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## Outcome of pulmonary rehabilitation in patients with COPD: Comparison between patients receiving exercise training and those receiving exercise training and CPAP

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## ABSTRACT

**Background:** Pulmonary rehabilitation (PR) using exercise training has been useful to increase the exercise capacity and life quality in patients with chronic obstructive pulmonary disease (COPD). However, airflow limitation which characterizes COPD usually worsens during exercise due to the lack of flow reserve and dyspnea hinders exercise maintenance. Non-invasive ventilation (NIV) has been a beneficial therapeutic tool for COPD patients to ameliorate their dyspnea and intensify their exercise. Thus, using NIV during exercise training program might have a synergistic effect in managing patients with COPD by increasing their physical activity, exercise intensity and capacity and their quality of life.

**Objective:** To study the effect of using NIV during PR by exercise training on dyspnea, exercise tolerance and quality of life as compared to effect of exercise alone in patients of COPD.

**Subjects and methods:** The present study was conducted on 24 stable male patients with COPD who were ex-smokers. Patients were divided into 2 groups; group 1 (Exercise gp) included 12 patients who had undergone exercise training only and group 2 (EX/CPAP gp) which included also 12 patients who had undergone exercise in addition to NIV using continuous positive airway pressure (CPAP). Baseline and after 1 month assessment of patients' pulmonary functions, arterial blood gases, dyspnea scale assessed with the Modified Medical Research Council (MRC), 6 minute walking test (6MWT), BODE index and COPD Assessment Test (CAT) score was done.

**Results:** Group 2 (Ex/CPAP gp) showed a statistically significant improvement in 6MWD, BODE index, SaO<sub>2</sub>, PaCO<sub>2</sub>, Pimax, mMRC, and CAT score ( $p < .05$ ). Group 1 (exercise group) showed a statistically significant improvement in 6MWD, Pimax, BODE index, mMRC and CAT score ( $p < .05$ ). As regards comparison of group 1 to group 2, the % of improvement in 6MWD and BODE index was significantly more in group 2 than group 1 ( $p = .010$  and  $< .001$ , respectively). No significant differences were found between both groups as regards blood gases, mMRC and CAT score.

**Conclusion:** Adding non-invasive ventilation to an exercise rehabilitation program in patients with stable COPD has shown to augment improvement in exercise performance.

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## Introduction

COPD is defined by irreversible airway obstruction that causes expiratory airflow limitation and an increased functional residual capacity called hyperinflation. The result is a deleterious effect on the diaphragm and alveoli length-tension relationship by prevention of complete end expiration elastic recoil [1]. This creates a positive above atmospheric intrapulmonary pressure at end of expiration (PEEPi) and a decreased resting inspiratory capacity. A negative pressure above this PEEPi is required to be generated for inspiration to happen [2]. The end result is an increase in work

**Abbreviations:** PR, pulmonary rehabilitation; COPD, chronic obstructive pulmonary disease; NIV, non-invasive ventilation; CPAP, continuous positive airway pressure; 6MWD, 6 minute walk distance; CAT, COPD assessment test, HRQOL, health related quality of life.

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of breathing, muscle bulk wasting, debilitating dyspnea, and exercise intolerance, even in patients with mild COPD [3,4]. These effects are intensified during exercise due to the increased oxygen demand. An increased respiratory rate during exercise decreases the expiratory time and results in shallow breathing, increased work and FRC, both augment PEEPi and dynamic hyperinflation. This results in severe breathlessness with the slightest effort and causes exercise limitation [5–7].

Pulmonary rehabilitation (PR) has shown evidence to be a significant tool for managing patients with COPD. Many trials have shown that PR for 3–12 weeks was able to decrease dyspnea, increase exercise duration, improve quality of life and even decrease hospitalizations in patients with COPD [8–10]. Other therapies included bronchodilators, nutritional support, growth hormone, vitamin D and noninvasive ventilation (NIV) [11].

It has been shown that supplying ventilatory aid to COPD patients by using CPAP or pressure support ventilation (PSV) had several beneficial effects and was able to decrease the work of breathing and inspiratory muscle effort which in turn caused the improvement of dyspnea in those patients [11,12]. Decreasing the work of breathing by the use of CPAP with exercise reduced heart rate, metabolic acidosis and minute ventilation and increased muscular mitochondrial enzymatic activity [13,14].

For many years, NIV has been frequently used in stable COPD, described as beneficial and considered as a reliable therapeutic tool [15,16]. NIV exerts these effects via a number of ways. It adjusts the respiratory central drive, improves gaseous exchange, decreases the work of breathing during exercise and relieves respiratory muscles load [17]. These effects are reflected clinically on mechanical performance of patients in the form of decreased breathlessness, improved quality of life [18] and an added potentiated effect to rehabilitation programs [8,19].

A number of studies have assessed the relationship between decreased work of breathing and reduced dyspnea with exercise during rehabilitation programs [20–24]. Others have studied the use of positive pressure ventilation in addition to rehabilitation and demonstrated a decrease in lung dynamic hyperinflation and an improved exercise tolerance and duration and muscle endurance [14,25,26].

So, the aim of this study was to evaluate the effect of using NIV during exercise and compare it to the effect of exercise alone in patients with stable COPD.

## Patients and methods

The population of the present study comprised 24 patients with COPD admitted to the Chest Diseases Department, Alexandria University Hospital. Informed consent was obtained from all patients. The study was approved by the local ethics committee.

24 patients with stable COPD were recruited at a PR program. All the studied patients were males and ex-smokers and were diagnosed as COPD according to Global Initiative for Obstructive Lung Disease (GOLD) classification having a post-bronchodilator FEV<sub>1</sub>/FVC less than 0.70 and as stable having no exacerbation for the earlier 4 weeks [4]. Patients received their regular medical treatment throughout the duration of the program and were subjected to full detailed history taking including the age, smoking history, presenting complaints specially dyspnea, cough, and history of comorbidities. Clinical examination, general and local was done thoroughly. All patients were investigated for their routine laboratory work including total and differential count of white blood cells, hemoglobin, fasting blood glucose level, liver and renal function tests, INR and prothrombin activity. E.C.G., plain X-ray chest postero-anterior and lateral views as well as CT scan were done for all patients. Exclusion criteria included any orthopedic or neu-

rological problem that might interfere with exercise, recent cardiac infarction, peripheral venous thrombosis or any chest condition other than COPD.

Patients were divided into 2 groups; group 1 (Exercise gp) included 12 patients who had undergone exercise training only and group 2 (EX/CPAP gp) which included also 12 patients who had received CPAP during the exercise program. According to GOLD classification for COPD severity based on FEV<sub>1</sub>% [4], group 1 (exercise group) included 3 patients (25%) with moderate, 7 patients (58.3%) with severe and 2 patients (16.7%) with very severe COPD. Group 2 included two patients (16.7%) with moderate, 9 patients (75%) with severe and one patient (8.3%) with very severe COPD. Patients were also classified guided by the combined assessment of GOLD classification plus modified Medical Research Council (mMRC) dyspnea scale, CAT score (COPD Assessment Test) and exacerbation history [4]. Accordingly, Exercise group (gp 1) included 3 patients (25%) belonging to group B and 9 patients (75%) to group D. Ex/CPAP group (gp 2) included two patients (16.7%) belonging to group B and ten patients (83.3%) to group D.

## Intervention

The PR program was tailored in accordance with American Thoracic Society and the European Respiratory Society recommendations [27–29]. The program extended for 4 weeks. The frequency of training was three sessions each week. It included:

### Aerobic exercise training using treadmill

Intensity of exercise was estimated guided by the patient's maximum heart rate which equals (220–Age in years). The patient has performed high intensity exercise (75% of maximal heart rate). In less conditioned patients, exercise intensity was guided by patient's tolerance. The duration of each exercise session lasted 20–30 min (5 min to warm up, 10–20 min of exercise proper and final 5 min to cool down). Total duration of exercise and its intensity were gradually increased during sessions guided by the patient tolerance. The Borg Scale of perceived exertion was used to monitor the exercise intensity. Exercise intensity was increased by 5% to 10% (guided by patient's maximum heart rate) when patients rated their perceived dyspnea as moderate. The test was stopped when patients were unable to carry on their exercise because of dyspnea or leg fatigue or when critical changes in vital signs were detected. During exercise, heart rate (HR) and arterial oxygen saturation (SaO<sub>2</sub>) were continuously recorded using pulse oximetry.

### Diaphragmatic breathing with pursed lip

The patient was instructed to lie on his back on a flat surface with his knees bended. One hand was kept on the chest and another on the abdomen which allowed the patient to feel his diaphragm moving during breathing. Also, the patient could have the exercise done while sitting on a chair [30]. Then the patient was asked to take deep slow inspiration allowing him to feel his abdominal wall moving outwards [31]. Pursed lip breathing involved active expiration against resistance of pursed lips [30].

Strengthening exercises using Multigym device for quadriceps muscle with “isotonic” contractions against a fixed weight. To determine the proper weight for training, 60–80% of the maximum weight the patient could lift in a single contraction during preliminary testing was used. A set of 10 repetitions was performed 3 times with a rest period between sets, 3 sessions per week were prescribed [32]. The same strategy was used for strengthening exercises for the upper limbs [33,34].

NIPPV settings: Settings of CPAP were started at rest at the level that could be tolerated by the patients. Initially, pressure was set at

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