 Materials and methods

2.1 General data

90 patients with stable COPD admitted to our hospital from May 2018 to June 2019 were selected, and further divided into the observation group and the control group using the random number table method, with 45 cases in each group. The study was approved by the Medical Ethics Committee and the written informed consent was signed by all study participants and their families. There was no significant difference between patients in the two groups in terms of gender, age, comorbid chronic diseases and course of disease (Table 1, $p > 0.05$), which were comparable.

Inclusion criteria: (1) Patients met the diagnostic criteria of COPD [4]; (2) Patients aged 35-75 years; (3) Patients whose clinical symptoms were in remission, symptoms such as cough, expectoration and shortness of breath were stable or mild, and the condition basically returned to the state before acute exacerbation.

Exclusion criteria: (1) Patients with asthma, bronchiectasis, congestive heart failure, tuberculosis and diffuse pain bronchitis; (2) Patients with severe respiratory, gastrointestinal, haematological, urinary and neurological diseases; (3) Women who were breastfeeding or pregnant; (4) Patients with severe cognitive impairment.

Table 1 Comparison of general data between patients in two groups.

Group	Case	Gender		Age (years)	Course of disease (years)	Comorbidities (cases)				
		Male	Female			High blood pressure	High blood lipids	Diabetes	Pulmonary emphysema	Chronic bronchitis
Observation	45	28	17	61.53 ± 8.64	9.66 ± 2.75	19	16	13	10	25
Control	45	30	15	62.43 ± 7.86	10.23 ± 3.12	21	14	11	12	23
χ^2/t		0.194		-0.517	-0.919	0.180	0.270	0.227	0.241	0.179
p		0.660		0.607	0.360	0.671	0.603	0.634	0.624	0.673

2.2 Methods

Conventional respiratory rehabilitation training was adopted in patients in the control group. The health care staff provided health education to patients for the cultivation of healthy routines. Patients mastered the respiratory rehabilitation training contents including abdominal breathing, pursed lip breathing, breathing exercises, aerobic endurance training as well as upper limb muscle strength training and performed the above respiratory rehabilitation training under the guidance of the medical staff.

Staged respiratory rehabilitation training was applied to patients in the observation group in four main stages: Stage 1: In the first month, patients were subjected to lip-constricted abdominal breathing training under the guidance of the health staff. For abdominal breathing training, patients were in a sitting position with hands on the abdomen and chest respectively and performed abdominal breathing training in the form of inhalation, drumming and expiration under the guidance of the health care staff for 5 minutes (min) each time. Daily practice increased to 5-10 times as the training time increased. For pursed lip breathing training, patients tightly closed the lips, inhaled through the nose and then exhaled slowly for 4-6 seconds (s) while retracting the lips. The training lasted 3 min each time, with the number of training sessions gradually increasing to 5-10 times per day. Stage 2: In the second to the third month, patients took additional respiratory exercises on the basis of first stage training. The patient raised both arms, straightened the elbows and moved upward; patients placed hands on each side of the body and moved up and down alternatedly. Patients, with their backs against the wall, gradually squatted down until the thighs are parallel to the floor and then slowly stand up. Daily training times gradually increased to 10-20 times with the training time. Stage 3: In the fourth month, patients performed upper extremity muscle strength training on the basis of the second stage. Under the guidance of health care staff, patients pulled the upper limb expander weighing 0.5-2 kg at a constant speed. Daily practice increased to 10-20 times over the training time. Stage 4: In the 5-6th month, patients underwent aerobic endurance training on the basis of stage 3. Exercise methods included brisk walking, jogging, walking and stair climbing with customized training plans for each patient according to their conditions. Patients were trained once a day for 15 to 60 min.

All patients received regular follow-up visits with one telephone call every week for the first three months and one home visits every two weeks. The monthly visit was carried out depending on the training of patients, with detailed and accurate records. Follow-up visits lasted for 6 months.

2.3 Observation indexes

2.3.1 Pulmonary function

Before and after training, pulmonary function indexes, including forced expiratory volume in the first second (FEV_1) level and the ratio of forced expiratory volume in the first second to forced vital capacity (FEV_1/FVC) of patients were detected using a MINATO AS-507 spirometer (OLABO, Jinan, China). 24 hours (h) prior to detection, patients stopped taking bronchodilators and seated at rest for 10 min. Each index was measured three times and an average was taken.

2.3.2 Quality of life

St George's respiratory questionnaire (SGQR) was used to assess the quality of life of patients in both groups before and after training. The questionnaire consists of 50 questions ranging from 0 to 100 points with three sections: the symptom score, impact score and activity score. A lower score indicates less severe COPD symptoms, lower impact of the disease on life, lower limitation of activities and better quality of life of the patients.

2.3.3 Exercise ability

Before and after training, patients were given a six minute walking test (6MWT) by the same trained practitioner to count the distance walked in 6 min. The longer the walking distance, the better the exercise ability of the patient. The patients' maximum oxygen consumption (VO_2 max) was assessed by a Master Screen CPX cardiorespiratory fitness device (Richer Trading Co., Ltd., Guangzhou, China). The British Medical Research Council Dyspnea Scale (MMRC) was adopted to assess the degree of dyspnea in patients in both groups, and the scores were divided into five levels, ranging from 0 to 4. The higher the score, the more severe the dyspnea and the weaker the patient's exercise ability.

2.3.4 Self-efficacy

The General Self-Efficacy Scale (GSES) was used to evaluate the self-efficacy of patients in both groups before and after training. The scale consisted of 10 items, with scores of each item ranging from 1 to 4. A higher score refers to better self-efficacy of patients.

2.3.5 Statistical analysis

The statistical analysis was performed using the SPSS 20.0. software. Count data were expressed as cases and compared using the X^2. Measurement data were processed as mean ± standard deviation and compared by *t*-test. Statistical significance was established at $p < 0.05$.

3 Results

3.1 Comparison of pulmonary function indexes between patients in the two groups

Before training, there was no significant difference between the FEV_1 and FEV_1/FVC levels of patients in two groups ($p > 0.05$). After training, the FEV_1 and FEV_1/FVC levels of patients in both groups were significantly upregulated, and these indexes in the observation group were notably higher than those in the control group (Table 2, $p < 0.05$).

3.2 Comparison of quality of life between patients in two groups

No significant difference in the SGQR symptom scores, impact scores, activity scores and total scores of untrained patients was observed in both groups ($p > 0.05$). After training, the symptom score, impact score, activity score and total score of St George's respiratory questionnaire (SGQR) of patients in two groups all declined with those in the observation group much lower than those in the control group (Table 3, $p < 0.05$).

3.3 Comparison of exercise ability between patients in two groups

Before training, there was no significant difference in the comparison of 6MWT level, VO_2 max level and mMRC scores between patients in both groups ($p > 0.05$). However, after training, a reduction in 6MWT level, VO_2 max level as well as mMRC scores of patients in the two groups was observed, and those in the observation group were lower than those in the control group (Table 4, $p < 0.05$).

3.4 Comparison of self-efficacy between patients in two groups

Before training, there was no significant difference between the GSES scores of patients in the two groups ($p > 0.05$). After training, the GSES scores of patients in both groups were increased, and the scores in the observation group exceeded those in the control group (Table 5).

Table 2 Comparison of pulmonary function indexes between patients in two groups.

Group	Case	FEV1 (L)		FEV1 /FVC (%)	
		Pre-training	After training	Pre-training	After training
Observation group	45	1.34 ± 0.32	1.78 ± 0.28 *	53.45 ± 5.87	62.38 ± 4.72 *
Control group	45	1.28 ± 0.34	1.61 ± 0.30 *	54.13 ± 6.52	58.33 ± 5.47 *
t		0.862	2.779	-0.520	3.761
p		0.391	0.007	0.604	0.000

Note: * vs. pre-training: * $p < 0.05$.

Table 3 Comparison of quality of life between patients in two groups (scores).

Group	Case	Symptom score		Impact score	
		Pre-training	After training	Pre-training	After training
Observation group	45	58.46 ± 8.47	45.56 ± 6.57 *	52.46 ± 6.85	34.77 ± 6.39 *
Control group	45	59.12 ± 7.64	51.46 ± 7.32 *	51.85 ± 7.12	42.38 ± 8.63 *
t		-0.388	-4.024	0.414	-4.754
P		0.699	0.000	0.680	0.000
Group	**Case**	**Activity Score**		**Total score**	
		Pre-training	**After training**	**Pre-training**	**After training**
Observation group	45	57.36 ± 7.46	40.56 ± 8.55 *	57.46 ± 10.38	42.62 ± 8.46 *
Control group	45	58.23 ± 8.22	49.38 ± 7.72 *	58.23 ± 9.47	50.79 ± 10.58 *
t		-0.526	-5.136	-0.368	-4.046
p		0.600	0.000	0.714	0.000

Note: * vs. pre-training: * $p < 0.05$.

Table 4 Comparison of exercise ability between patients in two groups.

Group	Case	6MWT (m)		VO_2 max (mL/kg-min)		mMRC score (points)	
		Pre-training	After training	Pre-training	After training	Pre-training	After training
Observation	45	368.45 ± 34.62	495.38 ± 42.37 *	12.38 ± 2.75	23.34 ± 4.56 *	2.42 ± 0.47	1.32 ± 0.34 *
Control	45	374.68 ± 38.72	448.55 ± 45.73 *	12.74 ± 2.63	18.56 ± 4.32 *	2.48 ± 0.50	1.80 ± 0.45 *
t		-0.805	5.039	-0.635	5.105	-0.587	-5.709
p		0.423	0.000	0.527	0.000	0.559	0.000

Note: * vs. pre-training: * $p < 0.05$.

Table 5 Comparison of self-efficacy between patients in two groups (scores).

Group	Case	Pre-training	After training
Observation group	45	23.46 ± 4.38	32.44 ± 3.88 *
Control group	45	22.85 ± 4.82	26.74 ± 4.50 *
t		0.628	6.435
p		0.531	0.000

Note: * vs. pre-training: * $p < 0.05$.

4 Discussion

COPD is a progressive lung disease characterised by incomplete and reversible airflow restriction. Patients mainly present with symptoms such as cough, shortness of breath, sputum and dyspnoea [5]. Respiratory rehabilitation training has emerged as a novel non-pharmacological method for COPD. A previous study has shown that systematic respiratory rehabilitation training helps to improve cardiopulmonary function and exercise tolerance in COPD patients. However, due to a lack of clear understanding of the disease in some patients, training adherence is relatively low, which affects the effectiveness of respiratory rehabilitation training [6]. Staged training is a method that is tailored to the different stages of diverse diseases and the various needs of patients and their families. It can effectively improve patient compliance and is widely adopted in the rehabilitation of patients with stroke, hemiplegia and schizophrenia [7].

Patients with COPD often suffer from irreversible lung damage as a result of repeated and frequent exacerbations, which leads to a serious decline in lung function [8]. FEV_1 and FEV_1/FVC are important lung function markers, and their levels reflect the degree of airflow obstruction in COPD patients [9]. The results of this study showed that after training, the FEV_1 and FEV_1/FVC levels in patients in both groups were elevated, and those in the observation group were higher than those in the control group. This indicates that staged respiratory rehabilitation training can effectively improve the lung function of COPD patients. In respiratory rehabilitation training, by changing the mouth shape, pursed lip breathing training increases the airway pressure during exhalation, postpones the closure of the small airway during exhalation, thus increasing the patients' lung ventilation and improving lung function. Abdominal breathing training enhances the diaphragm contractile force of patients through the contraction of the abdominal muscles during exhalation to ameliorate alveolar ventilation. However, for patients with severe conditions, conventional respiratory rehabilitation training is too intensive and difficult to complete, which affects the effectiveness of their training. In the early stages of staged respiratory rehabilitation training, patients first perform pursed lip and abdominal breathing training, which is easy to complete and results in a higher degree of completion. In this case, patient compliance was hence increased, and their lung function and physical quality were promoted as well [10]. Then, the intensity of rehabilitation training is gradually increased and exercise training is started in the third stage, which improves the patients' confidence and compliance due to improved physical fitness and increased completion of rehabilitation training. Aerobic training started at the fourth phase, which improves rehailitation training effecs while ensuring the completeness of training. Therefore, staged respiratory rehabilitation exhibits better effects on the improvement of pulmonary function in COPD patients as compared with conventional respiratory rehabilitation.

Due to lung damage, COPD patients have reduced ventilation and air exchange function, and are prone to wheezing and fatigue, resulting in significantly limited exercise ability and compromised quality of survival [11]. The findings of this study revealed that after training, the 6MWT and VO_2 max levels were increased after training and those in patients in the observation group were significantly higher than those in the control group, whereas the mMRC score and SGQR score were significantly lower than those in the control group. These indicate that staged respiratory rehabilitation training can effectively improve the exercise ability and quality of life of COPD patients. Breathing exercises, aerobic endurance training and upper limb muscle strength training in respiratory rehabilitation training help to effectively improve the pulmonary ventilation function and exercise endurance of COPD patients, thereby improving their exercise ability and quality of life [12]. However, aerobic endurance training and upper limb muscle strength training require high physical fitness, which can easily lead to muscle fatigue and affect patients' compliance with rehabilitation training, further affecting the effectiveness of rehabilitation training. In the early stage of rehabilitation training, the patient first carries out less difficult rehabilitation training, which can enhance the patient's confidence and improve the patient's rehabilitation training effect and physical quality; in the late stage of rehabilitation training, the patient undergoes upper limb muscle strength training and aerobic endurance training, at which time the patient's physical quality has been improved and patients are able to complete relevant sports, achieve great training effects and increase the exercise ability and quality of life of patients. Therefore, the effect of phased respiratory rehabilitation training on improving patients' exercise ability and quality of survival is better than that of conventional respiratory rehabilitation training [13].

Patients with stable COPD are influenced by the lack of medical knowledge and negative emotions, and lack confidence in following medical advice and adhering to respiratory rehabilitation training. Patients have a low level of self-efficacy and low compliance with rehabilitation training [14]. The results of the present study demonstrated that after the training, the GSES scores of patients in both groups were remarkably boosted, and those in the observation group were higher than those in the control group. During the staged respiratory rehabilitation training, the health care staff provided patients with health education and timely encouragement to help patients fully understand their disease and the rehabilitation training process, so as to avoid patients' anxiety and fear as well as improve their sense of self-efficacy. In addition, the phased respiratory rehabilitation training is classified into four stages gradually progresses from weak to strong according to the patient's ability and needs. This can improve the patient's completion of rehabilitation training and compliance. Moreover, every time a difficulty was overcome or a training was complted, the patient will be filled with a sense of achievement, and the sense of self-efficacy will be improved [15].

In conclusion, the application of staged respiratory rehabilitation training to patients with stable COPD can effectively improve their lung function, quality of life, exercise ability and self-efficacy.

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Conflicts of Interest

All authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential confict of interest.

Author Contributions

R.C. and H.L. conceptualized the trial, participated in creating the study design and the statistical analysis plan. H.L. made the first draft of the manuscript. All authors reviewed and revised the manuscript critically for important intellectual content. All authors reviewed the final manuscript as submitted. All authors read and approved the final manuscript.

Ethics Approval and Consent to Participate

The study was approved by the Medical Ethics Committee and the written informed consent was signed by all study participants and their families.

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Availability of Data and Materials

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding authors.

Supplementary Materials

Not applicable.

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