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Original Article

Effectiveness Of Core Stability Training On Balance And Gross Motor Function Among Spastic Cerebral Palsy Subjects

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ABSTRACT

Background: Spastic cerebral palsy commonly affects balance, trunk control, and gross motor function in children, limiting their functional independence. Core stability training is considered an effective physiotherapy intervention to improve postural control and movement performance. Objective: To evaluate the effect of core stability training on balance and gross motor function in children with spastic cerebral palsy. Methodology: A pre-experimental study was conducted among 10 children aged 4–12 years with spastic cerebral palsy. Participants underwent structured core stability training three times per week for 8 weeks. Balance and gross motor function were assessed before and after intervention using the Pediatric Balance Scale (PBS) and Gross Motor Function Measure-88 (GMFM-88). Data were analyzed using a paired t-test. Results: Significant improvements were observed after the intervention. The mean PBS score increased from 47.6 to 52.3, while the mean GMFM-88 score improved from 86.7 to 92.1, showing statistical significance at $p < 0.005$. Conclusion: Core stability training effectively improves balance and gross motor function in children with spastic cerebral palsy and may enhance functional independence and quality of life.

Keywords: Spastic cerebral palsy, core stability training, balance, gross motor function, pediatric balance scale, GMFM-88.

INTRODUCTION

Cerebral palsy refers to a group of conditions sharing the features of a central motor deficit which is non-progressive pathologically and is acquired in early life[1]

The prevalence of cerebral palsy refers to the number of cases present during a specific period of time and is usually calculated as an age-specific prevalence rate. A reasonable estimate of the prevalence of cerebral palsy at school age is about 1.5 to 4 per 1,000 live births. The incidence of a condition refers to the number of new cases occurring within a defined time period in a population at risk and health care facilities and survival rate of high risk infants across different regions[2]

From an aetiological perspective, cerebral palsy may originate during the prenatal, perinatal or postnatal period. The severity of impairment varies widely, ranging from mild limitations to severe disability, with some children showing subtle difficulties that may not be immediately apparent. Topographically, the condition is described based on limb involvement, including monoplegia, diplegia, paraplegia, triplegia, tetraplegia, and pentaplegia. Physiologically, cerebral palsy can be categorized as spastic, ataxic, dyskinetic, or mixed, depending on the nature of motor dysfunction[1]

Among the different types, spastic cerebral palsy is the most common accounting for approximately 70–80% of cases. It is primarily caused by damage to the motor regions of the brain, especially the corticospinal tract, which is responsible for controlling voluntary muscle movements. This damage leads to spasticity, characterized by increased muscle tone, muscle stiffness, particularly in the adductors, exaggerated deep tendon reflexes, and positive extensor plantar responses. Children with spastic cerebral palsy often display a scissoring gait due to muscle imbalance. When intellectual impairment is present, it is usually less severe in

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children with spastic diplegia compared to other forms of cerebral palsy[3]

Children with spastic cerebral palsy commonly experience difficulties in trunk stability, balance and coordination along with delays in achieving gross motor milestones such as sitting, standing, and walking. Trunk control is a critical component for performing these functional tasks. When trunk stability is compromised and postural control is affected which can significantly limit independence in daily activities[4]

The underlying pathophysiology of spastic cerebral palsy involves injury to the immature brain regions responsible for motor control. This injury may occur before, during or shortly after birth and affects the corticospinal tract which is essential for transmitting signals from the brain to the muscles. Damage to this pathway increases the sensitivity of the stretch reflex resulting in heightened muscle tone, stiffness, and exaggerated reflex responses. Consequently children face difficulties in controlling smooth coordinated movements which affects posture, balance, and the execution of everyday motor tasks[5]

This neurological disruption leads to an imbalance between inhibitory and excitatory signals within the central nervous system. The resulting impaired neural regulation affects muscle coordination, movement precision and postural control. Over time these motor impairments can lead to secondary complications such as joint deformities, muscle contractures and reduced functional abilities. These changes may progressively restrict mobility and hinder participation in daily activities further impacting independence and overall quality of life[6]

The balance and gross motor function are measured by pediatric balance scale and gross motor function measure-88**.** The pediatric balance scale is a 14-item functional balance assessment adapted from the berg balance scale to evaluate balance performance in school-aged children with motor impairments[7]

The gross motor function measure-88 is a standardized tool used to assess and monitor changes in gross motor skills in children with cerebral palsy. The gross motor function measure is a standardized observational tool designed to evaluate change in gross motor function in children with cerebral palsy across five functional dimensions like lying, rolling, sitting, crawling, kneeling, standing, walking, running and jumping. Gross motor function measure helps to assess baseline function, therapy goal and track progress after treatment of physiotherapy providing useful data for both clinical and research purposes[8]

Despite the availability of various physiotherapy approaches there remains a need for evidence-based exercise programs that specifically target core stability in children with spastic cerebral palsy. Core stability is defined as the ability to control the position and movement of the trunk over the pelvis allowing efficient generation and transfer of force to the extremities. It plays a vital role in maintaining posture, balance, and controlled movements during both static and dynamic tasks. Strengthening core muscles can enhance postural control, improve balance and support better functional performance. Therefore, the current study aims to evaluate the effectiveness of core stability training on balance and gross motor function in subjects with spastic cerebral palsy[9]

2. MATERIALS AND METHODS

A. Study Design

A pre-post experimental study was carried out at R.V.S. College of Physiotherapy, Sulur, Coimbatore, to evaluate the effectiveness of core stability training on balance and gross motor function among spastic cerebral palsy subjects.

B. Subjects

A total of 10 subjects were selected for the study based on the following inclusion and exclusion criteria. The inclusion criteria were: (1) children clinically diagnosed with diplegic spastic cerebral palsy, (2) age between 4 and 12 years, (3) both male and female participants, (4) children classified under Gross Motor Function Classification System (GMFCS) Levels I and II, (5) subjects able to follow simple verbal commands, (6) medically stable children fit for physiotherapy intervention, and (7) subjects whose parents or guardians were willing to provide informed consent.

The exclusion criteria were: (1) subjects with uncontrolled seizures, (2) severe musculoskeletal deformities, (3) severe cognitive, visual, or hearing impairments, (4) subjects with cardio respiratory disorders, and (5) subjects undergoing other intensive rehabilitation programs.

C. Methods

Ethical clearance was obtained prior to the study. A pre-test and post-test experimental study design was used. A total of 10 children with diplegic spastic cerebral palsy who fulfilled the inclusion and exclusion criteria were selected by convenient sampling. The participants underwent a structured core stability training program for 8 consecutive weeks, with sessions conducted three times per week. The intervention included progressive exercises such as abdominal draw-in, trunk twisting, bridging exercises, medicine ball twists, and plank exercises. Balance and gross motor function were assessed before and after the intervention using the Pediatric Balance Scale (PBS) and Gross Motor Function Measure-88 (GMFM-88). The collected data were analyzed statistically using the paired t-test to determine the effectiveness of the intervention.

D. Description of the intervention

The study was conducted in a calm and comfortable environment to help the child remain relaxed and focused. The procedure was explained to both the child and caregiver before starting, and sufficient time was provided for familiarization with the environment and materials. Instructions were given clearly and consistently according to standardized guidelines, with demonstrations provided when necessary. Short rest periods were allowed between tasks to prevent fatigue, and the child's responses and performance were carefully observed and documented based on the assessment scoring guidelines.

The treatment procedure consisted of a progressive core stability training program conducted three times per week for 8 consecutive weeks. Level 1 exercises included abdominal draw-in, double knee-to-chest, and supine trunk twist exercises to improve abdominal activation and trunk mobility. Level 2 included supine trunk bridging and medicine ball twists to enhance trunk stability and dynamic core control. Level 3 consisted of trunk bridging with back support on a physio-ball and prone bridging (plank) exercises to improve balance, postural control, and core strength. Each exercise was performed within a pain-free range with adequate rest intervals between exercises.

Abdominal draw-in

The patient was positioned in crook lying, and the abdominal draw-in maneuver was performed by gently pulling the lower abdomen inward while maintaining normal breathing. The contraction was held for 5–10 seconds and repeated for 20 repetitions.

Double knee-to-chest

Abdominal draw-in with double knee-to-chest is performed by maintaining the abdominal contraction and slowly bringing both knees towards the chest, holding for about 5 seconds, and then returning to the starting position; this is repeated for 10–20 repetitions.

Supine trunk twist exercises

Supine trunk twist is performed with knees flexed together the patient tightens the abdominal muscles and slowly lowers both knees to one side within pain-free range, holds for 5 seconds, and returns to the starting position, then repeats on the opposite side. This exercise is performed for 10–20 repetitions.

Supine trunk bridging

Supine trunk bridging performed in supine lying to improve trunk stability and dynamic core control. The patient first performs supine trunk bridging by lying in crook lying position with arms by the side. The patient tightens the abdominal muscles and slowly lifts the pelvis off the bed until the hips are aligned with the trunk and shoulders. The position is held for about 5–10 seconds and then the pelvis is slowly lowered back to the starting position. This exercise is repeated for 3–5 repetitions.

Medicine ball twists

Supine medicine ball twists are performed in supine lying with hips and knees flexed. The patient holds a medicine ball (or weight) with both hands and performs controlled trunk rotation by moving the arms with the ball from one side to the other while maintaining abdominal contraction and keeping the pelvis stable. The movement is performed slowly within pain-free range and repeated for 10–20 repetitions.

Trunk bridging with back support on a physio-ball

The patient first performs trunk bridging with back supported on physio-ball. The patient sits with the back supported on a physio-ball and feet placed firmly on the floor. The abdominal muscles are tightened and the pelvis is lifted to achieve a neutral trunk position while maintaining balance on the ball. The position is held for about 3–5 seconds and then slowly returned to the starting position. This exercise is repeated for 3–5 repetitions

Prone bridging

Prone bridging (plank) is performed by positioning the patient in prone lying supported on forearms and toes. The body is lifted off the surface while maintaining a straight line from head to heel. The abdominal and trunk muscles are kept contracted without holding breath. The position is maintained for 3–5 seconds and then relaxed. This exercise is repeated for 3–5 repetitions.

3. DATA ANALYSIS AND RESULTS

Ten subjects with spastic cerebral palsy underwent a core stability training program for 8 weeks. Balance was assessed using the Pediatric Balance Scale, and gross motor function was measured using the Gross Motor Function Measure-88 before treatment and at the end of eight weeks.

The analysis of the Pediatric Balance Scale showed a statistically significant improvement in balance following core stability training in subjects with spastic cerebral palsy. The calculated paired ‘t’ value was 18.081, which was higher than the table value of 3.250 at the 0.005 level of significance, indicating the effectiveness of the intervention. The graphical representation also demonstrates the improvement in balance after the treatment period.

The analysis of the Gross Motor Function Measurement Scale showed a statistically significant improvement in gross motor function following core stability training in subjects with spastic cerebral palsy. The calculated paired ‘t’ value was 24.42, which was higher than the table value of 3.250 at the 0.005 level of significance, indicating the effectiveness of the intervention. The graphical representation also demonstrates the improvement in gross motor function after the treatment period.

4. DISCUSSION

The present study aimed to evaluate the effect of core stability training on balance and gross motor function in subjects with spastic cerebral palsy. The findings demonstrated significant improvement in both balance and gross motor abilities following the intervention. These improvements may be due to enhanced trunk muscle strength and postural control achieved through core stability exercises. Children with spastic cerebral palsy commonly exhibit poor trunk control, which affects balance and functional movements. Core stability training strengthens the abdominal and back muscles, helping to maintain the center of gravity within the base of support and improving activities such as sitting, standing, and walking.

The findings are supported by Nancy Mohamed et al. (2025), who reported significant improvements in balance, gait, and gross motor function following core stability training. Their study explained that trunk stabilization improves the length–tension relationship of upper and lower limb muscles and facilitates better spinal muscle contraction, resulting in more coordinated and purposeful movement.

Similarly, Mostafa (2019) compared whole-body vibration and core stability training in children with spastic cerebral palsy and reported that core muscle strengthening improves postural control and balance by stabilizing the central part of the body and supporting controlled limb movement.

Huang Y C et al. (2020) also reported improvements in gait and motor performance following core strengthening exercises. Their study suggested that improved trunk function and balance result from the coordinated action of passive, active, and neural control subsystems, thereby enhancing walking ability and overall motor function.

In addition, Iona Novak et al. (2020) emphasized the importance of evidence-based physiotherapy interventions, including strengthening and task-specific training, in improving functional outcomes in children with cerebral palsy. Their findings support structured rehabilitation programs targeting trunk control through neuroplasticity and motor learning.

The outcome measures used in the present study, namely the Pediatric Balance Scale and Gross Motor Function Measure, showed significant improvement after the intervention. Improved scores reflected better static and dynamic balance, as well as enhanced gross motor abilities such as standing and walking.

Therefore, the findings of the present study are consistent with previous literature and confirm that core stability training is an effective intervention for improving balance and gross motor function in children with spastic cerebral palsy. Incorporating core strengthening exercises into physiotherapy programs may improve functional independence, postural control, coordination, and quality of life.

CONCLUSION

The present study was conducted to evaluate the effect of core stability training on balance and gross motor function in children with spastic cerebral palsy. The results demonstrate significant improvement in both balance and gross motor performance following the intervention. These improvements can be attributed to enhanced trunk control, postural stability, and better neuromuscular coordination achieved through core strengthening exercises. Outcomes measures such as the pediatric balance scale and gross motor function measure showed noticeable improvements after the training period. Therefore, it can be concluded that core stability training is an effective physiotherapy intervention for improving functional abilities in children with spastic cerebral palsy. Incorporating these exercises into rehabilitation program can enhance functional independence and overall quality of life.

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