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Comparison of Reliability between a Ten-metre and a One-minute Walking Test in Children and Adolescents with Cerebral Palsy at Mean Velocity

Volpini Lana MR, da Cruz dos Anjos DM*, Moura Batista AC, Martins E, Oliveira de Souza KC and Leocadio RM

Centro Universitário Estácio, Physical Therapy Course, Minas Gerais, Belo Horizonte, Brazil

***Corresponding author:** Daniela Maria da Cruz dos Anjos, Centro Universitário Estácio, Physical Therapy Course, Minas Gerais, Belo Horizonte, Brazil

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Abstract

Cerebral palsy (CP) is a non-progressive neurological syndrome, but with frequent adaptation to abnormal patterns of posture and movement. The gait of children with CP follows an abnormal pattern and their persistence results in many damages and even a loss of ambulatory capability over the years. The gait analysis allows the management of possibilities for therapeutic intervention. A good, low-cost option for gait assessment of PC patients is the 10-meter walk test (10MWT) and the 1-minute walk test (1MWT) that demonstrate validity and reliability. However, not all gait tests can be performed by the various levels of motor function present in the PC. Thus, the purpose of this study was to compare the reliability for the mean velocity between the 10MWT and 1MWT in children and adolescents with CP. 30 children and adolescents (aged 7-18 years) with CP, levels I, II and III of the Gross Motor Function Classification System (GMFCS) were included. The Graph Pad Prism® program was used for statistical calculations and t-test for comparison between walking tests. The difference in mean velocity was not significant between 10MWT and 1MWT gait tests at $p < 0.05$. However, both groups presented high CV due to the nature of the sample, presenting three different motor levels (GMFCSI, GMFCSII and GMFCSIII). The 10MWT and 1MWT with 30 participants with CP revealed efficacy to extract reliable values about mean velocity. Although the 10MWT is shorter than the 1MWT, it can be used as a valid medium speed analysis tool.

Keywords: Gait; Cerebral palsy; Reliability; Gait test

Introduction

Cerebral palsy (CP) is a non-progressive neurological disorder that causes abnormal patterns of movement and posture [1]. The etiology of cerebral palsy is heterogeneous, but knowing the exact cause does not considerably change the direction of treatment. Gait in CP has a pattern different than normal, with deficits in spatiotemporal parameters such as speed, and quality of performance on such tasks [2].

Children with cerebral palsy that show impairments in ability and performance of gait have limitations in their participation in activities of daily living and, consequently, in social interaction [3]. Therefore, appropriate assessment and gait training are essential for the rehabilitation of children with CP.

Assessment of gait has been widely used in the treatment of individuals with neuromuscular disability, especially cerebral palsy. This evaluation may find specific motor alterations in patients, which allows for a more accurate physical functional diagnosis and better treatment options. Alterations in gait are observed by health professionals and allow them to implement per-case appropriate interventions, such as prostheses, injection of botulinum toxin, conservative treatment such as physical therapy, and others [4].

The spatiotemporal parameters of gait, especially the speed variables, are often used to assess the development of gait in children, and identify possible disorders. Not only does the analysis of these parameters evaluate aspects of pathological gait, it quantifies its evolution after surgical interventions or rehabilitation [5].

Although assessing gait deviation is essential for treatment planning, of the necessary equipment, such as the gait laboratory and surface electromyography (EMG), is often costly. Consequently, this limits its availability at rehabilitation clinics.

A viable low-cost alternative for gait assessment in patients with CP is walking tests that show validity and reliability [6-8]. For instance, there is a ten-metre walking test (10MWT) and the one-minute walking test (1MWT).

Studies have demonstrated that the severity of functional impairment is quite variable. Furthermore, it is associated with the severity of neurological injury [9]. Thus, whilst some children are able to walk long distances, other children need auxiliary devices even for short routes [10].

Hence, not all tests for the assessment of gait may be performed by the various levels of motor function found in CP. For some children, walking for one minute is an easy task, whereas it is a strenuous activity for others. However, it may be more easily executed over ten metres.

This study aimed at comparing the reliability of the mean velocity between the ten-metre and one-minute walking test in ambulatory

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children and adolescents with CP, which correspond to the levels I, II, and III of the Gross Motor Function Classification System (GMFCS).

Methodology

Clinical methodology

After the Ethics and Research Committee of Estácio de Sá University (UNESA/RJ) under opinion 1.385.724/16 approved this study, and the Free Informed Consent and the Free and Clarified Assentment Term forms were signed, testing was performed.

We compared the medical speed values of children with CP acquired from two different gait tests and determined the influence of the duration of the test (longer or shorter), and the severity of neurological impairment in the value found.

The results were obtained from the analysis of data collected by a 10MWT, and a 1MWT.

Selection of sample

Thirty children and adolescents (aged seven to 18 years) with CP were included in this study. Participants were randomly selected and agreed to participate. The criteria of selection were that they had good vision, ability to understand instructions, ability to walk continuously for 14 metres and for one minute with or without walking aids, and classification of gross motor function at levels I, II, or III in accordance with the GMFCS for cerebral palsy. Individuals who had been administered botulinum toxin, had undergone orthopedic surgery within the previous 6 months, or had orthopedic conditions (shortenings, contractures) that could negatively alter gait were excluded from the study.

According to this classification, GMFCS I (n=17), GMFCS II (n=8), and GMFCS III (n=8) children with CP participated in this study.

Gait analysis

Gait analysis was performed with a 10MWT and a 1MWT. Both were performed on the same day. There were three repetitions for each test, with a rest period of three to five minutes. After each test, the mean velocity was calculated. The tests were performed on a flat surface, without distracting factors. The children were instructed to walk at their preferred speeds. They were allowed their own clothes and shoes, and the use of their lower limb orthoses.

The 10MWT was performed with a "*flying*" method, i.e. while the individual walked for approximately 14 metres, time was recorded during the intermediate ten metres. The initial two acceleration metres and the finial two deceleration metres were discarded [11]. The ten-metre walking times were measured using a digital timer [12].

During the one-minute walking test, participants were instructed that when instruction to start walking was given, they should continue walking around a track with markings at meters for one minute. The distance was measured with a manual tape measure using the markings on the track.

Statistical analysis

The Graph Pad Prism® software, version 6.0 Trial was used for statistical calculations. The t-test was applied to compare two groups, and a one-way ANOVA was applied for multiple comparisons. Newman Keuls was the post-test.

Table 1: Verification of correlation and effectiveness of pairing.

Efficacy of pairing	
Correlation Coefficient (r)	0.9036
p-value (one tailed)	< 0.0001
Summary of the p-value	yes

Table 2: Comparison of *Vm* between the 10MWT and 1MWT tests.

	10MWT	1MWT
Vm (mean ± SD)	0.9202 ± 0.3370	0.9331 ± 0.2694
Lower 95% CI mean	0.7944	0.8325
Superior 95% CI mean	1.046	1.034
CV	36.62%	28.87%

10MWT: ten-minute walking test, 1MWT: one-minute walking test. CV: coefficient of variation, Lower CI: lower limit of coefficient of variation with a confidence interval of 95%. Superior CI: upper limit of coefficient of variation with a confidence interval of 95%. Significant Differences for t-test p (< 0.05).

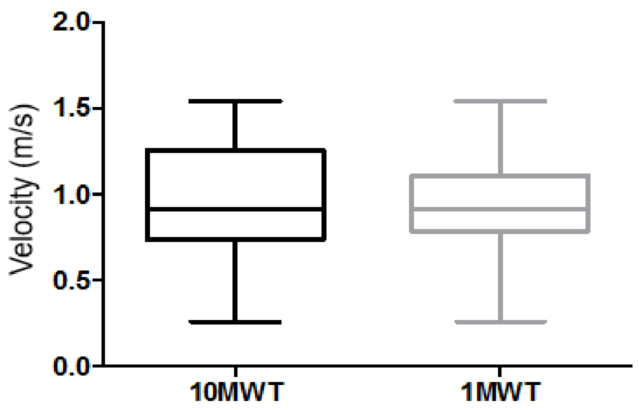

Figure 1: Comparison of means of *Vm* between the 10MWT and 1MWT gait tests. The difference in mean velocity was not significant between the 10MWT and 1MWT tests at p < 0.05.

Results

The demographic characteristics of the sample are described below. The sample consisted of 30 children with CP. Of these, 15 were boys and 15 were girls. The average age was 7.4 ± 0.69. Seventeen children were classified as GMFCS level I, eight children were classified as GMFCS level II, and eight children were classified as GMFCS level III.

Data (mean ± SD) of *Vm* and (mean ± SD) of gait were analyzed within each group (each test) and between groups (between tests).

To verify the correlation and efficacy of pairing between tests, the Pearson's correlation coefficient (r) was calculated, whose value was above 0.90. This value indicated a very strong correlation (Table 1).

Table 2 shows the values of *Vm* (mean ± SD) for the 10MWT and 1MWT for the sample of 30 children who had been evaluated three times in each test. Coefficient of variation (CV) was calculated as a measure of variability of each walking test. The 10MWT had a higher CV than the 1MWT (p < 0.05).

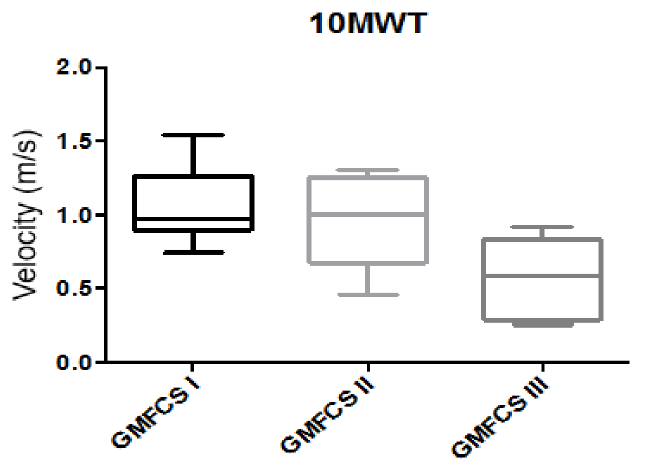

Figure 2: Comparison of mean velocities between the different levels of motor function (GMFCS). The difference in mean velocity between GMFCS I (1.061 ± 0.2262, of 3 tests each child) and GMFCS II (0.9653 ± 0.3084, 3 tests each child) was not significant. The difference in mean velocity between GMFCS I and GMFCS III (0.5760 ± 0.2692, 3 tests each child) was significant at p < 0.001. The difference in mean velocity between GMFCS II and GMFCS III was significant at p < 0.1.

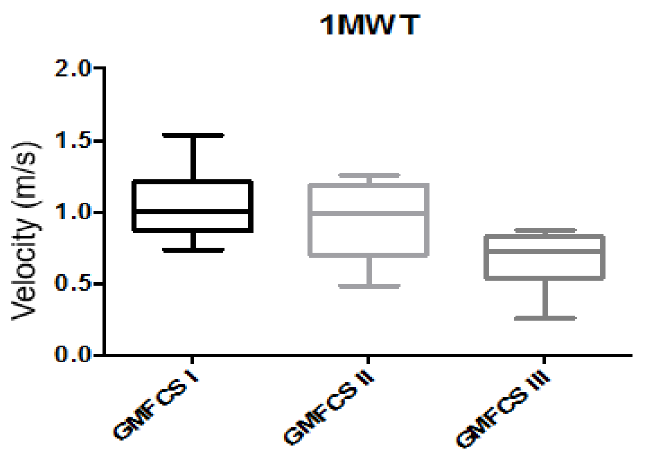

Figure 3: Comparison of mean velocities between different levels of motor function (GMFCS). The difference in mean velocity between GMFCS I (1.039 ± 0.2176, for 3 tests each child) and GMFCS II (0.9549 ± 0.2728, for 3 tests each child) was not significant. The difference in mean velocity between GMFCS I and GMFCS III (0.6689 ± 0.2141, 3 tests each child) was significant, p < 0.01. The difference in mean velocity between GMFCS II and GMFCS III was not significant.

The mean values of velocity for the two walking tests are shown in Figure 1.

The data also revealed an association between the degree of neuromotor impairment and a reduction in the value of *Vm* in which a greater deviation from the normal value was found both in the 10MWT (Figure 2) and in the 1MWT (Figure 3) (Tukey test).

In the 10MWT, the velocity of children at GMFCS level I (n=17) was 1.06 ± 0.23 m/s. For level II (n=8), 0.96 ± 0.31 m/s and for level III (n=8) 0.58 ± 0.27 m/s (Table 3). Moreover, in the 1MWT, the velocity of children at GMFCS level I (n=17) was 1.04 ± 0.22 m/s, for level II (n=8) 0.95 ± 0.27, and for level III (n=8) 0.67 ± 0.21 m/s (Table 3).

Table 3: Mean velocity of different levels of motor function (GMFCS) in the 10MWT and the 1MWT.

10MWT			
	GMFCS I (N = 17)	GMFCS II (N = 8)	GMFCS III (N = 8)
Vm (mean ± dp)	1.061± 0.2262	0.9653 ± 0.3084	0.5760 ± 0.2692
Std. Error of Mean	0.05487	0.109	0.09519
Lower 95% CI	0.9446	0.7074	0.3509
Upper 95% CI	1.177	1.,223	0.8011
1MWT			
	GMFCS I (N = 17)	GMFCS II (N = 8)	GMFCS III (N = 8)
Vm (mean ± dp)	1.039 ± 0.2176	0.9549 ± 0.2728	0.6689 ± 0.2141
Std. Error of Mean	0.05441	0.1031	0.08091
Lower 95% CI	0.9232	0.7026	0.4709
Upper 95% CI	1.155	1.207	0.8668

Significant Differences for p (< 0.05). ANOVA.

Discussion

The ten-metre and one-minute walking test are accessible, easily-applicable tests. They are widely used in locomotion studies [6,7,13]. In addition, they are short-distance tests; they may be executed by ambulatory individuals with CP (GMFCS levels I, II, and III) [14].

Despite the potential applicability of the 10MWT and the 1MWT in individuals with CP, there is a scarcity of research on the reliability of these tests in this group. The reliability of a test must be investigated keeping in mind the specific context and population to which it will be administered [15].

Thus, the aim of this study was to compare the reliability of the 10MWT and the 1MWT in children and adolescents with CP at GMFCS levels I, II, and III to extract data related to the mean velocity of the participants.

Initially, the results indicated an effectiveness of pairing between tests as measured by Pearson's correlation coefficient (r > 0.90).

Other studies have also shown efficacy of pairing between different gait tests. For instance, Forrest (2014) [7] showed that the velocities between the 10MWT and 6-minute WT were highly correlated in 249 patients with spinal cord injury.

Moreover, the CV-related results showed that the walking tests had good repeatability in the children and adolescents with cerebral palsy that participated in this study. The 10MWT (36.62%) showed greater variability than the 1MWT (28.87%). It is accepted that a CV value above 30% often indicates data or experiment control issues. Nevertheless, these values are acceptable for research in humans, especially individuals with CP, owing to within-sample variability [16].

Steinwender (2000) [17] also used CV to analyze the repeatability measure considering spatiotemporal parameters. Twenty children with typical development and 20 children with CP were compared, and a CV was found for the highest velocity in children with CP.

The results of this study showed a higher CV value in the 10MWT, which may suggest greater variability in this test in comparison to the 1MWT. However, its validity for production of accurate results remains supported by numerous studies [6,10,18].

Bohannon et al. (2014) [10] showed that during the 6MWT, the results found in the last four minutes of the test are redundant. This may suggest two minutes of testing are sufficient to collect reliable data. Additionally, after evaluating 38 children with CP, McDowell et al. (2005) [18] provided evidence for the validity of the 1MWT for the assessment of functional ability. They concluded that its cost-benefit ratio and ease of use makes this test a potentially useful tool in the clinical context. A study by Peters et al. (2013) [6], aimed to examine the reliability and concurrent validity between the four-metre walking test and 10MWT after gait velocity measurements. They concluded that although one test may be shorter than the other, both tests' reliability was excellent.

Furthermore, our results provided evidence of significant differences in values of mean velocity between the different motor function levels (GMFCS) of participants in both tests (10MWT and 1MWT).

These results corroborate the findings of a study by Hassanio et al. (2014) [12], who were able to detect significant differences between the three GMFCS levels after evaluating the gait of 219 children with spastic CP, using the modified timed-up-and-go test (TUG). In addition, Pirpiris et al. (2003) [17] reported that the reduction of velocity is proportional to the level of motor impairment of the individual. Our results are also consistent with those findings.

The present study is in line with previous findings regarding differences in mean velocities according to GMFCS levels. Therefore, considering the GMFCS classification of functionality, children with GMFCS level I had velocity scores closer to the norm, and children with GMFCS level III had more distant scores.

Finally, our results are in agreement with previous findings providing evidence for the validity of walking tests that were once considered too short to provide reliable mean velocity values

Conclusion

This study compared the reliability of mean velocity between the 10MWT and 1MWT in children and adolescents with CP at GMFCS levels I, II, and III.

The 10MWT and 1MWT performed by 30 children and adolescents with CP proved effective in extracting reliable values from mean velocities. The data also suggested that the mean velocity value is significantly affected by the degree of severity of motor impairment.

In conclusion, although the 10MWT is shorter than the 1MWT, it may also be applied as a valid tool to analyse mean velocity.

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