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ORIGINAL ARTICLE

Non-invasive positive pressure ventilation and exercise training in patients with stable hypercapnic chronic obstructive pulmonary disease

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KEYWORDS

Exercise training;
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Abstract *Background:* Chronic obstructive pulmonary disease (COPD) is a disease with progressive course of dyspnea which leads to reduced health related quality of life (HRQoL). Exercise training has useful effects toward their exercise tolerance and health related quality of life (HRQoL). However extreme breathlessness limits these patients in maintaining exercise training. Non-invasive positive pressure ventilation (NIPPV) is considered a beneficial treatment option for chronic stable hypercapnic respiratory failure. So, the aim of this study is to assess the effect of adding NIPPV to Exercise training program compared to Exercise training program alone in stable hypercapnic COPD patients.

Patients and methods: Thirty patients with stable hypercapnic COPD were selected, subdivided into two groups; 15 patients underwent Exercise training alone (Ex. group) and another 15 patients performed Exercises training in association with receiving NIPPV (Ex. + NIPPV group). Baseline and after 3 months assessment of arterial blood gases analysis (ABGs), pulmonary function tests (PFTs), dyspnea scale by modified Medical Research Council (mMRC) and assessment of HRQoL guided by COPD Assessment Test (CAT) were done for both groups.

Results: In the Exercise training group, they showed statistical significant improvement in dyspnea scale (mMRC) and CAT score after 3 month performance ($p < 0.05$), but insignificant changes occurred in their ABGs or PFTs ($p > 0.05$). While in the Ex. + NIPPV group, a highly statistical significant improvement regarding PCO_2, FEV_1 and dyspnea scale (mMRC) ($p \leqslant 0.001$) and a significant difference as regards HRQoL assessment score ($p < 0.05$) were found after 3 month follow up.

Conclusion: Addition of NIPPV to exercise training in patients with stable hypercapnic COPD patients improved PCO_2, FEV_1, dyspnea scale and HRQoL.

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Introduction

Chronic obstructive pulmonary disease (COPD) is one of the leading causes of death worldwide [1]. Patients with severe COPD often develop chronic hypercapnic respiratory failure with a worse prognosis and more frequent exacerbations [2]. Even during stable states and with optimal medications, these patients are always suffering from dyspnea which is a very common complaint especially during physical activities [3].

This leads to chronic physical inactivity, exercise intolerance and sedentary life style, with more ventilation demands feeding the dyspnea-inactivity-dyspnea cycle [4]. Among the wide range of non-pharmacological therapeutic approaches for stable COPD, starting from smoking cessation, long term oxygen therapy (LTOT) [5], pulmonary rehabilitation [6] and ending with Bronchoscopic lung volume reduction [7], there are still a few interventions which diminish the number of exacerbations and improve survival [8].

Exercise training as a part of multidisciplinary pulmonary rehabilitation (PR) has useful effects toward exercise tolerance and health related quality of life in stable COPD patients [9]. These effects underwent via reduction of lactic acidosis, minute ventilation, heart rate and enhance the activity of mitochondrial enzymes with increased capillary density in the trained muscles [10], However extreme breathlessness limits these patients in maintaining exercise training [10]. Therefore, there is a need for additive therapies enhancing the effectiveness of PR [11].

Non-invasive positive pressure ventilation (NIPPV) is considered a beneficial treatment option for chronic stable hypercapnic respiratory failure [12].

A number of positive effects have been documented during NIPPV; it improved gas exchange, unloaded respiratory muscles and reset the central respiratory drive [13]. Clinical manifestations of these physiologic changes are reflected as reduced dyspnea, improved health related quality of live (HRQoL) [14], and potentiated the benefits of rehabilitation program [15].

The effect of NIPPV in association with multidisciplinary pulmonary rehabilitation program in chronic stable COPD had been investigated by different studies, but with different contradictory results. Garrod et al. [16], Kohnlein et al. [17] and Duiverman et al. [18], had assessed the effect of combination of NIPPV and PR but in short term interval. Other studies used low ventilator pressure settings which resulted in unbeneficial effect [19].

So, the aim of this study is to assess the effect of adding NIPPV to Exercise training program compared to Exercise training program alone in stable hypercapnic COPD patients for a period of 3 months.

Patients and methods

This study was conducted at (Chest, Rheumatology and Rehabilitation) Departments and outpatient clinics Faculty of Medicine, Zagazig University hospitals in the period from October 2012 till April 2014. Written informed consents were obtained from all patients. The study was approved by the local ethics committee of the institute.

Patients

Thirty patients were selected with severe and very severe COPD (GOLD 3 and GOLD 4) with Forced expiratory volume in 1st second/Forced vital capacity (FEV_1/FVC) $< 70\%$ and FEV_1 $< 50\%$ predicted [20], associated with day time hypercapnia ($PaCO_2 \geqslant 50$ mmHg) and stable clinical condition (no exacerbation for the prior four weeks with ($pH \geqslant 7.35$) [21], receiving proper medications according to GOLD 2011 [20]. They were 20 males and 10 females with age range 66.05 ± 9.4 years.

They were subdivided into two groups:

Exercise Training group (Ex): 15 patients performed Exercise training.

Exercises training + NIPPV (Ex. + NIPPV): 15 patients performed exercise training in association with NIPPV in the form of BiPAP home mechanical ventilation.

Exclusion criteria were: After invasive mechanical ventilation, obstructive sleep apnea [8], cardiac diseases limiting exercise tolerance [11], neuromuscular diseases [18] or orthopedic impairment of shoulder girdle [4].

Method

All patients were subjected to:

(1) Thorough medical history taking.
(2) General and local chest examination.
(3) Chest X-ray (posteroanterior and lateral views).
(4) Arterial blood gases analysis (ABGs).
(5) Routine laboratory investigations:
  – Complete blood count
  – Liver function tests
  – Kidney function tests

(6) ECG.
(7) Pulmonary function tests (PFTs):

All patients underwent spirometric PFT with reversibility testing after inhalation of short acting B_2-agonist (200 μg salbutamol) of metered-dose inhaler. PFT was done using ZAN-100 (flow HANDY II) pulmonary function apparatus. The following parameters were assessed as absolute values and percentage of predicted post bronchodilator: Forced expiratory volume in 1st second (FEV_1), Forced vital capacity (FVC) and (FEV_1/FVC) ratio.

(8) Assessment of health related quality of life (HRQoL) by using COPD Assessment Test (CAT) [22,23]:

This score included eight items assessing: cough, phlegm, chest tightness, breathlessness going up a hill/stairs, activity limitations at home, confidence leaving home, sleep and energy. Each item was scored from 0 to 5 giving a total score from 0 to 40, corresponding to the best and worst health status in patients with COPD. Scores of 0–10, 11–20, 21–30 and 31–40 represented mild, moderate, severe or very severe clinical impact, respectively.

(9) Assessment of dyspnea level by modified Medical Research Council (mMRC) dyspnea scale [20]:

It is a 5-point scale from 0 to 4 based on levels of dyspnea according to patient's response, describing dyspnea from none (Grade 0) to almost complete incapacity (Grade 4).