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ORIGINAL ARTICLE

Effectiveness of Pulmonary Rehabilitation in Exercise Capacity and Quality of Life in Chronic Obstructive Pulmonary Disease Patients With and Without Global Fat-Free Mass Depletion

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Abstract

Objective: To investigate the effectiveness of pulmonary rehabilitation (PR) in exercise capacity and quality of life in patients with chronic obstructive pulmonary disease (COPD) with and without global fat-free mass (FFM) depletion.

Design: Retrospective case-control.

Setting: Outpatient clinic, university center.

Participants: COPD patients (N = 102) that completed PR were initially evaluated.

Intervention: PR including whole-body and weight training for 12 weeks, 3 times per week.

Main Outcome Measures: St. George Respiratory Questionnaire (SGRQ), 6-minute walk distance (6MWD), and FFM evaluation applied before and after PR.

Results: Patients were stratified according to their FFM status measured by bioelectric impedance. They were considered depleted if the FFM index was $\leq$15kg/m^2 in women and $\leq$16kg/m^2 in men. From the initial sample, all depleted patients (n = 31) composed the FFM depleted group. It was composed predominantly by women (68%) with a mean age $\pm$ SD of 64.4$\pm$7.3 years and a forced expiratory volume in 1 second of 33.6% = −13.2% predicted. Paired for sex and age, 31 nondepleted patients were selected from the initial sample to compose the nondepleted group. Improvement in the 6MWD was similar in these 2 groups after PR. Both groups improved SGRQ scores, although the observed power was small and did not allow adequate comparison between depleted and nondepleted patients. There was no difference between groups in weight change, whereas FFM tended to be greater in depleted patients. This increase had no correlation with the 6MWD or the SGRQ.

Conclusions: Benefits of PR to exercise capacity were similar comparing FFM depleted and nondepleted COPD patients. Although FFM change tended to be greater in depleted patients, this increase had no definite relation with clinical outcomes.

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The cardinal symptoms in most patients with chronic obstructive pulmonary disease (COPD) are dyspnea and exercise intolerance, resulting in decreased health status.[1] Extra-pulmonary manifestations often include profound peripheral muscle deconditioning and sarcopenia. Peripheral muscle weakness and an altered muscle energy metabolism have been recognized as contributing factors to impaired exercise capacity,[2,3] and these associations are related to depletion of muscle mass.[4] Loss of muscle mass causes significant impact on muscle function[5] and on survival.[6-9] No current treatment strategy could reverse the loss of lung function in these patients.[1] Nonetheless, improvements in skeletal muscle function after exercise training result in gains in exercise capacity despite the absence of changes in lung function.[10]

Improving peripheral skeletal muscle mass and function is, therefore, an important goal of pulmonary rehabilitation (PR)

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programs. PR is currently considered standard care for patients with chronic lung diseases and is associated with improvement in important clinical outcomes, such as exercise capacity, health-related quality of life (HRQOL), and dyspnea.[11] Unfortunately, poor adherence is common in daily practice of PR, because many COPD patients fail to attend programs and others drop out.[12] Some studies have shown that low fat-free mass (FFM)[13] and reduced quadriceps strength[14] are major conditions associated with PR absenteeism and drop out, respectively.

Additionally, exercise can induce increased systemic inflammatory and oxidative responses in muscle-wasted COPD patients[15] and can alter amino acid intermediary metabolism in patients with COPD, regardless of muscle depletion.[16] Increasing evidence associates systemic inflammation and oxidative stress with muscle wasting and muscle dysfunction in COPD.[17,18] FFM depleted COPD patients may represent, therefore, a group less likely to improve in PR programs.

Despite these findings, we believe that FFM depleted patients can achieve the same clinical benefits after PR as nondepleted patients. Previous studies evaluating depleted COPD inpatients showed an increase in FFM after rehabilitation, mainly when combining rigorous nutritional supplementation with or without androgenic steroid administration.[19,20] More recently, a community-based rehabilitation plus nutritional support program demonstrated that wasted patients improved FFM and weight, a finding not observed in nonwasted patients.[21] However, these studies did not primarily compare depleted and nondepleted COPD patients regarding improvement in exercise capacity, HRQOL, and the relation of these clinical outcomes with FFM changes after PR.

The aim of the current study is to evaluate the effects of an outpatient PR program on improvements in exercise capacity, HRQOL, and FFM, contrasting FFM depleted and nondepleted patients with moderate-to-severe COPD. The relations between changes in FFM and clinical outcomes after PR were also evaluated. We hypothesized that FFM depleted patients could achieve similar clinical benefits as nondepleted COPD patients from an outpatient PR program.

Methods

Participants

Pulmonary function, dyspnea, body composition, exercise capacity, and disease-specific health status have been assessed prospectively in 129 consecutive pulmonary disease patients before and after a specialized PR program. Subjects with clinical and functional diagnosis of COPD (n = 102) according to the global strategy for the diagnosis, management, and prevention of COPD guidelines[1] (irreversible airflow limitation defined as forced expiratory volume in 1s [FEV_1]/forced vital capacity [FVC] <.70) and FEV_1 <80% of predicted normal values were initially selected. Thereafter, all FFM depleted patients with complete data for main outcome analysis (n = 31) and nondepleted patients matched for age and sex to depleted patients (n = 31) were included in the study analyses (fig 1). Patients also had disease stability indicated by no change in medication dosage or exacerbation of symptoms in the preceding 4 weeks.

The study was approved by the local ethics committee, and all subjects gave written informed consent to participate in the PR program.

List of abbreviations:

BMI	body mass index
COPD	chronic obstructive pulmonary disease
FEV_1	forced expiratory volume in 1 second
FFM	fat-free mass
FVC	forced vital capacity
HRQOL	health-related quality of life
MANOVA	multiple analysis of variance
MRC	Medical Research Council
PR	pulmonary rehabilitation
RM	repetition maximum
SGRQ	St. George Respiratory Questionnaire
6MWD	6-minute walk distance

Design

This was a single-center, retrospective case-control study of participants in a 12-week PR program. Exercise capacity (6-minute walk distance), HRQOL using the St. George Respiratory Questionnaire (SGRQ), and nutritional status were evaluated at baseline and after completion of PR (last day up to the following week). Effects of PR were analyzed according to patients' FFM status, as measured by bioelectric impedance analysis. They were considered depleted if FFM index was $\leq$15kg/m^2 in women and $\leq$16kg/m^2 in men.[4]

Pulmonary rehabilitation

Subjects participated in a standard comprehensive outpatient rehabilitation program comprising endurance training and individually prescribed resistance training for 36 sessions over 12 weeks.

Aerobic exercise training was performed on a treadmill aiming to achieve the maximum tolerated exercise intensity for at least 20 minutes. Speed was anchored to perceived effort ranked from moderate to intense, according to the Borg scale.[22] Thus, at the beginning of each week, new increased speed was set in order to maintain moderate to intense effort perception.

Resistance training involved gym equipment[a] and free weights. Before being tested for 1 repetition maximum (RM), subjects performed 3 series of 15 light-weight repetitions for the muscle group to be tested. Loads were initially set at 50% to 60% of 1 RM during the first 2 weeks, and then they were gradually increased each week, as tolerated, toward 85% of 1 RM.[23] Thereafter, the training workload was increased when more than 12 repetitions per set could be performed. Resistance training was performed after aerobic training consisting of 2 sets per muscle group, each of 8 to 12 repetitions.[10] Exercises to strengthen the upper body included bench press (pectoralis), chest cross (horizontal flexion of the shoulder joint), shoulder press (trapezius), pull downs (latissimus dorsi), biceps flexion, triceps extensions, and exercises for abdominal muscles (sit-ups). Lower-body exercises included knee extension, knee flexion, and plantar flexion.

Dietary intake was advised based on 3-day food diaries, 24-hour recall dietetic analysis, and nutritional status, as evaluated by body mass index (BMI). Subjects were managed according to their needs and nutritional status. Low-weight patients (BMI <22kg/m^2) or those considered to ingest insufficient food received specific instruction to fulfill minimum daily energetic needs according to the total energetic value method,[24]