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Effect of Aerobic Training versus Resisted Exercises on Peak Expiratory Flow Rate on Patients with Chronic Obstructive Pulmonary Disease

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Abstract

Background: Rehabilitation of pulmonary diseases has several types and is beneficial for COPD patients to enhance their level of daily activity, and getting back independence, social integration, self-confidence and mental abilities. The primary shape of pulmonary rehabilitation is exercise which may be aerobic that depends mainly on oxygen for production of energy through a low to high intensity, or resisted exercises which aim to improve strength of skeletal muscles, and till now There is a wide debate about the preference of both exercise shapes over each other.

Aim of Study: Comparison between the effect of aerobic training and resisted exercises on peak expiratory flow rate on patients with chronic obstructive pulmonary disease.

Subject and Methods: This study is a cross sectional study. Forty male patients, aged 30-40 years, suffer from moderate COPD (FEV1 is 50%-80% of predicted value), were recruited from Outpatient Clinic of Chest Medicine, Al-Zahraa University Hospital. Practical work was done from October 2020 till February 2021. They were assigned into two equal groups. Group (A) received aerobic training in the form of jogging on elliptical trainer at intensity of 60-70% of maximum heart rate for twelve weeks (3 days per week). Group (B) received resisted exercises by elastic rubber bands with intensity of 60% of one repetition maximum for twelve weeks (3 days per week). Peak expiratory flow rate was measured for each patient in the two groups before and after completion of the treatment program, it was measured by the Peak Flow Meter.

Results: There was a statistically significant increase in the PEFR in both groups (A and B) with p-value=0.001 in both groups, also the post PEFR of Group A is statistically higher than that of Group B with p-value=0.006.

Conclusion: Both aerobic and resisted exercises has positive effects on ventilator functions, exercise tolerance, and dyspnea level, but aerobic training is better than resisted exercises in improvement of peak expiratory flow rate.

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Key Words: *Chronic obstructive pulmonary disease – Pulmonary rehabilitation – Aerobic training.*

Introduction

COPD is related to Long-term inhalation of poisonous substances, smoking of tobacco is considered the main cause of this disease that leads chronic inflammation of the lungs. Other causes include occupational dust exposure, poisonous fumes and steam, air pollution delivered from burning of biomass, and environmental air pollution. According to the tests of pulmonary function, COPD causes obstruction of the pulmonary airflow that is irreversible and progressive. The obstruction of airflow is considered a result of sophisticated effects of airflow lesions and the lesions of emphysema that affect the pathology in different ratio **[1-3]**.

The symptoms and signs of COPD may be imperceptible. Nonetheless, as the disease advances, the majority of COPD patients will suffer frombreathing difficulty and shortness; cough which results in a lot of mucus production, wheezing and tightness of the chest, and other symptoms. Clinically, other findings that may be observed include gases of arterial blood that indicate chronic hypercapnia or high CO_2 of the arterial blood and low to medium hypoxemia and hyperinflation signs that may be seen in chest X-ray **[4]**.

Chronic obstructive pulmonary disease is developed through chronic inflammation which is characterized by raised count of inflammatory cells, and changes of the structural tissue of the lung. These inflammatory changes are present in pulmonary vessels, functional tissue of the lung, and large airways. An increase of lymphocytes,

neutrophils, and macrophages is considered as an evidence of chronic inflammation of the lung in COPD, caused by the imbalance between proteases and antiproteases which will result in connective tissue damage [5].

Patients with COPD are more susceptible to develop diseases of the cardiovascular system, with an incidence that may reach two to five times higher than normal in developing ischemia of the heart, dysrhythmia of the heart, pulmonary circulation disease, and arterial diseases. In addition to these diseases, COPD patients may develop diabetes mellitus and hypertension [6].

Diagnosis of lung disease is done by evaluating the efficiency and functional capacity of the lungs through measuring the different volumes of lung which are called ventilator function. The most important variables of ventilatory function include: Forced expiratory volume in the first second (FEV_1), and forced vital capacity (FVC) [7].

Peak expiratory flow rate may be a good replacement of FEV_1 indicating the severity of disease and response to therapy, to overcome the disadvantages of spirometer. PEFR is the highest flow of air reached during expiration forcefully; normally it can be reached during 100 Msec, and is measured by the peak flow meter [8,9].

Pulmonary rehabilitation is a must for COPD patients or every patient who's FEV1 less than 60% according to the American society of thoracic diseases. PR is important because of its positive effect on the patient's exercise tolerance. PR also has behavioral and biological benefits on COPD patients via increasing development of certain neurotransmitters like norepinephrine, dopamine, and serotonin which all are affected biologically in depressed COPD patients. Other effects of exercises are decreased secretion of pro-inflammatory cytokines and increased secretion of endorphins which also affects patient's behavior [10,11].

Several shapes of exercises are important for COPD patients. Aerobic exercises, like walking, runningand swimming, are beneficial for improving the chest flexibility, lung oxygen capacity, the heart pumping ability, and oxygen saturation. Also, resisted exercises, like training by weights or elastic bands are important for increasing strength of skeletal muscles, improves patients walking and effort ability, and strengthening of the immune system, via strengthening antioxidant mechanism, decreasing long-term inflammation and chance of development of new inflammation [12,13].

Subjects and Methods

Design of the study: This study is a cross sectional study.

Subject: Forty male patients, aged 30-40 years, suffer from moderate COPD (FEV_1 is 50%-80% of predicted value), were recruited from Outpatient Clinic of Chest Medicine, Al-Zahraa University Hospital. Practical work was done from October 2020 till February 2021. They were assigned into two equal groups. Group (A) received aerobic training in the form of jogging on elliptical trainer at intensity of 60-70% of maximum heart rate for twelve weeks (3 days per week). Group (B) received resisted exercises by elastic rubber bands with intensity of 60% of one repetition maximum for twelve weeks (3 days per week). Peak expiratory flow rate was measured for each patient in the two groups before and after completion of the treatment program, it was measured by the Peak Flow Meter.

Inclusion criteria: Patients have moderate COPD or stage 2 according to GOLD staging system (2019 report), patients are male only, aged from 30 to 40 years old, and their BMI ranged from 25 to 29.9kg/m^2.

Exclusion criteria: Very severe cases of exacerbation, Cases of respiratory failure, cases with decompensated comorbid disease, unstable cardiac disease. (Myocardial infarction), neuromuscular condition that would interfere with the exercise test, and inability to follow instructions, and uncontrolled hypertension and angina.

Methods: Ethical consideration: The study protocol was approved by The Department of Cardiovascular/Respiratory Disorders and Geriatrics, Faculty of Physical Therapy, Cairo University by the No: REC/012/002444.

Before the initiation of the study a consent form will be obtained from each subject as an agreement to be included in the present study.

Anthropometric measurements: Body weight (BW), body length (BL), and body mass index (BMI) were taken initially.

Material:

A- Evaluative tools:

Peak flow meter: Used to measure the peak expiratory flow rate (PEFR).

B- Therapeutic tools:

1- Elliptical trainer: Which is a stationary exercise machine used for combined upper and lower limb aerobic exercises.

2- Elastic rubber bands: Thick elastic bands that provide a way to strengthen muscles.

Procedure:

History was taken to collect data about patient's general condition, physical therapy and current medication.

The procedure of this study was divided into the following main parts:

A- *Preparatory procedure:*

All medical and demographic data of subjects will be collected. Vital signs will be measured to ensure that all subjects are medically stable.

B- *Evaluating procedure:*

Both groups were evaluated by the peak flow meter before and after completion of the treatment program.

Peak expiratory flow testing:

It is tested by the using of peak flow meter which measures how fast the air moves out of the lungs when exhaling forcefully after inhaling fully, the test is repeated 2 times and the highest of the 3 readings is the PEFR, the test measures how well the lungs work.

C- *Therapeutic procedure:*

1- Group (A) Aerobic training: Its patients trained by elliptical trainer which combined upper and lower limbs cycling, three sessions per week (day after day), for 30 minutes each session divided into (5min. warming up, 20min. active phase and 5min. cooling down), and with intensity of 60-70% of maximum heart rate.

2- Group (B) Resisted exercises: Its patients trained by the elastic rubber bands (Theraband loops), which combined resisted exercises for upper and lower limbs, three sessions per week, for 30 minutes each session divided into (5min. warming up, 20min. active phase and 5min. cooling down), and with intensity of 60% of one repetition maximum.

D- Stat*istical procedure:*

Results are expressed as mean ± standard deviation. Test of normality, Kolmogorov-Smirnova test, was performed to measure the distribution of data. Comparison between normally distributed data (variables) in the two groups was performed using unpaired *t*-test. Analysis of covariance (ANCOVA) test was used to compare the pre-treatment values of the two groups and on the same time between post-treatment values on controlling the effect of pre-treatment values. Comparison between pre- and post-treatment data in the same group was performed using paired *t*-test. Comparison between not normally distributed data (variables) in the two groups was performed using Mann Whitney test. Comparison between pre- and post-treatment data in the same group was performed using Wilcoxon Signed Ranks test. Statistical Package for Social Sciences (SPSS) computer program (version 19 windows) was used for data analysis. p-value ≤0.05 was considered significant.

Results

1- *General characteristics of the patients:*

As presented in Table (1), there was no statistical difference of the values of age, weight, height, and body mass index between group A and group B.

Table (1): General characteristics of the two studied groups.

	Group A (n=20)	Group B (n=20)	*t*-value	p-value
Age (yrs.)	35.05±3.78	34.45±3.50	0.521	0.605 (NS)
Weight (kg.)	83.58±8.17	85.48±8.42	–0.724	0.473 (NS)
Height (m)	1.75±0.08	1.74±0.07	0.431	0.669 (NS)
BMI (kg/m^2)	27.29±1.86	28.19±1.48	–1.708	0.096 (S)

Data are expressed as mean ± SD.
NS = p> 0.05 = Not significant.

Peak Expiratory Flow (PEF):

Within group comparison (intra-group comparison):

In group A, there was a statistical significant increase in the mean value of PEF measured at post-treatment (545.00 ±55.49) when compared with its corresponding value measured at pre-treatment (488.50 ±54.51) with *t*-value=–5.722 and p-value=0.001 (Table 2; Fig. 1).

Also in group B, there was a statistical significant increase in the mean value of PEF measured at post-treatment (531.50 ±74.92) when compared with its corresponding value measured at pre-treatment (507.50 ±70.48) with *t*-value=–6.564 and p-value=0.001 (Table 2; Fig. 1).

Between groups comparison (inter-groups comparison):

ANCOVA test was used to compare the post-treatment values of the two groups on controlling the effect of pre-treatment value. The results of PEF revealed that there was a statistical significant increase in its values in group A (545.00 ±55.49) when compared with its corresponding value measured in group B (531.50 ±74.92) (F=8.363 & p= 0.006) (Table 2; Fig. 1).

Table (2): Inter- and intra-groups comparison between mean values of PEF in the two studied groups measured at pre- and post-treatment.

	Group A (n=20)	Group B (n=20)	F-value	*p*-value
Pre-treatment	488.50± 54.51	507.50± 70.48	0.910	0.346 (NS)
Post-treatment	545.00± 55.49	531.50± 74.92	8.363	0.006 (S)
Mean difference	56.50	24.00		
% change	11.57 ↑↑	4.73 ↑↑		
t-value	–5.722	–6.564		
p-value	0.001 (S)	0.001 (S)		

Data are expressed as mean ± SD. NS = $p>0.05$ = Not significant.
F-value = ANCOVA test. S = $p\leq0.05$ = Significant.
t-value = Paired *t*-test.

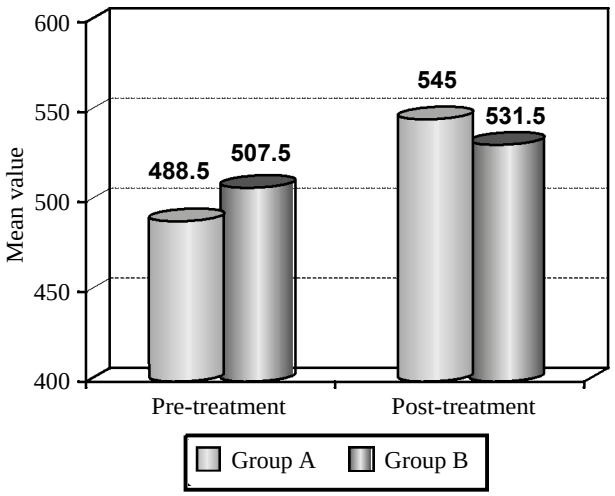

Fig. (1): Mean values of mean PEF in the two studied groups measured pre- and post-treatment.

Discussion

In the current study, the effect of aerobic training on ventilator functions good results, there was significant increase ($p<0.05$) in PEFR, after application of treatment (post) when compared with the corresponding mean value before beginning of treatment (pre). In the other hand, although there is a significant difference in the PEFR after application of resisted exercises,but it is still significantly lower than the PEFR after aerobic exercises.

The current study agreed with Esha and Amit (2016), who examined the effect of aerobic activities, in the form of running on treadmill, on lung functions in healthy subjects, this resulted in statistical significant increase in forced vital capacity (FVC) and forced expiratory volume in first second (FEV_1). They attributed this improvement to the improved efficiency of respiratory muscles, increased thoracic flexibility and balance between chest elasticity and lung got from regular training **[14]**.

The current study agreed with Walid et al., (2016), who evaluated the effect of resisted exercises, for upper and lower limbs, on COPD patients ventilatory functions, there was significant increase of the FEV_1 after training for 12 weeks, this result support our study because there is a direct relationship between FEV_1 and peak expiratory flow which is measured by the peak flow meter, in this study, in the first second of the patient's expiration **[15]**.

The findings are more supported by Rawashdeh and Alnawaiseh (2018), who preferred the use of Aerobic exercise training with high intensity in plans to decrease sedentary lifestyle, increase aerobic endurance, and improve or at least keep pulmonary efficiency in sedentary and lazy persons, and recommended that a much longer exercise prescription or higher exercise intensity may be wanted to markedly improve lung capacity in inactive people **[16]**.

According to Chaitra and Vijay (2011), who studied the impact of aerobic activities on the peak expiratory flow rate in normal people. The effects of aerobic exercise on ventilatory capacity depend on intensity and time of training. We conclude that aerobic exercise training leads to improvement in PEFR in normal people; and thus gives further support for the aerobic exercise being an essential corner of lung system rehabilitation. The medical care field should better experience aerobics as a supplement to traditional medical service. This will result in better and enhanced management of COPD **[17]**.

Roger and Thomas (2016), supported this study by illustrating the processes by which aerobic training enhances pulmonary capacity: Training with endurance exercises decreases total lung ventilation at any under maximal training intensity. The processes of reduction of ventilation include reduction of the blood circulating exciters (like ions of hydrogen, potassium, and noradrenalin), a decreased ventilatory sensitivity of the chemical receptors to the serum exciters and delayed central motor control owing to a lateness in limb dynamic muscle tiredness. Generally, the tidal volume becomes higher and the ventilation frequency is reduced with endurance exercises. Uniform aerobic training decreases the vagal parasympathetic stimulus to the pulmonary airways, this withdraw of vagal stimulus happens through a reaction comes from activation of limb dynamic muscle mechanoreceptors during movement **[18,19]**.

Combination of both aerobic and resisted exercises is thought to be beneficial for COPD patients as they showed both statistical and clinical marked effect.

Conclusion: From the obtained results of this study aerobic training is better than resisted exercises in improvement of peak expiratory flow rate, and combination of both aerobic and resisted exercises may be more beneficial.

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تأثير التمرينات الهوائية مقارنة بتمارين المقاومة المتعددة على معدل ذروة تدفق الزفير لدى مرضى الإنسداد الرئوى المزمن

الغرض من هذه الدراسة مقارنة تأثير التمرينات الهوائية بتمرينات المقاومة المتعددة على معدل ذروة تدفق الزفير لدى مرضى الإنسداد الرئوى المزمن (متوسط الخطورة).

أجريت هذه الدراسة على أربعين رجلاً مريضاً بالإنسداد الرئوى المزمن (متوسط الخطورة). تم اختيارهم بالعيادة الخارجية بمستشفى الزهراء الجامعى. وقد تراوحت أعمارهم بين ثلاثين وأربعين عاماً، وقد تم تقسيم المرضى عشوائياً إلى مجموعتين متساويتين فى العدد، واستمرت الدراسة لمدة ثلاثة أشهر، وتم الحصول على موافقة جميع المرضى قبل بدء الدراسة، وخضع جميع المرضى إلى ما يلى:

تجميع البيانات الأساسية للمرضى المشاركين فى الدراسة من العمر والوزن والطول .... الخ، والتاريخ المرضى للحالة، والتاريخ المرضى لأى أمراض أخرى مزمنة، وتم قياس جميع العلامات الحيوية للمرضى قبل بدء البرنامج العلاجى.

المجموعة الأولى (أ) قامت بعمل تمرينات هوائية باستخدام جهاز التمرينات المغزلية لمدة إثنتى عشر أسبوعياً، ثلاثة أيام أسبوعياً، والمجموعة الثانية (ب) قامت بعمل تمارين مقاومة متعددة للأطراف العليا والسفلى لمدة إثنتى عشر شهراً، ثلاثة أيام أسبوعياً، تم قياس معدل التنفس الزفيرى بواسطة الجهاز الخاص بذلك لكل مريض قبل بدء برنامج العلاجى وبعده للمجموعة (أ) والمجموعة (ب).

أظهرت كلتا التمارين الهوائية وتمارين المقاومة المتعددة اختلاف إحصائى ملحوظ فى معدل التنفس الزفيرى بالنسبة للمجموعتين (أ)، و(ب) ، ومن ناحية أخرى، هناك إختلاف إحصائى كبير بين قيمتى معدل التنفس الزفيرى (بعد البرنامج العلاجى) للمجموعتين (أ) و (ب) لصالح المجموعة (أ).

من واقع نتائج الدراسة الحالية، يمكن إستنتاج أن للتمرينات الهوائية وتمرينات المقاومة المتعددة تأثير إيجابى على وظائف التنفس، ولكن التمرينات الهوائية أفضل من تمرينات المقاومة المتعددة فى تأثيرها الايجابى على وظائف التنفس.