Respiratory Medicine (2007) **101**, 516–524

ELSEVIER

respiratoryMEDICINE

Clinical outcomes of expiratory muscle training in severe COPD patients ☆

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Received 28 December 2005; accepted 29 June 2006

KEYWORDS
Respiratory muscles;
Rehabilitation;
Breathing exercises;
Exercise;
Quality of life;
Dyspnoea

Summary
The most common symptoms in chronic obstructive pulmonary disease (COPD) patients are breathlessness and exercise limitation. Although both general and inspiratory muscle training have shown clinical benefits, the effects of specific expiratory muscle training remain controversial.
Objective: To investigate the effects of expiratory training on lung function, exercise tolerance, symptoms and health-related quality of life in severe COPD patients.
Methods: Sixteen patients (FEV_1, $28 \pm 8\%$ pred.) were randomised to either expiratory muscle or sham training groups, both completing a 5-week programme (30 min sessions breathing through an expiratory threshold valve 3 times per week) (50% of their maximal expiratory pressure (MEP) vs. placebo, respectively). Lung function, exercise capacity (bicycle ergometry and walking test), and clinical outcomes (dyspnoea and quality of life (St. George Respiratory Questionnaire (SGRQ)) were evaluated both at baseline and following the training period.
Results: Although lung function remained roughly unchanged after training, exercise capacity, symptoms and quality of life significantly improved. The improvement in both walking distance and the SGRQ score significantly correlated with changes in MEP.

☆This study was supported, in part, by Spanish Grants from FUCAP, SEPAR, FIS (98/1143) and ISC III (RTIC C03/11), as well as by a Grant of the European Commission (BMH4-CT98-3406). Very preliminary results were presented at the European Respiratory Society Annual Congress, Stockholm 2002.

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0954-6111/$ - see front matter
doi:10.1016/j.rmed.2006.06.024

Conclusion: Our results confirm that a short outpatient programme of expiratory training can improve symptoms and quality of life in severe COPD patients. These effects could be partially explained by changes in expiratory muscle strength.

Introduction

The efficacy of pulmonary rehabilitation on chronic obstructive pulmonary disease (COPD) patients has been demonstrated in many studies.[1,2] Although pulmonary rehabilitation is a multi-dimensional therapy, muscle training appears to be its most effective component. This is not surprising since muscle dysfunction is common in COPD patients and, at least in part, appears to be the result of muscle deconditioning. General exercise, the training modality supported by the strongest evidence (level A) has been shown to improve exercise tolerance, dyspnoea and health-related quality of life.[2–4] Clinical benefits of specific ventilatory muscle training, however, have remained equivocal.[5] Nevertheless, different recent studies have shown that when training loads are well controlled, inspiratory training can induce specific improvements in the strength and endurance of inspiratory muscles, as well as a decrease in dyspnoea sensation both at rest and during exercise.[6–8] Therefore, it is currently accepted that inspiratory training is a meaningful addition to pulmonary rehabilitation programmes, mostly in those COPD patients with inspiratory muscle weakness.[7,9] However, the role of expiratory muscle training in COPD patients is much less well understood. On one hand, there is a relative paucity of data on expiratory muscle role in chronic respiratory conditions, on the other hand, the prevalence of expiratory muscle dysfunction and its impact in general clinical outcomes is unclear. Finally, the studies evaluating specific expiratory training programmes are rather scarce.

Expiratory muscles have been found to be active in COPD patients both at rest and during exercise, mostly at the end of expiration.[10,11] Moreover, these muscles are progressively recruited during bronchospasm and ventilatory loading.[12,13] Finally, they are essential for coughing and therefore, the clearance of the airways. However, these actions do not appear to result in significant muscle conditioning (training effect) in COPD patients. Although their maximal strength can be either only mildly decreased or relatively maintained,[14–17] COPD patients can actually suffer from progressive expiratory muscle dysfunction as expressed by a reduced endurance and early appearance of fatigue.[16] Moreover, even normal subjects can develop expiratory muscle fatigue during heavy ventilatory efforts.[18,19] Therefore, it is more likely that expiratory muscles of COPD patients, which persistently work under the overloads of increased airway resistance and decreased lung elastic recoil,[20] would develop muscle dysfunction. It should be recognised, however, that the intensity of expiratory muscle dysfunction appears to be relatively low if compared with weakness shown by COPD patients in peripheral or inspiratory muscles.[14–17]

Weiner et al.[17] recently reported that a 3-month programme of partially supervised expiratory muscle training using a threshold device was able to induce a significant increase in exercise capacity. These results were confirmed in a second study by the same authors.[21] However, the benefits of expiratory training programme were lower than those achieved with inspiratory training alone, and similar to those obtained by combining inspiratory plus expiratory components.[21] Nevertheless, the paucity of data does not allow for definitive conclusions. In addition, as previously demonstrated for inspiratory muscles, the intensity, frequency and duration of the loads, as well as the profile of the candidates, are determinant, and essential in the interpretation of data.[6,22,23]

The aim of the present study was to confirm the clinical benefits of a specific expiratory muscle training, and to provide new information about the effects of a relatively short training programme (only 5 weeks) on respiratory function, exercise capacity, dyspnoea and health-related quality of life in severely obstructed COPD patients. These outcomes can be considered as the main short-time targets in the treatment of these patients.

Methods

Patients

We studied patients with COPD in stages III (severe) or IV (very severe) according to GOLD classification[23] (FEV_1/FVC $<70\%$ and FEV_1 $<50\%$ pred.). Exclusion criteria were a positive bronchodilator response (FEV_1 increase >200 ml after 200 μg of inhaled salbutamol), chronic respiratory failure (PaO_2 lower than 60 Torr), abnormal body mass index (BMI) >30 or $<20\,kg/m^2$, bronchial asthma, coronary disease, chronic metabolic or orthopaedic diseases, recent abdominal or thoracic surgery, and/or treatment with corticosteroids, hormones or chemotherapy. The patients were simultaneously participating in parallel studies aimed at investigating phenotypic changes induced by different training programs in respiratory muscles. All subjects gave their written informed consent prior to their participation in the study.

Study design

The protocol followed the World Medical Association guidelines for research on humans[24] and was approved by our institutional ethical committees. After a 4-week run-in period, during which their clinical stability was verified, the patients were randomised to either expiratory muscle training or sham training. Clinical and physiological measurements were performed before and at the end of the programme, and the research team was blind regarding the assigned training or sham groups.