

Factors limiting exercise capacity in COPD patients

R. Djebaili ^{1*}, N. Righi ², A. Benbouza ³, B. Chiboub ⁴

¹ Department of Pulmonary diseases, public hospital establishment of Batna, faculty of medicine of Batna -Algeria

² Department of Infectious diseases, public hospital establishment of Batna, faculty of medicine of Batna -Algeria

³ Department of Microbiology, public hospital establishment of Batna, faculty of medicine of Batna -Algeria

⁴ Department of Epidemiology, university hospital center of Batna, faculty of medicine of Batna -Algeria

*Corresponding author E-mail: djebaili_rach@yahoo.fr

Abstract

Introduction: Impaired exercise capacity in COPD patients leads to deterioration in their physical activity and quality of life. The aim of our study was to assess the exercise capacity of COPD patients using the 6-minute walk test (6MWT) and to determine the factors limiting their exercise capacity.

Methods: Stable COPD patients were included in this study to assess their exercise capacity using the 6-minute walk test (6MWT) and to investigate the relationship between exercise capacity, functional status (FEV1), quadriceps muscle dysfunction (strength and endurance), and fat free mass index (FFMI).

Results: 175 COPD patients (166 males and 9 females) aged between 40 and 86 years with a mean age of 67.95 years. The functional stages distribution according to GOLD was GOLDI: 19.43%, GOLDII: 30.29%, GOLDIII: 33.71%, GOLD IV: 16.57%. 25% of patients received long-term oxygen therapy (LTOT). The mean distance covered by COPD patients was 432.26 ± 129.731 meters, corresponding to $64.71 \pm 19.04\%$. 56 (32%) COPD patients had exercise intolerance as assessed by the distance walked over 6 minutes (6MWD). A significant correlation was found between the 6MWD, quadriceps endurance ($P < 0.000$) and FEV1 ($p < 0.002$), whereas no correlation was found with MVC ($P < 0.039$) and (FFMI) ($P < 0.062$).

Conclusion: Muscle dysfunction and the severity of bronchial obstruction are the factors most associated with impaired exercise capacity in COPD patients.

Keywords: COPD; Exercise Capacity; 6-Minute Walk Test; Muscle Dysfunction.

1. Introduction

Exercise capacity in COPD patients may be limited by muscular, respiratory, or cardiac factors. Assessment of exercise capacity can be performed using the 6-minute walk test (6MWT) which is an easy, accessible, and validated test, but required rigorous application. It is often used to assess the effectiveness of a respiratory rehabilitation program.

2. Patients and methods

Stable COPD patients were recruited to assess their exercise capacity using the 6-min walk test (6MWT). Patients also underwent spirometry, body composition assessment using bioelectrical impedance (BIA), and quadriceps muscle assessment (quadriceps strength and endurance). Patients were clearly informed about their participation in the study, and their free consent was sought. Anonymity was respected when using the data of the subjects included. Contraindications to the test were respected.

The 6MWT was carried out in accordance with the American Thoracic Society (ATS) guidelines in a flat, metre-long corridor 30 m long. The 6 MWT was performed twice to allow for the learning effect and to put the patients at ease.

Muscle strength was measured by isometric maximal voluntary contraction (MVC) of the right lower limb while the patient was seated on an exercise bench with trunk and thigh fixed at 90°. The highest value of three brief (3 s) reproducible maneuvers was recorded.

Quadriceps endurance was assessed by the dynamic test, which consisted in measuring how long the patient could repeat leg extension-relaxation movements at a rate of 10 movements per minute and at a load equivalent to 30 or 40% of the MVC. Exercise was stopped if patients reached a fatigue-free time of 30 min.

3. Results

3.1. Functional status



175 COPD patients (166 males and 9 females) aged between 40 and 86 years with a mean age of 67.95 years, the percentage of functional stages according to GOLD are shown in table 1. 25% of patients received long-term oxygen therapy (LTOT).

Table 1: Distribution of Patients According to Functional Stages (GOLD) and LTOT

Characteristics	Results
Functional stages (GOLD)	GOLDI: 19,43% GOLDII: 30,29% GOLDIII: 33,71% GOLD IV: 16,57%
LTOT	25%

3.2. Assessment of exercise capacity in COPD patients

The mean distance covered by the COPD patients (6MWD) was 432.26 ± 129.731 metres, which corresponds to $64.71 \pm 19.04\%$ of the predicted distance in the North African population.

56 (32%) patients had exercise intolerance, which corresponds to a 6MWD less than the lower limit of normal (LLN) of the predicted distance table 2.

Table 2: Distribution of COPD patients according to 6MWD

6MWD	Distance < LLN	Distance \geq LLN
Number	56	119
Percentage	32%	68%

3.3. Factors limiting exercise capacity in COPD patients.

A significant correlation was found between the 6MWD, quadriceps endurance ($P < 0.000$) and FEV1: ($p < 0.002$) whereas no correlation was found with MVC ($P < 0.039$) and FFMI ($P < 0.062$) table 3.

Table 3: Correlation between 6MWD (M) and: FEV1, MVC, Endurance, FFMI

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Standard error	Bêta		
(Constant)	107,918	40,523		2,663	,008
MVC (Nm)	,299	,144	,099	2,082	,039
1 Endurance E	88,403	5,033	,780	17,565	,000
FFMI	-4,424	2,355	-,082	-1,879	,062
FEV1	,757	,245	,126	3,086	,002

4. Discussion

Exercise capacity can be assessed by maximal cardiorespiratory exercise test on a cyclo-ergometer or treadmill [1], but the field tests which are most widely used because of their ease and reproducibility are the 6-minute walk test (6MWT) [2] [3] [4] and the shuttle test [5] [6] [7], performed on flat courses.

In addition to assessing exercise capacity [8], 6MWT can be used to predict mortality [9] [10], determine the indication for oxygen therapy [11], and to assess the effectiveness of treatments such as a respiratory rehabilitation program [12] [13]. Furthermore, exercise intolerance is frequently reported as one of the main factors limiting activities of daily living [14].

The mean 6MWD covered by our patients was 432.26 ± 129.731 meter which correspond at $64.71 \pm 19.04\%$ of predicted distance in healthy north African calculated by Bensaad et al [15]. Exercise intolerance was present in 32% of COPD patients in our series, which corresponds to a value of the 6MWD below than the lower limit of normal (LLN).

In our study, a significant correlation was found between 6MWD, quadriceps endurance ($P < 0.000$) and FEV1: ($p < 0.002$), whereas no correlation was found with MVC ($P < 0.039$) or FFMI ($P < 0.062$). Other studies suggested that there was a significant correlation between FEV1 and 6MWD ($p < 0.05$) [16].

In another study, the distance covered in a 12-minute walk test used to evaluate exercise tolerance in chronic bronchitis patients [17], was poorly correlated with FEV1 but significantly correlated with forced vital capacity and maximum oxygen. Furthermore, the data provided by Gosselink et al [18] showed that a 6MWD was more closely related to skeletal muscle dysfunction.

On the other hand, a relationship between exercise capacity and lung function, maximum inspiratory pressure, dyspnoea, and quality of life was found in another study in COPD patients [19].

5. Conclusion

6MWT is currently widely used to assess exercise capacity in COPD patients, particularly those recruited for a respiratory rehabilitation program, which has become an integral part of the patient's therapeutic management, leading to an improvement in exercise tolerance and quality of life.

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