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HANDGRIP STRENGTH AND HEALTH RELATED QUALITY OF LIFE IN INDIVIDUALS WITH COPD

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ABSTRACT

In individuals with chronic obstructive pulmonary disease (COPD), skeletal muscle wasting and changes in muscle fiber composition limit the muscle strength with consequences on daily physical activities. In the present study we aimed to investigate about the interconnection among upper limb strength, body composition and health related quality of life (HRQoL) in patients with COPD to verify the impact of muscle mass loss on HRQoL. Twenty-six consecutive patients (69.2% male; age: 69.7±7.29 years) with COPD were included. Patients underwent pulmonary function tests. Body composition was evaluated through Bioelectrical Impedance Analysis (BIA); handgrip test was used for measure upper limb strength. St George's Respiratory Questionnaire (SGRQ) was used to evaluate patients' HRQoL. Upper limb muscle strength was negatively correlated with SGRQ (Pearson= -0.571; p=0.002) in particular with activity and impact domains (Pearson= -0.668; p<0.001 and Pearson =-0.461; p=0.02). Multivariate linear regression confirm that poor handgrip strength is a predictor of worse SGRQ after adjusting for gender, age, fat free mass index and inhaled corticosteroids use (p=0.012). Upper limb muscle strength and body composition are two essential tools in the multisystemic assessment of patients with COPD.

1. Introduction

Chronic obstructive pulmonary disease (COPD) is a common, preventable and treatable disorder characterized by the presence of airflow limitation , and respiratory symptoms as result of chronic exposure to smoking or noxious agents (1,2).

Exhaled lung inflammation cause spill-over of systemic pro-inflammatory mediators and plasma cytokine resulting in increased oxidative stress affecting musculoskeletal system. The combination of dyspnoea and muscle wasting contributes to inactivity leading to progressive exercise intolerance. (1,3)

Several factors have been implicated in systemic muscular involvement among patients with COPD. Skeletal muscular disuse lead weakness, atrophy, transverse section area reduction, type I muscle fibres reduction, reduced capillary density, early lactate release, reduced phosphocreatine synthesis and exalted redox status.

These changes are promoted by the release of IL-6, IL-8, and TNF-α stimulates muscle cell apoptosis, macroautophagy and ubiquitin-proteasome system induction through nuclear factor kappa-light-chain-enhancer of activated B cells (NF-kB) and forkhead box O (FOXO) activation (4).

The identification of muscular dysfunction among patients with COPD allow to identify subjects with increased risk of exercise intolerance, morbidity and mortality risk. (5–7)

In this scenario, body composition coupled with peripheral muscle evaluation should integrate in clinical practice the functional assessment of patients with COPD(7–9). Handgrip test is a simple, rapid and economic test which is the expression of voluntary strength of the upper limb. In COPD patients, handgrip test has been associated with reduced pulmonary function and 6-minute walking distance, increased hospitalization and mortality (10,11). In the present study we aim to investigate the association between handgrip and health related quality of life (HRQoL) in patients with COPD.

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2. Material and methods

Study design

This was a prospective, observational, single-center study conducted at Pulmonology Clinic at Cardarelli Hospital, Campobasso, Italy between October 2019 e August 2020. We included current or former smoker with age 40 years or more with COPD diagnosis in accordance with the 2019 Global Initiative for Chronic Obstructive Lung Disease criteria (12). Patients were excluded if they have musculoskeletal or neurological disorders limiting the handgrip test; have participated in a training program during the previous 6 months; presence of recent pneumonia or exacerbation during the last 12 weeks; being unable to sign the written informed consent. This study was conducted in accordance with the Declaration of Helsinki.

COPD diagnosis

COPD diagnosis was established in presence of the clinical history, physical examination and pulmonary function tests (FEV1/ FVC below 70% after bronchodilator) (13,14). Eligible patients underwent pulmonary function tests with Sensormedics Viasys Carefusion Vmax Encore 22 according ATS/ERS criteria (13–15). Clinical and anamnestic data were systematically collected. Severity degree and COPD classes were defined using the values of the FEV1% predicted, history of exacerbations and severity of symptoms by using mMRC questionnaire according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) recommendation (12). Stable state was defined as the absence of relevant changes in symptoms beyond the expected daily variation, requiring additional treatment during the previous 12 weeks(16,17).

Anthropometric and body composition

The anthropometric and body composition of total study participants are reported in the Table 1. The height and weight of patients were measured using standard techniques and the BMI was calculated as body weight (kg)/ height^2 (m^2). Nutritional indexes were quantified with BIA (TANITA brand, model BC-420MA, Tanita Corp., Tokyo, Japan) as otherwise reported (18). Fat mass index (FMI) and fat-free mass index (FFMI) were calculated as fat mass or fat-free mass (FFM) divided by the square of the patient's height (kg/height2).

Handgrip test

Handgrip test was performed using handheld dynamometer DynX (MD Systems, Inc, Ohio, USA). Patients stand in upright position with shoulders at 0° adduction and neutral rotation, elbows at 90° flexion, and forearms in neutral position. Three tests for each arm were performed with a rest period of 1 minute between trials; maximum and average values were recorded.

HRQoL assessment

For the assessment of the HRQoL, patients were instructed to answer the Saint George Respiratory Questionnaire (SGRQ) with minimal assistance from the investigators. The SGRQ is a disease specific quality of life assessment tool validated in both COPD and asthma (19,20). The questionnaire consists of 76 items divided into three domain measuring symptoms, activity limitation and social and emotional impact of disease. A validated Italian version of SGRQ was administered (21). Overall scores range from 0 (absence of impact on quality of life) to a maximum score of 100 (maximum perceived distress).

Results were entered into a pre-programmed spreadsheet with formulae to calculate a total score and scores for each of the individual components of the SGRQ (symptoms, activity and impacts).

Statistical analysis

Continuous variables were presented either as median and interquartile range (IQR) or mean and standard deviation (SD), based on their distribution; categorical data were expressed as number and percentage. Bivariate correlations were expressed by the Pearson's correlation coefficient, which assumes a value ranging between -1 and +1. Negative values are expression of an inverse correlation between variables. Multivariate linear regression analysis was performed with stepwise method. A *p*-value <0.05 was considered statistically significant. Data were analyzed using SPSS Software, Version 24 (IBM, Armonk, New York).

3. Results

The anthropometric and biochemical characteristics of the 26 COPD consecutive patients are reported in Table 1.

	N. 26 Mean	Standard deviation
Gender (male)	18 (69.2%)	
Age	69.7	7.29
Smokers		
Current	10 (38.5%)	
Former	16 (62.5%)	
Pack Years	49.4	30.5
Number of exacerbations during previous 12 months	1.4	1.04
ICS Users	6 (28.6%)	
Weight (Kg)	72.8	16.3
Height (cm)	160	8.19
BMI (Kg/m2)	28.6	6.08
FFM (Kg)	51.3	9.13
FFMI (Kg/m2)	20	2.31
Waist Circumference (cm)	106	20
FEV1 (L)	1.53	0.46
FEV1% predicted	70.1	22.9
FVC (L)	2.46	0.56
FVC% predicted	86.7	18.7
FEV1/FVC	61.7	11.5
FEF25%	66	29.4
FEF50%	41.2	23.3
FEF75%	34.5	15.3
DLCO% predicted	74.5	25.9
Handgrip right hand (kg)	22.5	7.49
Handgrip left hand (kg)	21.1	8.94
Handgrip dominant (kg)	23.3	7.25
Handgrip average (kg)	22.2	7.61
COPD Stage		
1-2	18 (69.2%)	
3-4	8 (30.8%)	
MMRC		
0-1	10 (38.5%)	
≥ 2	16 (62.5%)	
SGRQ	50.3	23.6
Symptoms	43	26.2
Activity	67.5	27.8
Impact	41.5	26.2

Table 1. Baseline characteristics in COPD study population.

Patients were predominantly male (69.2%) with a median pack/year of 49.4 ± 30.5. Only 28.6% of patients were ICS users. Mean SGRQ score was 50.3 ± 23.6. Significant correlation between handgrip strength and clinical and functional data in the study population is reported in table 2. Handgrip strength of the dominant arm negatively correlates with SGQR (Pearson coefficient -0.571; p= 0.002; Figure 1). Interestingly, activity and impact domains showed significant association (Pearson coefficient -0.668 and -0.461; p < 0.001 and 0.02, respectively) (Table 2). Conversely, symptom domain did not reach the statistical significance. In our study cohort, handgrip was not associated with both pulmonary function neither respiratory symptoms. After adjusting for age, gender and fat free mass, the handgrip strength was associated with SGRQ (p=0.002) (Table 3).

	Dominant Handgrip Strength	p*
SGRQ	-0.571	**0.002**
SGRQ Activity	-0.668	**< .001**
SGRQ Impact	-0.461	**0.02**

§ Correlations are expressed by the Pearson's Correlation coefficient

Table 2. Significant correlation of dominant handgrip strength with study population characteristics

Predictor	B-coefficient	SE	t	p
Gender:	4.9561	2.5436	1.9485	0.066
Age	0.0311	0.1672	0.1862	0.854
FFMI	-0.0513	0.5877	-0.0872	0.931
ICS Use	3.0529	2.8410	1.0746	0.295
SGRQ	-0.1617	0.0587	-2.7554	**0.012**

Table 3. Multivariate linear regression for handgrip association with clinical characteristics.

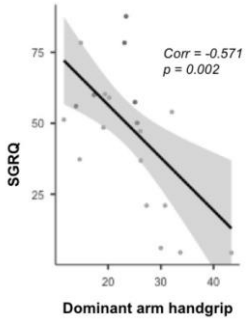

Figure 1. Correlation between dominant arm handgrip and Saint George Respiratory Questionnaire

4. Discussion

Multisystemic assessment including body composition and muscle strength is crucial in patients with COPD. Skeletal muscle dysfunction is highly frequently associated with COPD counteracting the exercise capacity and daily living activities performance (22).

In this study, we documented that upper limb strength is a predictor of worse HRQoL and particularly with activity and impact domain of the SGRQ. Conversely, we did not report significant associations with lung function or dyspnoea severity. In our study, we proved that the handgrip was associated with HRQoL also after adjusting for the FFMI. In a previous study, Kaymaz et al. (22) reported that handgrip test was associated with respiratory symptoms and HRQoL; however, in this study no clear correction for body composition was made. Therefore, our results suggest that reduced handgrip strength might reflect beyond the fat free mass loss. In patients with COPD muscle mass wasting is associated with increased systemic inflammation, comorbidities burden and early all-cause mortality(23–26). Furthermore, reduction in adipose tissue alters the adiponectin/letpin axis triggering a pro-inflammatory cascade(27–29). In COPD patients, several factors including aging, chronic inactivity, malnutrition and use of corticosteroids induce muscular fiber type shift – increase of type IIx and reduction in type I fibers. These structural changes lead to fibers with exalted anaerobic glycolytic metabolism and low threshold of exercise resistance (30,31).

The abovementioned results suggest that the muscular strength assessment allow the identification of COPD who might benefit for pulmonary rehabilitation (32,33). Upper limb strength deterioration could therefore be the target of tailored pharmacological and non-pharmacological intervention. Our study however has some limitations; firstly, our study is limited from the reduced number of patients were predominantly male. Moreover, body composition evaluation would be more accurately established using dual-energy X-ray absorptiometry (DEXA); however, this latter method is hardly feasible in routine clinical practice. On the contrary, BIA offers accurate and rapid results and is more practicable in an ambulatory setting.

In conclusion, our study provides new insights on the importance of upper limb strength assessment and its relationship with body composition in individuals with COPD.

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