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ORIGINAL ARTICLE

Effect of inspiratory muscle training on exercise performance and quality of life in patients with chronic obstructive pulmonary disease

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KEYWORDS

COPD;
Exercise capacity;
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Quality of life

Abstract *Background:* Chronic obstructive pulmonary disease (COPD) is associated with skeletal muscle dysfunction. This study aimed to evaluate effectiveness of inspiratory muscle training (IMT) as a part of exercise training in COPD patients.

Methods: Sixty male patients were assigned to 3 groups; twenty in each group. In addition to medical treatment given for all patients; patients in group A received peripheral muscles exercise training plus IMT at an intensity that increased from 30% to 60% of their maximal inspiratory pressure (P_{Imax}). Patients in group B received peripheral muscle exercise training alone, and in group C; they received no training. All patients underwent clinical evaluation, chest X-ray, electrocardiogram, body mass index, and spirometry. Outcome measures in the form of respiratory muscle strength [P_{Imax}, maximal expiratory pressure (P_{Emax})], dyspnea, exercise performance (six minutes walk test) and quality of life [BODE index and St. George's Respiratory questionnaire for COPD patients (SGRQ-C)] were carried out at study entry, after 4 and 8 weeks.

Results: IMT plus peripheral muscle exercise training led to a significant improvement in P_{Imax}, P_{Emax}, and 6-min walking distance (6MWD) compared to peripheral muscle exercise training alone. Both IMT plus peripheral muscle exercise training and peripheral muscle exercise training alone improved dyspnea, BODE index and SGRQ-C without significant differences between 2 groups.

Abbreviations: 6MWD, 6-min walk distance; 6MWT, 6-min walk test; BMI, body mass index; COPD, chronic obstructive pulmonary disease; FEV1, forced expiratory volume in the first second; FVC, Forced vital capacity; GER, general exercise reconditioning; GOLD, Global Initiative for Chronic Obstructive Lung Disease; IMT, Inspiratory muscle training; LABD, long acting bronchodilators; MCID, minimal clinical important difference; mMRC, modified Medical Research Council; P_{Emax}, maximal expiratory pressure; P_{Imax}, maximal inspiratory pressure; SGRQ-C, St George's Respiratory Questionnaire for COPD patients

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Conclusion: For P_{Imax}, P_{Emax}, and 6MWD; IMT provides additional benefits to peripheral muscle exercise training in COPD patients. However, this did not translate into additional improvement in dyspnea and quality of life compared with what is achieved by peripheral muscle exercise alone.

Introduction

Chronic obstructive pulmonary disease (COPD) is a multisystem disease affecting the skeletal muscle both peripheral and respiratory [1,2]. Weakness of respiratory muscle in COPD patients leads to hypercapnia, dyspnea, and decreased exercise capacity [3]. In COPD; inspiratory muscle training (IMT) as a monotherapy improves inspiratory muscle strength, exercise capacity, and decreases dyspnea [3,4]. However, the value of addition of IMT to a general exercise training program is still questionable [5,6]. The aim of this work was to evaluate the effectiveness of IMT as a part of exercise training program in patients with COPD.

Methods

This prospective comparative interventional study was carried out at Chest Medicine and Rheumatology and Rehabilitation Department; Mansoura University Hospital; Egypt. All subjects enrolled from October, 2011 to April, 2014. Ethics approval has been obtained from Medical Research Ethics Committee in July, 19th, 2011; Mansoura University. The protocol for this work was published on ClinicalTrials.gov (identifier: NCT02257463).

Ninety-four male patients between 45 and 65 years old with moderate to very severe COPD were recruited in this study. The severity was classified according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) into stage II, III, and IV based on post bronchodilator forced expiratory volume in one second (FEV_1) values in patients with FEV_1/forced vital capacity (FVC) < 0.70 [7]. In addition to theophylline, patients also received medications in the form of either inhaled long acting bronchodilators (LABD) or combined LABD and inhaled steroids according to GOLD recommendations [7]. All patients were exsmokers, had a stable clinical condition at the time of study and with low maximal inspiratory pressure (P_{Imax}) [< 60 cm H_2O] [8]. Patients with significant reversibility following bronchodilation defined as an increase in FEV_1 of more than 12% and 200 ml from the pre-bronchodilator value [9], those with unstable cardiac diseases, uncontrolled hypertension, recent pneumothorax, recent abdominal or thoracic surgery, known progressive neuromuscular disorders, advanced liver diseases, or renal impairment, known connective tissue diseases, or significant endocrinal abnormalities were excluded from the study.

While 34 patients dropped out from the study, 60 patients completed the study and were classified into 3 groups. Group A (study group) included 20 patients treated with pharmacological therapy, peripheral muscle exercise training, and IMT. Group B (control positive group) included 20 patients treated with pharmacological therapy, peripheral muscle exercise training without IMT; and 20 patients were enrolled into group C (control negative group). They were treated only with pharmacological therapy without any kind of pulmonary rehabilitation.

Patients in group A and group B were chosen randomly. Those with odd numbers were classified to be in group A while those with even numbers were classified to be in group B. For group C and to decrease the drop out ratio, patients from distant localities who found difficulty in adherence with the study protocol from the start because of the economic state and transportation issues were classified in this group to ensure only one monthly visit. We also chose male patients as the disease is not common in females in our locality, and to avoid gender-associated differences in the response to pulmonary rehabilitation.

All patients underwent baseline assessment including thorough history taking, clinical examination, plain chest X-ray, electrocardiogram, and body mass index (BMI). Patients were then evaluated before the study, after 4 and 8 weeks (except for reversibility after bronchodilators) using spirometry, respiratory muscle strength device, six minute walk test (6MWT), dyspnea grading, BODE index, and St. George's Respiratory questionnaire for COPD patients (SGRQ-C). Spirometry was performed to measure FEV_1, FVC, FEV_1/FVC ratio, and reversibility after bronchodilators using smart *pft* lab, Medical Equipment Europe GmbH, Germany according to the standardized protocol [10]. Respiratory muscle strength was evaluated using a handheld mouth pressure meter (Micro MPM; Micro Medical, UK) with measuring P_{Imax} and maximal expiratory pressure (P_{Emax}) as previously described [11]. Six minute walk test (6MWT) was conducted according to the procedures recommended by the American Thoracic Society [12]. Grading of dyspnea was performed using the modified Medical Research Council (mMRC) [13]. With recording BMI, the FEV_1, mMRC dyspnea scale, and the six minutes walk distance (6MWD); BODE index was calculated [14]. Finally, assessment of quality of life using St. George's Respiratory questionnaire for COPD patients (SGRQ-C) was done.[15].

Training protocol

1. Peripheral exercise trainingWe followed The Pulmonary Rehabilitation Toolkit on behalf of The Australian Lung Foundation [16]. The program was conducted following a schedule of 24 visits in the 8 week period. Patients in group A and group B were subjected to a combination of lower limb endurance training using treadmill walking, upper limb endurance training with a combination of arm raise and arms together, upper limb strength training using hand weights for biceps and triceps, and lower limb strength training using straight leg raise.
2. Inspiratory muscle training (IMT)All subjects in group A only were trained daily, six times a week; each session consisted of 30 min, for 2 months using a threshold inspiratory