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Research Article

Impact of Pulmonary Rehabilitation Program on Ventilatory Functions and Severity Score in Patients with Chronic Obstructive Pulmonary Disease

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Abstract

Background: Chronic Obstructive Pulmonary Disease (COPD) is characterized with poor quality of life and many symptoms that burden their medical care and increased mortality rate. In the other hand, pulmonary rehabilitation program plays a vital role in reversing the COPD adverse effects.

Objective: This study was to investigate the effect of a designed pulmonary rehabilitation program consisted of breathing exercise, aerobic exercise added to low intensity laser therapy on ventilatory functions and severity score in COPD patients.

Methods: Sixty patients with moderate severity of COPD, their age ranged between 38-55 years were participated in the study was divided into two equal groups the training group received pulmonary rehabilitation program consisted of breathing exercise, aerobic exercise added to low intensity laser therapy in addition to the current medical treatment and the control group (received only their current medical treatment) for 12 weeks.

Results: The results of this study showed that there was a significant difference in ventilatory functions and COPD severity score between the training group and the control group (B).

Conclusion: Pulmonary rehabilitation program is an effective treatment policy to improve ventilatory functions and COPD severity score.

Keywords: Aerobic exercises; Breathing exercises; Chronic obstructive pulmonary disease; Pulmonary rehabilitation program; Low intensity laser therapy

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a worldwide prevalent medical problem that reaches about 10% among subjects older than 40 years [1]. The mortality rate is about 4% due to COPD that is considered the fifth leading cause of mortality and the 3rd burden medical problem in the developed countries [2,3].

Many medical problems usually associated with COPD [4,5] with high economic burden [6]. Systemic inflammation associated with COPD elevates the mortality and mortality rate of COPD [7] as this systemic inflammation induces cardiovascular disorders [8] in addition to its adverse effects on respiratory muscles, skeletal muscles and quality of life [9-13]. Pulmonary hyperinflation and airway obstruction apply more loads on the respiratory muscles in patients with COPD in addition to increased airway resistance that is three times higher in COPD than normal subjects [14].

Application of laser acupuncture therapy produced a good immune-correction, broncholytic effects and anti-inflammatory effect which improves potency of bronchi in asthmatic patients [15,16]. However, beneficial effect of exercise training corrects some pathological effects of COPD [17,18]. In healthy subjects, exercises were proved to improve immune system response [19]. Even low intensity exercise training was found to modulate poor quality of life, exercise intolerance and the elevated level of systemic cytokines of COPD [20].

The adverse effects of COPD are not limited to the respiratory system, but have many systemic adverse effects. Pulmonary rehabilitation has a vital role for management of the deconditioning effects of systemic inflammation and other pathological features of COPD as exercise intolerance and poor quality of life [21,22]. Therefore, this study investigated the effect of a designed pulmonary rehabilitation program consisted of respiratory exercise, aerobic exercise in added to low intensity laser therapy on ventilatory functions and severity score in patients with COPD.

Materials and Methods

Subjects

Sixty COPD patients of moderate severity according to GOLD [23] were enrolled in this study. Patients with exacerbations in the last month were excluded; their age ranged from 38 to 56 years. Exclusion criteria included lung cancer, cardiovascular disorders, dementia, psychiatric illness, tuberculosis and diabetes mellitus. Participants were enrolled in two groups, the first group received breathing exercise, aerobic exercise added to low intensity laser therapy, while

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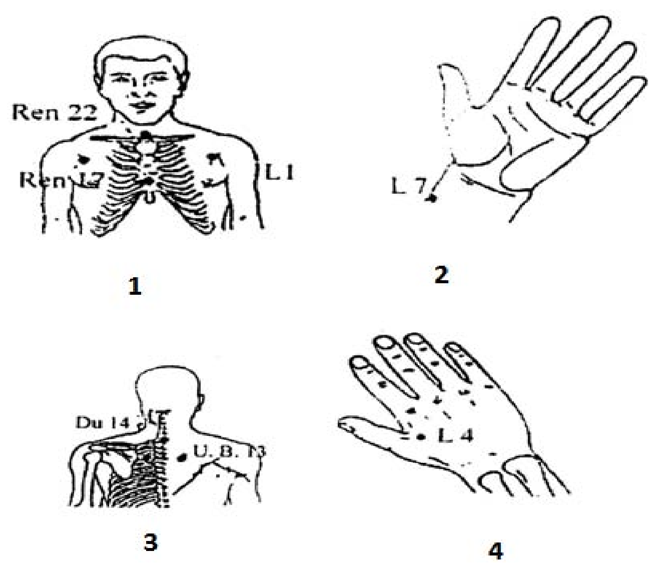

Figure: 1, 2, 3 and 4 shows the acupuncture points for the respiratory system disorders.

the second group was considered as a control group and received no training intervention for three months.

Equipment

- Spirometer (Schiler-spirovit SP-10) was used to measure the Forced Vital Capacity (FVC), the forced vital capacity in the first second (FEV1), Forced Expiratory Flow at 0.2-1.2% of forced vital capacity (FEF0.2-1.2%), Forced expiratory flow at 25-75% of forced vital capacity (FEF25-75%), Forced expiratory flow at 75-85% of forced vital capacity (FEF75-85%), Maximum Expiratory Flow at 75% of forced vital capacity (MEF75%), Maximum Expiratory Flow at 50% of forced vital capacity (MEF50%).

- Cunometer was used to detect the respiratory system acupuncture points.

- Laser LTU 904 (class I laser product manufactured by laserex technologies PTYLTD, Australia).

Measurements of ventilatory function test (FVC, FEV¬1, FEF0.2-1.2%, FEF25-75%, FEF75-85%, MEF75% and MEF50%) and COPD severity score were performed for each subject before the study and repeated after three months at the end of the study.

Participants were divided randomly into the following groups:

1. Patients in Group (A) received current medical treatment in the form of bronchodilators and antibiotics in addition the pulmonary rehabilitation program that included:

a) Treadmill aerobic exercise training, each session lasted for 40 minutes (5-minute warm-up phase performed on the treadmill (Enraf Nonium, Model display panel Standard, NR 1475.801, Holland) at a low load, training session lasted 30 minutes and finished with 5-minute cooling down), training intensity based on guidelines of the American College of Sport Medicine, using the maximal heart rate index (HRmax) estimated by: 220-age. First 2 weeks = 60–70% of HRmax, 3rd to 12th weeks = 70–80% of HRmax. Three sessions per week for three months [24].

Table 1: Participants baseline characteristics in both groups.

	Mean +SD		Significance
	Group (A)	**Group (B)**	
Age (year)	34.27±4.54	36.12±3.98	P>0.05
Gender ratio (male/female)	16/14	17/13	P>0.05
BMI (kg/m²)	23.29±4.27	21.48±3.95	P>0.05
FVC (L)	2.83±0.81	2.77±0.96	P>0.05
FEV_1 (L)	1.35±0.42	1.31±0.53	P>0.05
FEV_1/FVC (%)	46.12±7.32	45.73±6.15	P>0.05
MVV (L/minute)	46.35±9.76	44.19±9.21	P>0.05
COPDSS	7.81±2.17	7.97±2.33	P>0.05

BMI: Body Mass Index; FVC: Forced Vital Capacity; FEV_1: Forced Expiratory Volume in the first second; FEV_1/FVC: Ratio between forced expiratory volume in the first second and forced vital capacity; MVV: Maximum Voluntary Ventilation; COPDSS: Chronic Obstructive Pulmonary Disease Severity Score.

Table 2: Mean value and significance of FVC, FEV_1, $FEF_{0.2\text{-}1.2\%}$, $FEF_{25\text{-}75\%}$, $FEF_{75\text{-}85\%}$, $MEF_{75\%}$, $MEF_{50\%}$ and COPD severity score in group (A) before and at the end of the study.

	Mean ± SD		t-value	Significance
	Before	After		
FVC (L)	2.83±0.81	3.38±0.97*	4.76	P<0.05
FEV_1 (L/sec.)	1.35±0.42	1.83±0.56*	4.64	P<0.05
FEF $_{0.2\text{-}1.2\%}$ (L/sec.)	1.21±0.51	1.62±0.54*	4.63	P<0.05
FEF$_{25\text{-}75\%}$ (L/sec.)	0.92±0.32	1.23±0.44*	4.27	P<0.05
FEF $_{75\text{-}85\%}$ (L/sec.)	0.59±0.22	0.72±0.29*	3.94	P<0.05
MEF $_{75\%}$ (L/sec.)	1.41±0.54	1.71±0.58*	3.67	P<0.05
MEF$_{50\%}$ (L/sec.)	0.82±0.48	1.22±0.52*	3.66	P<0.05
COPDSS	7.81±2.17	5.11±1.74*	5.12	P<0.05

FVC: Forced Vital Capacity; FEV_1: Forced Expiratory Volume in the first second; $FEF_{0.2\text{-}1.2\%}$: Forced Expiratory Flow at 0.2-1.2% of forced vital capacity; $FEF_{25\text{-}75\%}$: Forced Expiratory Flow at 25-75% of forced vital capacity; $FEF_{75\text{-}85\%}$: Forced Expiratory Flow at 75-85% of forced vital capacity; $MEF_{75\%}$: Maximum Expiratory Flow at 75% of forced vital capacity; $MEF_{50\%}$: Maximum Expiratory Flow at 50% of forced vital capacity; COPDSS: Chronic Obstructive Pulmonary Disease Severity Score; (*) indicates a significant difference between the two groups, $P < 0.05$.

b) Breathing exercise: Pursed lips breathing exercise was applied to all participants in group (A) as the patient was asked to inhale deeply through his/her nose and purse his/her lips & slowly exhale and to prolong his/her exhalation as long as possible in addition to repeat this maneuver for 10 minutes/session, 3 sessions/week for 12 weeks.

c) Low intensity laser therapy: Respiratory system acupuncture points received laser for 90 seconds for each point, three sessions per week for four successive weeks. The acupuncture (L.1), shamzhong (Ren 17), Tiantu (Ren 22), feishu (U.B.B), Dazhui (Du 14), lieque (L.7) and Heagu (L.I.4) (Figure).

2. Patients in Group (B) received the usual medical treatment in the form of bronchodilators and antibiotics and participated in this study as the control group.

Statistical analysis

The mean values of ventilatory function and COPD severity score were measured before and after 3 months for both groups. Then the

Table 3: Mean value and significance of FVC, FEV_1, $FEF_{0.2-1.2\%}$, $FEF_{25-75\%}$, $FEF_{75-85\%}$, $MEF_{75\%}$, $MEF50_{\%}$ and COPD severity score in group (B) before and at the end of the study.

	Mean ± SD		t-value	Significance
	Before	After		
FVC (L)	2.77±0.96	2.95±0.98*	2.96	P<0.05
FEV_1 (L/sec.)	1.31±0.53	1.52±0.55*	2.84	P<0.05
$FEF_{0.2-1.2\%}$ (L/sec.)	1.14±0.45	1.35±0.48*	3.04	P<0.05
$FEF_{25-75\%}$ (L/sec.)	0.88±0.30	1.06±0.37*	2.98	P<0.05
$FEF_{75-85\%}$ (L/sec.)	0.52±0.19	0.61±0.21*	2.89	P<0.05
$MEF_{75\%}$ (L/sec.)	1.28±0.47	1.46±0.52*	2.95	P<0.05
$MEF_{50\%}$ (L/sec.)	0.75±0.34	1.02±0.36*	3.05	P<0.05
COPDSS	7.97 ± 2.33	6.43±2.12*	3.13	P<0.05

FVC: Forced Vital Capacity; FEV_1: Forced Expiratory Volume in the first second; $FEF_{0.2-1.2\%}$: Forced Expiratory Flow at 0.2-1.2% of forced vital capacity; $FEF_{25-75\%}$: Forced Expiratory Flow at 25-75% of forced vital capacity; $FEF_{75-85\%}$: Forced Expiratory Flow at 75-85% of forced vital capacity; $MEF_{75\%}$: Maximum Expiratory Flow at 75% of forced vital capacity; $MEF_{50\%}$: Maximum Expiratory Flow at 50% of forced vital capacity; COPDSS: Chronic Obstructive Pulmonary Disease Severity Score; (*) indicates a significant difference between the two groups, P < 0.05.

data were compared using paired "t" test to determine the level of significance. Comparison between both groups was done by using the independent "t" test (P< 0.05).

Results

All participants were enrolled into two groups with no significant differences between both groups (Table 1). Regarding the comparison between values of ventilatory function test (FVC, FEV¬1, FEF0.2-1.2%, FEF25-75%, FEF75-85%, MEF75% and MEF50%) there were significant improvement and significant reduction in the mean value of the COPD severity score before and after treatment for the two groups (p<0.05) (Tables 2 & 3). Regarding the comparison between the mean values of ventilatory function test and COPD severity score in the two groups at the end of the study (p<0.05) (Table 4).

Discussion

Globally, COPD becomes more prevalent and becomes the third cause of death [25,26]. However, by 2030 it is expected to have about 9 million patients to die with COPD every year [27]. Moreover, the economic and health related burden of COPD are enormous [28]. Our study was conducted to measure the impact of a designed pulmonary rehabilitation program consisted of breathing exercise, aerobic exercise added to low intensity laser therapy on ventilatory functions and COPD severity score in COPD patients. The results of this study showed that there was a remarkable significant improvement in ventilatory functions and COPD severity score between the training groups received pulmonary rehabilitation program consisted of breathing exercise, aerobic exercise added to low intensity laser therapy added to the current medical treatment and the control group (received only the usual medical treatment).

The results of the present study agreed with some previous studies as Weiner, et al. believed that aerobic exercise and inspiratory muscle training significantly modulates perception of dyspnea COPD patients [29]. In the other hand, Neder and colleagues mentioned that two months aerobic training program improved cardiopulmonary fitness

Table 4: Mean value and significance of FVC, FEV_1, $FEF_{0.2-1.2\%}$, $FEF_{25-75\%}$, $FEF_{75-85\%}$, $MEF_{75\%}$, $MEF_{50\%}$ and COPD severity score in group (A) and group (B) at the end of the study.

	Mean ± SD		t-value	Significance
	Group (A)	Group (B)		
FVC (L)	3.38±0.97*	2.95±0.98	2.97	P<0.05
FEV_1 (L/sec.)	1.83±0.56*	1.52±0.55	3.16	P<0.05
$FEF_{0.2-1.2\%}$ (L/sec.)	1.62±0.54*	1.35±0.48	2.94	P<0.05
$FEF_{25-75\%}$ (L/sec.)	1.23±0.44*	1.06±0.37	3.12	P<0.05
$FEF_{75-85\%}$ (L/sec.)	0.72±0.29*	0.61±0.21	3.01	P<0.05
$MEF_{75\%}$ (L/sec.)	1.71±0.58*	1.46±0.52	3.15	P<0.05
$MEF_{50\%}$ (L/sec.)	1.22±0.52*	1.02±0.36	2.98	P<0.05
COPDSS	5.11±1.74*	6.43±2.12	3.11	P<0.05

FVC: Forced Vital Capacity; FEV_1: Forced Expiratory Volume in the first second; $FEF_{0.2-1.2\%}$: Forced Expiratory Flow at 0.2-1.2% of forced vital capacity; $FEF_{25-75\%}$: Forced Expiratory Flow at 25-75% of forced vital capacity; $FEF_{75-85\%}$: Forced Expiratory Flow at 75-85% of forced vital capacity; $MEF_{75\%}$: Maximum Expiratory Flow at 75% of forced vital capacity; $MEF_{50\%}$: Maximum Expiratory Flow at 50% of forced vital capacity; COPDSS: Chronic Obstructive Pulmonary Disease Severity Score; (*) indicates a significant difference between the two groups, P < 0.05.

and reduced the dose of the corticosteroid intake among children with bronchial asthma [30]. Moreover, Hallstrand, et al. and Ram, et al. found that exercise training program improved dyspnea and ventilatory functions in patients with mild asthma [31,32]. However, Cambach, et al. proved that the standard pulmonary rehabilitation programs that included exercises of upper and lower extremities could improve quality of life and increase walking distance in patients with asthma [33]. In addition, David and colleagues stated that aerobic exercise training improved cardiopulmonary fitness and reduced severity of asthmatic symptoms among children [34]. While, Mahler stated that breathing exercise is a standard part in any pulmonary rehabilitation program [35], which has a beneficial effect in modulation of airway collapse as it increases intraluminal pressure of air ways [36]. Moreover, Kellett C. and Mullan proved that inspiratory muscle training in asthmatic patients improved respiratory muscle strength and modulate pulmonary hyperinflation and airway obstruction in asthmatic patients [37].

The possible mechanism of improvement in the parameters of the ventilatory function test and COPD severity score following pulmonary rehabilitation program consisted of breathing exercise, aerobic exercise added to low intensity laser therapy may be related to broncholytic effect, modulation of bronchial mucosa inflammatory changes, improved airways resistance and muscles strength of respiratory muscles. This explanation agreed with Shesterina, et al. who stated that low intensity laser therapy improved pulmonary functions in asthmatic children because of the improved small airways patency and anti-inflammatory [15] and good immune-correction effect of laser therapy [16]. However, Zhang enrolled 71 asthmatic patients in a treatment program of acupuncture for 12 days and proved that the treatment group had significant improvement in parameters of the ventilatory function [38]. In addition, Zhang explored clinical value of acupuncture on 104 cases of bronchial asthma for 10 sessions, there were significant improvement in the form asthma symptoms score and ventilatory functions [39].

Conclusion

Pulmonary rehabilitation program improves ventilatory functions and COPD severity score among patients with chronic obstructive pulmonary disease.

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