Original Article

Correlation between Pediatric Balance Scale and Functional Test in Children with Cerebral Palsy

Natália de A. C. Duarte[1], Luanda André Collange Grecco[2], Renata Calhes Franco[2], Nelci Zanon[3], Cláudia Santos Oliveira[4]*

[1] Master Program in Rehabilitation Sciences, Universidade Nove de Julho, Brasil

[2] Doctoral Program in Rehabilitation Sciences, Universidade Nove de Julho, Brasil

[3] Center of Pediatric Neurosurgery, Brasil

[4] Rehabilitation Sciences, Universidade Nove de Julho: Rua Itapicuru, 380. Apto:111. Perdizes. CEP: 05006-000, São Paulo, Brasil

Abstract. [Purpose] To investigate the correlation of functional balance with the functional performance of children with cerebral palsy. [Subjects and Methods] This was a cross-sectional study of children with cerebral palsy with mild to moderate impairment. The children were divided into 3 groups based on motor impairment. The evaluation consisted of the administration of the Pediatric Balance Scale (PBS) and the Pediatric Evaluation Disability Inventory. Correlations between the instruments were determined by calculating Pearson's correlation coefficients. [Results] In Group 1, a strong positive correlation was found between the PBS and the mobility dimension of the Pediatric Evaluation Disability Inventory (r=0.82), and a moderate correlation was found between the PBS and self-care dimension of the Pediatric Evaluation Disability Inventory (r=0.51). In Group 2, moderate correlations were found between the PBS and both the self-care dimension (r=0.57) and mobility dimension (r=0.41) of the Pediatric Evaluation Disability Inventory. In Group 3, the PBS was weakly correlated with the self-care dimension (r=0.11) and moderately correlated with the mobility dimension (r=0.55). [Conclusion] The PBS proved to be a good auxiliary tool for the evaluation of functional performance with regard to mobility, but cannot be considered a predictor of function in children with cerebral palsy.
Key words: Cerebral palsy, Children, Postural balance

INTRODUCTION

Cerebral palsy (CP) refers to permanent, mutable motor development disorders stemming from a primary brain lesion, leading to secondary musculoskeletal alterations, and limitation of activities of daily living[1]. Motor impairment is the main manifestation in children with CP, and it has consequent effects on the biomechanics of the body[2]. Children with CP exhibit impaired muscle coordination, difficulties in organization of sensory information and functional limitations[3].

Postural control is fundamental to efficient, effective functional performance in all activities of daily living[4]. This complex process depends on the interaction of the visual, vestibular and peripheral systems, commands of the central nervous system and neuromuscular responses[5]. Deficits in postural control due to motor impairment have been identified as one of the main limitations in the development of children with CP[6]. Abnormal movements and posture of children with CP are the consequences of limitations stemming from the disease, which directly affect overall neuromuscular development and the postural control mechanism[7].

A number of studies in the scientific literature propose combining the Pediatric Evaluation of Disability Inventory (PEDI) and the Gross Motor Function Classification System (GMFCS)[2] for the classification of CP with regard to function[8]. The GMFCS allows grouping of individuals based on the severity of motor impairment. The PEDI allows the assessment of skills and functional performance in typical tasks and activities of daily living[9], and it is administered in the form of a structured interview with one of the child's caregivers. The first part of the questionnaire evaluates the skills in the child's repertoire grouped into three functional categories: self-care, mobility and social function. In the present study, only the self-care and mobility dimensions were considered to determine the importance of functional balance in the performance of activities of daily living.

Due to the lack of specific scales, assessment tools for the clinical evaluation of postural control in elderly individuals are often also applied to the pediatric population[10, 11]. The Berg Balance Scale was developed for the analysis of balance of elderly individuals[12, 13] and was translated into Portuguese by Miyamoto et al[14]. This scale has been widely

used for the assessment of balance of adult and child populations. However, a pilot study involving children found that the Berg Balance Scale demonstrated contestable reliability in a child population[15]. Thus, changes were made to the 14 items of the scale to adapt it to the pediatric population and a specific scale was developed − the Pediatric Balance Scale (PBS).

The PBS was developed in the United States and has 14 items that assess daily functional activities of children aged 5 to 15 years with mild to moderate motor impairment. This scale has demonstrated reliability and ease of application[15]. The PBS was used to detect successive changes in the functional balance of six children with CP with mild to moderate impairment in evaluations performed at four-month intervals over a three-year period[16]. The adaptation of the scale consisted of changes to the order of the application of the tests, the time for maintaining static positions, the instructions and the equipment used. Ries et al.[17] published a study in which the PBS was adapted and validated for use with Brazilian pediatric populations. The cross-cultural adaptation process involved four translators and 33 healthcare professionals. Intra-examiner reliability was demonstrated through the administration of the scale for five volunteers with CP on three different occasions. The PBS has demonstrated reliability for use with Brazilian children with a diagnosis of CP classified as Levels I and II on the GMFCS.

As the PBS and PEDI are important tools for the evaluation of function of children, the primary aim of the present study was to determine whether there was a correlation between functional balance (PBS) and functional performance (PEDI) in a sample of children with CP at a physical therapy teaching clinic. The secondary aim was to determine differences in functional balance and functional performance (self-care and mobility dimensions) in children classified as Levels I, II and III on the GMFCS. The hypothesis to be tested was that different results would be found among children classified on different GMFCS levels.

SUBJECTS AND METHODS

The present study complied with the principles of the Declaration of Helsinki and the Regulating Norms and Guidelines for Research Involving Human Subjects formulated by the Brazilian National Health Council, Ministry of Health, established in October 1996. The study received approval from the ethics committee of the Universidade Nove de Julho (Sao Paulo, Brazil) under protocol number 409972\2011. All parents/guardians agreed to the participation of the children by signing a statement of informed consent.

An observational, cross-sectional study was carried out involving 30 male and female children aged four to 10 years with a diagnosis of spastic CP. The participants were recruited from the physical therapy clinics of Nove de Julho University in São Paulo, Brazil. Convenience sampling was performed and the initial sample was made up of 53 children with a diagnosis of CP, 30 of whom were selected based on the following eligibility criteria: a diagnosis of spastic CP; a functional classification of Levels I, II or III on the

GMFCS[2] an age between 4 and 12 years; and agreement from a parent/guardian to the child's participation received through a signed statement of informed consent. The exclusion criteria were a) incompatible degree of comprehension and cooperation for performance of the activities proposed, and b) orthopedic deformities with indication for surgery.

The sample was divided into three groups based on the GMFCS[2]: Group 1 − children classified as Level I; Group 2 − children classified as Level II; and Group 3 − children classified as Level III. The participants were evaluated using the following functional test and scale.

Pediatric Balance Scale (PBS): Functional balance was assessed using the PBS, which consists of 14 tasks similar to activities of daily living. The items are scored on a five-point scale (0, 1, 2, 3 or 4), with zero denoting an inability to perform the activity without assistance and four denoting the ability to perform the task with complete independence. The score is based on the time for which a position can be maintained, the distance to which the upper limb is capable of reaching in front of the body, and the time needed to complete the task. The maximum score is 56 points. The test is performed with the child clothed and making use of his/her habitual brace and/or gait-assistance device[4, 13].

Pediatric Evaluation Disability Inventory: The PEDI quantitatively measures functional performance. This questionnaire was administered in interview form to one of the child's caregivers who was knowledgeable about the performance of the child in typical activities and tasks of daily routine. The first part of the questionnaire was used. This assesses skills in the child's repertoire grouped into three functional categories: self-care (73 items), mobility (59 items) and social function (65 items). An item is scored 0 (zero) when the child is unable to perform the activity or 1 (one) when the activity is part of the child's repertoire of skills. The scores are totaled per category[18–20].

Each participant was evaluated on two non-consecutive days by previously trained physiotherapists blinded to the objectives of the study. The children were first classified based on the GMFCS[2] and topographic impairment. Anthropometric characteristics (height, body mass and body mass index) were then determined. The order of the administration of the assessment tools was determined randomly by lots. During all evaluations, the children were clothed and made use of their habitual ankle-foot orthoses, walkers or crutches, since the aim of the study was to obtain results similar to normal daily performance. Children classified as Level III were evaluated using their gait-assistance device. The children could interrupt the evaluation at any time due to fatigue or discomfort.

The Kolmogorov-Smirnov test was used to determine whether the data adhered to the Gaussian curve. A normal distribution was demonstrated, the data were expressed as mean and standard deviation. Pearson's correlation coefficient (r) was used to determine correlations between the PBS and PEDI. One-way ANOVA was used for the comparison of means of the results among the different groups. A p-value < 0.05 was considered statistically significant. The data were organized and tabulated using the Statistical Package for the Social Sciences (SPSS v.19.0).

Table 1. Anthropometric data of the sample (mean ± SD)

	Group 1 GMFCS I	Group 2 GMFCS II	Group 3 GMFCS III
Age (years)	8.5 ± 0.7	8.4 ± 0.7	7.9 ± 1.4
Body mass (kg)	27.4 ± 2.5	26.5 ± 2.9	25.8 ± 3.2
Height (cm)	127.3 ± 5.8	124.1 ± 6.9	122.4 ± 4.2
Body mass index (kg^2/m)	16.5 ± 0.6	17.0 ± 0.3	15.9 ± 0.9

Table 2. Results (mean and SD) of the functional test and PEDI scale in the different groups

	Group 1 (n=10)	Group 2 (n=10)	Group 3 (n=10)
PBS	51.0 (2.7)	46.6 (4.7)	34.8 (4.9) *#
PEDI- Mobility	51.1 (3.3)	50.6 (3.0)	34.5 (6.9) *#
PEDI- Self-care	62.0 (7.6)	63.5 (7.0)	41.7 (6.2) *#

* ANOVA I X III (p<0.05); # ANOVA II X III (p<0.05)

RESULTS

Thirty children (18 boys and 12 girls) participated in the present study. Each group was made up of 10 children. Group 1 was made up of two children with diparesis and eight with hemiparesis. Group 2 was made up of nine children with diparesis and one with hemiparesis. Group 3 was entirely made up of ten children with diparesis who used forearm crutches as a gait-assistance device. Table 1 displays the anthropometric data for the sample.

A strong correlation was found between the PBS and both the self-care (r = 0.73; p < 0.001) and mobility (r = 0.82; p < 0.001) dimensions of the PEDI. A strong positive correlation was also found between the self-care and mobility dimensions of the PEDI (r = 0.72; p < 0.001).

In the analysis of the different GMFCS levels, a moderate correlation was found between the PBS and self-care dimension of the PEDI (r = 0.51; p = 0.12), and a strong correlation was found between the PBS and the mobility dimension of the PEDI (r = 0.82; p < 0.001) in Group 1 (GMFCS Level I). Moderate correlations were found between the PBS and both the self-care dimension (r = 0.57; p = 0.10) and mobility dimension (r = 0.41; p = 0.23) of the PEDI in Group 2 (GMFCS Level II). The PBS was weakly correlated with the self-care dimension (r = 0.11; p = 0.77) and moderately correlated with the mobility dimension (r = 0.55; p = 0.12) in Group 3 (GMFCS Level III).

The results of ANOVA (Table 2) revealed statistically significant differences in the self-care dimension of the PEDI between Groups 1 and 3 (p < 0.001) as well as between Groups 2 and 3 (p < 0.001), whereas no significant difference was found between Groups 1 and 2 (p = 1.0). Statistically significant differences were also found in the mobility dimension of the PEDI between Groups 1 and 3 (p < 0.001) as well as between Groups 2 and 3 (p < 0.001), whereas no significant difference was found between Groups 1 and 2 (p = 1.0). Likewise, statistically significant differences were found in the PBS between Groups 1 and 3 (p < 0.001) as well as between Groups 2 and 3 (p < 0.001), whereas no significant difference was found between Groups 1 and 2 (p = 0.08).

DISCUSSION

Falls constitutes one of the most frequent complaints of children with CP who have the ability to walk independently[21]. Thus, functional balance is a fundamental aspect of therapy for such patients[13]. The aim of the present study was to analyze correlations between the results of the Pediatric Balance Scale and the functional test, the Pediatric Evaluation Disability Inventory (self-care and mobility dimensions), for children classified as Levels I to III on the GMFCS.

The current preference in the literature is to classify children with CP based on the GMFCS, which measures functional independence with regard to gross motor skills. A number of studies report that this classification, which takes the child's age into account, maintains a certain stability over the years[22, 23]. Children classified on Levels I and II have a good prognosis regarding gait and do not require gait-assistance devices. Auxiliary resources, such as orthoses, conventionally improve the positioning of the ankle. In contrast, walkers and forearm crutches are indicated to compensate for deficient balance and are fundamental for children classified as Level III. The present findings revealed significant differences between the children classified as Levels I and II and those classified as Level III regarding self-care, mobility and the PBS; there were no significant differences between the children classified as Levels I and II.

Despite the lack of significant differences between the children classified using the GMFCS as Groups 1 and 2, the results of the correlations analyzed were not equal. The only significant correlation for Group 1 participants was between the PBS and the mobility dimension of the PEDI. A strong correlation was found between functional bal-

ance and the mobility dimension of the PEDI in Group 1 and moderate correlations were found in Groups 2 and 3. The mobility dimension of the PEDI evaluates performance during locomotion as well as overall mobility, including transfers. The PBS involves items such as changing from a sitting to a standing position, transfers and picking up objects from the floor, which is similar to the assessments performed with the mobility dimension of the PEDI. Many of the items of these two instruments are similar, and the results demonstrate the clinical status of children with CP regarding muscle tone and impaired postural control, both of which affect functional balance[6, 24, 25].

With the current interest in the analysis of functional balance, there is a need for detailed evaluations of assessment tools designed for such an analysis. In study carried out by Ries et al.[17], the PBS was shown to be a simple, valid, reliable assessment tool for individuals with CP. The administration of the PBS requires a maximum of 15 minutes and uses materials that are easy to obtain (stopwatch, ruler/tape measure, chair, stool, adhesive tape, foot support).

Good postural control is necessary for adequate gait performance. Among individuals with CP, postural control is inversely proportional to the classification level of the GMFCS, as a higher level denotes worse postural control. Balance and postural control in the standing position are fundamental components of movement, involving the ability to anticipate and recover from instabilities as well as to take action to avoid instability[26]. As poor balance hampers the performance of functional activities of daily living[5], we expected the PBS would be significantly correlated with all dimensions of evaluation employed in the present study, which did not prove to be true. Thus, the PBS cannot be considered a predictor of performance of global functions in children with CP, especially children classified as Level III, since a strong correlation was only found for the mobility dimension of the PEDI for Level I subjects, and only moderate correlations were found for Levels II and III. Regarding the self-care dimension, moderate correlations were found among all levels, which may be explained by the fact that this dimension does not involve a change in position and only evaluates activities performed while sitting (eating, brushing one's teeth, brushing one's hair). The PBS demonstrated a positive correlation with the mobility dimension of the PEDI, regardless of the degree of motor impairment (GMFCS level). Thus, the results of the scale can help to determine the degree of independence in activities related to functional mobility in children with CP, such as the ability to walk, demonstrating that balance is a prerequisite for independent gait performance.

In the present study, no significant differences were found between Groups 1 and 2, which is likely due to the similarity in these two functional levels. Reliable measures of functional balance for children with CP are important in clinical practice for the determination of the proper therapy protocol and the assessment of the results obtained.

Based on the present findings, the PBS may be considered a good auxiliary tool for the assessment of functional performance with regard to mobility, but cannot be used in an isolated fashion as a predictor of performance of other

functions. Thus, a complete analysis is necessary for the functional classification of children with CP.

The small number of participants is a limitation of the present study. The study population was composed of a convenience sample (children with CP registered at the physical therapy clinics of the Universidade Nove de Julho, Brazil) and therefore no sample size calculation was performed. Thus, the data can be considered preliminary findings. Future studies with a larger number of participants should stratify the sample based on functional level (GMFCS Levels I/II and Level III).

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