Relationship between performance on six-minute walk test and treadmill test in patients with intermittent claudication of lower limbs

Relação entre o desempenho nos testes de esforço em esteira e de seis minutos de caminhada em pacientes com claudicação intermitente dos membros inferiores

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Abstract

Background: Six-minute walk test and treadmill test have been often used to evaluate functional limitations in patients with peripheral artery disease. However, whether these tests are correlated remain poorly known.
Objective: To analyze the relationship between total walking distance (TWD) obtained in six-minute walk test and treadmill test in patients with peripheral artery disease and symptoms of intermittent claudication.
Methods: Thirty-four patients (65.5 ± 8.9 years) of both genders (26 men and 8 women) participated of the study. They performed the six-minute walk test in a 30 meters corridor and the treadmill test using a specific protocol for this population, with an interval of at least 7 days between tests. Pearson correlation coefficient was used for data analysis.
Results: Significant correlation was observed between TWD obtained in six-minute walk test and treadmill test ($r = 0.48$, $p < 0.01$). Significant correlation between TWD obtained in these tests was observed in patients with a less severe limb hemodynamic impairment ($r = 0.69$; $p = 0.01$). In patients with a more severe hemodynamic impairment, the correlation was not significant ($r = 0.03$, $p = 0.91$). Furthermore, a significant correlation between TWD obtained in six-minute walk test and treadmill test was observed in patients with low ($r = 0.57$; $p = 0.02$) and high levels of adiposity ($r = 0.48$, $p < 0.05$).
Conclusion: Results of this study show that the data obtained from six-minute walk test and treadmill test are correlated, except in patients with a more severe limb hemodynamic impairment.

Keywords: peripheral arterial disease; intermittent claudication; exercise; walking.

Resumo

Contexto: O teste de caminhada de seis minutos e o teste de esforço em esteira têm sido frequentemente utilizados para quantificação da limitação funcional dos pacientes com doença arterial periférica. Todavia, ainda não está bem estabelecido se os resultados desses testes são correlacionados.
Objetivo: Relacionar a distância total de caminhada (DTC) obtida nos testes de seis minutos e de esforço em esteira em pacientes com doença arterial periférica e sintomas de claudicação intermitente.
Métodos: A amostra foi composta por 34 pacientes (65,5 ± 8,9 anos) de ambos os gêneros (26 homens e 8 mulheres). Os indivíduos realizaram o teste de seis minutos em corredor de 30 metros e o teste de esforço em esteira ergométrica utilizando-se protocolo específico para essa população, com intervalo de pelo menos sete dias entre os testes. Para a análise dos dados, foi utilizada a análise de correlação de Pearson.
Resultados: Houve correlação significante na DTC obtida nos testes de seis minutos e de esforço em esteira ($r = 0,48$, $p < 0,01$). Foi observada correlação significante entre a DTC obtida nos testes nos pacientes com menor comprometimento hemodinâmico do membro ($r = 0,69$; $p = 0,01$), enquanto que, nos pacientes com maior comprometimento hemodinâmico do membro, a correlação não foi significante ($r = 0,03$, $p = 0,91$). Além disso, foi observada correlação significante entre os testes tanto nos pacientes com baixos níveis de adiposidade ($r = 0,57$; $p = 0,02$) como nos pacientes com altos níveis de adiposidade ($r = 0,48$, $p < 0,05$).
Conclusão: Os resultados deste estudo mostram que os dados obtidos do teste de seis minutos e de esforço em esteira são correlacionados, exceto em pacientes com maior comprometimento hemodinâmico do membro.

Palavras-chave: doença arterial periférica; claudicação intermitente; exercício; caminhada.

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Introduction

Treadmill test has been widely used to assess the functional limitation in patients with peripheral artery disease (PAD) and symptoms of intermittent claudication (IC)[1]. In fact, currently, there are several specific protocols to assess the severity of their functional limitation, as well as to quantify the effectiveness of therapy[2-8].

Nevertheless, treadmill test is still underutilized in clinical practice, possibly due to the high cost of equipment and the need of specialized professionals for the evaluation, as well as the time taken for the completion of each assessment. In this sense, six-minute walk test, originally proposed for functional assessment in patients with chronic obstructive pulmonary disease, has been used in patients with IC. This test is cheaper, faster and with greater resemblance to locomotion activities compared to treadmill test[9]. In addition, six minute-walk test has shown equivalent prognostic compared to other stress tests protocols, being considered a marker of morbidity and mortality[10-16].

A previous study found that total walking distance (TWD) obtained in treadmill tests was correlated with that obtained in six-minute walk tests[17], suggesting that both tests provide similar data regarding the severity of locomotion limitation in PAD patients. However, this study examined a heterogeneous group of patients, and remains unknown whether the relationship between these tests occurs in patients with different characteristics.

Studies have shown that the walking capacity obtained in treadmill test is influenced by many factors, among which limb hemodynamics and adiposity levels[7,18]. On the other hand, the impact of these variables on the walking capacity in six-minute walk test is still unclear. It is possible that the influence of limb hemodynamics and body adiposity in six-minute walk test is different from that observed in treadmill test, which could influence the relationship between these tests.

The objective of this study was to analyze the relationship between TWD obtained in six-minute test and treadmill test, as well as the influence of limb hemodynamics and body adiposity in the relationship between these tests.

Materials and methods

Subjects

To identify a significant correlation of 0.52, as observed in a previous study[17,] with an α error of 0.05 and a power of 0.80, a sample of 21 individuals is required. In order to ensure the power of analyses, the study sample consisted of 34 subjects (26 men and 8 women), aged 48-84 years, recruited in public hospitals and private clinics in Recife-PE. As inclusion criteria, patients had to have ankle-brachial index (ABI) ≤ 0.90[19], IC symptoms for more than six months at the time of the study and be able to walk at least two minutes at a speed of 3.2 km/h, besides not having undergone revascularization surgery in the six months preceding the study. Patients who could walk for more than 20 minutes on treadmill test were excluded.

According to Resolution nº 196 of 1996, from the National Health Council, all subjects were informed about the objectives and procedures of the study. Those who agreed to participate signed a consent form. This study was approved by the Ethics Committee of the authors' University.

Clinical variables

In order to obtain ABI, arm and ankle blood pressure were measured using a portable vascular doppler (Martec DV600, Brazil) and a mercury sphygmomanometer (Unitec hospitalar, Brazil), following the procedures previously described[20]. ABI was calculated by the ratio between arm and ankle blood pressure, as previously described[21].

Body mass and height were obtained using a mechanical scale with coupled stadiometer (Welmy model 110, Brazil), with an accuracy of 0.1 kg and 1 cm respectively. Body mass index (BMI) was calculated by the quotient between body mass (kg) and squared height (m^2).

Treadmill test

Treadmill test (Inbrasport model ATL) was conducted up to patients' maximum walk capacity. The specific protocol for individuals with IC[4] was used, with constant speed of 3.2 km/h and 2% of inclination increments every two minutes. The test was stopped when the subjects could no longer walk due to pain in their lower limbs. At this moment TWD was identified.

Six-minute walk test

Six-minute walk test was conducted in a 30 m long corridor, following the protocol previously described[22]. Patients were instructed to complete as many laps as possible. Individual stops were allowed during the test if claudication pain became intolerable, but the clock was not stopped during this time. Patients who stopped walking due to claudication pain were encouraged to return to walk as soon as possible. At the end of the test, after six minutes,

TWD was identified. The interval between six-minute walk test and treadmill test was at least seven days.

Statistical analysis

Mean and standard deviation were used for the presentation of subjects' characteristics. After the normality of data was confirmed, Pearson (r) correlation coefficient was used to determine the relationship between TWD obtained in treadmill test and six-minute walk test. Furthermore, patients were stratified according to limb hemodynamics (ABI < 0.55 and ≥ 0.55) and adiposity levels (BMI < 26.6 kg/m^2 or ≥ 26.6 kg/m^2), according to the median of the group. The correlation between performance on treadmill test and six-minute walk test was made in each of these subgroups. Analyses were performed in SPSS statistical package version 17.0. The significance level for all analyses was $p < 0.05$.

Results

The characteristics of patients included in the study are shown in Table 1. The majority of patients were elderly (73.5%), aged 65.5 ± 8.9 years, overweight and with moderate ABI (ranging from 0.42 to 0.76).

Figure 1 shows the correlation between TWD obtained in treadmill test and six-minute walk test. Significant correlation between TWD obtained in these tests ($r = 0.523$ $p < 0.001$) was observed.

Figures 2 and 3 show the correlation between TWD obtained in treadmill test and six-minute walk test, according to ABI and BMI. Significant correlation between TWD obtained in these tests was observed in patients with a less severe limb hemodynamic impairment (ABI ≥ 0.55, $r = 0.69$; $p = 0.01$). The correlation was not significant in patients with a more severe limb hemodynamic impairment (ABI < 0.55, $r = 0.03$, $p = 0.91$). Regarding BMI, the correlation between treadmill test and six-minute walk test was significant both in patients with higher (BMI ≥ 26.6, $r = 0.57$; $p = 0.02$) and lower levels of adiposity (BMI < 26.6, $r = 0.48$; $p < 0.05$).

Discussion

Treadmill test and six-minute walk test differ in several points. In treadmill test the exercise is performed on an ergometer using a progressive protocol, the overload is imposed by increasing treadmill inclination and there is support for the armrest. On the other hand, in six-minute walk test the exercise can be performed in a corridor without intensity control, allowing rest breaks during its execution, if necessary. Despite these differences, the results of this study showed that data from both tests show positive and significant relationship. The correlation values obtained in the present study ($r = 0.48$) are similar to those observed in a previous study[17] conducted in patients with PAD ($r = 0.52$), indicating that both tests discriminate similarly the functional capacity of PAD patients.

In order to increase the knowledge concerning the relationship between treadmill test and six-minute walk

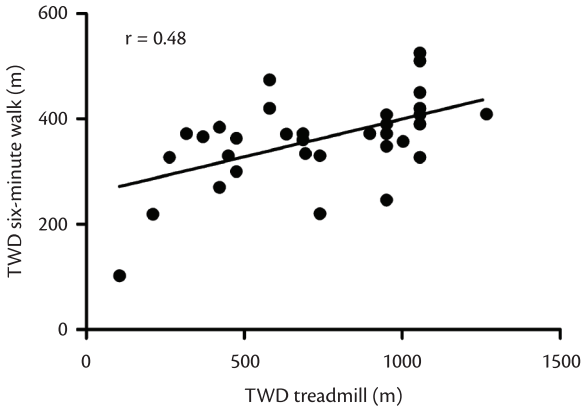

Figure 1. Correlation of TWD between six-minute walk test and treadmill test in 34 patients.

Table 1. Clinical characteristics of 34 patients.

Variables	Values
Age (years)	65.5 ± 8.9
Body mass index (kg/m^2)	26.8 ± 4.9
Ankle-brachial index	0.63 ± 0.12
Total walking distance in treadmill test (m)	904 ± 303
Total walking distance in six-minute walk test (m)	361 ± 83

Data are presented as mean and standard deviation.

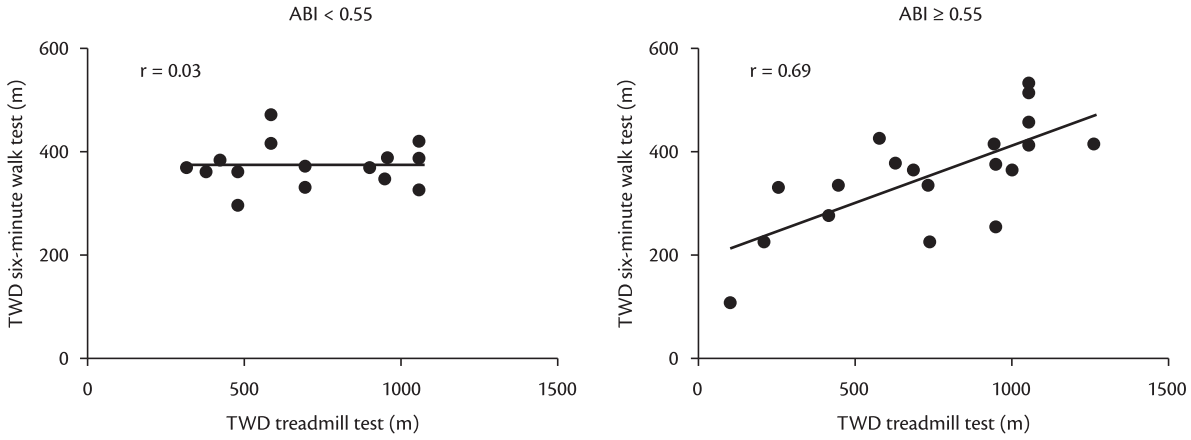

Figure 2. Correlation of TWD between six-minute walk test and treadmill test, according to ABI.

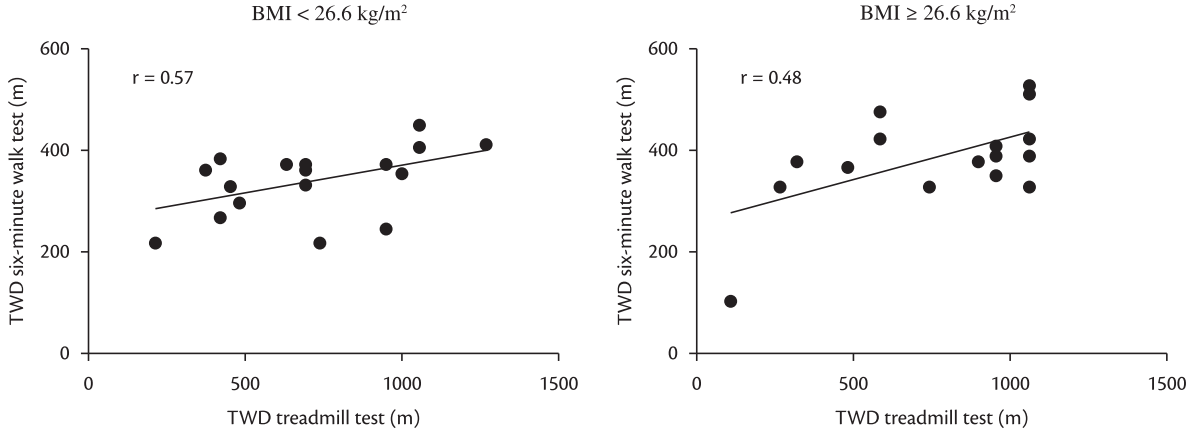

Figure 3. Correlation of TWD between six-minute walk test and treadmill test, according to BMI.

test, secondary correlations were made between them, stratifying patients according to limb hemodynamic impairment and body adiposity. Results indicated a correlation between these tests in patients with a less severe limb hemodynamic impairment. In patients with a more severe limb hemodynamic impairment, the correlation was not significant. The causes of this difference in correlation were not analyzed in this study. However, it suggests that this may occur because treadmill test allows a greater variability of results when compared to six-minute walk test. In fact, in treadmill test the walk speed remains constant and patients can support their arms while walking. Thus, the individual does not need to change the cadence of walking to achieve longer distances. On the other hand, in six-minute walk test, in order to achieve long distances, patients necessarily need to increase the walk speed, which may precipitate the symptom of claudication[23].

Results indicated that correlations between treadmill test and six-minute walk test were significant both in patients with lower and higher levels of adiposity. It is known that higher levels of adiposity increase the overload during walking. However, a previous study observed that obese patients with IC and eutrophic patients[18] have similar walk capacity, which seems to occur due to higher strength levels observed in obese patients. Thus, it is possible that the significant correlations observed between patients with different levels of adiposity are due to higher strength levels of patients with higher levels of adiposity, which compensate an increased overload during exertion.

This study has limitations that should be considered. Although it is possible to quantify claudication distance in

both tests, only TWD was used as an indicator of patients' locomotion capacity. Thus, the correlation between tests in this indicator has not been evaluated. Both tests were performed only once and the influence of individual variability in test performance could not be determined. Also, this study examined only patients with PAD and IC symptoms, so that the extrapolation of findings to individuals in other stages of the disease should not be done.

Conclusion

The results of this study show that six-minute walk test and treadmill test are correlated only in patients with a less severe limb hemodynamic impairment (ABI greater than or equal to 0.55). The level of body adiposity assessed by BMI does not interfere in the correlation between these studied tests.

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