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Published in:
Gait and Posture

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Test–retest reliability of a 1-min walk test in children with bilateral spastic cerebral palsy (BSCP)

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ABSTRACT

The test–retest reliability of a 1-min walk test at a child’s maximum walking speed was assessed in children with bilateral spastic cerebral palsy (BSCP). Twelve male and five female children (age range 3–18 years, mean age 12 years 8 months) participated in the study. Children were classified as GMFCS level I (n = 5), level II (n = 8) and level III (n = 4). Results showed that for walk tests performed on different days, distances varied by no more than 13.1 m (for 95% of participants) and that a practice walk was vital for reducing systematic bias. The intraclass correlation coefficient was 0.94. A 1-min walk test is a reliable method of assessing function in children with CP but care must be taken when interpreting changes in individual patient data.

Article info

Article history:
Received 6 March 2008
Received in revised form 11 September 2008
Accepted 12 September 2008

Keywords:
Walk tests
Test–retest Reliability
Cerebral Palsy

As early as in the 1970s, walk tests (WT) have been utilised and evaluated within the field of cardiorespiratory medicine [1]. A recent systematic review provided an overview of the measurement properties of WTs used within this field and concluded that the 6-min WT was the most extensively researched, best tolerated and most reflective of activities of daily living [2]. Despite the growing use of WTs as a useful outcome tool within areas of rehabilitation medicine [3–6], research regards their validity and reliability in children and adults with disability is just starting to appear within the literature. Three recent papers concluded high test–retest reliability of the 6-min protocol in adults [7] and children [8,9] with cerebral palsy (CP), although results conflicted with regards to the necessity of a practice walk. Considerably less work has been conducted on WTs of lesser duration.

Two recent papers [10,11], demonstrated moderate to very good relationships between a fast 1-min walk and measures of energy efficiency [10] and function [11] respectively in children with bilateral spastic cerebral palsy. It was concluded that a fast 1-min protocol might provide clinicians with a useful measure of function in this population, should time restrictions preclude the use of a gold standard measure, such as the Gross Motor Function Measure (GMFM). Thus the aim of the following study was to assess the test–retest reliability of a fast 1-min walk test for children with BSCP and within the protocol, determine the need for a practice walk.

1. Method

1.1. Participants

Nineteen children with bilateral spastic CP (BSCP) aged between 3 and 18 years were recruited, as a sample of convenience, via a local special school or the regional gait analysis facility. Exclusion criteria included an inability to walk more than 10 m without the assistance of another person, current ill health or any lower limb surgery or Botulinum toxin injection within the previous 12 months. Ethical approval was obtained from the local Office for Research Ethical Committees and written parental and child (where possible) consent was obtained for all participants.

1.2. Procedure

Children were tested on two occasions 1 week apart at the same time of the day (± 1 h). Testing on both occasions occurred within the same environment, either within the school gym (for children recruited through the special school) or within the gait analysis laboratory (for children recruited through the gait laboratory). The same conditions, including standardised instruction, were maintained on each occasion with the same assessors carrying out the test. The surface texture was consistent at both venues. Both assessors were physiotherapists with a minimum of 7 years experience in paediatric orthopaedics and gait analysis. One assessor (LM) explained the protocol to each subject before the test, demonstrated one lap of the track and gave the order to start and stop. A second assessor (BMD) recorded the total distance walked. During testing children wore their own comfortable clothing, shoes and splints (as appropriate), and used their walking aids as appropriate. On each occasion participants were asked to complete two 1-min walks using the following procedure: following a 5 min seated rest, children stood at a starting point inside the outline of an oval 20 m level track (track width 30 cm at both venues). They were given the
following instruction: ‘Once you are given the instruction to start, you should walk as fast as possible around the track for 1 min, until you are asked to stop. You are not allowed to run’. Distance was calculated to the nearest metre using markings on the track. During the test children were informed after 30 s had elapsed and again when 10 s remained. A 10 min seated rest was given between tests.

1.3. Data analysis

Data were compiled and analysed using Microsoft Excel and the Statistical Package for the Social Sciences (SPSS version 11). The first walk on each occasion has been referred to as the practice walk while the second walk has been referred to as the test walk. Descriptive statistics in the form of means, standard deviations (S.D.) and mean difference scores were used to assess any systematic bias between walks. Repeatability was assessed using the intraclass correlation coefficient (ICC) and the repeatability coefficient (defined as $2.77S_w$, where $S_w$ = within-subject standard deviation) [12].

2. Results

Two children were unable to walk more than 10 m unassisted, thus 17 children (4 females, 13 males) were included in the analysis. Five of the children were classified in Gross Motor Function Classification System (GMFCS) [13] level I, eight in level II and four in level III. Of the four children in GMFCS level III, two used crutches and two used posterior walkers.

Table 1 provides further characteristics of the study sample. Means and standard deviations of the distance completed for both fast 1-min walks on each test occasion are shown in Table 2. The range of distances walked over the four completed tests was 41–122 m. Differences in the recorded distances between occasions were also expressed as mean differences with 95% confidence intervals ($\pm 1.96 \text{S.E.}$). Mean differences (Table 2) between the practice and test walks showed a systematic bias towards an increased walking distance on the second attempt both within and between days. No systematic bias was apparent between the test walks on different days (mean difference = 0.0 m). Recorded test walk distances are also illustrated in the form of a Bland and Altman plot (Fig. 1), where difference scores are plotted against average scores for each individual patient. The even distribution of difference scores about a mean difference of 0 m also illustrates the lack of a relationship between average walking distance and differences between occasions (Fig. 1) which indicates a lack of a relationship between average walking distance and differences between occasions) suggests that variability between occasions is not dependent on ability.

The ICC for this test walk data was 0.94 with a repeatability coefficient of 13.1. The latter corresponds to a 13.1 m difference between occasions for 95% of participants.

![Fig. 1. Test walk distance (m): differences (day 2 – day 1) plotted against average values (n = 17).](image)

### Table 1

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All subjects (n = 17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>12 Male: 5 Female</td>
</tr>
<tr>
<td>Age (years)</td>
<td>12.7 ± 4.5 (3.1–18.0)</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.43 ± 0.21 (0.93–1.69)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>41.1 ± 14.7 (14.0–60.2)</td>
</tr>
</tbody>
</table>

### Table 2

<table>
<thead>
<tr>
<th>Walking Distance</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Mean difference: day 2 – day 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(lower, upper 95%CI)</td>
<td>(lower, upper 95%CI)</td>
<td></td>
</tr>
<tr>
<td>1-min walking distance (m)</td>
<td>76.2 ± 19.0</td>
<td>80.1 ± 18.3</td>
<td>3.9 (2.0, 5.8)</td>
</tr>
<tr>
<td></td>
<td>81.4 ± 19.8</td>
<td>81.4 ± 18.2</td>
<td>0.0 (–3.3, 3.3)</td>
</tr>
<tr>
<td></td>
<td>5.2 (3.0, 7.4)</td>
<td>1.3 (0.4, 2.2)</td>
<td></td>
</tr>
</tbody>
</table>

3. Discussion

This study has demonstrated very good test–retest reliability for a fast 1-min walk in children with BSCP (GMFCS levels I to III), providing that a practice walk is performed prior to test data collection. Furthermore, a 10-min rest appears to be an adequate interval between practice and test walks. In terms of variability, the reliability coefficient of 13.1 suggests that for individual patient data, walking distance may vary by up to 13 m between test occasions. In practical terms, this means that a child with BSCP (GMFCS levels I–III) would need to demonstrate an improved walking distance of at least 13 m following an intervention before one could attribute the change as ‘real’. While subject numbers did not allow for further analysis within each GMFCS level, Fig. 1 (which indicates a lack of a relationship between average walking distance and differences between occasions) suggests that variability between occasions is not dependent on ability.

Distance covered during a fast 1-min walk has been shown to provide a good representation of functional ability in children with BSCP, correlating very well with GMFM–88 scores ($r^2 = 0.84$) in this population [11]. It has also been shown to have a significant moderate relationship with the energy efficiency of gait as measured using a 5-min Oxygen cost protocol (adjusted $r^2 = 0.48$) [10]. The test is shorter in duration to other well-reported walk tests of 2, 6 and 12 min [2], and therefore likely to be a poorer discriminator of exercise tolerance [14]. Alternatively, the 1-min protocol is likely to be more acceptable for the majority of ambulant children with CP, particularly those children in GMFCS level III that use walking aids and/or a wheelchair for mobility within the community. Furthermore, due to the short duration of the test, it is more feasible to include within a battery of tests assessing gait in CP. The 6-min protocol is more likely to leave a child exhausted, thus compromising the results of further testing, or be underestimated if carried out after other assessments.

The current study suggests the 1-min protocol, as described here, is more subject to variability than the 6-min protocol. Previous papers on the latter [7–9] have documented ICC scores of 0.99, 0.98 and 0.98.
respectively. This is perhaps not surprising as distance walked over a longer time period, causing more exertion and demands on the cardiovascular system, is likely to result in a more stable value. Testing a child at their ‘maximum’ walking speed was designed to better discriminate functional ability within this population [11], however, observation during testing, suggests the ‘fast’ nature of the test may be susceptible to participant motivation.

One conflicting finding in previous investigation of the 6-min protocol is with regards to the inclusion of a ‘practice’ walk. The work of Andersson et al. [7], which compared four walks conducted over four different days (carried out in adults with CP), demonstrated positive bias without the inclusion of a ‘practice’ walk; repeatability coefficients dropped from 66 m to 40 m once data from the first test day were excluded from the analysis. Alternatively, Thompson et al. [8] compared two walks conducted on two different days without the use of a practice walk (carried out in children with CP). Despite a systematic bias of 7.3 m (walking distance greater on the second test day) and a repeatability of 54.9 m, they concluded that a practice walk was not necessary in the majority of children with CP. Their results also indicated that children who were able to walk longer distances at baseline were more likely to increase their walking distance on retest, thus warranting further investigation of a practice walk in children with a GMFCS level I. A further study by Maher et al. [9], which also did not include a practice walk (carried out in children with CP), found a repeatability of 43.1 m with minimal systematic bias (0.85 m) between WTs conducted on the same day. Thus, they also concluded that a practice walk was not necessary before testing. While the differences discussed above may be attributed to differences within the test protocol and the population under investigation, the current study concurs with the work of Andersson et al. [7] and demonstrates the need for a practice walk, particularly on the first day of testing. The considerably reduced systematic bias on the second day of testing (1.3 m) suggested that a practice might not have been necessary on this occasion. This perhaps concurs with the conclusions of Wu et al. [15] who reported that an initial learning effect is maintained in healthy adults for 2 months.

Limitations of the study included low subject numbers and the recruitment strategy. While the spread of ability within the recruited sample was intentional (GMFCS levels I–III), a greater number of participants selected at random from an ambulant population of CP would have resulted in more representative data. Not only would this have confirmed the suggested lack of a relationship between ability and variability, but also would have facilitated a subgroup analysis by GMFCS level. A comparison with the 6-min protocol would also have been useful. However this was not considered as the latter is not a feasible test within our service and the study was designed for practical application.

In summary, a 1-min fast walk test represents a reliable method of assessing functional ability in children with CP, however care must be taken when interpreting changes in individual patient data.

Conflict of interest

None.

Acknowledgements

We extend our thanks to the students at Fleming Fulton Special School who participated in this project. The study was funded by the Northern Ireland R&D Office: Project grant RSG/1708/01.

References