



ORIGINAL ARTICLE

## Assessment of dyspnea and dynamic hyperinflation in male patients with chronic obstructive pulmonary disease during a six minute walk test and an incremental treadmill cardiorespiratory exercise test

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### KEYWORDS

Treadmill  
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**Abstract** The six minute walk test (6MWT) is a standardized test that provides information on exercise capacity in patients with COPD. It is considered a submaximal test in opposition to incremental cardiopulmonary exercise tests (CPET) that provide valuable information on all the systems involved in exercise.

**Objectives:** 1. To compare the perceptive, physiological responses and degree of dynamic hyperinflation during two exercise tests: the 6MWT and the incremental CPET on a treadmill. 2. To evaluate how dyspnea is related to dynamic hyperinflation (DH) and other functional parameters in both tests.

**Methods:** 29 stable COPD male patients, age  $68 \pm 5.8$  years, mean post-bronchodilator FEV1  $57 \pm 11\%$ , were recruited. To evaluate dynamic hyperinflation, inspiratory capacity (IC) was measured at rest and upon completing each one of the tests. At the same time, perceived dyspnea and leg discomfort were rated on specific modified Borg scales.

**Results:** The mean walk distance in 6MWT was  $494 \pm 88$  m. The Borg scale rating for shortness of breath upon completing the test was  $4.7 \pm 2$ , whilst  $2.9 \pm 2$  for leg discomfort. IC changed from  $2.53 \pm 0.63$  l before to  $2.34 \pm 0.60$  l after completion of the test.

In the treadmill CPET, maximal oxygen consumption ( $\dot{V}O_2$  max) was  $21.8 \pm 5$  mL/kg/min with  $6.6 \pm 2$  dyspnea and  $4.3 \pm 2$  leg discomfort on Borg scales. IC changed from  $2.17 \pm 0.53$  l to  $1.20 \pm 0.43$  l.

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**Conclusions:** Dynamic hyperinflation occurs in male COPD patients during submaximal exercise such as the 6MWT. This phenomenon is more pronounced after incremental CPET on a treadmill. Despite being dyspnea the dominant limiting symptom for both tests, we observed different physiological responses.

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## Introduction

Patients with chronic obstructive pulmonary disease (COPD) develop dynamic hyperinflation (DH) during exercise,<sup>1,2</sup> which has been invoked as one of the main mechanisms in the development of dyspnea.<sup>3-5</sup>

Cardiopulmonary exercise tests (CPET) provide information on the exercise capacity of these patients. Among them the 6 minute walk test (6MWT) is the most standardized field test.<sup>6</sup> Some authors believe that 6MWT can be considered a maximum exercise test. In a study conducted in patients with moderate-to-severe COPD, Troosters et al.<sup>7</sup> reported the 6MWT as a high-intensity submaximal exercise protocol which showed an exponential oxygen uptake ( $\dot{V}O_2$ ) increase up to a plateau during the last 3 min and these authors hypothesized that the self-paced walking speed during the test is set to achieve "maximal" sustainable exercise. These data are quite similar to those found by Casas.<sup>8</sup> On the other hand, in the pulmonary function laboratory setting, incremental CPET on a treadmill is regarded as a more accurate way to reflect daily life exercise.<sup>9-12</sup> Despite being based on the same type of exercise and not differences made for exercise performance evaluation, few studies have compared the 6MWT and the incremental CPET on a treadmill in COPD patients.<sup>13,14</sup>

The purpose of this study is to compare the perceptive, physiological responses and degree of dynamic hyperinflation in 6MWT and incremental CPET on a treadmill; and to evaluate how dyspnea is related to dynamic hyperinflation (DH) and other functional parameters in both tests.

## Material and methods

### Study population

Male patients with moderate to severe COPD from our outpatient clinic were selected. They had to meet diagnostic criteria for COPD according to GOLD in stages 2-4. To be included, patients had to have been clinically stable on the previous 2 months and had to be free of other conditions limiting exercise capacity. No contraindication to undertake a CPET according to the *SEPAR* proceedings (*Spanish Society of Pathology of the Respiratory System*) should be present.<sup>15</sup> Patients had to provide written consent to be included in the study, and for each single test the usual information was provided by laboratory staff.

The study was approved by the Hospital's Research Ethics Committee.

### Study design

Patients included were evaluated in three separate visits as is shown in Fig. 1: a run-in inclusion visit and two separate exercise test visits.

During the *first visit*, suitable patients were interviewed and included in the study if they met inclusion criteria and gave written consent to participate in the study and to perform the tests. Thorough clinical interview and physical exam were performed. Pulmonary function tests (PFT), at baseline and after bronchodilation were performed, including a plethysmography and a single-breath CO diffusion test ( $TLCO_{SB}$ ). CAT (COPD Assessment Test) questionnaire was filled in and patient's dyspnea was rated according to the mMRC (modified Medical Research Council) scale.

The *second and third visits* were scheduled in a period of 5-7 days to perform the incremental treadmill CPET and the 6MWT, in a random order determined by a computer based randomization method.

### Procedures

#### Pulmonary function tests

All measurements were taken according to SEPAR guidelines and European Respiratory Society (ERS) reference values were used.<sup>16,17</sup> Forced spirometry, carbon monoxide diffusion capacity ( $TLCO_{SB}$ ) and plethysmography measurements were performed with *Master Lab C Jaeger Care Fusion equipment (Würzburg, Germany)*.

#### Symptom perception

Dyspnea was rated according to the mMRC scale. Prior to each exercise test and at the completion of the tests, patients were asked to indicate their shortness of breath and leg discomfort using a modified Borg dyspnea scale.<sup>18</sup>

#### Inspiratory capacity (IC)

IC was determined prior to starting both tests, during rest (pre-exercise IC) and immediately after finishing the exercise (post-exercise IC). All patients had been previously instructed on how to perform the maneuver. Patients were always supervised by technicians with experience in this maneuver.<sup>19</sup>

IC was performed as described by Guenette.<sup>2</sup> After performing four to six tidal breaths, with the patient at functional residual capacity (FRC), he was encouraged to breathe in as much air as possible, up to his total lung capacity (TLC). On the expiration preceding each maneuver, the patient was notified that a full inspiration maneuver

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