Validity of the Muscle Power Sprint Test in Ambulatory Youth With Cerebral Palsy

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Purpose: To validate the Muscle Power Sprint Test (MPST) against the Wingate Anaerobic cycling Test (WAnT) in a group of youth with cerebral palsy (CP). **Methods:** Twenty children and adolescents (11 boys and 9 girls; mean age = 14.8 years) with spastic CP, and classified as either level I or II of the Gross Motor Function Classification System, completed the study. **Results:** Very strong significant correlations were seen for peak power (PP) and mean power (MP) from the MPST and WAnT PP and MP values (PP: $r = 0.731$, $P < .001$; MP: $r = 0.903$, $P < .001$). **Conclusions:** The results of this study show that the MPST is a valid test for measuring anaerobic capacity in children with CP, and that this test can be used as an evaluation tool for anaerobic performance in exercise interventions focusing on children and adolescents with CP who are able to walk or run independently. **(Pediatr Phys Ther 2013;25:25–28)** *Key words: adolescence, anaerobic threshold, cerebral palsy/pathophysiology, cerebral palsy/rehabilitation, female, human, male, motor skills, reliability and validity*

INTRODUCTION AND PURPOSE

Anaerobic performance is an important physiologic factor that plays a critical role in the ability of a child or an adolescent with cerebral palsy (CP) to participate in daily activities.[1] Anaerobic performance in children who are developing typically as well as those with neuromuscular conditions such as CP has been measured in the laboratory setting using the Wingate Anaerobic cycling Test (WAnT). While the WAnT is known to be both reliable and valid,[2-4] its application requires the use of sophisticated and costly technical equipment and software, rendering it impractical for use in a field setting. Given its scientific acceptance as a method of assessing anaerobic performance, the cycling WAnT has been used to verify the validity of various anaerobic performance tests that are more readily used in sportive modalities.[5,6]

For children with CP who are able to walk or run independently, a running-based field test, the Muscle Power Sprint Test (MPST), has been developed to examine anaerobic muscle power.[7] The MPST is known to be reliable and its construct validity is supported in children with CP classified at Gross Motor Function Classification System (GMFCS) levels I and II.[7] From a practical standpoint, the MPST is particularly relevant in the assessment of anaerobic performance, since running is more similar to the typical physical activity behaviors seen in children classified as GMFCS level I or II. Moreover, the test is inexpensive, easily administered, and interpreted with the available reference values[8,9] and can be performed in a relatively short time frame.

Despite its advantages, the validity of the MPST protocol requires further investigation. Thus, the purpose of the present study was to validate the MPST against the WAnT, a universally accepted reference standard for anaerobic testing, in a group of ambulatory youth with CP.

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METHODS

Subjects

A convenience sample of 20 children and adolescents from a school for special education were invited to participate in 2 testing sessions. To be included, subjects had to be between 7 and 18 years of age, diagnosed with spastic CP, and classified as either level I or II using the GMFCS. All participants were able to follow simple commands and were not known to have any cardiopulmonary, vascular, or metabolic diseases, or any medical contraindications to exercise. In total, 20 children (11 boys and 9 girls) completed the study. Group characteristics are described in Table 1. All parents and/or children provided informed consent.

Procedures

Participants were instructed to refrain from engaging in any strenuous exercise during the 24-hour period before testing. During the first visit, all subjects reported to the laboratory where height (in meters) and body mass (in kilograms) were determined using a wall-mounted stadiometer and a calibrated scale, respectively. Anaerobic performance was then determined using either the MPST or the 30-second WAnT (random selection). During the second visit, participants were asked to perform the exercise test they had not completed at their last visit. Peak anaerobic power (PP) and mean anaerobic power (MP) were recorded for each test. Both tests were separated by a minimum of 2 days and a maximum of 10 days (mean $\pm$ SD $= 4.1 \pm 1.3$ days).

Measures

Wingate Anaerobic cycling Test. The WAnT was performed on an electromagnetically braked cycle ergometer (Lode Corrival, Procare BV, Groningen, the Netherlands). The ergometer handlebars and seat height were adjusted for each participant, and toe clips with straps were used to prevent the feet from slipping. The WAnT was administered by 2 experienced pediatric exercise physiologists (B.B. and J.O.) who were blinded to the participants' MPST performance.

The WAnT protocol was performed as described previously.[10] Briefly, participants completed a 3-minute warm-up with 2 unloaded 10-second all-out sprints at 1 minute and 2 minutes. Participants were then given a 2-minute rest, after which maximal pedaling speed was determined using a 20-second unloaded, all-out sprint. Following a 3-minute rest, participants performed one 30-second WAnT. The test was performed with a flying start, which consisted of 1 minute of unloaded cycling; in the last 5 seconds, participants were instructed to cycle as fast as possible and an age-appropriate braking force (<14 years: girls 0.53 $\times$ body mass, boys 0.55 $\times$ body mass; $\geq$14 years: girls 0.67 $\times$ body mass, boys 0.70 $\times$ body mass) was applied once participants attained 80% of their maximal pedaling speed.

The WAnT provides 2 primary markers of performance: PP and MP. Peak anaerobic power is defined as the highest mechanical power (watts) achieved at any stage of the test and represents the explosive characteristics muscle power. With the fully computerized Lode Ergometry Manager Software (LEM; Procare bv, Groningen, the Netherlands) system, instantaneous power values can be obtained. This value is closest to a person's "real" maximal mechanical power. Mean power represents the average local muscle endurance over the entire 30 seconds of the WAnT.

Muscle Power Sprint Test. Peak power and MP (watts) were also calculated and used as markers of anaerobic power in the MPST, which was performed as described previously.[7] In short, the participants were instructed to complete six 15-m runs at maximum pace. The 15-m distance was marked by 2 lines taped to the floor. Cones were placed at the end of each of the lines. The participant was instructed to run as fast as possible from one line to the other, and to be sure to cross each line. Between each run, participants were allowed to rest for 10 seconds before turning around to allow them to prepare for the following sprint. Power output for each sprint was calculated using body mass and running times, where power = (body mass $\times$ distance^2)/time.[3] Power was calculated for each of the 6 runs. Peak power was defined as the highest calculated power, while MP was defined as average power over the 6 runs.

The MPST was administered by experienced pediatric physical therapists (T.R. and O.V.) who were blinded to the participant outcomes from the WAnT session.

TABLE 1
Subject Characteristics and Results of the WAnT and MPST

Variable	Mean	SD	Range
Age, y	14.8	2.0	8.9-17.4
Height, cm	164.0	12.7	137.0-188.0
Body mass index, kg	57.1	16.8	29.5-104.1
MPST peak power	250.3	41.9	41.4-799.0
MPST mean power	194.7	33.1	37.4-638.4
WAnT peak power	556.7	262.2	238.7-1077.7
WAnT mean power	240.2	111.1	101.2-480.6

Abbreviations: MPST, Muscle Power Sprint Test; WAnT, Wingate Anaerobic cycling Test.

Statistical Analysis

The data were analyzed using SPSS 18.0. Descriptive statistics were used to summarize data. Correlation coefficients (Pearson r) for PP and MP were computed for validity. Differences in PP and MP were evaluated using paired t tests. The level of significance was set at $\alpha < 0.05$. Results are expressed as mean $\pm$ standard deviation.

RESULTS

A total of 9 boys and 11 girls with a mean age of 14.8 ± 2.0 years completed all tests without complications.

Subject characteristics as well as WAnT and MPST results are presented in the Table 1. The total exercise time in the MPST was 27.29 ± 6.6 seconds. The MPST variables were significantly lower than the WAnT scores, but very strong significant correlations were seen for PP and MP from the MPST and WAnT PP and MP values (PP: $r = 0.731$, $P < .001$; MP: $r = 0.903$, $P < .001$; see Figure 1).

DISCUSSION

The aim of this study was to validate the MPST against the WAnT in a group of children and adolescents with CP. Post hoc sample size calculation (alpha of 0.2, beta of 0.05, and a minimal correlation of 0.75) estimated a minimal required sample size of 12 subjects, suggesting that this study was sufficiently powered. Significant correlations between the performance on the WAnT and MPST for both PP and MP were found. This indicates that MPST seems to be a valid test for the assessment of anaerobic performance in children with CP.

When power outputs (PP and MP) from both tests were compared, we found that MPST values were consistently lower than those of the WAnT. This difference may be explained by the fact that whereas both the MPST and WAnT measure power output of the lower limbs, the MPST uses intermittent running instead of continuous cycling and measures the power based on the individual's body mass. Moreover, the outcomes of the MPST are based on averages over a 15-m distance or roughly 5 seconds, while the WAnT outcomes are measured instantaneously (<1 second). It must, therefore, be noted that the MPST and WAnT measure slightly different qualities and as such, results from these tests cannot be used interchangeably. In spite of these differences, our results indicate that like the WAnT, the MPST can be used to measure the capacity of the legs to generate power. From a rehabilitation medicine perspective, this finding is very promising because of the minimal cost associated with performing the MPST, its easy application and its similarity and therefore relevance to children's activities of daily living.

Verification of the reliability and reproducibility of an evaluative tool is important for its acceptance and application in scientific, clinical, and training settings.[11] The reliability of the MPST is similar to that previously reported for the WAnT.[2-4] This is not surprising when one considers the fact that the MPST is an adaptation of the WAnT for running. Indeed, the total exercise time between the 2 tests is very similar: 27.3 seconds for the MPST and 30 seconds for the WAnT; however, it is important to note that the physical ability of the participant performing the test will influence the time required to complete the MPST.

As discussed previously, anaerobic testing has some intrinsic methodological limitations.[12] The MPST and the 30-second WAnT are largely dependent on participant motivation. Currently, there are no objective physiological criteria that can be used to establish a "true" maximal anaerobic effort. Therefore, the researcher or the clinician must rely on the cooperation of the individual performing the exercise. Encouragements and a friendly environment are also important so as to ensure that the participant performs the test to the best of his or her ability.

The results of this study have highlighted the validity of the MPST as a running-based tool to assess anaerobic performance. To date, a number of studies have used the cycling-based WAnT to assess anaerobic power in children with CP. It must, however, be noted that the use of the cycle ergometer may not necessarily be representative of the complex muscular and motor activities associated with running. The advantage of using the running-based MPST to measure anaerobic power is that it more closely mimics movements that are common and specific to sporting events or activities of daily living. Another distinct advantage of this test is that it can easily be applied by physical therapists in a field-based training setting.

Our findings must be interpreted in light of certain limitations. Chief among these is that the study included only youth with spastic CP. Whether our results are generalizable to other clinical types of CP requires further investigation. Moreover, the participants in this study represented an "open-source" convenience sample of children and adolescents with CP who were receiving physical therapy. This selection procedure may have led to some degree of selection bias, as it is unknown whether or not these participants differ from children and adolescents who are not receiving treatment in a rehabilitation center or special education school.

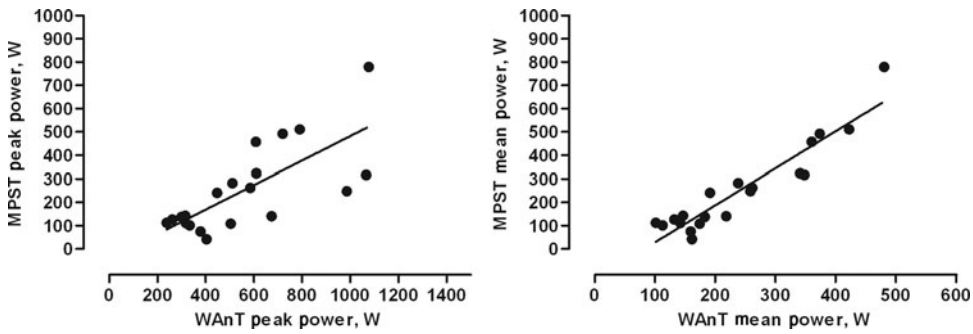

Fig. 1. Association between anaerobic peak power and mean power for children with CP. MPST indicates Muscle Power Sprint Test.

CONCLUSIONS

The results of this study have shown that the MPST is a valid test for measuring anaerobic performance in children with CP. Because it has also proven to be reliable[7] and sensitive to change,[13] this test can be used as an evaluation tool for anaerobic fitness in exercise interventions focusing on children and adolescents with CP who are able to walk or run independently.

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