



Handgrip and functional capacity in Chronic Obstructive Pulmonary Disease patients

Força de preensão palmar e capacidade funcional em portadores de Doença Pulmonar Obstrutiva Crônica

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Abstract

Introduction: In the Chronic Obstructive Pulmonary Disease (COPD) both pulmonary and systemic condition increase dyspnea, intolerance to exercise and inactivity. **Objective:** To evaluate possible association between Hand Grip Strength (HGS) and the distance covered in the Six-Minute Walk Test (6MWT) in patients with Chronic Obstructive Pulmonary Disease (COPD). **Methods:** A cross-sectional study that evaluated 34 patients with COPD from moderate to very severe stages. The HGS test was performed with a manual hydraulic dynamometer (Jamar®, California, USA) with three bilateral measures, allowing

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60-seconds rest time in-between measurements. Afterwards, the patients were submitted to the 6MWT along a 30-meters level corridor following the rules of the *American Thoracic Society*. **Results:** Average age 62.7 ± 7.2 years old, body mass index 26.7 ± 6.9 Kg/m². The value of the HGS in the dominant hand was 28.0 ± 8.7 Kgf and in the non-dominant hand was 26.7 ± 7.7 Kgf (99.2% of the predicted value and 106.3% of the predicted value, respectively). The subjects covered in average 421.0 ± 110.4 meters in the 6MWT and there has been detected direct and significant correlation between the distance covered and the HGS of the dominant hand ($r=0,430$; $p=0,011$) and non-dominant ($r=0,502$; $p=0,002$). The patients with COPD that presented lower HGS also covered less distance in the 6MWT. **Conclusion:** The hand grip strength was directly associated with the functional capacity assessed through the distance covered in the Six-Minute Walk Test in the evaluated trial.

Keywords: Hand Strength. Exercise Test. Pulmonary Disease. Chronic Obstructive.

Resumo

Introdução: Nos portadores de Doença Pulmonar Obstrutiva Crônica (DPOC), a disfunção pulmonar, as manifestações sistêmicas e o aumento da dispneia podem conduzir à piora progressiva do condicionamento físico, à inatividade e intolerância ao exercício físico. **Objetivo:** avaliar possível associação entre a força de preensão palmar (FPP) e a distância percorrida no Teste de Caminhada de Seis Minutos (TC6M) em portadores de DPOC. **Métodos:** Estudo transversal que avaliou 34 portadores de DPOC com estadiamento entre moderado a muito severo. A FPP foi realizada com dinamômetro hidráulico manual (Jamar®, Califórnia, EUA) com três medidas bilateralmente, respeitando um tempo de descanso de 60 segundos entre as medidas. Posteriormente, os pacientes foram submetidos ao TC6M em um corredor plano de 30 metros, seguindo as normas da American Thoracic Society. **Resultados:** Média de idade de $62,7 \pm 7,2$ anos, índice de massa corporal $26,7 \pm 6,9$ Kg/m². O valor da FPP na mão dominante foi $28,0 \pm 8,7$ Kgf e da mão não dominante foi $26,7 \pm 7,7$ Kgf (99,2% do predito e 106,3% do predito, respectivamente). Os sujeitos percorreram em média $421,0 \pm 110,4$ metros no TC6M tendo sido detectada correlação direta e significativa entre a distância percorrida e a FPP da mão dominante ($r=0,430$; $p=0,011$) e não-dominante ($r=0,502$; $p=0,002$). Os portadores de DPOC que apresentaram menor FPP apresentaram menor distância no TC6M. **Conclusão:** A força de preensão palmar esteve diretamente associada à capacidade funcional avaliada através da distância percorrida no Teste de Caminhada de Seis Minutos na amostra avaliada.

Palavras-chave: Força da mão. Teste de Esforço. Doença Pulmonar. Obstrutiva Crônica.

Introduction

The Chronic Obstructive Pulmonary Disease (COPD) is characterized by persistent and progressive obstruction of the superior airways, associated with an enhanced chronic inflammatory response to inhalation of pollutants/particles or noxious gases (1). The inflammatory cells are active and there is an increase in pro-inflammatory plasma cytokine levels in the systemic circulation, causing oxidative stress that will result in musculoskeletal disorders and reduction of the functional capacity (2). The pulmonary dysfunction, the systemic manifestations

and the increase of dyspnea can lead to progressive worsening of the physical conditioning, inactivity and physical exercise intolerance (3).

As a result, the COPD patient adopts a more sedentary lifestyle that worsens the quality of life and is the determining factor to the progression of the disease (2, 4). The evaluation of the physical performance of patients with COPD by using sub-maximal and non-invasive tests, like the Six-Minute Walk Test (6MWT), besides being easy to apply, can also reflect in activities of daily life, physical fitness, functional capacity (5), as well as monitor the effectiveness of several treatments due to its good correlation with

the maximal oxygen uptake ($VO_2\text{max}$) (6). Another important method to evaluate the changes of peripheral muscle strength, as this is one of the most important extra pulmonary manifestations of the COPD physiopathology (7), is the Hand Grip Strength (HGS). The HGS has as principle to estimate the musculoskeletal function through good reproducibility for the measurement of maximal manual voluntary handgrip strength, being considered a good index for overall muscle strength, and it can also reflect the impairment of the functional capacity (8).

We hypothesized that the reduction of hand grip strength is associated with the decrease of functional capacity in patients with COPD. Therefore, our objective was to evaluate the association between hand grip strength and the distance covered in the Six-Minute Walk Test in patients with Chronic Obstructive Pulmonary Disease.

Methods

This descriptive, prospective and transversal study was carried out in the Pulmonary Rehabilitation Program at the Santa Cruz Hospital. It was approved by the Research Ethics Committee of the University of Santa Cruz do Sul (protocol number 435093/2013). The study population was composed of patients diagnosed with COPD in accordance with the international criteria (1).

There were forty-one COPD patients eligible in the program, however, only Thirty-four met the following inclusion criteria: age between 40 and 80 years old, with clinical diagnosis of COPD through the pulmonary function test by spirometry and clinically stable. COPD patients with musculoskeletal disorders, neurological sequelae that would affect the locomotor system and cognitive deficit, skin lesions on the feet and/or superior limbs, exacerbations of the disease within the 30 days prior to the study and the ones with lung cancer diagnosis, were excluded.

Clinical Variables

Analysis of the expiratory volume forced in the 1^o second (FEV_1), relation expiratory volume forced in the 1^o second/vital capacity forced (FEV_1/VCF), Socio-demographic and clinical data (gender, age, Body Mass Index – BMI, time of the diagnosis of the

COPD, smoking history, dyspnea by the scale *Medical Research Council* - MRC and index of BODE - *Body Mass-Index: Airflow Obstruction, Dyspnea and Exercise Capacity*).

Handgrip Strength

The HGS test was performed with a manual hydraulic dynamometer (Jamar[®], California, USA), following the recommendations of *The American Society of Hands Therapists*. The patients remained seated, with the shoulder abducted, elbow flexed at 90°, forearm in neutral position of pronosupination and the wrist joint between 0° and 30° of dorsiflexion. Three bilateral measures were taken, allowing 60 seconds rest time in-between measurements, and the average of the measurements of each participant was separately calculated. The values obtained compared with the ones predicted as reported by Luna-Heredia et al. (9).

6MWT

The 6MWT was performed according to the American Thoracic Society standards to measure the distance the study participants were able to walk within a 6-minute period (10). The study participants were asked to walk as far as possible at a self-determined speed. No other guidance was provided. The test was carried out by an experienced physical therapist. The percentage predicted in the 6MWT distance was calculated considering gender, age, height, and weight of each subject based on the equation by Enright, et al. (11).

Statistical analysis

The software SPSS (version 20.0) was used to verify the normality of the distribution of data through the test of Shapiro-Wilk, and the results were shown in frequency, average \pm standard deviation. The association between the variables was analyzed by using Spearman's correlation test and the analysis of the variance for multiple comparisons (ANOVA) by using the post hoc of *Tukey test*. It was considered significant a $p < 0.05$.

Results

The clinical characteristics and the performance of the 34 COPD patients in the tests are shown in Table 1.

Table 1 - Clinical Characteristics and performance in tests of patients with COPD

Variables	COPD. (n = 34)
Sex Male. n (%)	18 (52,9)
Age (years)	62.7 ± 7.2
BMI. (Kg/m ²)	26.7 ± 6.9
Classification BMI	
Underweight. n (%)	07 (20.6)
Normal weight. n (%)	11 (32.4)
Obesity. n (%)	16 (47.1)
Spirometrics	
FEV ₁ . % predicted	39.1 ± 15.3
FEV ₁ /FVC. % predicted	62.3 ± 19.2
GOLD*	
II. n (%)	7 (21.2)
III. n (%)	16 (48.5)
IV. n (%)	11 (30.3)
Smoking (years)	
Former. n (%)	27 (79.4)
Current. n (%)	07 (20.6)
BODE index	
Quartile I. n (%)	11 (33.3)
Quartile II. n (%)	15 (45.5)
Quartile III. n (%)	05 (15.2)
Quartile IV. n (%)	02 (6.1)
6MWT	
Distance (m)	421.0 ± 110.4
Distance. (% predicted)	99.1 ± 34.1
Hand Grip	
Dominant (Kgf)	28.03 ± 8.7
Dominant (% predicted)	99.2 ± 31.6
Non-Dominant (Kgf)	26.72 ± 7.7
Non-Dominant (% predicted)	106.3 ± 37.5

Note: Data are presented as mean ± SD; n (%): number sample (frequency); COPD, chronic obstructive pulmonary disease; BMI, body mass index; Classification of BMI second Cuppari et al. (12); GOLD: Global Initiative for Chronic Lung Disease; FEV₁, forced expiratory volume in 1 second; FEV₁/FVC=forced expiratory volume in the first second and forced vital capacity. % predicted second Pereira et al. (13) BODE index: Body Mass-Index. Airflow Obstruction. Dyspnea and Exercise Capacity; Quartile I: 0 to 2 points; Quartile II: 3 to 4 points; Quartile III: 5 to 6 points; Quartile IV: 7 to 10 points. 6MWT: 6-minute walk test. % predicted second Enright, et al. (11)

Direct correlations were observed between the measures of the HGS of the dominant hand and the non-dominant hand with the distance covered in the 6MWT in meters ($r = 0.430$ $p = 0.011$) and ($r = 0.502$; $p = 0.002$), respectively (Figure 1 and 2).

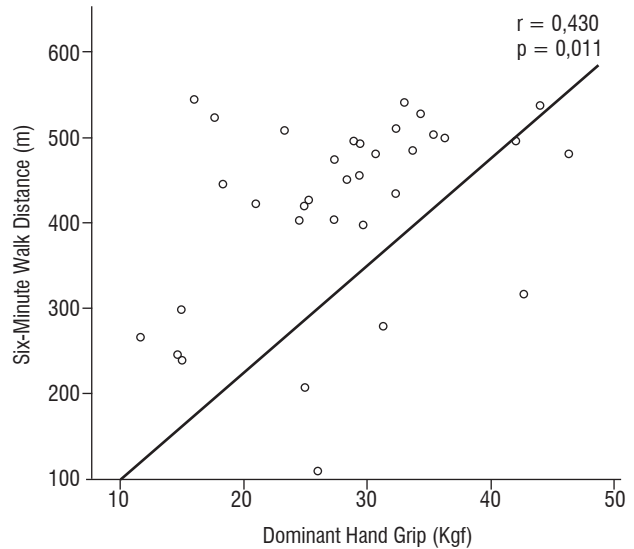


Figure 1 - Correlation between 6MWT (m) and dominant Hand Grip.

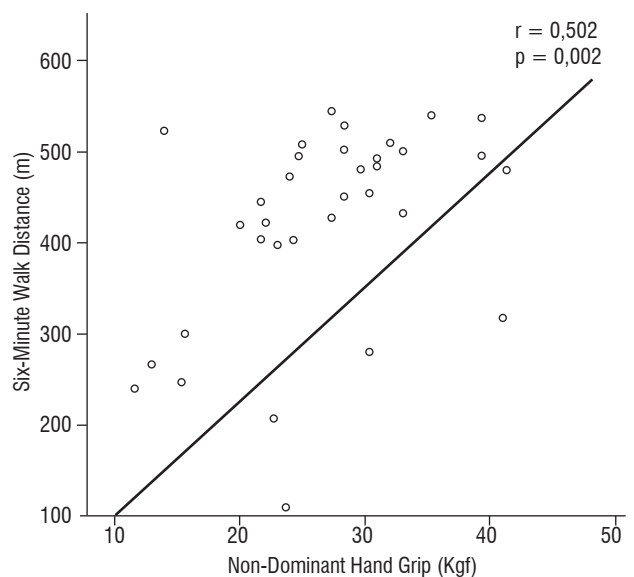


Figure 2 - Correlation between 6MWT (m) and non-dominant Hand Grip.

The HGS also correlated itself significantly and inversely with the BODE Index (Figure 3). It is possible to observe a reduction of HGS related with the worsening of the patients quality of life, which was determined by the quartiles of the BODE index, as described in Table 2, although no significant statistical

difference was found (values of p ranging between 0.18 and 0.96).

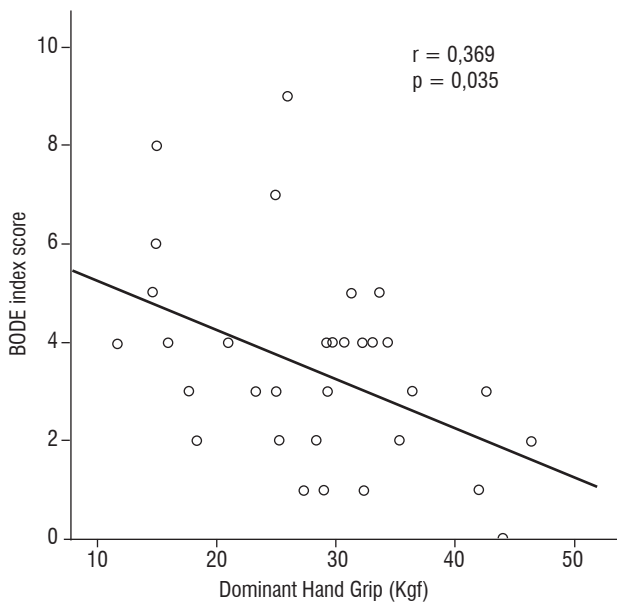


Figure 3 - Correlation between BODE index and Dominant Hand Grip.

Table 2 - BODE index stratified by the Hand Grip dominant and non-dominant in patients with COPD

Variables	COPD. (n = 34)	
	Dominant Hand Grip (Kfg)	Non-Dominant Hand Grip (Kfg)
BODE index		
Quartile I	11 (33.3 ± 8.6)	11 (29.8 ± 7.2)
Quartile II	15 (27.4 ± 8.3)	15 (27.0 ± 7.7)
Quartile III	5 (23.9 ± 8.8)	5 (22.9 ± 7.5)
Quartile IV	2 (20.5 ± 7.7)	2 (17.6 ± 8.4)

Note: Data are presented as mean ± SD; n (%): number sample (frequency); COPD, chronic obstructive pulmonary disease; Índice de BODE: Body Mass-Index: Airflow Obstruction, Dyspnea and Exercise Capacity BODE index: Body Mass-Index. Airflow Obstruction. Dyspnea and Exercise Capacity; Quartile I: 0 to 2 points; Quartile II: 3 to 4 points; Quartile III: 5 to 6 points; Quartile IV: 7 to 10 points.

Discussion

Our study aimed to analyze the association between hand grip strength and the distance covered in the 6MWT by patients with COPD and we found that the changes that occurred in HGS are directly related with the subject's worsening of survival range in the performance of this test. Our results meet the

literature that states that hand grip strength and 6MWT are reduced in patients with COPD particularly in those with hyperinflation (14) and patients with mainly moderate and severe COPD experience a loss of peripheral muscle strength and endurance, exercise capacity and general quality of life (15).

The loss of muscle strength of COPD patients can be related to exercise restrictions which reflect alterations in the respiratory tract, cardiovascular, neuromuscular and neurosensory system in highly variable combinations with multifactorial interactions (15, 16). The changes in the peripheral musculature strength and in muscle mass can be associated with a systemic inflammation, reduction of the capillaries in the fibers, and also with the oxidative stress (15, 17), which is more accentuated in the lower limbs.

On the other hand, our results meet the findings of those in the studies, that states that the muscular strength of the upper limbs of COPD patients can be preserved in the distal muscles, due to the fact that they are used in the daily activities, and reduced in the proximal muscles due to increased dyspnea during the activity sustained by the arm (18, 19, 20). However, studies highlight that there is a very strong correlation between the HGS and the strength of the other peripheral muscles, like the ones evaluated by the strength of the flexors of the elbow and the knee, as well as the respiratory muscle strength (maximal inspiratory muscle pressure and maximum voluntary ventilation) (15, 21). In COPD the supply of oxygen to the peripheral and respiratory muscles may be deficient as a result of hypoxemia (22).

The response obtained in the 6MWT reflects the effort made in daily life activities and the short distance covered in this test translates such limitations (21). This is because the intolerance to exercise of these subjects is of multifactorial construction involving more work and oxygen consumption by the respiratory muscles, the dysfunction of the skeletal muscles of the lower limbs and the mechanism of lung dynamic hyperinflation, acting alone or in conjunction (23).

In the same way that the 6MWT influences the BODE index, we found, in our study, a direct association of HGS with the worsening of this index and the consequent worsening of survival of COPD patients. The BODE is considered an index of multidimensional (24, 25), classification of the severity of COPD (26, 27) where a score of 3 points or more is associated

with an increase of mortality and exacerbation rates in patients with COPD (28, 29, 30).

Some limitations can be observed in our study, such as the sample size which does not allow us for many inferences and future perspectives, making it possible to evaluate the effectiveness of pulmonary rehabilitation thru improvement of muscle strength and consequently, the performance in the 6MWT.

Conclusion

The hand grip strength was directly associated with the performance in the Six-Minute Walk Test in our study, where the patients with COPD that presented a lower HGS in the dominant and non-dominant hand also covered less distance and worsening of survival. Further studies are necessary to identify how much the hand grip strength can influence the performance in the 6MWT in this population.

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