



Thigh muscle strength and endurance in patients with COPD compared with healthy controls

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KEYWORDS

COPD;
Fatigue;
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Summary The aim of this study was to evaluate thigh muscle strength and endurance in patients with COPD compared with healthy controls. Forty-two patients (26 women; 16 men) with moderate to severe COPD and 53 (29 women; 24 men) age-matched healthy controls participated in the study. The subjects were tested for maximum voluntary contractions (MVC), endurance and fatigue of the thigh muscles on an isokinetic dynamometer (KinCom[®]). Endurance was expressed as the number of attained repetitions of knee extension and muscle fatigue as a fatigue index (FI).

MVC in knee extension was 17% lower in female patients ($P = 0.017$) but no difference was found in male patients ($P = 0.56$) compared to controls. MVC in knee flexion was lower both in female (51%) ($P < 0.001$) and male patients (40%) ($P < 0.001$) compared to controls. Both female and male patients had significantly lower muscle endurance compared to controls. Female patients had a higher FI (22.5%) than female controls (10%) ($P = 0.001$) while no difference was found regarding FI between male patients (15%) and male controls (10%) ($P = 0.103$). The level of self-reported everyday physical activity did not differ between groups.

The results showed impaired skeletal muscle function in COPD, except for MVC in knee extension in male patients. Female patients seemed to be more prone to decrease in thigh muscle function. More focus on improving muscle strength and muscle endurance should be considered when designing pulmonary rehabilitation programs. Patients with preserved level of physical activity can be included in exercise programs and gender-related differences should be taken into account.

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Introduction

Exercise intolerance in patients with chronic obstructive pulmonary disease (COPD) contributes to a poor quality of life in these patients and an increased need for medical assistance.^{1–3} This exercise limitation has traditionally been explained by the impairment of ventilatory function.⁴ However, studies have suggested that many patients with COPD may stop exercising because of leg muscle fatigue prior to ventilatory limitation.^{5,6} Furthermore, skeletal muscle dysfunction is common in patients with COPD and might be explained by muscle atrophy, reduced oxidative metabolism, reduced muscle capillarization and change in muscle fiber type, i.e., reduced proportion of type I fibers and increased proportion of type IIb.^{7,8}

Inactivity is often assumed to be one of the main reasons for these peripheral muscle abnormalities in patients with COPD.⁹ Exercise training has been shown to improve muscle function in patients with COPD, suggesting that deconditioning is an important contributor to the skeletal muscle dysfunction.^{10–13} Coronell et al.¹⁴ showed that despite relatively preserved level of physical activity, patients with COPD have reduced muscle function compared to healthy age-matched controls, suggesting that other factors than inactivity may contribute to the alterations in peripheral muscle function. These factors, related to the disease, are suggested to be malnutrition, exposure to systemic corticosteroids, tissue hypoxia, coexisting heart disease, systemic inflammation, skeletal muscle apoptosis, oxidative stress, tobacco use, individual susceptibility and hormone alterations.^{4,8} In addition, some authors have found elevated levels of inflammatory cytokines indicating presence of systemic myopathy.¹⁵

The majority of the studies on lower-extremity muscle function in COPD are focused on muscle strength rather than muscle endurance. Furthermore, it is still unclear which modality of physical training is the best to increase muscle function in these patients. Defining whether patients with COPD have reduced muscle strength and/or muscle endurance compared to healthy controls is necessary in order to be able to find the best exercise modality for these patients. The level of everyday physical activity is important to assess when comparing skeletal muscle dysfunction in patients with COPD with healthy controls. To our knowledge, there are not many studies that have taken this issue into consideration. Moreover, to the authors' knowledge, only Van't Hul et al.¹⁶ have investigated gender-related differences regarding muscle strength and endurance of lower extremities in patients with COPD.

Our hypothesis is that peripheral muscle abnormalities found in patients with COPD might lead to decrease in muscle strength and endurance which consequently results in increased muscle fatigability. The aim of this study was thus (i) to determine whether patients with COPD have impaired strength and endurance in the thigh muscles compared to age-matched healthy controls, (ii) to investigate if the level of self-reported everyday physical activity was decreased in patients with COPD and (iii) whether gender-related differences in muscle performance exist compared to a control group.

Material and methods

Study population

Forty-two patients (26 women and 16 men) aged 53–74 years with moderate to severe, stable COPD and 53 (29 women and 24 men) age-matched healthy controls were included in the study. The patients were clinically diagnosed with COPD according to GOLD criteria¹⁷ and recruited from outpatients on treatment at two Hospitals in Northern Sweden. The inclusion criteria used to select the patients were $FEV_1/VC < 0.7$, $FEV_1 < 80\%$ of predicted, stable medication and no infection during the last month before participating in the study, and absence of cardiac, orthopaedic, neurological or psychological disorders. All patients performed an exercise electrocardiogram test on a cycle ergometer (Rodby TM, RE 829, Enhörna, Sweden) and a spirometry test (Spirolab, Medical International Research, Roma, Italy) before entering the study. The patients were ex-smokers and none of them were treated with long-term oxygen therapy. Thirty-three patients were using inhaled corticosteroids and one used daily oral corticosteroids. None of them was engaged in any organized physical activity before the study. The patients were referred to the clinic to participate in a pulmonary rehabilitation program and were tested, in addition to other tests, for muscle strength and endurance. The healthy control group was recruited from pensioner's associations in Umeå, Sweden. The controls had to meet the following criteria: age between 53 and 74 and no presence of pulmonary, cardiac, orthopaedic, neurological or psychological disorders. The controls should not have smoked in the last 10 years and should not be participants in any organized physical activity. All subjects gave their informed consent before the study. The Research Ethics Committee of

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