ORIGINAL ARTICLE

How to determine the initial treadmill speed for the aerobic training of chronic hemiparetics?

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ABSTRACT

Objective: To investigate the criteria for establishing the initial treadmill speed and create a functional or cardiorespiratory motor training for hemiparetic individuals. **Methods:** Fifteen chronic hemiparetic individuals were recruited and qualified by the Lower Extremity Motor Coordination Test (LEMOCOT) and submitted to gait evaluation through the Timed Up and Go (TUG), Stress Test (ST), and the 10-Meter Walk Test (10MWT). **Results:** The analysis of the LEMOCOT results showed a mean of 26.87 ± 9.76 target hits for the non-paretic side and 15.40 ± 8.46 for the paretic side. In the TUG, the average speed of 0.37 ± 0.14 m/s was found and in the 10MWT, 0.63 ± 0.23 m/s. In the ST the average speed was 0.60 ± 0.25 m/s. There was strong and significant correlation between the TUG, 10MWT, and ST values. **Conclusion:** The ST and 10MWT are suitable tests to be used as eligibility criteria for the initial speed of aerobic trainings, however the ST is able to reveal the time for which the patient is able to maintain the gait. The TUG did not prove to be a good instrument to establish the initial training speed.

Keywords: Stroke, Exercise, Gait

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INTRODUCTION

Strokes (CVA) are a worldwide health problem and one of the main causes of disability.[1] The most evident sequela is hemiparesis, characterized by motor deficiency, spasticity, and muscle weakness on side contralateral to the brain injury. It can be accompanied by difficulties in shifting one's posture, deficits in mobility, motor coordination, and selectivity of movements, as well as sensory, cognitive, perceptual, and language alterations,[2] which affect all the domains of the ICF (International Classification of Functioning, Disability, and Health) with limitations on activities and restrictions on participation.[3]

Stroke victims are commonly relegated to sedentary life and little physical conditioning due to the alterations brought on by the lesion, which can increase the risk of a recurrence in addition to precipitating other problems such as falling, osteoporosis, limitations in physical ability, reduction in social participation, and dependence on others. After completing their rehabilitation, 14% of individuals manage a full recovery of physical function, 60-70% are able to walk independently, 25-50% of them need some help with their activities of daily living, and only 7% are able to walk around in the community.[4-7]

Hemiparetics present an independent gait after completing their rehabilitation, however this gait has defects such as reduced speed, reduced distance, asymmetrical movements, and postural instability,[6-8] so in this context their need to continue participation in motor training is evident in order to maintain or improve their physical conditioning and functioning and reduce sedentarism and its consequences.

The rehabilitation of these individuals often ends when they reach the chronic stage (more than six months after the stroke), for motor recuperation no longer shows the significant results seen at the beginning of the treatment. Chronic hem iparetic patients reach a plateau or slow down their motor recovery, which can occur due to the minimum specific training practiced in the clinical environment, associated with their inactivity in the domestic environment.[9]

Physical training can promote a series of positive effects such as reducing blood pressure and cardiovascular risks, improving respiratory conditioning, reducing mortality via coronary disease, and alleviating depression. In addition, training can mitigate various post-stroke problems such as fatigue and the incidence of falls and fractures, as well as improve independence and quality of life, and help avoid another stroke.[10] Various studies show that aerobic physical training can benefit the hemiparetic at any post-stroke phase.[2,4,11-13]

In introducing aerobic training to hemiparetics, it is fundamental to establish suitable parameters including intensity, frequency, and duration of the training, for normally physiotherapy sessions do not provide enough stimulation to increase cardiorespiratory capacity.[14] The intensity of the physiotherapeutic activities performed in post-stroke rehabilitation only increases the heart rate reserve (HRR) by approximately 30%, which contributes to the low cardiorespiratory performance levels and reinforces sedentarism.[15]

Gait training on a treadmill has been described as a good method for improving the motor performance and cardiorespiratory condition of hemiparetics, in spite of residual deficiencies, asymmetries, and limitations of activities,[7,15] aside from diminishing sedentarism. The trainings are done at intensities that range from 40 to 85% of the HRR[2,14,16,17] as determined by the formula proposed by Karvonen et al.[18] The HRR is an important physiological variable to quantify the maximum effort during training, and is also an important indicator used to prescribe training intensities of aerobic exercise programs - in addition, it presents a good correlation with the tests done on stationary bicycles.[19,20]

The importance of and the training parameters for hemiparetics are well established, however there is no clear description as to the speed to be used to begin treadmill training in a clinical physiotherapeutic practice.

OBJECTIVE

The objective of this work was to analyze gait tests to establish the initial treadmill speed for functional and aerobic motor training for hemiparetic patients.

METHODS

To do this methodological clinical study, hemiparetic patients were recruited who were attending physiotherapy at the *Centro de Estudos Atendimento de Fisioterapia e Reabilitação* (CEAFIR) at the *Universidade Estad ual Paulista* (UNESP) at the Presidente Prudente Campus. Included in this study were medically-referred patients with a unilateral hemiparesis for more than 12 months capable of walking without a prosthesis, able to do the walking test, free of any cognitive deficits as evaluated by the Mini-Mental State Examination[21] (cut-off point for illiterate persons 18/19 and for those schooled, 24/25), having no tonus alterations in the ankle extensor muscles on the paretic side, and a non-zero score on the Modified Ashworth scale.[22]

All patients volunteering for this study were informed as to its objectives and procedures, and after agreeing to participate, signed the informed consent form. The study was approved by the Ethics Committee of the FCT-UNESP (CAAE: 34601014.4.0000.5402).

Individual interviews were arranged to collect data, then they were evaluated to establish the presence of hemiparesis using the Lower Extremity Motor Coordination Test (LEMOCOT) and 3 tests of functional mobility and gait. The first test was the Timed Up and Go test (TUG), followed by the Ten Meter Walk Test (10MWT), and a Stress Test (ST).

The LEMOCOT is an instrument to evaluate motor coordination (MC) of the lower limbs. To do the test, the subject sits in an adjustable chair so that his knees are approximately 90º with no shoes on. Two standardized 6 cm targets are installed on a rigid plate on the floor, one closer and the other 30 cm farther away. After 5 to 10 seconds to familiarize each leg the test is done - starting with the non-paretic side. To begin the test, the big toe is positioned on the nearer target and, when signaled by the examiner, the subject moves the big toe from one target to the other for 30 seconds as rapidly as possible.

The number of hits on a target is the person's score and the predictive equation determines the number of healthy individuals.[23] This instrument was used to demonstrate the difference between the subjects' hemibodies and determine whether they had hemiparesis. The scores were expressed as the number of hits.

The TUG evaluates the mobility and functional ability of the elderly during gait and consists of seating the subject in a comfortable chair, with support for back and arms, wearing their normal shoes and their assistive gait device. After the "go" command, the subject gets up from the chair and walks a linear path for 3 meters, with firm steps, turns around and returns to the chair, sitting again. The time required to complete the task was measured in seconds by a chronometer[24] and the speed to perform the test was expressed in meters per second.

The 10MWT evaluates the gait and consists of walking at the regular pace through a corridor of at least 14 meters, where the time needed to walk the central 10 meters is recorded by a digital chronometer, not considering the two initial and final meters.[25] The speed to perform the test was calculated and expressed in meters per second.

The ST sought to verify the subject's tolerance to exercise. In the stress test used in this study, the patients walked through a signalized 30-meter corridor, where they were constantly encouraged by the therapist until they asked to stop due to tiredness. In the presence of signs and symptoms such as dizziness, shortness of breath, abrupt change in the heart rate, or intense pains, the test was stopped, regardless of the intensity of tiredness. The cardiorespiratory parameters (blood pressure, heart rate, and O2 saturation) were measured with the patient at rest, during, and after the test. The heart rate was monitored constantly to prevent readings from surpassing the maximum heart rate (MHR) determined by the formula: MHR = 220 - age.[18] At the end of the test, the distance walked and the time spent for that were checked and, based on those values, the gait speed was calculated and expressed in m/s.

For the statistical treatment, the Shapiro-Wilk test was used to verify the normality in the data set. In the analysis the data were presented as mean and standard deviation values. The analysis of repeated measurements, followed by the Tukey post-hoc were used to compare the three speeds (ST, 10MWT, and TUG) and identify possible differences. The relationship between the variables was tested by the Pearson or Spearman correlation according to the distribution of normality. All the analyses were made with the BioEstat (version 5.0) statistical software. The significance level was established at 5%.

RESULTS

The sample consisted of 15 hemiparetic individuals. Of those, 9 were males and 6 were females, aged 58.27 ± 13.42 years, ranging from 28 to 73 years. Right hemiparesis was found in 5 individuals and 9 had left hemiparesis. As for muscle tone, two hemiparetic subjects scored 0, six scored 1, four scored 1+, and three scored 2. The average time with the lesion was 59.80 ± 50.40 months.

The analysis of the values for the LEMOCOT performed by the subjects of this study showed a mean of 29 ± 6.4 target hits for the non-paretic side and 14 ± 8.9 on the paretic side. The statistical analysis revealed a significant difference ($p \leq 0.05$) between the paretic and non-paretic sides.

The TUG showed a mean speed of 0.35 ± 0.14 m/s and of 0.64 ± 0.23 m/s in the 10MWT. In the ST, the mean speed was 0.61 ± 0.25 m/s. The statistical analysis showed a difference between the TUG and ST values ($p \leq 0.006$) and between the TUG and 10MWT ($p \leq 0.002$), however, no difference between the 10MWT and ST was found.

The analysis showed a strong correlation (r = 0.865, $p \leq 0.05$) between the ST and the 10MWT and between the ST and the TUG (r = 0.756, $p \leq 0.05$). The same strong correlation (r = 0.865, $p \leq 0.05$) could be seen between the TUG and 10MWT values.

DISCUSSION

Various studies showed results of training based on the MHR or VO_2max, however they did not clarify how the treadmill speed was established to start the training. [2,14,16,17]

The present study investigated which of the tests used could define the initial speed on a treadmill to improve functional and aerobic motor performance of chronic hemiparetic individuals. These individuals frequently present a sedentary lifestyle that negatively affects their performance in the activities of daily living.[4]

The average time of lesion above 12 months indicated the chronic stage of pathology in the hemiparetic sample used in this study. The results shown by the LEMOCOT[23] indicated a significant difference in the coordination between the paretic and non-paretic sides, clearly characterizing the hemiparesis and the functional motor deficits of those individuals.

The results for the 10MWT and ST showed similar speeds. The values of those speeds revealed that the hemiparetic subjects evaluated presented deficient community-dwelling[25] and, therefore, reinforced the need for appropriate training so that these patients could improve their capacities.

The guidelines to prescribe exercising emphasize its potential to improve the cardiorespiratory function, to reduce conditions of risk, and to improve quality of life, and recommend physical activities at different intensities from 20 to 60 minutes a day, at least in 3 of the 7 weekdays, continuously or with breaks, depending on the patient's level of physical aptitude of the.[22,27] The present study has shown that the 10MWT as well as the ST are suitable for establishing the initial treadmill speed, however, the 10MWT is not capable of measuring for how long the patient can walk, while the ST reveals the time for which the patient is able to maintain his gait. Based on this time, it is possible to infer the minimum condition in relation to the values established by the protocols for exercising, [27] that is, 20 minutes of gait.

The TUG revealed a significantly slower speed than the 10MWT and ST, which could be justified by the test measuring the time spent for the patient to get up from the chair, walk 3 meters and sit again, and therefore, showed the functionality of sitting down and getting up associated with the gait. A number of authors have used this instrument to evaluate the functional mobility of hemiparetic individuals submitted to treatment and not as a test to determine the speed to initiate a training.[28,29] The gait speed between the ST, 10MWT, and the TUG showed a strong and significant correlation demonstrating their similar abilities to evaluate gait, however with different characteristics and objectives.

Hemiparetic individuals in the chronic phase may benefit from exercising, with changes in their capacity to walk and improvement in their activities and social participation, in addition to improving psychosocial aspects, however, many physiotherapists still do not use cardiorespiratory training as an intervention, due to their doubts on the proper manner of application or even for fear of reinforcing pathological patterns, preferring classic physiotherapy methods that have low intensity and do not present enough stimulus to take the individual in the chronic phase out of the sedentary condition.[14]

One of the propositions to modify the sedentary condition of hemiparetic individuals is to include aerobic exercise in their therapeutic routine as long as the directives from the American College of Sports Medicine (ACSM)[27] and Healthcare Professionals From the American Heart Association/American Stroke Association[30] are respected regarding dose, intensity, and duration of these exercises. Many studies show gait training for hemiparetic individuals on the treadmill lasting 20 to 60 minutes at different intensities.[2,14,16]

Therefore, after establishing the initial speed for the treadmill, it is necessary to study training routines with more suitable intensity for these individuals and that is safe for the patient as well as for the physiotherapist.

Choosing a good evaluation instrument allows a training to start appropriately. The ST, in addition to determining the initial speed, contributes to guide the best type of training.

CONCLUSION

In the present study, the ST and the 10MWT showed themselves to be suitable tests to choose the initial speed of aerobic trainings, however the ST is capable of revealing the time for which the patient is able to maintain the gait. The TUG did not prove to be a good instrument for establishing the initial training speed.

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