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Original article

Fixed-distance walk tests at comfortable and fast speed: Potential tools for the functional assessment of coronary patients?

Marie-Doriane Morard [a,c], Delphine Besson [a,c], Davy Laroche [a], Alexandre Naaïm [a], Vincent Gremeaux [a,b,c], Jean-Marie Casillas [a,b,c,*]

[a] CIC INSERM 1432, Plateforme d'Investigation Technologique, CHU de Dijon, Dijon, France
[b] INSERM U1093, Cognition, Action, Plasticité Sensori-motrice, Dijon, France
[c] Cardiac Rehabilitation Department, University Hospital of Dijon, Dijon, France

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ABSTRACT

Objectives: There is ambiguity concerning the walk tests available for functional assessment of coronary patients, particularly for the walking speed. This study explores the psychometric properties of two walking tests, based on fixed-distance tests, at comfortable and fast velocity, in stabilized patients at the end of a cardiac rehabilitation program.
Methods: At a three-day interval 58 coronary patients (mean age of 64.85 ± 6.03 years, 50 men) performed three walk tests, the first two at a comfortable speed in a random order (6-minute walk test – 6MWT – and 400-metre comfortable walk test – 400mCWT) and the third at a brisk speed (200-metre fast walk test – 200mFWT). A modified Bruce treadmill test was associated at the end of the second phase. Monitored main parameters were: heart rate, walking velocity, VO_2.
Results: Tolerance to the 3 tests was satisfactory. The reliability of the main parameters was good (intraclass correlation coefficient > 0.8). The VO_2 concerning 6MWT and 400mCWT were not significantly different ($P = 0.33$) and were lower to the first ventilatory threshold determined by the stress test ($P < 0.001$): 16.2 ± 3.0 vs. 16.5 ± 2.6 vs. 20.7 ± 5.1 $mL \cdot min^{-1} \cdot kg^{-1}$ respectively. The VO_2 of the 200mFWT (20.2 ± 3.7) was not different from the first ventilatory threshold.
Conclusions: 400mCWT and 200mFWT are feasible, well-tolerated and reliable. They explore two levels of effort intensity (lower and not different to the first ventilatory threshold respectively). 400mCWT is a possible alternative to 6MWT. Associated with 200mFWT it should allow a better measurement of physical capacities and better customization of exercise training.

1. Introduction

In current practice, walk tests are used in patients with various chronic disabilities, particularly cardiovascular and respiratory diseases, to assess their adaptation to effort and the evolution of this under the effect of pharmacotherapies or non-pharmacotherapeutic interventions (such as exercise training programs). As they more specifically explore submaximal capacities, which is the intensity often required during daily activities, they complement data obtained from maximum cardiopulmonary exercise testing (CPET). Compared with the CPET, walk tests have the advantage of requiring limited human and technological resources, and can thus be repeated regularly. Consequently, walk tests haves been diversified and many different protocols are available: fixed-duration walking test (6-minute walk test, 2-minute walk test...), fixed-distance walking tests (6-metre walk test, 100-metre walk test, 200-metre walk test, 400-metre walk test...) and walking tests with incremental speed (10-metre shuttle walk test) [1]. Most of these tests explore aerobic capacities [2]. Indeed, recommended exercise programs in cardiovascular and respiratory diseases mainly seek to improve the aerobic performance [3].

Walking speed appears to be the key parameter, because it conditions the other physiological parameters such as metabolic parameters [4]. The comfortable walking speed (or self-velocity) is of great interest, because it represents the best bioenergetic efficiency of walking, in a steady state of aerobic metabolism [5]. It correlates with age and sex [6], it is associated with functional capacities and global health status [7], it represents an appropriate and well-tolerated stimulus for exercise training during cardiac rehabilitation [8] and it is a predictive factor of mortality [9,10].

* Corresponding author. Cardiac Rehabilitation Department, CHU Dijon, 23, rue Gaffarel, 21078 Dijon cedex, France. Tel.: +33 3 80 29 38 14; fax: +33 3 80 29 36 43.
E-mail address: jean-marie.casillas@chu-dijon.fr (J.-M. Casillas).

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On the other hand, many usual activities involve anaerobic metabolism, and, high-intensity training programs, such as interval training, have also been validated [11], giving particular interest to brisk walk tests, which are designed to assess tolerance to higher levels of effort, beyond the strict aerobic limits. Finally, the comfortable and the fast walking speed appear to be highly complementary measurement, and for some authors the difference between the two is the best indicator of locomotor capacity [12].

Among current walk tests, the 6-minute walk test (6MWT) is the most commonly used as the main parameter to assess the impact of various therapeutic interventions in clinical practice and during experimental studies. However, there is some ambiguity in the instructions for the 6MWT concerning the required walking speed. Indeed, in its initial proposal, dedicated to heart failure patients, the 6MWT should be practiced at a self-selected velocity [13], though recommendations are different in other contexts. For example, for respiratory rehabilitation, the test is designed as "the distance that a patient can walk quickly" [14]. This leads to divergence regarding the modalities of the 6MWT, sometimes with conditions that must be strictly aerobic [2,12,15], and at other times with the aim to achieve an intensity close to maximum capacity [16]. This limitation and the heterogeneity in the available walk tests make them difficult to apply in clinical practice [17] and there are currently no recommendations regarding their indications.

This study is the first step in a project whose ultimate objective is to validate a new procedure dedicated to usual applications of walk tests. It is based on two preliminary observations: firstly, it seems justified to favor fixed-distance walking tests rather than fixed-duration walking tests (such as the 6MWT), because for planning motor activity, the use of spatial criteria has long been known to be more effective than time references [18,19]; secondly, it appears appropriate to specifically evaluate two levels of walking speed: comfortable walking speed (strictly aerobic) and fast walking speed (exceeding the limits of strict aerobic metabolism). For this purpose, the main objective of this study was to compare, in stabilized coronary patients, the metrological qualities of the 400-metre comfortable walk test (400mCWT), a fixed-distance walking test at a self-pace (comfortable speed), with the reference walk test, the 6MWT. The second objective was to compare these two self-pace walk tests with a CPET and a fast walk test, the 200-metre fast walk test (200mFWT), to clarify their respective characteristics.

2. Methods

2.1. Participants

Participants were included without distinction of sex, if they were aged between 55 and 80 years, at the end of an outpatient cardiac rehabilitation program and referred for either myocardial infarction, or coronary angioplasty (+ stenting), or coronary artery bypass surgery, or stabilised coronary artery disease. Enrolled subjects were excluded if they presented significant cognitive disorders that hampered participation in the tests (Mini Mental State examination < 24), any cardiac rhythm other than sinus rhythm (permanent or exercise-induced), acute or chronic respiratory failure, any associated disease that limited walking capacity or could stop an exercise test prematurely for a reason other than fatigue or dyspnoea, acute or chronic heart failure (left ventricular ejection fraction $< 45\%$ using the echocardiographic Simpson method), renal failure, residual myocardial ischaemia, pacemaker, severe obstructive heart disease, moderate to severe aortic stenosis, intracavitary thrombosis, pulmonary hypertension > 70mmgHg, heart transplantation or any modification of drugs affecting adaptation to effort (diuretics, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, beta-blockers, anti-aldosterones, ivabradine) within the 15 days preceding the tests. Anthropometric measurements included height, weight, and body mass index.

Written informed consent, approved by the institutional ethics committee (Subjects Protection Committee, Dijon Est I), was obtained for all participants, after they had been clearly informed about the protocol. This was a prospective single-centre study published in Clinical Trials Registration (reference NCT01904929).

2.2. Protocol

The whole protocol was carried out on a motricity analysis platform in a rehabilitation center of a university hospital.

2.2.1. Different phases of the protocol

The same experimental protocol was repeated at an interval of 72 hours to assess the reliability of the three walk tests (6MWT, 400mCWT, 200mFWT). A CPET, without pharmacologic wash-out, was carried out only at the end of the second phase of the protocol. Concerning the order of the walk tests, the two self-pace tests (6MWT, 400mCWT) were done first, in a random order, in order to subject the patients to an effort of increasing intensity, thus limiting the effects of fatigue for the brisk walk test and the CPET. All the walk tests were conducted on the same flat 50-metre-long indoor walking track at the same time of day. The same operator monitored the three successive tests, and the final CPET was supervised by a cardiologist specialised in cardiac rehabilitation. For all the tests, the occurrence of limitations or early termination (dizziness, chest pain, musculoskeletal pain...) was collected. The protocol was preceded by a 15-minute rest phase, and each test was separated by a new 15-minute rest period, or longer if the heart rate (HR) had not returned to the resting HR: Goal was to allow a sufficient recovery phase between each walking test (at least twice the duration of the test), with a return to resting levels of physiological parameters. The monitored parameters were HR assessed continuously by an HR monitor (POLAR FT1-Polar Electro Oy–90440 Kempele, Finland), blood pressure in the sitting position on the right arm before and after each test and continuous assessment of breath-by-breath gas exchange using a portable device (K4b2, Cosmed, Rome, Italy), VO_2 and VCO_2 being computed and extracted directly using the incorporated software.

2.2.2. The 6MWT

The patients were instructed to cover as much ground as they could during the allotted time, at their free–chosen walking speed (comfortable self-selected speed). Running was forbidden, but stopping and resting was allowed. No encouragement was given during the test, but patients were informed every 2 minutes of the time spent. The distance walked was recorded at the end of the test as an absolute value in metres.

2.2.3. The 400mCWT

The walking speed directives were the same as for the 6MWT, but on a fixed-distance of 400 m. The test result was expressed in seconds (time to cover the distance of 400 m).

2.2.4. The 200mFWT

The instruction was to cover a distance of 200 m as quickly as possible, without running. Standard encouragement was provided at mid-distance. Slowing down and stopping to rest were authorised. The results were also given in absolute values (time to complete the test in seconds).

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