Effectiveness of Vestibular Stimulation Training in Cerebral Palsy

Mandar Malawade[1], Tahura Shabnam Shaikh[2]

[1]*Faculty of Physiotherapy, KIMS, Karad 415110,*
[2]*Dr. APJ Abdul Kalam College of Physiotherapy, Loni BK, Ahmednagar*

Abstract

Introduction: Various studies are carried out to improve posture and balance in children with cerebral palsy by using different approaches. But the aspect of vestibular stimulation exercises on improving posture and balance in children with CP have not yet been studied. Hence this study is design to see the effect of vestibular stimulation exercises on posture and balance in children with CP.

Methodology: Thirty children with clinical diagnosis of Cerebral palsy, were randomly allocated into control group and interventional group. Participants in control group were given Conventional Physiotherapy. Participants in intervention group were given Conventional Physiotherapy and vestibular stimulation exercises.

Results: The result of the study found extreme significant effects of the conventional physiotherapy in control group and extreme significant effects of conventional physiotherapy and vestibular stimulation exercises on posture and balance in children with CP in intervention group according to the results of the GMFM-88 and PBS. There is significant difference in mean score of GMFM-88 and PBS in intervention group as compared to the control group.

Conclusion: There will be significant effect of vestibular stimulation exercises on posture and balance in children with CP.

Keywords: *Cerebral Palsy, Vestibular Stimulation, Posture, Balance.*

Introduction

Cerebral palsy (CP) is well recognized neurodevelopmental condition beginning in early childhood and persisting through the lifespan. It is one of the most common causes of chronic childhood disability.[1,2,3] It is a descriptive term applied to a group of motor disorders of young children, in whom full function of one or more limbs is prevented by paresis, involuntary movement, or incoordination.[4,5] It varies extremely from very mild to very severe motor disabilities with many comorbidities and complications.[6,7,8]

It is estimated that the worldwide incidence being 2 to 2.5 per 1000 live births.[9,10,11] In the United States, it is estimated that approximately 764,000 children and adults manifest one or more of the symptoms of CP and that 10,000 babies born annually develop CP and 1200–1500 are diagnosed at preschool age.[12,13,14] Globally, CP prevalence data show some geographic differences, but overall, population-based reports have shown a fairly stable rate among the term group at 1 to 1.5 per 1,000 live births. In India the incidence of CP is high and it is 3 per 1000 live births.[15,16, 17]

Corresponding Author:
Mandar Malawade
Associate Professor, Krishna College of Physiotherapy, KIMS, Karad 415110
Contact No.: +919923421636
e-mail: mandarmalawade@gmail.com

Commonly in CP child's leg and hip muscles are tight. The gait is typically characterized by a crouch gait where the knees are extensively flexed and ankles are in planter flexion. Lack of direction specificity in the leg muscles during backward body sway, points to a basic deficit in balance and postural control.[9, 18, 19]

CP is characterized by insufficient force generation by affected muscle groups and decreased movement of force output.[20] The condition for normal growth appear to be regular stretching of relaxed muscle under normal physiologic loading, but in CP the skeletal muscle may not relaxed during normal stretching activity and furthermore, greatly reduced forces are generated during movement.[21] In CP the impairment of posture and balance are due to poor selective control of muscle activity, poor regulation of muscle activity in anticipation of postural changes and body movements and decreased ability to learn unique movements.[22, 23] In healthy individuals, changes in posture and maintenance of balance are preceded by preparatory muscle contractions that stabilize the body, whereas in CPthere is poor anticipatory regulation of muscle sequencing during maintenance of posture and.[24, 25]

Vestibular system is one of the sensory systems to control posture, equilibrium, balance and orientation. The vestibular system works on the principle of three reflexes, the vestibulocularreflex, vestibulospinal reflex and vestibulocollic reflex. These reflex pathways are responsible for postural control, making compensatory movements and adjustments of body in position.[26] Vestibular system also involved in the function of maintaining visual fixation during head movement and in maintaining posture. The studies suggest that, vestibular system is one of the systems affected in the children who have damage to the brain during birth, which is one of the causes for postural imbalance and poor equilibrium.[27]

In physiotherapy the children with CP are managed by different approaches but very few studies are available to find effects of vestibular stimulation in CP. Thus the study aimed to find its effects in managing CP.

Methodology

Thirty participants with clinical diagnosis of Cerebral palsy were included in the study. They were randomly allocated into control group (group A) and interventional group (group B). Training was given once a day, thrice a week for total 6 weeks. For control group, the training duration for each session was 30 minutes with 5 minutes of rest period and for intervention group, 60 minutes with 10 minutes of rest period in between.

Participants in group A were given Conventional Physiotherapy. It included Passive Soft tissue elongation of tight muscles, Lower limb resistance exercises, Movement transitions, balance board and foam board standing, walking and stair climbing.

Participants in group B were given Conventional Physiotherapy and vestibular stimulation exercises. It included Conventional Physiotherapy was the same as given to the control group andVestibular Stimulation Exercises such as Swinging in standing in all directions, trampoline jumps, rocking movement in rocking chair, gaze stabilization exercises and visual pursuit exercises under supervision. Pre and post intervention data for Pediatric Balance Scale and GMFM-88 was taken for data analysis.

Data Analysis: Statistical analysis was done using Graph Pad InStat software- Trail version 3.10. Statistical measures such as mean, standard deviation (S.D) and test of significance such as Unpaired 't' test were utilized to analyze the data. The results were concluded to be statistically significant with $p < 0.05$ and highly significant with $p < 0.01$.

Pediatric Balance Scale (PBS): The balance was measured with the help of the PBS score. In group A, the pre intervention mean PBS score was 33 ± 5.141 and the post intervention mean PBS score was 40.4 ± 4.595. The difference in pre and post intervention mean PBS score of group A was statistically extremely significant ('t' = 20.412, d.f = 14, 'p' < 0.0001). In group B, the pre and post intervention mean PBS score was 30.58 ± 6.037 and 43.67 ± 4.960. And the difference in pre and post intervention mean PBS score was statistically extremely significant ('t' = 32.867, d.f = 11, 'p' < 0.0001). The difference in pre intervention mean PBS score of the two groups was statistically not significant ('t' = 1.124, d.f = 25, 'p' = 0.1359). The difference in post intervention mean PBS score of the group A and group B was statistically significant ('t' = 1.772, d.f = 25, 'p' = 0.0443).

Table 1: Comparison between pre and post intervention mean PBS score in group A and group B

PBS	Group A	Group B
	Mean ± SD	**Mean ± SD**
Pre	33.00 ± 5.141	30.58 ± 6.037
Post	40.4 ± 4.595	43.67 ± 4.960
‘t’ value	20.412	32.867
d.f	14	11
‘p’ value	< 0.0001	< 0.0001
Result	Extremely significant	Extremely significant

Gross Motor Function Measure (GMFM-88):

The posture was measured with the help of the GMFM-88 score. In group A, the pre intervention mean GMFM-88 score was 58.14 ± 1.486 and the post intervention mean GMFM-88 score was 74.396 ± 0.963. The difference in pre and post intervention mean GMFM-88 score of group A was statistically extremely significant (‘t’ = 33.418, d.f = 14, ‘p’< 0.0001). In group B, the pre and post intervention mean GMFM-88 score was 57.076 ± 2.700 and 75.02 ± 0.534. The difference in pre and post intervention mean GMFM-88 score was statistically extremely significant (‘t’ = 20.319, d.f = 11, ‘p’< 0.0001). The difference in pre intervention mean GMFM-88 score of the two groups was statistically not significant (‘t’ = 1.302, d.f = 25, ‘p’ = 0.102). The difference in post intervention mean GMFM-88 score of the group A and group B was statistically significant (‘t’ = 2.006, d.f = 25, ‘p’ = 0.0279).

Table 2: Comparison between pre and post intervention mean GMFM-88 score of group A and group B

GMFM-88	Group A	Group B
	Mean ± SD	**Mean ± SD**
Pre	58.14 ± 1.486	57.076 ± 2.700
Post	74.39 ± 0.963	75.02 ± 0.534
‘t’ value	33.418	36.646
d.f	14	11
‘p’ value	< 0.0001	< 0.0001
Result	Extremely significant	Extremely significant

Discussion

In children with CP, poor posture and equilibrium are the common problems interfering in functional activity.[28] The vestibular apparatus is a part of inner ear or labyrinth which is responsible for maintaining posture and equilibrium of the body. It also helps to stand upright and move through space in antigravity position. It coordinates information from inner ear, visual, tactile and musculoskeletal system. Maintenance of an upright posture involves postural reflexes which include stretch reflex. They are aided by afferent sensory information from vestibular apparatus and efferent response is to the skeletal muscles.[26] The research suggest that, on standing upright, activity increases in the antigravity postural muscles to counteract the force of gravity**.** And this is maintained by vestibular apparatus.[28]

Vestibular inputs activated by a change in head orientation alter the distribution of postural tone in the neck and limbs. These are called Vestibullocollic and vestibular spinal reflexes. Antigravity muscles are the muscles in the body that are active during quiet stance and include gastrosoleus, tibialis anterior, gluteus medius, tensor fascia lata, Iliopsoas, thoracic erector spinae in the trunk along with intermittent activation of abdominals.[29] Vestibular nuclei control selectively the excitatory signals to the antigravity muscles to maintain upright posture and equilibrium by functioning in association with the pontine reticular nuclei via lateral and medial vestibulospinal tracts.[30]

In case of sensory integration dysfunction, there is possible role of the vestibular system stimulation in controlling muscle tonus. Stimulation of the vestibular system elicits a change in the tonic state of the skeletal muscle, specifically, the antigravity muscles. With the vestibular stimulation, normal muscular tone of the skeletal muscle can be obtained, thereby normalizing the postural tone.[31]

A study was carried out to find out reflex control of spine and posture in an attempt to identify the important role of the nervous system in maintaining reflex control of spine and posture. It concluded that visual and vestibular stimulation as well as joint and soft tissue mechanoreceptors play an important role in the regulation of static upright posture.[32]

During vestibular stimulation exercises, there are stimulation of the otholitic and semicircular canal system which are sensitive to linear and angular head acceleration. In response to these vestibular stimulation exercises the vestibular reflexes get stimulated which helps to maintain posture and equilibrium.[26] Few studies state that vestibular system plays an important role in balance and equilibrium and it reinforces the tone of extensor muscles of limbs and trunk thus is responsible for normal posture and gait.[29]

The child can be placed in a normal posture such as sitting, kneeling or standing so as to stimulate a normal muscular tone. This allows for normal somatosensory perception and integration for future motor response, thereby producing postural security. The mechanism of postural security can be assumed to involve the vestibular system, in such areas as maintaining control of the head in space and body equilibrium.[29]

Anatomically, the vestibular nuclei have a complex network of nerve fibers with the cerebellum which is described as the modulator of motor and postural activity. Vestibular primary and secondary fibers projects to the cerebellum and, in turn, the cerebellum projects fibers back to the vestibular nuclei to form feedback circuits. This intimate neuroanatomical relationship between the vestibular system and cerebellum suggests that the vestibular afferent fibers play a role in sensory integration and somatic responses through the cerebellum and helps in maintaining posture and equilibrium. However, the precise role of the vestibular system in overall motor performance is not entirely clear.[33, 34, 35]

The vestibular system controls the sense of movement, balance and coordination ofvision. It sends signals to the neural structures that control eye and body movements and helps in maintaining static balance. This is an instantaneous process so that the body maintains balance and equilibrium without think about it.[26, 27]The vestibular-ocular reflex by peripheral portion generates eye movements, which allow a clear view while the head is moving, while the vestibular-spinal reflex generates body motion compensation, to maintain head and postural stability and thus preventing falls.[36,]

Conclusion

The study concluded that both the vestibular stimulation exercises and conventional physiotherapy improve posture and balance in children with Cerebral Palsy, however, vestibular stimulation exercise group shows more improvement than conventional physiotherapy group.

Ethical Clearance: Taken from Krishna Institute of Medical Science Ethical committee.

Source of Funding: Self

Conflict of Interest: Nil.

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