



ASSOCIATION BETWEEN UPPER LIMB FUNCTION AND FUNCTIONAL BALANCE IN CHILDREN WITH SPASTIC CEREBRAL PALSY

Physiotherapy

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ABSTRACT

BACKGROUND

Cerebral Palsy (CP) describes a group of permanent disorders of the movement development and posture, which causing activity limitations. Seventy to eighty percent of children with cerebral palsy have spastic clinical features. Usually, upper limb impairment occurs in 50% to 70% of individuals with CP. Trunk balance is proposed to be an important contributor to voluntary upper extremity function, including motor control and dexterity in children with spastic CP. Some studies have found correlations between static posture and upper extremity function, but very few studies have compared functional balance and upper limb function in children with spastic CP. If there is any correlation found between functional balance and upper limb function, then treatment approaches can focus on balance training in order to improve upper limb function along with functional balance. Hence, this study was conducted to find if a correlation exists between upper limb function and functional balance.

OBJECTIVES

To determine correlation between upper extremity function and functional balance in children with spastic CP.

METHODOLOGY

Thirty children (age range 5-12 years, Gross Motor Function Classification System (GMFCS) Level I-III) with spastic CP were recruited for this cross sectional study and evaluated using Pediatric Balance Scale (PBS) and Quality of Upper Extremity Skill Test (QUEST).

RESULTS

On analysis using the Karl Pearson's correlation coefficient, it was seen that there was a significantly strong positive correlation between QUEST and PBS scores with $r=0.682$ and $p=0.000$

CONCLUSION

Findings of this cross sectional study show that there is a strong positive relationship between upper limb function and functional balance. Interventions to improve trunk control and balance may improve performance of upper limb function measures. Further studies are required to determine the influence of balance function on upper limb function.

KEYWORDS

Spastic cerebral palsy, Functional balance, Upper limb function.

INTRODUCTION

Cerebral Palsy (CP) describes a group of permanent disorders of the development of movement and posture, causing activity limitations that are attributed to non-progressive disturbances that are occurred in the developing fetal or infant brain¹. One of the most basic functions of living organisms is the ability to control and move the body in space². Damage to the central nervous system cause disorders in neuromuscular, musculoskeletal and sensorial systems which leads to major motor disability³.

Seventy to eighty percent of children with cerebral palsy have spastic clinical features and affected limbs may demonstrate increased deep tendon reflexes, tremors, muscular hyper tonicity, and weakness^{4,5}. Increased tone in upper and lower extremities leads to difficulties in postural control in children with spastic CP⁶.

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 instability⁷. Poor balance also hampers the performance of functional activities of daily living⁸.

The upper extremity is frequently affected in children with cerebral palsy. Arm movements, such as reaching and grasping, are essential for various activities of daily life. Almost 50% of children with CP present an arm-hand dysfunction^{9, 10}. The Quality of Upper Extremity Skill Test (QUEST) is an outcome measure that evaluates movement

patterns and hand function in children with cerebral palsy¹¹. The QUEST groups upper limb movement into four domains. Each domain focuses on areas of difficulty typically seen in children with spastic cerebral palsy: (a) Dissociated Movements, it measures ability to voluntarily isolate movement at the shoulder, elbow, wrist and fingers; (b) Grasps, which measures grasp function also rates sitting postures during grasps of 1 inch cube, cereal, pencil or crayon; (c) Weight Bearing, in this domain evaluate the ability to lean on the arms in prone or 4-point kneeling and sitting; and (d) Protective Extension evaluates using the arms to stop oneself from falling forward, backward and to the side.

The Pediatric Balance Scale (PBS) is a modification of the Berg Balance Scale and it is useful for assessing the functional balance of preschoolers and school aged children with CP¹². PBS consists of 14 tasks similar to activities of daily living.

Trunk stability is essential for limb movements. Trunk has an interdependent relationship with other body parts and nervous tissues¹³. In normal developmental processes, trunk stability is related to the movement of the limbs. When the trunk is stable, the upper and lower limbs are freely usable for their normal purposes¹⁴. Trunk control is essential for maintaining body balance and is also required for a stable base of support which is necessary to execute functional activities for limb movements¹⁵. Because of this relationship between functional balance and trunk control, which is essential for a good upper extremity function, this study was conducted in order to

correlate QUEST (upper extremity function) and PBS (functional balance) scores.

Various aspects of the sitting position in children with CP have also been investigated but very few studies have compared functional balance and upper limb function in children with CP^{16, 17,18,19}. If there is any correlation found between functional balance and upper limb function, then treatment approaches can focus on balance training in order to improve upper limb function along with functional balance. Hence, this study was conducted to find if a correlation exists between functional balance and upper limb function.

MATERIALS AND METHODS

The study was conducted during the period May 2017 to May 2018. Purposive sampling was used to recruit subjects into the study. Study setting was special schools around a tertiary care teaching hospital in Dakshina Kannada district, Karnataka, India; permission was obtained from the concerned authoritarians from the special schools. The study protocol was approved by the Institutional Ethical Committee (AJ Institute of Medical Sciences And Research Centre).

Children of 5 to 12 years of age diagnosed with spastic cerebral palsy and of GMFCS levels I, II and III, who were able to understand the test instructions and able to sit without trunk and feet support were recruited for this cross-sectional study. Exclusion criteria were children with any deformities/contractures in upper extremity, incompatible degree of comprehension and cooperation for performance of the activities proposed, and children with any visual and hearing impairment. After initial screening of the participants a total of thirty children who fulfilled the inclusion criteria were included. Informed consent was taken from the parents of the children. The subjects were evaluated using Pediatric Balance Scale (PBS) and Quality of Upper Extremity Skill Test (QUEST).

RESULTS

Descriptive statistics showed that the minimum age of participants were 5 years and maximum was 12 years, and mean age of the 30 subjects were 9.9± 2.55. The participants were scored minimum score of 3 (i.e. poor balance) on PBS and maximum of 52 (i.e. good balance skills). The mean score was 34.10± 14.62. The participants were scored minimum score of 27.23 on QUEST and maximum of 86.93 (i.e. good upper limb function) with a mean score of 57.56± 15.74.

On analysis using the Karl Pearson's correlation coefficient, correlation showed moderate positive correlation between QUEST and PBS scores. Correlation coefficient r value is 0.682 with p= < 0.001 which showed very high significance with QUEST and PBS.

Pearson's correlation was done between each domains of QUEST and PBS in the 30 samples. Statistical analysis described that PBS scores showed a very high significance with all four domains of QUEST. The correlations are shown in table 1.

	TOTAL(QUEST)	Dissociated Movement	Grasp	Weight Bearing	Protective Extension	
PBS	r	.682	.613	.537	.570	.538
	P	.000	.000	.002	.001	.002
	N	30	30	30	30	30

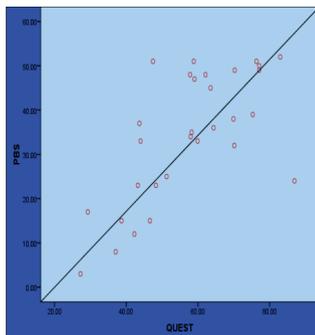


Figure 1: Scatter diagram of correlation between PBS and QUEST total scores

DISCUSSION

Functional balance is very much required for attaining good postural

stability. In children with spastic CP their ability to control body posture and functional balance will be affected, which leads to many functional disabilities. The present study was conducted to determine the correlation between upper limb function and functional balance by using Quality of Upper Extremity Skill Test and Pediatric Balance Scale in children with cerebral palsy. The results showed that there was a strong positive correlation between these outcome measures.

In the present study we included children who were of GMFCS levels I, II, and III i.e. children who were ambulating independently with or without assistive devices. Among the thirty children included in the study 23 were boys and 7 girls. Most of the subjects were in GMFCS level I, and it accounts for 50% of total participants. 23.33% subjects were in GMFCS level II and the remaining subjects were in GMFCS III, which is around 26.67 %. For classifying gross motor function in CP, the primary factor has been indicated to be the ability to maintain static postural balance while executing dynamic activities, which made up of 67% and the remains 33% was made up of other factors like muscle tone and muscle force.

Though the PBS measures standing balance, it has been seen to be highly correlated with measures of trunk control. Trunk control and balance are essential elements of the functional abilities of children with CP. A study by Panibatla S et al has shown that the static sitting balance, dynamic sitting balance and dynamic reaching as measured by Trunk Control Measurement Scale strongly correlated with the scores of PBS²⁰. Because of this relationship between standing balance and trunk control, which is essential for a good score on QUEST, this study chose to correlate PBS and QUEST scores.

According to neuro-developmental principles, movements of extremities are controlled in proximo-distal fashion with the trunk. Reaching distance seems to be a crucial factor in choosing a movement strategy for both healthy persons and children with CP. The arm, hand, and trunk are programmed together in a fixed temporal order during the reaching movement to assist transporting the hand to the target in a precise way²¹.

Balance and upright postural control are fundamental components of movement which plays a major role in maintaining the body in equilibrium^{19, 22}. Postural control development during early life is a complex and long term process. During this process of development, the postural control mechanism provides a vertical posture of stabilizing head and trunk against gravity to allow a proper base for performing adequate activities like sitting, reaching, standing and walking²³. The trunk plays a key role in maintaining the postural control mechanism and also in the organization of balance reactions in this developmental process. The trunk control is also required for a stable base of support which is necessary to execute functional activities for limb movements²⁴.

PBS is easy and may be a less expensive alternative to be used in clinical practice. It is a reliable and valid tool for children with CP and can be used to evaluate balance and detect small changes in their functional balance.

The QUEST groups upper limb movement into four domains. Each domain focuses on areas of difficulty typically seen in children with spastic cerebral palsy: (a) Dissociated Movements, it measures ability to voluntarily isolate movement at the shoulder, elbow, wrist and fingers; (b) Grasps, which measures grasp function also rates sitting postures during grasps of 1 inch cube, cereal, pencil or crayon; (c) Weight Bearing, in this domain evaluate the ability to lean on the arms in prone or 4-point kneeling and sitting; and (d) Protective Extension evaluates using the arms to stop oneself from falling forward, backward and to the side. In addition to the four domains of movement the QUEST also has three scales: Hand Function, Spasticity and Cooperativeness. However this scale does not measure certain aspects of hand function like grip strength, and that has been quoted as a limitation of its utility.

Trunk control and balance are essential elements of the functional abilities of children with CP. The ability to perform functional activities is dependent on the stability of the trunk to carry out the movements of upper and lower extremities. This is then leads to the relationship of dynamic balance and upper limb function, as demonstrated by the present study. Therefore, it can be assumed that trunk targeted interventions for improvement of trunk stability

increases gross motor function and thus performance on PBS as well as upper limb functions.

LIMITATIONS

The current study had the following limitations, namely, a relatively small sample size and lack of homogeneity of the sample, since we have included different topographical groups. The QUEST is a good outcome measure for evaluate upper limb function, but it is not sufficient to examine whole upper limb function such as hand grip strength. Functional balance was assessed using PBS which includes more of standing activities and lack trunk control measure components. The study only measured the relationship of upper limb function and functional balance at a given point of time. Further studies should examine the effect of interventions improving dynamic balance on upper limb function in similar populations.

CONCLUSION

Findings of this study showed that there is a relationship between upper limb function and functional balance. Statistical analysis reveals that there is very high significance in between QUEST and PBS and there is a moderate positive correlation found between these outcome measures. Interventions to improve trunk control and balance may improve performance of upper limb function measures. Further studies are required to determine the influence of balance function on upper limb function.

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Ethical clearance: Ethical clearance was obtained from Institutional Ethical Committee of AJ Institute of Medical Sciences And Research Centre.

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