

## Reliability of walking tests in claudicating patients: a pilot study

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## ABSTRACT

Background: Considering that peripheral arterial obstruction is a diffuse condition, manifesting as a variable clinical feature and with varied intervention outcomes, it is important to assess patients with peripheral arterial occlusive disease using instruments that may provide objective and reliable data.

Objective: To investigate and compare the reliability of both the 6-minute walking test (6MWT) and the shuttle walking test (SWT) in patients with claudication secondary to peripheral arterial occlusive disease.

Methods: Fourteen Fontaine stage II patients participated in the study. Eleven patients were submitted to both tests, while three patients only performed the 6MWT. After familiarization, the patients were tested on two occasions, with maximal 1-week interval between measurements. The intraclass correlation coefficient (ICC<sub>2,1</sub>) was used to check for test-retest reliability.

Results: Mean maximal walking distance for the 6MWT in both test and retest was 397.04±120.74 and 408.6±153.64 m (p = 0.58) respectively; ICC = 0.87 (p = 0.00005). For the SWT, mean was 345±145.75 m, and 345.91±127.97 m in the retest (p = 0.92); ICC = 0.99 (p = 0.00005). Mean times for claudication onset with the 6MWT test-retest were 172.25±88.23 and 148.58±70.36 s (p = 0.13); ICC = 0.81 (p = 0.0004); while for the SWT these values were 282±141.90 and 267.14±150.58 s (p = 0.55); ICC = 0.91 (p = 0.0008).

Conclusion: Both walking tests are reliable and can be used for clinical and functional assessment of these patients. The SWT, however, yielded higher reliability coefficients, which suggests that it may be preferable to evaluate these individuals' performance.

Keywords: Reliability test, intermittent claudication, walking.

## RESUMO

Contexto: Uma vez que a obstrução arterial periférica pode se apresentar de maneira difusa, com clínica diversa e com resultados de intervenção variados, é fundamental que a avaliação dos pacientes

com doença arterial obstrutiva periférica seja feita com instrumentos que possam apresentar dados objetivos e reprodutíveis.

Objetivo: Investigar e contrastar a confiabilidade do teste de caminhada de 6 minutos (T6M) com teste de deslocamento bidirecional progressivo (TDBP) em indivíduos claudicantes portadores de doença arterial obstrutiva periférica.

Métodos: Quatorze pacientes em estágio II de Fontaine participaram deste estudo piloto. Onze pacientes realizaram ambos os testes e três realizaram apenas T6M. Após familiarização, os pacientes foram avaliados em duas ocasiões distintas com intervalo máximo de 1 semana entre si. O coeficiente de correlação de intraclassa ( $CCI_{2,1}$ ) foi utilizado para avaliação da reprodutibilidade teste-reteste.

Resultados: A média da distância máxima de caminhada no teste e no reteste no T6M foi de  $397,04 \pm 120,74$  e  $408,6 \pm 153,64$  metros ( $p = 0,58$ ), respectivamente, com  $CCI = 0,87$  ( $p = 0,00005$ ); já no TDBP, a média foi de  $345 \pm 145,75$  metros e, no reteste, de  $345,91 \pm 127,97$  ( $p = 0,92$ ), com  $CCI = 0,99$  ( $p = 0,00005$ ). O tempo médio para surgimento da dor inicial, em segundos, com o T6M, foi de  $172,25 \pm 88,23$  (teste) e  $148,58 \pm 70,36$  (reteste) ( $p = 0,13$ ), com  $CCI = 0,81$  ( $p = 0,0004$ ). No TDBP, o tempo médio foi de  $282 \pm 141,90$  (teste) e  $267,14 \pm 150,58$  (reteste) ( $p = 0,55$ ), com  $CCI = 0,91$  ( $p = 0,0008$ ).

Conclusão: Ambos os testes de caminhada são confiáveis e úteis para avaliação clínico-funcional desses pacientes. O TDBP, entretanto, gerou índices de confiabilidade mais elevados, podendo ser melhor opção para avaliação da *performance* desses indivíduos.

Palavras-chave: Confiabilidade dos testes, claudicação intermitente, caminhada.

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## Introduction

Peripheral arterial occlusive disease (PAOD) is a disease characterized by inadequate perfusion secondary to arterial obstruction that mainly affects lower limbs. In Brazil, 5.3% of individuals aged 45 years or older have a high likelihood of developing PAOD.<sup>1</sup> Its prevalence is lower than 2% for men younger than 50 years, increasing to more than 5% in those aged 70 years or older.<sup>2</sup>

Intermittent claudication (IC) is an usual symptom in PAOD, which is commonly manifested as pain, cramps, paresthesia or discomfort in the affected muscles, which occurs at a given level of walking effort and may be relieved with rest.<sup>3</sup> IC restricts the individual's physical performance and consequently leads to impairment of functional activities. Distances walked by claudicating individuals can be reduced in 50%, when compared with those of healthy individuals at the same age.<sup>4,5</sup>

One of the forms of assessing PAOD severity is based on the degree of functional impairment of the claudicating limb. The literature describes varied assessment protocols, and time of pain onset and maximal limiting pain during walking is the variable of highest interest.<sup>1,3-8</sup> The 6-minute walking test (6MWT) is a submaximal *endurance* test that assesses the distance walked over a 6-minute period. This test has been used in patients with rheumatologic, neurological, cardiac, pulmonary and pediatric disorders, and its correlation with maximal aerobic capacity is considered satisfactory.<sup>9</sup> This test, therefore, can be used to compare functional capacity before and after interventions, but it has the disadvantage of being a test whose velocity is determined by the individual.<sup>10</sup>

More recently, a new ground walking test has been used to assess functional capacity in individuals with varied diseases.<sup>11</sup> This test, called *shuttle walking test (SWT)*, has the advantage of having its velocity externally controlled and imposing a progressive effort. It is a low-cost test that has its intensity gradually increased by external speed control; therefore, it has the possibility of showing the patient's functional capacity more reliably. However, the SWT is still not widely used in patients with IC, and its psychometric characteristics in this population have not been properly investigated.<sup>12</sup>

Since the peripheral arterial obstruction can be presented in a diffuse manner, with diverse clinical presentation and varied intervention outcomes, it is essential to assess these patients using instruments that can provide objective and reproducible data. Investigation of simple but reliable forms of assessment is important, especially in areas whose economic restriction does not allow for more advanced technological resources.

Therefore, this pilot study aims at investigating and comparing 6MWT and SWT reliability in claudicating individuals with PAOD.

## Methods

### *Sample*

This pilot study used a convenience sample among the participants of an Extension Project to Patients with Peripheral Vascular Diseases at the Centro Universitário de Belo Horizonte, to participate in the study. Patients who had PAOD confirmed by Doppler or by clinical assessment and Fontaine stage II,<sup>13</sup> regardless of gender, ethnicity or age, were included. Exclusion criteria were patients with asymptomatic PAOD, claudicating pain of a nonvascular origin, unstable angina, non-controlled diabetes, changes in electrocardiogram suggesting acute myocardial infarction or another acute cardiac episode, recent pulmonary embolism, and patients who had any neuromuscular change that limited the walking test.

The study was approved by the Ethics Committee of Centro Universitário de Belo Horizonte, and there are no conflicts of interest declared concerning the publication of this article. All participants received written and oral information about the study procedures and were only included in the project after signing a consent form.

### *Procedures*

The 6MWT was performed in a 60-m circular track, with marks every 2 meters along the circuit. The patient was advised to walk as fast as possible without running for 6 minutes. At every minute, a verbal command was given to encourage the patient to reach a uniform *performance*.

Before starting the test, the patients were equipped with a heart rate (HR) monitor (Polar™) to record the HR at each minute during the test. Blood pressure (BP) was measured before and after performing the test. The values used for statistical analysis were those obtained at the end of the test. A scale of subjective perception of effort (Borg's scale)<sup>14</sup> was used at the end of the test. In case the patient needed to stop walking during the test due to tiredness or maximal claudicating pain, he was allowed to resume walking as soon as he recovered to complete the 6 minutes required by the test.

To perform the SWT, a 10-meter distance was set on the ground using two cones. The participant was instructed to make consecutive laps around both cones, with speeds that increased progressively until exhaustion, presence of claudicating symptom or inability to maintain the previously established rhythm. Speed was increased at every minute (0.17 m/s) and controlled by audio signals, generated by a portable sound device. The SWT consists of 12 levels lasting 1 minute each, and initial speed was 0.5 m/s until a maximum speed of 2.37 m/s.

The same procedures regarding HR, BP and subjective perception of effort used in the 6MWT were applied to the SWT. Both walking tests were performed and repeated within up to 1 week. Order of test application was random, and each test was performed with a 20-minute interval. Before data collection, the patients went through a period of familiarization with the procedures. Time of pain onset, recorded in seconds, during walking, as well as total distance, were recorded in both tests.

### *Statistical analysis*

The data were presented as mean  $\pm$  standard deviation and 95% confidence interval. Intraclass correlation coefficient ( $ICC_{2,1}$ ) was used to evaluate reproducibility of the main variables in this study, which were walking distance and time in both tests. Student's *t* test was used to compare the difference between means whenever appropriate. Alpha value equal or lower than 0.05 was considered for statistical significance.

## Results

Fourteen individuals met the inclusion criteria and were included in this pilot study. Among the patients, 14 performed both tests and 11 performed only the SWT. There was no statistically significant difference regarding mean walking distances in the 6MWT in both assessments, neither in the SWT. The  $ICC_{2,1}$  showed high and significant reliability in both tests, and the SWT had an even better correlation than the 6MWT (Table 1). There was also no statistically significant difference between maximum distances between the 6MWT and the SWT, both in assessment 1 and 2 ( $p = 0.36$  and  $p = 0.35$ , respectively).

Table 1 - Maximum distance (in meters) walked in both tests (test-retest)

Test	n	Assessment 1 (95%CI)	Assessment 2 (95%CI)	p*	ICC2.1	p†
6MWT	14	397.04 $\pm$ 120.74 (329.08-465.00)	408.60 $\pm$ 153.64 (327.58-488.54)	0.58	0.87 (0.64-0.96)	< 0.00005
SWT	11	345.00 $\pm$ 140.75 (261.82-428.17)	345.91 $\pm$ 125.97 (271.46-420.35)	0.92	0.99 (0.95-0.99)	< 0.00005

$ICC_{2,1}$  = intraclass correlation coefficient, model 2.1; 95%CI = 95% confidence interval; 6MWT = 6-minute walking test; n = number of individuals; SWT = shuttle walking test.

\* Significance level between distance means for assessment 1 and 2.

† ICC significance level $_{2,1}$ .

Only two patients failed to report time of pain onset during the 6MWT. Mean time, in seconds, was not statistically different, although there has been a tendency to reduction in time of initial pain onset in the second assessment. Reproducibility of this measure was high ( $ICC_{2,1} = 0.81$ ) and significant (Table 2). Four patients failed to report pain onset in the SWT. There was no statistically significant difference between means of pain onset in both assessments performed in the SWT. Such measures had a high level of test-retest reliability ( $ICC_{2,1} = 0.91$ ). The patients spent longer mean time in absolute value to report pain onset during the SWT in assessments 1 and 2 when compared with the 6MWT ( $p = 0.05$  and  $p = 0.04$ , respectively).

**Table 2 - Time of initial claudicating symptom onset (in seconds) in both tests (test-retest)**

Test	n	Assessment 1 (95%CI)	Assessment 2 (95%CI)	p*	ICC <sub>2,1</sub>	p <sup>†</sup>
6MWT	12	172.25±88.23 (122.33-222.17)	148.58±70.36 (108.77-188.39)	0.13	0.81 (0.46-0.94)	0.0004
SWT	7	282.00±141.90 (176.88-387.12)	267.14±150.58 (155.59-378.69)	0.55	0.91(0.58-0.98)	0.0008

ICC<sub>2,1</sub> = intraclass correlation coefficient, model 2.1; 95%CI = 95% confidence interval; 6MWT = 6-minute walking test; n = number of individuals; SWT = shuttle walking test.

\* Significance level between distance means for assessment 1 and 2.

† ICC significance level<sub>2,1</sub> based on 12 pairs of observation for the 6MWT and seven pairs for the SWT.

There was no statistically significant difference in means between both assessments of HR, systolic blood pressure (SBP) and diastolic blood pressure (DBP) when the 6MWT was compared with the SWT, except for DBP, which had a statistically lower value in the second assessment during the 6MWT. However, there was a tendency of hemodynamic values being higher for the SWT in terms of HR (Table 3).

**Table 3 - Behavior of hemodynamic variables in walking tests**

	6MWT (n = 14)			SWT (n = 11)		
	Assessment 1 (95%CI)	Assessment 2 (95%CI)	p*	Assessment 1 (95%CI)	Assessment 2 (95%CI)	p*
HR	103.57±11.68 (97.45-109.69)	109.93±17.06 (101.00-118.86)	0.07	114.27±17.14 (104.15-124.40)	113.00±16.79 (103.08-122.02)	0.22
SBP	157.14±25.25 (143.92-170.37)	153.21±23.50 (140.90-165.52)	0.25	146.36±20.26 (134.39-158.34)	158.10±81.36 (145.56-170.81)	0.09
DBP	83.21±12.07 (76.91-89.51)	79.14±11.01 (73.32-84.96)	0.04	80.45±10.11 (74.48-86.43)	79.09±8.31 (74.18-84.00)	0.57

95%CI = 95% confidence interval; 6MWT = 6-minute walking test; DBP = diastolic blood pressure (mmHg); HR = heart rate (beats per minute); n = number of individuals; SBP = systolic blood pressure (mmHg); SWT = shuttle walking test.

\* Significance level between means of hemodynamic variables of the 6MWT and SWT.

## Discussion

The purpose of this study was to compare the 6MWT and SWT reliability and record the *performance* of individuals with PAOD through a report of pain onset, walking distance and cardiovascular stress. Both tests generated high reliability coefficients as to walking distance, although the SWT has shown higher correlation magnitude (ICC<sub>2,1</sub> = 0.99) compared with the 6MWT (ICC<sub>2,1</sub> = 0,87). The results obtained with the 6MWT corroborate the study conducted by Montgomery et al., who described high reliability and low variation coefficient (VC) – 0.94 and 10.4%, respectively – when assessing walking distance in patients with PAOD.<sup>10</sup> In the literature, reports of walking distance in the 6MWT range between 382±12 and 433±11 meters<sup>13,15-17</sup> similar to those found in the population of our study.

The SWT has not been universally used to assess the *performance* of patients with PAOD. Due to this fact, there is a restriction of data in the literature on the *performance* of this population in the SWT,

partly limiting the discussion of results obtained using this test. In a study on the SWT, Zwierska et al.<sup>18</sup> recorded a mean walking distance until claudicating symptom of  $217 \pm 17$  meters after three assessments, with high reliability rates = 0.88 and VC close to 16%. However, such values are lower compared with those shown in the present study.

Time of pain onset, observed in different protocols, has been reported in the literature with great variability in relation to other variables. In a study on claudicating patients using the 6MWT, 69% of the 64 patients reported pain onset, with mean time of  $135 \pm 59$  seconds and moderate test-retest correlation ( $ICC_{2,1} = 0.75$  and  $VC = 47\%$ ).<sup>9</sup> Other studies have reported high correlation coefficient (0.95) in relation to time of pain onset in the 6MWT.<sup>5</sup> Walker et al. reported high test-retest reliability in time and distance of pain onset using the SWT.<sup>12</sup> In this study, the correlation coefficient in time of pain onset for the 6MWT was high ( $ICC_{2,1} = 0.81$ ), but the correlation coefficient of the SWT was higher ( $ICC_{2,1} = 0.91$ ).

Walking tests are more frequently used to assess the patient's *performance* before and after the intervention. Since the rehabilitation base in patients with PAOD is walking, the results obtained through tests (distance, speed, time of symptom onset) can be useful to prescribe specific intensity for the activity and enhance the rehabilitation potential of these individuals. The 6MWT does not allow an accurate determination of walking speed, because the patient can have more control on it during his *performance*. On the other hand, the SWT determined the speed externally and the patient has lower control on his *performance*, therefore it is possible to find the exact appearance of symptoms; hence, the results obtained with this test become more reliable parameters for the prescription of rehabilitation intensity.

It has been suggested that the SWT causes more cardiovascular stress given that it is progressive and symptom-limited, compared with other walking tests with submaximal characteristics, such as the 6MWT.<sup>19</sup> The data found in this study do not confirm this suggestion, since there was no statistically significant difference in hemodynamic variables between both tests, except for the DBP during the 6MWT. However, such difference is not important from the clinical perspective. There was a tendency of HR being higher during the SWT.

Vaggagini et al. compared the 6MWT and the SWT in patients with PAOD and did not find that the SWT had imposed higher cardiorespiratory overload to the patients.<sup>20</sup> In another study on patients with PAOD, the distances obtained with the 6MWT and the SWT were similar; however, for the SWT the correlations generated with cardiorespiratory parameters were strong and significant, leading the authors to conclude that the SWT is more reliable than the 6MWT to assess the performance of patients with PAOD.<sup>21</sup>

## Conclusion

This study indicates that both walking tests are reliable and useful for a clinical and functional assessment of patients with IC secondary to PAOD. However, the SWT yielded higher reliability rates in the test-retest, and may be a better option for the assessment of these individuals' *performance*. It should be stressed that this research is focused on the investigation of measurement reliability and, therefore, does not aim at verifying differences between the tests. Generalization of results is limited by sample size; thus, to increase universality of results, a new study should be conducted with a larger sample size.

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