ONLINE DATA SUPPLEMENT

Six-Minute Walking Versus Shuttle Walking: Responsiveness to Bronchodilation in Chronic Obstructive Pulmonary Disease

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METHODS

Study design

A schematic representation of the study protocol is presented in Figure E1.

Incremental Shuttle Walk

The incremental shuttle walk was performed in an enclosed corridor on a flat 10-meter-long course. As previously described by Singh and colleagues[1], patients walked around two cones, each positioned 0.5 m from either end, following the rhythm dictated by the audio signal. Walking speed was initially set at 0.50 meters/second and subsequently increased by 0.17 meter/second every minute until the patient reached a symptom-limited maximum.

~~**Endurance Shuttle Walk**~~

~~The endurance shuttle walk was performed in an enclosed corridor on a flat 10-meter-long course, as previously described by Revill and colleagues[2]. After a two-minute warm-up, walking speed was set at the speed corresponding to 80% of $\dot{V}O_2$ peak, as predicted from the incremental shuttle walk. Before each test, patients were instructed to walk for as long as possible at the speed dictated by the auditory signal. Patients were notified that no further~~

~~encouragement would be provided to them during the test. This was done to avoid any potential confounding effect on their performance[3].~~

Six-Minute Walking Test

The 6MWT was completed in an enclosed corridor on a flat 30-meter-long course according to the procedures recommended by the American Thoracic Society (ATS)[4]. Before each test, patients were instructed to cover as much ground as possible in the allotted time period. Patients were also notified that no encouragement would be provided to them during the test, but that they would be kept aware of time, as per ATS guidelines[4]. Test time was recorded for every 60 meters completed to estimate walking speed.

Physiological Measures

Cardiorespiratory Parameters

For all exercise tests performed in this study, gas exchange parameters ($\dot{V}O_2$, $\dot{V}CO_2$, $\dot{V}_E$) and heart rate were monitored breath-by-breath with a portable telemetric system (K4b[2], Cosmed, Italy). The system consisted of a facemask, heart rate monitor, battery, transmitting unit (containing the O_2 and CO_2 gas analysers) and receiving unit. The turbine and gas analysers were calibrated before each test. The accuracy of this system has been previously tested in healthy subjects[5] and in COPD patients[6] with excellent results for $\dot{V}O_2$ while $\dot{V}CO_2$ and respiratory exchange ratio values can be slightly underestimated. Because of this, only $\dot{V}O_2$ values are reported in the present investigation.

Quadriceps force measurements

Before and after each endurance test, quadriceps twitch force was evaluated during a single magnetic stimulation of the femoral nerve as previously described by our group[7](Figure E2). From a supine position, the dominant leg was stabilised on a wooden frame with the knee

and the hip flexed at 45º. The box design ensured that the leg position was standardised during all measurements and that the length of the quadriceps remained identical throughout the experimentation. The ankle was attached to a strain gauge (Hewlett-Packard, Palo Alto, Ca) through a non-elastic ankle strap to measure the isometric knee extension tension. Care was taken to ensure that the ankle strap and transducer were perpendicular to the leg and the frame box. The position of the strap was marked on the leg ensuring that it remained identical throughout the pre and post exercise measurements. The strain gauge signal was amplified (Hewlett-Packard amplificaters 8811A, Hewlett-Packard, Palo Alto, Ca), transformed by an analog transducer (Biopac system, Santa Barbara, CA) and stored on a computer for data analysis (Acknowledge software, Biopac, Santa Barbara, CA).

The femoral nerve was stimulated using a commercial magnetic stimulator (Magstim 200; Magstim Co Ltd; Whitland, Dyfed, Wales, UK) and a figure-of-eight coil. The coil was positioned over the femoral nerve just lateral to the femoral artery. The coil position leading to the strongest muscle contraction was localized and used in subsequent twitches. Since potentiated twitches appear to be more sensitive for detecting fatigue than non potentiated twitches[8], each quadriceps twitch force was obtained 1 second after a 5-second isometric contraction. A set of 10 potentiated twitches was performed before (after 15 minutes of rest), 10, 20 and 30 minutes after exercise. All potentiated twitches were obtained at 100% of stimulator output. Reported twitch force of quadriceps values are the mean of the three strongest contractions. The preload on the gauge was subtracted from the peak tension measured during the twitch maneuvers so that the reported twitch force values include only the tension developed by the quadriceps contraction.

REFERENCES

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E2. Revill SM, Morgan MD, Singh SJ, Williams J, Hardman AE. The endurance shuttle walk: a new field test for the assessment of endurance capacity in chronic obstructive pulmonary disease. *Thorax* 1999;**54**:213-222.

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E7. Saey D, Debigaré R, LeBlanc P, et al.. Contractile leg fatigue after cycle exercise: a factor limiting exercise in patients with COPD. *Am J Respir Crit Care Med* 2003;**168**:425-430.

E8. Kufel TJ, Pineda LA, Mador MJ. Comparison of potentiated and unpotentiated twitches as an index of muscle fatigue. *Muscle Nerve* 2002;**25**:438-444.

LEGEND FOR FIGURES

Figure E1. Schematic representation of the study protocol. PFT: pulmonary function test; 6MWT: six-minute walking test; ESW: endurance shuttle walk; PL: placebo; IB: ipratropium bromide.

Figure E2. Schematic representation of the experimental setup showing the strain gauge (A), the non elastic ankle strap (B), the figure-of-eight coil (C) and the wooden frame (D) ensuring that the leg positioning during the magnetic stimulation was identical throughout the measurements.

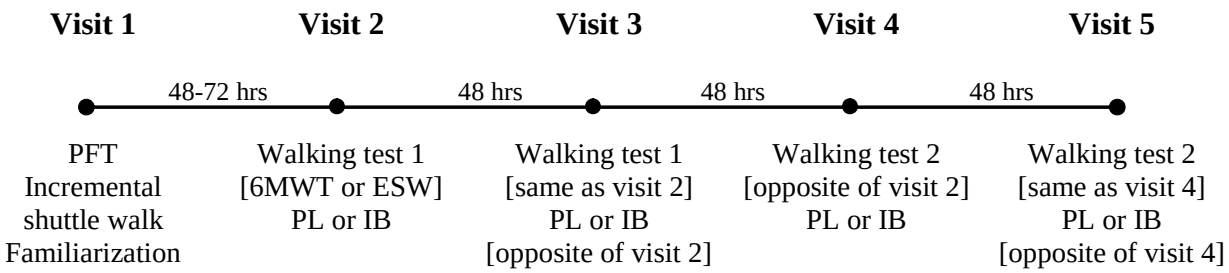
Visit 1
Visit 2
Visit 3
Visit 4
Visit 5
48-72 hrs
48 hrs
48 hrs
48 hrs
PFT
Incremental
shuttle walk
Familiarization
Walking test 1
[6MWT or ESW]
PL or IB
Walking test 1
[same as visit 2]
PL or IB
[opposite of visit 2]
Walking test 2
[opposite of visit 2]
PL or IB
Walking test 2
[same as visit 4]
PL or IB
[opposite of visit 4]

Figure E1.

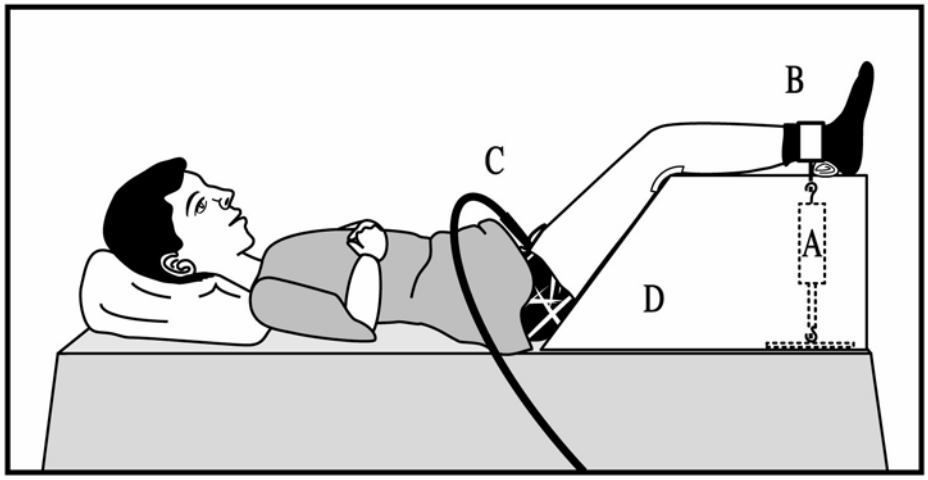

Figure E2.