ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2014;95:1638-45

ORIGINAL ARTICLE

Impact of Resistance Training in Chronic Obstructive Pulmonary Disease Patients During Periods of Acute Exacerbation

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Abstract

Objective: To evaluate the effects of whole-body resistance training on exercise capacity, health-related quality of life (HRQOL), and muscle strength in patients hospitalized for exacerbation of chronic obstructive pulmonary disease.

Design: Randomized controlled trial.

Setting: University hospital.

Participants: Patients (N=46) were randomized to either a control group (CG) or training group (TG), and 29 patients completed the study.

Intervention: Training consisted of weight-lifting exercises for 6 muscle groups in the upper and lower limbs (2 sets of 8 repetitions each), and the initial load was set at 80% of the 1-repetition maximum load.

Main Outcome Measures: Patients were evaluated on the second day of hospitalization, at hospital discharge, and 30 days postdischarge. Patients were evaluated on the basis of the 6-minute walking distance (6MWD), HRQOL, muscle strength, systemic inflammatory markers, and level of physical activity in daily life (PADL).

Results: The CG showed a reduction in the strength of lower-limb muscles ($P<.05$) but not in the 6MWD ($P>.05$). In contrast, patients from the TG improved strength in the lower-limb muscles and 6MWD during and 30 days after hospitalization ($P<.05$). The TG also improved the impact domain in HRQOL after hospitalization. No improvement in PADL was observed in the TG. Finally, a reduction in the blood levels of inflammatory markers was observed only in the TG after hospitalization.

Conclusions: Our results suggest that resistance training during hospitalization improves the 6MWD, HRQOL, and lower-limb muscle strength, without altering the levels of systemic inflammation. However, future research should explore this intervention in larger randomized trials.

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Acute exacerbation (AE) is common in patients with chronic obstructive pulmonary disease (COPD) and causes specific symptoms (eg, changes in baseline dyspnea, cough, expectoration beyond the daily variations in symptoms), which are sufficient to justify a change in treatment.[1] With disease progression, exacerbations become more frequent and have negative impacts on pulmonary function,[2] health status,[3] and health-related quality of life (HRQOL).[1] Commonly, severe exacerbations lead to reduced muscle strength[4] and exercise capacity[5] and often require patient hospitalization,[1] which results in large health expenditures. Previously, it was demonstrated that after an exacerbation, patients sustain a great loss in exercise capacity that is not recovered, even after improvement in the patients' symptoms and lung function.[5] This loss is a concern because lower exercise capacity has been shown to be a predictor of rehospitalization[6] and lower survival in patients with COPD.[7] Although various mechanisms may contribute to the decrease in exercise capacity during AE of COPD,[8] it seems that muscle dysfunction plays an important role because a reduction in exercise capacity has been shown to be strongly associated with musculoskeletal dysfunction.[9,10]

The effectiveness of pulmonary rehabilitation (PR) strategies to counteract these musculoskeletal dysfunctions are widely known, and there is a large body of evidence demonstrating the

Supported by the São Paulo Research Foundation (grant no. 2007/51-354-7) and Brazilian Scientific Foundation (grant no. 305987/2010-0).

Clinical Trial Registration No.: NCT01786928.

Disclosures: none.

0003-9993/14/$36 - see front matter © 2014 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2014.05.007

benefits in patients with stable COPD.[1] Currently, the ideal timing for the onset of PR and the effectiveness of different rehabilitation strategies during and/or immediately after the acute phase of the exacerbation[8,11] has been discussed. Some studies[12,13] have investigated a combination of PR programs during and after exacerbation. To the best of our knowledge, only a few studies have investigated the benefits during hospitalization[14,15]; therefore, the effect these strategies exercise in patients with unstable COPD remains uncertain.

Resistance training has been shown to be a therapeutic option for preventing and/or reversing muscular dysfunction caused by immobility in healthy subjects[16] and patients with stable COPD[17] by inducing hypertrophy of type II fibers[18] and increasing muscle strength and exercise capacity.[19] In addition, less dyspnea is reported with resistance training compared with other exercise modalities.[20] Recently, resistance training of a single lower-limb muscle group in hospitalized patients with COPD was found to induce a statistically significant increase in quadriceps strength and reduce the upregulation of myostatin; however, it did not result in altered levels of systemic inflammation or exercise capacity.[14] However, previous studies have shown that resistance training improves exercise capacity in outpatients with COPD when multiple muscles are trained.[18,21] We then speculate that whole-body resistance training is likely to be tolerated in symptomatic patients and can be used as a strategy to prevent muscle dysfunction during AE of patients with COPD and consequently to improve exercise capacity and HRQOL, without significant increases in the systemic inflammatory activity.

The primary objective of this study was to evaluate the effects of a whole-body resistance training program on exercise capacity, HRQOL, muscle strength, and adverse events in patients hospitalized because of AE of COPD. The secondary objective was to investigate whether resistance training alters systemic inflammatory activity and physical activity in daily life (PADL) during the study.

Methods

Participants

This randomized controlled trial studied 46 patients with COPD who had been hospitalized as a result of disease exacerbation. Patients admitted in the ward were screened daily through the hospital database. If they were hospitalized because of COPD exacerbations according to Global Initiative for Chronic Obstructive Lung Disease criteria,[1] the patient was then contacted on the first day of hospitalization. The inclusion criteria were as follows: COPD (forced expiratory volume in 1 second/forced vital capacity <70%) exacerbation characterized by an increase in sputum or cough or worsening of dyspnea[1]; no hospitalization in the last 30 days; aged between 40 and 85 years[1,14]; absence of musculoskeletal or neurologic conditions that might affect exercise performance; no participation in a rehabilitation program in the last 6 months; and absence of any other pulmonary diseases. The exclusion criteria were as follows: patients transferred to the intensive care unit (ICU) before the second day of hospitalization; patients exhibiting changes in mental status; worsening of hypoxemia (arterial oxygen pressure <40mmHg at room air) and/or respiratory acidosis (hydrogen ion concentration <7.25); hospitalization time <5 days; or inability to complete any of the evaluations. This study was a registered clinical trial. All patients were informed of the study and signed an informed consent form approved by the ethics committee of the São Paulo University Hospital.

List of abbreviations:

AE	**acute exacerbation**
CG	**control group**
COPD	**chronic obstructive pulmonary disease**
HRQOL	**health-related quality of life**
ICU	**intensive care unit**
IL	**interleukin**
PADL	**physical activity in daily life**
PR	**pulmonary rehabilitation**
6MWD	**6-minute walking distance**
TG	**training group**

Experimental design

All patients were evaluated on 3 separate occasions: the second day of hospitalization, at hospital discharge, and 1 month after hospital discharge. During each evaluation, the following parameters were analyzed: 6-minute walking distance (6MWD), muscle strength of the upper and lower limbs, systemic inflammatory mediators, blood gas levels, lung function, and HRQOL. PADL was also quantified during hospitalization and 1 month after discharge. On the second day of hospitalization, patients performed baseline assessments and were then allocated to either the control group (CG) or training group (TG). Evaluations were performed by a blinded evaluator. The randomization sequence was computer generated by 1 investigator who was not involved in the study, and allocation was concealed in sequentially numbered, sealed, opaque envelopes.

Control and whole-body resistance training protocols

The CG received normative daily care, including chest physiotherapy to remove bronchial secretions, noninvasive ventilation if needed, and verbal instructions to carry on with their normative daily physical activities. Drug treatment and oxygen therapy were adjusted by the medical staff according to the Global Initiative for Chronic Obstructive Lung Disease recommendations.[1] Patients did not receive any exercise program or recommendation to exercise after hospital discharge.

The TG also received the same normative care as the CG, in addition to undergoing a whole-body resistance training program for the upper (shoulder flexion and abduction, elbow flexion) and lower (knee extension and flexion, hip flexion) limbs by a physiotherapist in individualized sessions. The choice of muscles to be trained was based on data from previous literature[21] and the results of a pilot study in our institution. Exercise training started on the third day of hospitalization, and every patient completed a minimum of 3 sessions during the study. Exercise sessions were performed every morning with free weights in 2 sets of 8 repetitions[22] in the sitting position. During exercises of shoulder abduction and flexion, a movement of 90° to the trunk without full elevation of the limb was performed. The initial load was set at 80% of the load obtained in the 1-repetition maximum load test[23] (maximum load exercise performed with dumbbells and anklets in the range of motion without any compensatory movements), and adjustments in the load during subsequent sessions were made based on symptoms, Borg Dyspnea Scale scores, and patient fatigue. Weight increases were conducted as tolerated by the patient.