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Research Article

The Relationship Between Selective Motor Control and Trunk Control in Children With Spastic Cerebral Palsy

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Abstract

Aim: Cerebral palsy (CP) can cause a variety of musculoskeletal issues that impact everyday functioning and activities, including reduced muscle tone and selective motor control. Appropriate evaluation of these problems and determination of their interrelationships are important in treatment planning. The aim of this study was to investigate the correlation between control of the trunk and selectivity of the lower limbs in children with CP.
Material and Method: Sixty-eight children and adolescents with spastic CP, categorized as GMFCS levels I to III and aged between five and seventeen years, were enrolled in the present study. The Trunk Control Measurement Scale (TCMS) was utilized to evaluate the trunk control. The Selective Control Assessment of the Lower Extremity (SCALE) was performed to measure the selectivity of the lower extremity. Groups with varying GMFCS levels were analyzed using the Kruskal-Wallis test. For the relationship analysis, the Spearman rank correlation test was employed.
Results: Significant differences in total SCALE scores between levels of the GMFCS were found in the group comparisons (Kruskal-Wallis H test: 44.145, $p<0.001$). SCALE scores and TCMS scores showed a substantial high association for dynamic sitting balance (rho:0.743, $p<0.001$), selective movement control (rho: 0.739, $p<0.001$), and overall TCMS scores (rho: 0.767, $p<0.001$). TCMS dynamic reaching (rho: 0.676) and static sitting balance (rho: 0.690) had a moderate positive correlation with SCALE score ($p<0.001$).
Conclusion: The SCALE test, which is simple to administer in a clinical setting, may provide insight into the level of trunk control. To improve selectivity of the lower limbs, physiotherapy programs may include interventions related to trunk control.

Keywords: Cerebral palsy, evaluation tool, selective motor control, trunk control measurement scale

INTRODUCTION

One of the most prevalent motor diseases affecting posture and gait in childhood is cerebral palsy (CP) (1). Children with CP commonly experience neuromuscular deficits, including spasticity, weakness and loss of selectivity. Depending on where and how the brain gets affected, varying degrees of positive and negative motor signs may manifest (2). Reduced muscle activity and selective motor control are characteristics of negative motor signs, whereas increased muscle tone is present in positive motor signs (3).

Selective motor control refers to the capacity to carry out a desired movement in isolation. Selective motor control plays a pivotal role in normal human movement, providing rapid and voluntary control over joint mobility (4). The lateral corticospinal tract is responsible for directing and generating the force of voluntary movements. Injury to this tract can disrupt the speed, timing, and strength of these movements (5). Damage to the periventricular white matter's lateral corticospinal pathway is linked to motor dysfunction in CP. One of these motor deficits, the selective loss of motor control, may lead to the emergence of synergistic movement patterns (6).

Selective motor control in the daily activities can be difficult for children with CP (7). Inadequate selectivity is a typical problem in CP (8). Research has shown that

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problems with the selective lower limb motor control in children with CP can lead to problems with walking (9). In addition, functional exercise capacity has been reported to be affected by difficulties with the lower extremities's selectivity (10).

Postural control is defined as ensuring proper positioning of the body in space and maintaining body alignment and stability by keeping the center of gravity within the support surface (11). Trunk control is important in achieving postural control. The core part of the body is the trunk and plays crucial role in the function of the limbs (11). Children with CP often struggle with maintaining trunk control, leading to challenges in to carry out activities of daily living (11). Deficits in motor functions and a significant limitation in walking capacity are consequences of impaired control of the trunk in children with CP (12,13). There is a connection between impairments in lower extremity tone and trunk control in CP. Impaired trunk control can negatively affect walking parameters (14). In other words, the more severe the tone abnormality in the lower extremities is, the more compromised the trunk control. Nevertheless, not enough research has been done on the association between trunk control and lower extremity selectivity. Thus, the purpose of this study was to investigate the relationship between lower extremity selectivity and trunk control in children with CP.

MATERIAL AND METHOD

Study design

The Karadeniz Technical University's Ethics Committee for Scientific Research in the Health Sciences approved this study. Children and adolescents aged 5-18 (mean age: 10±4) diagnosed with CP were enrolled to this study. Prior to the child's participation in the study, the consent of both the child and the parents was obtained. This study recruited children and adolescents with Gross Motor Functional Classification System (GMFCS) levels I, II and III who could sit for at least 45 minutes with or without assistance. Children who had received botox injection in the previous 6 months in the lower extremities, had undergone orthopaedic surgery, or had mental problems that prevented them from understanding the instructions given were excluded from this study. The study evaluated a total of 72 children. Four children excluded because they did not meet eligibility criteria (2 had botox injection for 6 months, and 2 did not complete the assessment), and the study was completed with 68 children with CP. Between January and September 2023, the children in the study were examined.

Evaluations

Trunk Control Measurement Scale

This scale has been used to evaluate the control of the trunk in children. There are fifteen items in the TCMS. It evaluates sitting balance both dynamically and statically. These are the two primary parts of trunk control, including static sitting balance (SSB) and dynamic sitting balance (DSB), the two subscales that make up the TCMS. Dynamic reaching (DR) and selective movement control (SMC) constitute the two components of a DSB. The total score ranges from 0 to 58. High scores reflect excellent performance (15). The Turkish form of the TCMS was utilized in this study. Özal et al. conducted a reliability and validity study of the scale (16). Their findings confirmed that the Turkish TCMS has strong intrarater (intraclass correlation coefficient (ICC): 0.98) and interrater (ICC: 0.88) reliability as well as validity (correlation with gross motor functional measure (GMFM) r: 0.827), similar to the original form. In an assessment room with the right amount of light, sound and temperature, two physiotherapists - one with 12 years' experience and the other with 5 - carried out the trunk assessment. The assessment took approximately 20–30 minutes.

Selective Control Assessment of Lower Extremity

This scale evaluates the toe, subtalar, ankle, knee, and hip joints separately for selective movements. These joints are assessed as bilateral. On a three-point ordinal scale, each joint's selective motor control is assessed as "unable" (0 points), "impaired" (1 point), or "normal" (2 points). A participant received a "normal" score if they were able to effectively execute the specified movement sequence within the verbal count without moving the ipsilateral or contralateral lower limb joint that was not being assessed. The motion was classified as "impaired" if the participant isolated it but committed any of the following errors: only one direction of movement was made, the movement was completed less than 50% of the time, a non-tested joint (including mirror motions) was moved, or the verbal count was more than three seconds. A "unable" rating was assigned if the subject failed to initiate the intended movement or displayed a synergistic pattern of flexing or extending muscles (17). The scale was scored by 2 physiotherapists with 10 years of experience. In this study, the SCALE's Turkish version was utilized. The validity and reliability of the Turkish SCALE in children with spastic CP were examined by Tuncdemir et al (18). They found that the SCALE is valid and reliable when used with the Turkish population. SCALE assessment was performed in the same room where the trunk assessment was performed. All the evaluated joints were video recorded and evaluated. The SCALE assessment took approximately 10–15 minutes. Patients included in this study were evaluated at the Karadeniz Technical University Farabi Hospital Risky Infant Follow-up Unit or the Gazi University Faculty of Health Sciences Pediatric Rehabilitation Unit.

Statistical analysis

IBM SPSS Statistics version 25 was used to evaluate the data gathered for the study. To figure out whether or not the data are regularly distributed, analytical and visual techniques are employed. For regularly distributed data, descriptive statistics are shown as means and standard deviations; for nonnormally distributed data, they are shown as medians and interquartile ranges. Descriptive statistics are presented as frequencies and percentages for qualitative variables. The Kruskal-Wallis test was applied to compare groups with varying GMFCS levels. For pairwise comparisons, the Mann-Whitney U test was used. The Bonferroni adjustment was carried out. Correlation coefficients were calculated via Spearman correlation coefficients. The interpretation of Spearman's rank correlation is 0.70 + strong, 0.40 - 0.69 moderate, and 0.10 - 0.39 weak (19). P values considered statistically significant were less than 0.05. G*Power version 3.1 (Düsseldorf, Germany) was used for sample size calculation. In this study the number of participants was determined as 58, with a correlation effect size of 0.4, 90% power and a 0.05 error rate, according to the Yun et al. study (20).

RESULTS

This study included sixty-eight children and adolescents with spastic CP (median age at enrollment: 10 years, interquartile range: 7-12 years, GMFCS levels I (n=25, 36.8%], II (n=22, 32.4%), and III (n=21, 30.8%). Table 1 displays the participants' characteristics. The median TCMS score was 46, and the median SCALE score was 4 (Table 1).

Table 1. Characteristics of participants

n	68
Age	10 (7-12)
Gender (male/female)	36/32
Height (cm)	122 (110-130)
Weight (kg)	25 (20-35)
BMI (kg/m²)	18.2 (15.3-20.4)
GMFCS level I	25 (36.8%)
GMFCS level II	22 (32.4%)
GMFCS level III	21 (30.8%)
Unilateral CP	30 (44.1%)
Bilateral CP	38 (55.9%)
SCALE total	4 (2-7)
TCMS SSB	20 (14-20)
TCMS DSB	28 (13-34)
Selective movement control	18 (8-24)
Dynamic reaching	10 (5-10)
TCMS total	46 (30-54)

Data are presented as the median (interquartile range) or frequency (percentage); BMI: body mass index, CP: cerebral palsy, GMFCS: Gross Motor Function Classification System, SCALE: Selective Control Assessment of the Lower Extremity, TCMS-SSB: Trunk Control Measurement Scale-Static Sitting Balance, TCMS-DSB: Trunk Control Measurement Scale-Dynamic Sitting Balance

Significant differences in SCALE total scores between GMFCS levels were found in the group comparisons (Kruskal-Wallis H: 44.145, p<0.001) (Figure 1). SCALE total scores differed significantly between GMFCS I and II (u: 151.50, p: 0.008), between GMFCS I and III (u: 5.00, p<0.001) and between GMFCS II and III (u: 12.00, p<0.001) when pairwise comparisons were performed with Bonferroni correction.

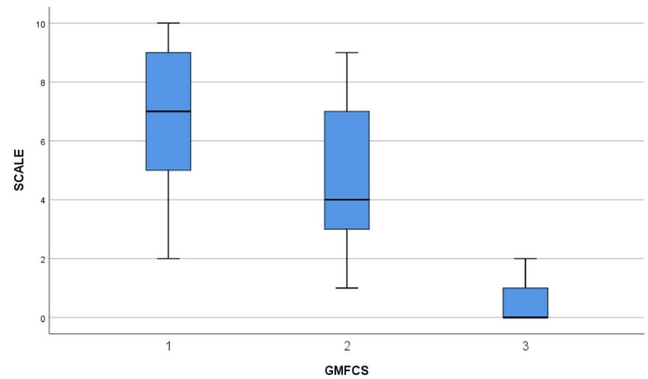

Figure 1. SCALE total score by GMFCS levels; GMFCS: Gross Motor Function Classification System, SCALE: Selective Control Assessment of the Lower Extremity

The SCALE scores and the TCMS scores were strongly correlated with the dynamic sitting balance, the selective movement control and the total TCMS score (p<0.001). There was a moderate correlation between TCMS static sitting balance and dynamic reaching and SCALE (p<0.001) (Table 2).

Table 2. Correlation analyses of the Selective Control Assessment of the Lower Extremity (SCALE) in relation to trunk control

SCALE	**Spearman's rank correlation coefficient**	
	rho	**p**
TCMS SSB	0.690	p<0.001
TCMS DSB	0.743	p<0.001
Selective movement control	0.739	p<0.001
Dynamic reaching	0.676	p<0.001
Total TCMS	0.767	p<0.001

TCMS: Trunk Control Measurement Scale, TCMS-SSB: Trunk Control Measurement Scale-Static Sitting Balance, TCMS-DSB: Trunk Control Measurement Scale-Dynamic Sitting Balance, SCALE: Selective Control Assessment of the Lower Extremity

DISCUSSION

The objective of this study was to explore the association between trunk control and selective motor control in ambulatory children with CP. The results of the study showed that children with spastic CP had a general trunk control deficit that was associated with lower limb selectivity. The TCMS total score and sub-scores and the SCALE score have been demonstrated to be significantly correlated. This can be the first study that examines at the association between Turkish children with CP's TCMS and SCALE scores. A previous study found that the control of the trunk was correlated with the selectivity in Korean children with CP (6). Similar studies on the impact of poor selective motor control have been reported in most cases, indicating that selectivity impacts balance, motor function and gait parameters in children with CP (9,20-22). In addition to these existing studies in the literature, our study revealed that loss of selective motor control was also associated with trunk control.

The results of our study showed that there was a difference between the SCALE score according to the GMFCS levels. Additionally, pairwise comparisons showed that GMFCS levels I–II, I–III, and II–III differed significantly in SCALE ratings. This finding revealed that as the GMFCS score increased, the SCALE score decreased. In other words, as the severity of the motor impairment increased, there was a decrease in the ability to move selectively in children with CP. Our study's findings are consistent with those of earlier research in the literature (3,18). Tuncdemir et al. reported a significant difference between levels I-II, I-III and II-III, similar to our study (18). Children with GMFCS levels I and II had significantly different SCALE scores than those reported by Balzer et al., whereas children with GMFCS levels II and III did not significantly differ in their SCALE scores (3). In contrast to our research, Balzer's study revealed no significant distinction between levels II and III. In this study, it was stated by the authors that the small number of patients in level 2 may affect the results of the study. Numerous CP-related problems, including weakness, a lack of reciprocal inhibition, and hyperreflexia, may be explained by central nervous system (CNS) damage (9). The more severe the damage to the CNS is, the more problems there are. This may explain the strong correlation between the GMFCS levels, a marker of the severity of motor impairment, and selective movements. Increasing the severity of impairment may lead to a decrease in the loss of selective movement in these children. Therefore, we believe that selective movements should also be evaluated in children with all levels of motor impairment.

The study findings showed that there was a moderate to strong association between the sub scores and total scores on the TCMS and SCALE. This result revealed that good lower limb selective control was associated with good trunk control. Our results were similar to those of Lim et al. (6). Their findings demonstrated a strong connection between the Korean-TCMS scores and the SCALE score. Trunk control impairment affects functional ability, according to Panibatla et al. (23). The control of the trunk and the ability to balance show that the trunk control is an essential part of the functional ability of the CP (23). Their findings indicated that trunk stability during upper and lower extremity movements influences one's capacity to perform functional tasks. Furthermore, a trunk-focused intervention to increase the TCMS score has been demonstrated to enhance balance performance and gross motor function (23). As can be understood from this study, the trunk is the basis for all limb movements and balance and daily performance. The results of our study additionally show that the trunk is strongly associated with lower limb selectivity. In this way, we can also obtain important information about the trunk with SCALE, which is an easier and time-saving assessment tool.

The TCMS static and dynamic sitting balance items were related to the total SCALE score in this study. This is consistent with early research by Balzer et al and Lim et al, who reported a significant relationship between the SCALE and TCMS (6,10). The TCMS dynamics revealed a strong relationship with SCALE. The dynamic reach parameter is a part that can be used alone in terms of balance assessment (15). This result shows that SCALE assessment can also provide insight into the balance of children with CP.

This study has a number of limitations. First, participants in this study included all children with GMFCS levels I, II and III who were able to sit independently for at least 45 minutes; those who were unable to do so were excluded. In addition, as this study only included children with spastic CP, the results cannot be extrapolated to other children with CP. We believe that future studies with different types of CP will contribute to the results of our study.

CONCLUSION

To summarize, this study investigated the relationship between selective lower limb control and trunk control in spastic CP. TCMS scores and overall SCALE scores were significantly positively associated. This study implies that trunk control is necessary for lower limb function and selective movement, and that trunk control is the basis of lower limb selective control. Therefore, a trunk control examination and intervention should be considered while attempting to enhance the selective control of a CP's lower extremities.

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