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ORIGINAL ARTICLE

Reliability and Validity of the Turkish Version of the Early Clinical Assessment of Balance (ECAB) for Young Children with Cerebral Palsy

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Abstract

The Early Clinical Assessment of Balance (ECAB) is a clinical tool that measures the postural stability of young children with cerebral palsy (CP) between the ages of one and a half to five years. The aim of this study was to test the reliability and the validity of the Turkish version of the ECAB in children with CP. Fifty children with spastic CP with the median age of 4.25 (IQR: 3–5) years were included in the study. The children were between the levels I-V according to the Gross Motor Function Classification System (GMFCS). Test-retest reliability of the ECAB was evaluated by using the Intraclass Correlation Coefficient ($ICC_{3,1}$). Validity of the ECAB was analysed by examining the differences in the ECAB scores between the GMFCS levels and investigating the relation between the Turkish version of the ECAB and the GMFM-88. We found that the Turkish version of the ECAB had good test-retest reliability. Mann-Whitney *U* pairwise analyses indicated that the ECAB scores differed significantly between GMFCS levels I-III, I-IV, I-V and II-V ($p < 0.00512$, Sidak correction, CI: 95%). Spearman correlation coefficient between the ECAB and the total GMFM-88 score was 0.968 ($p < 0.01$). The results of our study showed that the Turkish version of the ECAB has good test-retest reliability and validity to assess postural stability of Turkish children with spastic CP, but we recommend further research to evaluate the reliability and validity of the Turkish version of the ECAB in different types (ataxia, dyskinesia, etc.) of CP.

Keywords Cerebral palsy · Postural stability · Reliability · Validity

Postural stability is defined as 'the ability to maintain or control the body's center of mass in relation to the base of support to prevent falls and complete desired movements' (Horak 1987; Shumway-Cook and Woolacott 2012). Maintaining a stable

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posture is a complex process that relies on the interactions between both central and peripheral nervous systems and the musculoskeletal system (Horak 2006; Corrêa et al. 2007). Postural stability is necessary to explore and interact with the environment, and has been described as an anchor for purposeful movement and functional tasks that are involved in activities of daily living (ADL) (Shumway-Cook and Woolacott 2012). Children with many types of disabilities may have problems in maintaining postural stability. These children may exhibit clumsiness and frequent falls during regular daily motor activities or may not be able to maintain a sitting or standing position independently (Westcott et al. 1997).

Cerebral Palsy (CP) is the most common cause of physical disability in childhood, with a prevelance of 2.11 per 1000 live births (Oskoui et al. 2013). CP is defined as 'a group of permanent disorders that affects the development of movement and posture which is attributed to non-progressive disorders in the fetal development or infant brain' (Rosenbaum et al. 2007). Children with CP have motor impairments, which include decreased strength, increased spasticity, limited range of motion, and abnormal posture. The motor impairments present in CP are often accompanied by disturbances of sensation, perception, cognition, communication, and behavior (Rosenbaum et al. 2007). These impairments lead to difficulties in carrying out gross motor movements and ADL (James et al. 2014).

Postural stability may be impaired in children with CP, because of spasticity, decreased isometric force production, abnormal timing, reduced amplitude of muscle recruitment, sensory loss and secondary musculoskeletal impairments (Dewar et al. 2015). Also, variations in sensory cueing for postural adjustments (Saxena et al. 2014) and temporal and spatial aspects of motor coordination patterns cause impairments in postural stability (Chen and Woollacott 2007; Donker et al. 2008). Children with CP have significant limitations in ADL due to their lack of motor control ability and postural stability (van der Heide et al. 2004; Harbourne et al. 2010; Chen et al. 2013). These limitations can restrict the participation of children with CP across a broad range of life domains, including self care, education, recreation and interaction with the community (Imms 2008).

Improving postural stability becomes an important issue in rehabilitation and often the focus of interventions that are designed to improve the functional abilities of children with CP (Zadnikar and Kastrin 2011; Zipp and Winning 2012; Jelsma et al. 2013). Therefore, valid and reliable measures are needed in order to determine the impairments in postural stability and to evaluate the effects of interventions that aim to improve postural stability. There is no consensus on how postural stability should be assessed in children with CP (Saether et al. 2013). In a recent systematic review, Sibley et al. (2017) identified 21 measures that can be used in a regular clinical setting to assess the postural stability of children with CP. Most of these measures were developed in adult populations, however the Early Clinical Assessment of Balance (ECAB) was specifically developed for children with CP. The ECAB was developed by McCoy et al. (2014) in order to evaluate postural stability of young children with CP, between the ages of one and a half to five years across all functional levels. It evaluates postural stability from pre-sitting to walking positions and includes a broad range of abilities, from early head and trunk control to dynamic activities during standing. Ease of administration and low burden on the child are the advantages of the test in a clinical setting (Randall et al. 2014).

ECAB was developed and validated using the English language. The aim of this study was to translate the ECAB into the Turkish language and to determine the reliability and validity of the translated version in children with CP between the ages of one and a half to five years. We hypothesized that the Turkish version of the ECAB would show good test-retest reliability according to correlation coefficients proposed by Portney and Watkins (2015). In order to explore construct validity, a 'known groups method' was used. We hypothesized that ECAB scores would differ based on children's functional level; children with higher functional level would demonstrate higher ECAB scores. We used Gross Motor Function Classification System (GMFCS) in order to classify the children's gross motor function level (Palisano et al. 2000). The GMFCS was developed to provide a standardized classification of the patterns of motor disability in children with CP aged one to 18 years (Palisano et al. 2000). The focus is to determine the level that best reflects the present abilities and limitations of the child and youth in relation to gross motor functions (Wood and Rosenbaum 2000).

We also evaluated the convergent construct validity of the ECAB. We hypothesized that the ECAB scores would have a good correlation with the Gross Motor Function Measurement-88 (GMFM-88) which is the current "gold standard" for obtaining an estimate of gross motor function in children with CP (Brunton and Bartlett 2011). Although the primary purpose of the GMFM-88 is not to assess balance, we chose this tool for investigating the validity of the ECAB, because the balance assessment is part of a wider assessment of motor function (Saether et al. 2013).

Method

Design

This study examines the reliability and validity of the ECAB, once translated into the Turkish language, in children with CP. The study was approved by the Medical Ethics Committee of Eskisehir Osmangazi University. All research activity was performed according to the Helsinki Declaration.

Participants

Children diagnosed with CP between the ages of one and a half to five years were included in the study. Children were excluded if they had undergone orthopaedic interventions or received botulinum toxin injections within the last three months, or if they had severe visual, hearing and cognitive deficits were excluded from the study. The parents of the children who agreed to participate the study signed an informed consent form.

Measures

Early Clinical Measurement of Balance

The ECAB is a balance measure comprised of a total of 13 items that can be completed in approximately 15 min or less, depending on the child's functional ability. Part 1 of the ECAB tests early postural stability via reactive and anticipatory head stability in addition to trunk stability while sitting on the floor. Part 2 of the ECAB tests anticipatory postural stability, starting with bench sitting, then transfers, and static and dynamic standing. The total score can be obtained by summing the scores of all items and ranges between zero to 100 (McCoy et al. 2014; Randall et al. 2014) (https://canchild.ca/en/research-in-practice/current-studies/move-play-study-understanding-determinants-of-motor-abilities-self-care-and-play-of-young-children-with-cerebral-palsy). It is a valid and reliable tool in children with CP between the ages of one and a half to five years (McCoy et al. 2014; Randall et al. 2014).

Gross Motor Function Classification System

The GMFCS is a valid and reliable method that is used to classify the patterns of motor disability in children with CP, on the basis of self-initiated movement with emphasis on sitting, transfers, and mobility (Palisano et al. 1997; Bodkin et al. 2003; Palisano et al. 2008). The GMFCS comprises five age-intervals and levels. Differences between these levels are based on functional limitations, the need for assistive mobility devices, or wheeled mobility, and to a lesser extent, quality of movement. Children at GMFCS level I are capable of walking without any limitations, while those at level V have severe limitations of body control and need assisted technology and physical assistance for ADL (Palisano et al. 2000).

Gross Motor Function Measurement-88

The GMFM-88 consists of 88 items, which were organised into five dimensions as lying and rolling (A), sitting (B), crawling and kneeling (C), standing (D), and walking, running and jumping (E). Items are scored on a four-point ordinal scale by observation of a child's performance on each item (zero = does not initiate, one = initiates <10% of activity, two = partially completes 10% to 100% of activity, three = completes activity). Scores for each dimension are expressed as a percentage of the maximum score for that dimension, finally the total score of the GMFM-88 is obtained by dividing the percentage scores into five (Russell et al. 2000). The GMFM-88 was found to be a reliable and valid method in children with CP (Brunton and Bartlett 2011; Ko and Kim 2012).

Translation Procedure

Permission for the use, translation, cultural adaptation, and validation of the ECAB into the Turkish language was obtained via e-mail from Dr.McCoy before the study. The adaptation of scales for new countries, cultures or languages requires an unique method to achieve equivalance between the original source and target versions. For this reason, the ECAB was submitted to translation and cross-cultural adaptation according to internationally accepted and recommended guidelines (Beaton et al. 2000; World Health Organization 2018).

First, forward translations of the ECAB to the Turkish language were completed independently by two bilingual translators whose mother tongue is Turkish. Translator one was a health professional and familiar with the terminology used in the scale.

Translator two had no medical background. Then, the two translations were compared with each other and a single Turkish translation was created. The instrument was then translated back into English by two other independent bilingual translators (Translator three and Translator four) whose mother tongue is English, and who are fluent in Turkish. Translator three and Translator four were blinded to the original version of the ECAB. Variations in the translations were discussed and a consensus English version was obtained. The consensus English version was then compared with the original scale and approved for use by Dr. McCoy. The last stage of the process was to test the pre-final version. The Turkish version of the ECAB was tested on 30 relevant patients by 30 physical therapists in order to test alternative wording and to check the understandability, interpretation, and cultural relevance of the translation. Suggested amendments were included in the final version.

Procedure

The children were recruited from a special rehabilitation and education center in Eskisehir, between January and December 2016. Demographical data (age, gender, weight, height, and type of CP) were collected from all children before the evaluation process. Children were assessed in their private physiotherapy sessions in a quiet setting. The evaluations were done by two physical therapist with clinical experience in children with CP. A training session was held for the evaluators in order to become familiar with the ECAB and the criteria for definitions of the scoring criteria.

At the first session, physical therapist completed the ECAB, GMFM-88 and rated the GMFCS. To determine the test–retest reliability of the Turkish version of the ECAB, the children were assessed twice by the same physical therapist. The test–retest interval was approximately 14 days (range 9–14 days) to minimize recall bias.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) version 15 (*SPSS Inc. Chicago, IL, USA*) was used for data analysis. Distribution analysis using the Shapiro-Wilk test indicated that variables were not normally distributed. Two-way mixed model Intraclass Correlation Coefficients ($ICC_{3,1}$) with 95% confidence intervals were used to assess test-retest reliability. The Standard Error of Measurement (SEM) was also calculated to evaluate absolute reliability as follows:

$$\mathrm{SEM} = \mathrm{SD}\sqrt{1-\mathrm{ICC}}$$

where SD is the pooled standard deviation. From the SEM, the minimum detectable difference (MDD); the smallest difference in score that is likely to reflect a true change rather than a measurement error, was estimated as follows:

$$\mathrm{MDD} = \mathrm{SEM} \times 1.96 \times \sqrt{2}$$

where $\sqrt{2}$ accounts for the variance associated with two independent sessions and 1.96 represents the 95% confidence interval.

Known groups validity, which estimates how well the scale discriminates between groups, was analyzed by examining the differences in the ECAB scores according to the GMFCS levels by using Kruskal-Wallis Test. Post-hoc pair-wise comparisons between the GMFCS levels were analysed with Mann-Whitney *U* Test. For multiple pair-wise comparisons, the alpha value was adjusted and set at 0.00512 (Sidak correction, CI: 95%). For convergent construct validity, the relation between the ECAB and total and subscale scores of the GMFM-88 were analysed by using Spearman's correlation coefficients (r_{ho}). In our study, in order to interpret the correlation coefficients, we used the following definitions: 0–0.25 (no or little relationship), 0.25–0.50 (fair degree), 0.50–0.75 (moderate to good relationship), 0.75–1.00 (very good to excellent) (Dawson-Saunders and Trapp 1994). The level of significance was set at 0.05.

Results

50 children (22 females and 28 males) with the median age of 4.25 (IQR:3–5) years were included in the study. The median weight of the children was 14.25 kg (IQR:12–18) and the median height of the children was 95.75 cm (IQR:91.75–107.25). All of the children had previously been diagnosed with spastic CP. 13 children had hemiplegia, 12 had diplegia, 25 had quadriplegia. According to the GMFCS, 18 children were classified as level I, nine as level II, nine as level III, five as level IV and nine as level V. The median scores of the ECAB and the GMFM-88 for all children who participated in the study were 60 (IQR:31.25–100) and 67.56 (IQR:28.56–90.76), respectively.

Test-Retest Reliability The $ICC_{3,1}$ for the test-retest reliability of the ECAB scores was 1.00 indicating statistically good consistency (Table 1).

Validity The results of Kruskal-Wallis Test for comparison of the ECAB scores among GMFCS levels were statistically significant (Chi-square = 121.52, $p = .000$, $p < 0.05$) (Table 1). Mann-Whitney *U* pairwise analyses indicated that the ECAB scores differed significantly among children in level I-III, I-IV, I-V and II-V according to the GMFCS ($p < 0.00512$) (Table 2).

Spearman correlation coefficient between the ECAB and the total GMFM-88 scores was 0.968 ($p < 0.01$). The relation between the ECAB and both total and subscale scores of the GMFM-88 were shown in Table 3.

Discussion

The area of pediatric rehabilitation needs reliable, valid, practical and cost-effective tools to asssess postural stability as it is an important prerequisite for the development of gross motor abilities and functional tasks that are necessary for daily life (Kembhavi et al. 2002). This study was conducted to translate and adapt the ECAB into the Turkish language, and to determine the reliability and the validity of the Turkish version.

In most clinical settings, the age for diagnosis of CP is on average two years or older (Hubermann et al. 2016), but with the help of neurological and neuromotor assessments,

Table 1 Test-retest reliability analysis of the Turkish version of the ECAB

	ECAB Test-Retest Median (IQR) (min/max)	$ICC_{3,1}$*; SEM; MDD	95% CI lower bound	95% CI upper bound	Difference among GMFCS groups
GMFCS I (*n* = 18)	100 (97.12–100) (62–100) 100 (97.12–100) (62–100)	1.000; 0.00; 0.00	1.000	1.000	0,000**
GMFCS II (*n* = 9)	72.50 (62.50–87.25) (51.50–100) 72.50 (62.50–87.25) (51.50–100)	1.000; 0.00; 0.00	1.000	1.000	
GMFCS III (n = 9)	42 (33.25–44.75) (12–58) 42 (33.25–44.75) (12–58)	1.000; 0.00; 0.00	0.999	1.000	
GMFCS IV (n = 9)	28.50 (16–34.75) (14–38) 28.50 (16–34.75) (14–38)	1.000; 0.00; 0.00	1.000	1.000	
GMFCS V (*n* = 5)	6 (2.50–28.75) (1–34) 6 (2.50–28.75) (1–34)	1.000; 0.00; 0.00	1.000	1.000	
All GMFCS levels (*N* = 50)	60 (31.25–100) (1–100) 60 (31.25–100) (1–100)	1.000; 0.00; 0.00	1.000	1.000	

GMFCS, Gross Motor Function Classification System; ECAB, Early Clinical Assessment of Balance; ICC, Intraclass Correlation Coefficient; CI, Confidence Interval; SEM, Standard Error of Measurement; MDD, Minimum Detectable Difference; IQR, Interquartile Range; min, minimum; max, maximum; n, number; N, Total Number; *two-way mixed model; **Kruskal-Wallis test; $p < 0.05$

neuroimaging and neurophysiological tests, it is possible to diagnose CP earlier (Hadders-Algra 2014). In large research networks, investigators have successfully decreased the age of CP diagnosis to 18–19 months (Hadders-Algra 2014; Morgan et al. 2016). Many problems associated with CP respond well to interventions in early childhood, when brain plasticity is at its greatest (Johnston et al. 2009) and developmental trajectories can be altered with maximal benefit into adulthood (Heckman 2008). Early recognition of these problems including impairments in postural stability, helps clinicians to design appropriate interventions to improve postural stability, functional independence and the quality of life of the children with CP. The ECAB is the only test that evaluates the postural stability of children with CP across all functional levels under five years of age.

In the study of McCoy et al. (2014), Mann–Whitney *U* pairwise analyses indicated that median ECAB scores differed significantly among children in all GMFCS levels,

Table 2 Pairwise comparisons of GMFCS levels based on Mann-Whitney *U* Test

GMFCS levels	Test statistics	SE	STD test statistics	Significance
Level I-II	9.667	5.870	1.647	0.996
Level I-III	22.389	5.870	3.814	0.001*
Level I-IV	28.967	7.269	3.985	0.001*
Level I-V	33.333	5.870	5.679	0.000*
Level II-III	12.722	6.778	1.877	0.605
Level II-IV	19.300	8.020	2.406	0.161
Level II-V	2.3667	6.778	3.492	0.005*
Level III- IV	6.578	8.020	0.820	1.000
Level III-V	10.944	6.778	1.615	1.000
Level IV-V	4.367	8.020	0.544	1.000

GMFCS, Gross Motor Function Classification System; SE, Standard Error; STD, Standard; *$p < 0.01$

but in our study pair-wise comparisons could not reveal significant differences between all groups except for GMFCS level I-III, I-IV, I-V and II-V. This difference between two studies could be due to our small sample size.

The Turkish version of the ECAB has good construct validity with respect to the association with the GMFM-88. The children who obtained higher scores from the ECAB also attained higher scores from GMFM-88. In our study, the Spearman correlation coefficient between the Turkish version of the ECAB and the total GMFM-88 score was 0.968, and this value represents a very good to excellent relationship. In a previous study, the correlation between the ECAB and the GMFM-66 was found to be 0.970 (Randall et al. 2014) and this result was similar to our study.

Children with CP are an extremely heterogeneous group, varying considerably in movement abilities. The large amount of studies with small sample sizes reflects the difficulties that researchers face in recruiting a large and homogeneous sample from this population as there is a high variability of clinical features in CP (Pavão et al. 2013). In our study, the number of children according to GMFCS levels were not homogeneously distributed, and all of the study population had been diagnosed with a spastic type of CP. This makes the results of our study difficult to generalize to entire CP population and can be considered as a limitation of the study. Further research is needed in order to evaluate the reliability and

Table 3 Spearman correlation coefficients (r_{ho}) between the total and subscale scores of the GMFM-88 and the ECAB

		GMFM-88 A Lying and rolling	GMFM-88 B Sitting	GMFM-88 C Crawling and kneeling	GMFM-88 D Standing	GMFM-88 E Walking, running and jumping	GMFM-88 Total
ECAB Total	r_{ho}	.797**	.942**	.915**	.925**	.950**	.968**

ECAB, Early Clinical Assessment of Balance; GMFM-88, Gross Motor Function Measurement-88; **Spearman correlation; $p < 0.0$

validity of the Turkish version of the ECAB in a larger population of children with different types of CP such as ataxia, dyskinesia.

Conclusion

In our study we translated the ECAB into a Turkish version with the help of four translators. The Turkish ECAB showed good reliability and validity to assess postural stability of Turkish children with spastic CP. However, further research is necessary to evaluate the reliability and validity of the Turkish version of the ECAB for different types of CP.

Compliance with Ethical Standards

Ethical Approval The study was approved by the Medical Ethics Committee of Eskisehir Osmangazi University.

Informed Consent Written informed consent was obtained from all of the participants.

Conflicts of Interest The authors declared no conflicts of interest with respect to the research, authorship, and/or publication of this article.

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