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ORIGINAL ARTICLE

Pulmonary rehabilitation slows the decline in forced expiratory volume in 1 second and improves body mass index in patients with Chronic Obstructive Pulmonary Disease

Sameh Embarak [a,*], **Waleed Mansour** [a], **Mohammed A. Mortada** [b]

[a] *Chest Department, Faculty of Medicine, Zagazig University, Egypt*
[b] *Rheumatology Department, Faculty of Medicine, Zagazig University, Egypt*

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KEYWORDS

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Abstract *Background:* Chronic Obstructive Pulmonary Disease (COPD) is characterized by persistent airflow limitation that is usually progressive leading to disability with an increasing burden to the patient, his family and to the health services. Pulmonary rehabilitation (PR) is used as a complementary evidence-based effective treatment option for patients with COPD. This study was carried out to evaluate the effects of PR on the rate of forced expiratory volume in 1 second (FEV_1) decline in patients with stable COPD.

Patients and methods: Eighty five COPD patients completed the study, 60 with a mean age of 63 ± 7 years underwent PR for 3 years and 25 with a mean age of 62 ± 5.4 received only pharmacological treatment according to guidelines. Pulmonary function testing and body mass index (BMI) were carried out for all patients upon enrollment and at 1 year intervals for 3 years.

Results: The FEV_1 decreased from 1246.8 ml (46.9% of predicted value) to 1192.8 ml (44.8% of predicted) in the PR group, while in the control group the FEV_1 decreased from 1224.6 ml (45.4% of predicted) to 1060 ml (39.3% of predicted) (i.e., FEV_1 declined 54 ml versus 164.6, respectively, $p = 0.008$). Also, the PR group showed an improvement in BMI, while in the control group a decreased BMI was noticed ($p = 0.001$).

Conclusion: Pulmonary rehabilitation resulted in slowing down the decline in FEV_1, as well as improving BMI in patients with stable COPD.

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Introduction

Chronic Obstructive Pulmonary Disease (COPD) is characterized by persistent airflow limitation that is usually progressive

* Corresponding author. Tel.: +20 1111680540.
E-mail addresses: sembarak75@yahoo.com (S. Embarak), waleedmansour123@yahoo.com (W. Mansour), m_a_mortada@yahoo.com (M.A. Mortada).

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leading to disability with an increasing burden to the patient, his family and to the health services [1]. The most commonly used lung function parameter is the forced expiratory volume in 1 second (FEV_1), the decline of which is estimated to be 47–79 ml/year in COPD patients as compared to 30 ml/year in healthy subjects [2–7]. Smoking cessation has been shown to be the only effective intervention to alter the rate of decline in FEV_1 in patients with COPD [2,8,9]. However, two recent large placebo-controlled trials have shown that such a result can be also obtained with an appropriate pharmacotherapy [10,11].

Pulmonary rehabilitation (PR) is used as a complementary evidence-based effective treatment option for patients with COPD. It has been recognized to improve symptoms, exercise tolerance and quality of life in those patients [12,13]. However, the effects of PR on lung function have been poorly investigated [14–16]. Moreover, one of the major unresolved issues is the duration of treatment. For example, outpatient exercise training with two or three weekly sessions for 4 weeks showed less benefit than similar training for 7 weeks [17–19]. Hence, the present study was carried out to evaluate the effects of three years pulmonary rehabilitation on the rate of FEV_1 decline and the change of body mass index (BMI) in patients with stable COPD.

Patients and methods

Patients

This study was carried out in Respiratory and Rheumatology Departments and Outpatient Clinics during the period from August 2010 through March 2014. It included COPD patients diagnosed and under pharmacological treatment according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines [1]; supported by spirometric evidence of airflow obstruction (forced expiratory volume in one second (FEV_1)/forced vital capacity (FVC) < 0.70) when clinically stable. We excluded patients who were active smokers or had quit smoking less than 2 years prior to the onset of this study, patients with chronic respiratory failure requiring long-term oxygen therapy and those in whom there were other major medical problems such as heart failure, myocardial infarction, cerebrovascular disease, cancer, neuromuscular, or severe orthopedic disorders. Also, patients who had an acute exacerbation in the 4 weeks before the enrollment (i.e., requiring antibiotics, oral/parenteral steroids, oxygen or increased bronchodilators dosage) were excluded.

Methods

All patients underwent pulmonary function test according to ATS/ERS [20] recommendations, upon enrollment and at 1-year intervals up to 3 years using the Zan-100 (Flow Handy II) pulmonary function apparatus. Forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV_1) were measured. The post-bronchodilator values were used for statistical analysis. BMI (kg/m^2) was measured for each patient and was re-calculated at every spirometry.

PR program was carried out in groups of 6–8 patients according to Riario-Sforza et al. [21]. It involved a schedule of 12 sessions in a 6-week period and included: (1) exercise training using a treadmill for 30 min; (2) upper-limb and trunk exercise training, with warm-up and limbering exercises focused on arm, shoulder and trunk muscle groups for 30 min. Exercise intensity was graded, as the patient progressed in the PR program. In addition, patients attended a COPD education course, and were instructed on how to perform muscle exercises and respiratory training daily at home for the entire duration of the program. The PR cycle was repeated every 6 months for a duration of 3 years.

Statistical analysis

Statistical analysis was performed with Epi Info™ version 7 and SPSS version 19 statistical software package (SPSS Inc., Chicago, IL, USA). Data are presented as mean ± SD. Analysis of variance (ANOVA) was used to compare between the groups for the analysis of the entire 3 year period. For time point differences, a two-sample t test was used. p-Value < 0.05 was considered significant.

Results

First, this study included 95 COPD patients, 67 of them agreed to receive PR (PR group) and 28 did not require and received pharmacotherapy only (control group). Ten patients, 10.5% withdrew during the observation period (7 in the PR group and 3 in the control group). So, finally 85 patients completed the present study (60 in the PR group with a mean age of 63 ± 7 and 25 in the control group with a mean age of 62 ± 5.4) and their demographic data are shown in Table 1.

Table 2 shows body mass index (BMI) changes in the studied groups over 3 years. The PR group showed an improvement in BMI, while in the control group a decreased BMI was noticed ($p = 0.001$).

Table 3 & Fig. 1 shows FEV_1 values over 3 years in the studied population. In the PR group, the FEV_1 decreased from 1246.8 ml (46.9% of predicted value) to 1192.8 ml (44.8% of predicted), while in the control group the FEV_1 decreased from 1224.6 ml (45.4% of predicted) to 1060 ml (39.3% of predicted) (i.e., FEV_1 decline of 54 ml versus 164.6, respectively, $p = 0.008$).

Discussion

To date, none of the existing medications for COPD has been shown conclusively to modify the long-term decline in lung function that is the hallmark of this disease [1]. Pulmonary rehabilitation (PR) is used as a complementary treatment option for these patients [16]. The American Thoracic Society (ATS) and the European Respiratory Society (ERS) published a statement, in which PR was recognized as an evidence-based, multidisciplinary and comprehensive intervention for patients with chronic respiratory diseases who are symptomatic and often have decreased daily life activities [12]. However, little data are available about the effects of PR on pulmonary function in patients with stable COPD. So, the aim of the current work was to investigate the effects of PR over 3 years on lung function of COPD patients.

Results of the present study illustrated that three years of PR program for COPD patients resulted in a significant lower decline in FEV_1 compared to patients in the control group who

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