

Can the Cardiopulmonary 6-Minute Walk Test Reproduce the Usual Activities of Patients with Heart Failure?

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Objective - The 6-minute walk test is a way of assessing exercise capacity and predicting survival in heart failure. The 6-minute walk test was suggested to be similar to that of daily activities. We investigated the effect of motivation during the 6-minute walk test in heart failure.

Methods - We studied 12 males, age 45 ± 12 years, ejection fraction $23 \pm 7\%$, and functional class III. Patients underwent the following tests: maximal cardiopulmonary exercise test on the treadmill (max), cardiopulmonary 6-minute walk test with the walking rhythm maintained between relatively easy and slightly tiring (levels 11 and 13 on the Borg scale) (6EB), and cardiopulmonary 6-minute walk test using the usual recommendations (6RU). The 6EB and 6RU tests were performed on a treadmill with zero inclination and control of the velocity by the patient.

Results - The values obtained in the max, 6EB, and 6RU tests were, respectively, as follows: O_2 consumption ($ml \cdot kg^{-1} \cdot min^{-1}$) 15.4 ± 1.8 , 9.8 ± 1.9 ($60 \pm 10\%$), and 13.3 ± 2.2 ($90 \pm 10\%$); heart rate (bpm) 142 ± 12 , 110 ± 13 ($77 \pm 9\%$), and 126 ± 11 ($89 \pm 7\%$); distance walked (m) 733 ± 147 , 332 ± 66 , and 470 ± 48 ; and respiratory exchange ratio (R) 1.13 ± 0.06 , 0.9 ± 0.06 , and 1.06 ± 0.12 . Significant differences were observed in the values of the variables cited between the max and 6EB tests, the max and 6RU tests, and the 6EB and 6RU tests ($p < 0.05$).

Conclusion - Patients, who undergo the cardiopulmonary 6-minute walk test and are motivated to walk as much as they possibly can, usually walk almost to their maximum capacity, which may not correspond to that of their daily activities. The use of the Borg scale during the cardiopulmonary 6-minute walk test seems to better correspond to the metabolic demand of the usual activities in this group of patients.

Keywords: heart failure, exercise, oxygen consumption

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A limited tolerance for effort is frequently the first and major clinical characteristic of heart failure, reflecting a reduction in cardiac function and alteration in peripheral response^{1,2}. The cardiopulmonary test is used to assess the functional capacity, therapeutic response, and prognosis in this group of patients^{3,4}. However, some patients may have difficulty in undergoing the maximum cardiopulmonary exercise test, and limitation to maximum exercise does not reflect the usual activity⁵.

The 6-minute walk test is a simple method for assessing exercise capacity and predicting survival in patients with heart failure⁶⁻⁸. The type of exertion perceived during a 6-minute walk test has been suggested to be similar to that of daily activities^{3,9}. In addition, the patient may determine the walking rhythm, which is an additional advantage for the more physically limited patient, who certainly would not tolerate the maximal exercise test¹⁰. However, the walking intensity during the 6 minutes may be influenced by verbal encouragement¹¹.

The Borg scale is a descriptive marker of subjective physical exertion, whose degree of intensity corresponds to an odd number, categorized at 15 degrees varying from 6 to 20¹². Quantification of the exertion perceived and the heart rate is linearly related to the intensity of the physical activity^{13,14}. In addition to being a valid and reliable indicator of exercise intensity, the Borg scale is reproducible and may be used in repetitive tests¹⁵.

The objective of our study was to compare the effect of motivation on the results of the cardiopulmonary 6-minute walk test in patients with heart failure using the Borg scale (between 11 and 13) and the usual recommendation about the intensity of exertion.

Methods

From March to April 1997, we consecutively studied 12 patients with heart failure, which in 10 was due to idiopathic dilated cardiomyopathy and in 2 was due to ischemic cardiomyopathy, who were hospitalized to undergo assess-

ment for surgical or clinical treatment for heart failure. All patients were males in New York Heart Association (NYHA) functional class III.

The following patients were excluded from the study: patients whose medicamentous therapy had not been optimized within 1 month, patients with orthopedic problems or with noncardiovascular limitations to exertion, with atrial fibrillation, or cachexia, those interrupting the walking test prior to the 6th minute, and those whose respiratory exchange ratio [R (VCO_2/VO_2)] in the maximal cardiopulmonary exercise test did not reach a value > 1.05 ¹⁶. Female patients were not included in the study due to the reduced number of females assessed during the study period.

All patients with heart failure referred for cardiopulmonary assessment during the period studied were hospitalized in the clinical sector of the Heart Failure and Transplantation Unit of InCor of the Hospital das Clínicas of the FMUSP. These patients had been previously advised about the technique and protocol of the study. All patients were studied in a temperature-controlled environment (21-23°C) at least 2 hours after a meal, and they were using their medication (digitalis, diuretics, angiotensin-converting enzyme inhibitors). All assessments were part of the clinical procedures and were performed after the patients agreed that the results could be reported in the scientific literature.

The maximal cardiopulmonary exercise test, the 6-minute walk test, using the Borg scale, and usual recommendations for exertion intensity were randomized, conducted by the same professional, and performed on 3 consecutive days at the same hour.

Initially, all patients underwent resting standard 12-lead electrocardiography and exercise testing with continuous electrocardiographic monitoring (Max 1; Marquette Electronics; Milwaukee, WI, USA), with blood pressure monitoring through the auscultation method, and with monitoring of ventilation and gas exchange during the exercise test. The test was performed on a programmable treadmill (Series 2000; Marquette Electronics; Milwaukee, WI, USA) according to the modified Naughton protocol¹⁷. After 2 minutes standing without exercising, all patients were encouraged to exercise until the symptoms (fatigue or dyspnea) prevented them from continuing the test. The ventilatory data of oxygen consumption and carbon dioxide production were obtained at each respiratory cycle using the computerized system (Vmax 229 model, SensorMedics, Yorba Linda, CA, USA), and the analysis of the data collected was performed through the arithmetic mean of intervals at each 60 seconds. Peak oxygen consumption (VO_{2peak}) was considered the highest VO_2 reached during exercise¹⁸, which was used as an index of maximal exercise capacity for each individual.

The cardiopulmonary 6-minute walk test using the Borg scale was performed on a treadmill with zero inclination and velocity controlled by the patient. All patients were advised to maintain walking velocity during the test between relatively easy and slightly tiring (between 11 and 13 on the Borg scale)¹⁰. The following 3 alert phrases were

standardized for the patients to adjust their walking rhythm between 11 and 13: “if it is easy, increase the velocity,” “if it is between 11 and 13, maintain the velocity,” and “if it is above 13, reduce the velocity.” The cardiopulmonary variables were measured during the test, and the values found in the last 60 seconds were considered the maximal values. The distance walked during the 6 minutes was recorded by the microprocessor of the manual control of the treadmill.

The cardiopulmonary 6-minute walk test according to the usual recommendations was performed on a treadmill with zero inclination, and the patient had control of the velocity¹⁹. During the test, patients were systematically encouraged to increase velocity to walk the most they could. Encouragement was standardized with phrases like “if you can walk faster, increase the velocity,” “you are doing very well,” and “if it is very tiring, you can reduce the velocity.” Blood pressure was measured at rest and at the 6th minute. The electrocardiographic, ventilatory, and gas exchange variables were continuously assessed during the test. The mean values of the last 60 seconds of the test were considered the maximum cardiopulmonary variables. The microprocessor of the manual control of the treadmill recorded the distance walked during the test.

The descriptive analysis was presented as mean and standard deviation. The variables studied underwent the analysis of variance (ANOVA), and the statistical significance level adopted was $p < 0.05$. When significance was found, the post-hoc analysis of Bonferroni was performed.

Results

All patients completed the 3 tests with no complications.

In the maximal cardiopulmonary exercise test, the mean value of the maximum heart rate (HR_{max}) was 142 ± 12 bpm, of the peak oxygen consumption (VO_{2peak}) was 15.4 ± 1.8 ml.kg⁻¹.min⁻¹, and of the maximum distance was 733 ± 147 m. All patients reached levels considered as maximum exertion R (respiratory exchange ratio) > 1.05 (1.13 ± 0.06).

In the cardiopulmonary 6-minute walk test using the Borg scale, the mean distance walked was 332 ± 66 m (45% of the maximum distance), the mean VO_2 was 9.8 ± 1.9 ml.kg⁻¹.min⁻¹ (60% of the VO_{2peak}), the mean heart rate was 110 ± 13 bpm (77% of the HR_{max}), and R was 0.90 ± 0.04 (79% of the maximum R).

In the cardiopulmonary 6-minute walk test using the usual recommendations, the mean distance walked was 470 ± 48 m (64% of the maximum distance), the mean VO_2 was 13.3 ± 2.2 ml.kg⁻¹.min⁻¹ (90% of the VO_{2peak}), the mean heart rate was 126 ± 11 bpm (89% of the HR_{max}), and R was 1.06 ± 0.05 (94% of the maximum R).

When comparing the results of the tests, the distance walked was statistically different in the different tests (fig. 1). Oxygen consumption (fig. 2), heart rate (fig. 3), and the respiratory exchange ratio (fig. 4) also showed significant differences in the 3 assessments.

Discussion

Our results showed that motivation during exercise may have determined better physical performance, such as an increase in the distance walked, in oxygen consumption, and in heart rate. Assessment of submaximal exercise capacity on the treadmill with zero inclination and velocity controlled by the patient was also possible in heart failure.

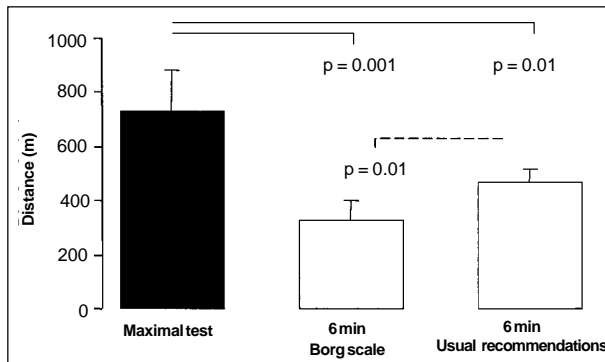


Fig. 1 - Distance walked in the maximal cardiopulmonary exercise test, in the 6-minute walk test using the Borg scale with relatively easy and slightly tiring rhythms (11 and 13), and in the 6-minute walk test with the usual recommendations.

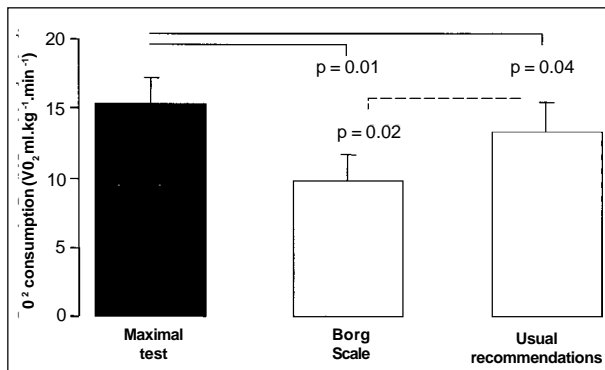


Fig. 2 - Oxygen consumption in the maximal cardiopulmonary exercise test, in the 6-minute walk test using the Borg scale with relatively easy and slightly tiring rhythms (11 and 13), and in the 6-minute walk test with the usual recommendations.

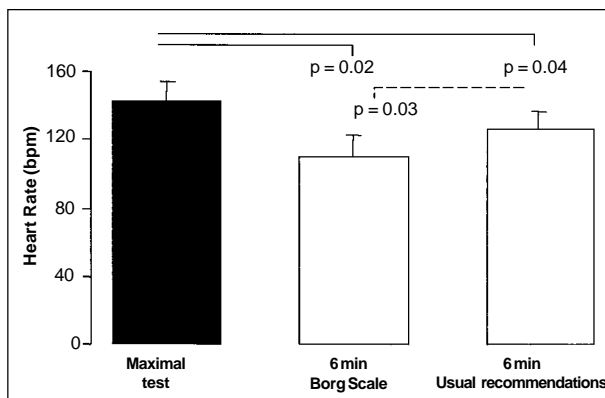


Fig. 3 - Heart rate in the maximal cardiopulmonary exercise test, in the 6-minute walk test using the Borg scale with relatively easy and slightly tiring rhythms (11 and 13), and in the 6-minute walk test with the usual recommendations.

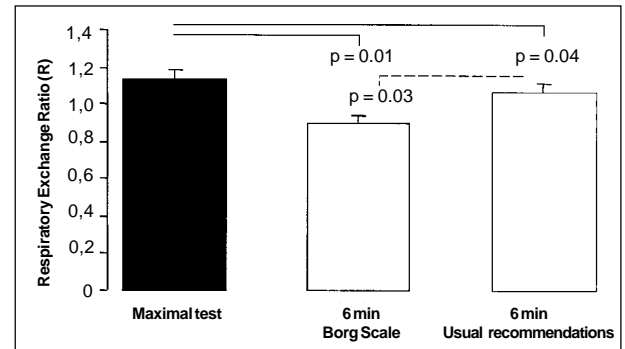


Fig. 4 - Respiratory exchange ratio in the maximal cardiopulmonary exercise test, in the 6-minute walk test using the Borg scale with relatively easy and slightly tiring rhythms (11 and 13), and in the 6-minute walk test with the usual recommendations.

Performance of the cardiopulmonary 6-minute walk test on a treadmill proved to be safe and that patients could collaborate in the testing by controlling velocity.

The physiological alterations induced by exertion depend essentially on the intensity of the overload. During exercise, systolic volume increases from rest to mild to moderate exercises, maximal values being achieved between 40% to 50% of VO_2 peak. From these values on, cardiac output increases more due to a higher heart rate^{20,21}. We demonstrated that, when encouraged to walk as fast as possible, patients walked at VO_2 and heart rate intensities close to the maximum (90% and 89%, respectively). When advised to walk at intensities between relatively easy and slightly tiring (between 11 and 13 in the Borg scale), their walking intensity was 60% of VO_2 peak and 77% of the maximum heart rate. This fact confirms that which has already been demonstrated, that the adequate pacing rhythm of an individual is around 60 to 70% of VO_2 peak²². In addition, exercise intensity may be classified according to physiological stress, ie, from 30 to 74% of VO_2 peak and from 35 to 79% of the maximum heart rate, which are activities considered mild to moderate; above those levels, the activities are considered intense¹⁸.

The Borg scale has a good correlation with some physiological variables. A 0.85 correlation was demonstrated in relation to oxygen consumption, heart rate, pulmonary ventilation, and lactate levels. In this regard, the scale may provide objective data of the degree of fatigue during the test. The Borg scale may be useful to assess constancy versus change in the individual exertion during the 6 minutes of the test²³. Therefore, the aerobic capacity and performance during the 6-minute walk test may be higher or lower, and with the walking rhythm maintained between relatively easy and slightly tiring (11 and 13), this may reflect the physical condition or clinical condition, and not higher or lower work for the patients.

The increase in the distance walked due to verbal motivation influenced the performance of the patients in the cardiopulmonary 6-minute walk tests. The means of the group were, respectively, 470 m and 332 m when encouraged to walk as fast as possible and when advised to walk between a relatively easy and slightly tiring rhythm accor-

ding to the Borg scale. As has already been reported by other authors⁴⁻⁶ and shown in our study, the level of encouragement may have a crucial effect on the individual's performance. The distance walked during the 6-minute test is a marker of worse prognosis and poorer clinical condition in patients with functional class II and III heart failure³. Patients with better performance were shown to have a lower mortality rate and to require less hospitalization due to heart failure and other causes^{3,7}. According to the distance walked, the patients were divided into levels as follows: level 1 – patients who walked less than 300 m; level 2 – patients who walked between 300 and 375 m; level 3 – those who walked between 375 and 450 m; and level 4 – those who walked more than 450 m. The result of our study showed that when the patients were encouraged to walk as fast as possible, they reached level 4. However, when advised to walk in a rhythm between relatively easy and slightly tiring, they reached level 2.

The cardiopulmonary 6-minute walk test with velocity controlled by the patient requires maximal patient's collaboration. However, the number of patients studied was limited. All patients were in functional class III, hospitalized, and

compensated. The randomization of the tests may not have had the training effect as has already been reported^{18,24}.

This study shows that the 6-minute walk test, when applied in its original form, achieves relatively high percentages of exertion, suggesting that the determinants of the submaximal and maximal exercise capacity in this group of patients may not differ. Considering that one of the objectives of the 6-minute test is to reproduce the daily activities of the patients with heart failure, the use of walking rhythms between 11 and 13 on the Borg scale during the walking test seems more appropriate for this outcome.

In conclusion, our results are the first, in our environment, to show that when patients undergoing the cardiopulmonary 6-minute walk test are encouraged to walk as fast as they possibly can, they walk close to their maximum, and this may not correspond to their daily activities. The use of the Borg scale during the cardiopulmonary 6-minute walk test seems to better correspond to the metabolic demand of the usual activities in this group of patients. We suggest that the Borg scale should be used between the relatively easy and slightly tiring rhythm (11 and 13) during the 6-minute walk test to assess the usual activities in this group of patients.

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