

# Effects of Vestibular Stimulation on Balance in Children with Quadriplegic Cerebral Palsy

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## ABSTRACT

**Objective:** The objective of the study was to determine the effects of vestibular stimulation on balance in quadriplegic cerebral palsy.

**Methodology:** This was quasi experimental study in which total 44 quadriplegic cerebral palsy children were included who have no associated neurogenic conditions which may be aggravated with vestibular stimulation such as epilepsy or other orthopedic or functional complication. The children were assessed by an independent assessor before and after 6 weeks of vestibular stimulation. The assessment was made on gross motor measure and pediatric evaluation disability index. The data was analyzed using SPSS 20.0. Paired sample t test was used for pre-post testing.

**Results:** The descriptive statistics of paired samples regarding Gross Motor Function Measure showed mean and standard deviation to be  $49.61 \pm 1.75$  and  $64.54 \pm 1.04$  before and after treatment, respectively. Paired sample testing for pre-post treatment measurement of mean score of Gross Motor Function Measure (GMFM) showed that mean difference and standard deviation found to be  $14.93 \pm 1.90$  with a significant p value 0.00. The descriptive statistics of paired samples regarding Total PEDI score showed mean and standard deviation to be  $42.88 \pm 0.86$  and  $51.47 \pm 1.24$  before and after treatment, respectively. Paired sample testing for pre-post treatment measurement of mean score of total Pediatric Evaluation Disability Inventory (PEDI) showed that mean difference and standard deviation found to be  $8.59 \pm 1.48$  with a significant p value 0.00.

**Conclusion:** The findings of study concluded that vestibular stimulation has significant effect of vestibular stimulation on balance in quadriplegic cerebral palsy. Moreover, there were seen significant improvement in other domains such as behavior, emotions, psychology and interactive learning approach.

**Keywords:** Cerebral Palsy, Quadriplegia, Child, Vestibular Stimulation

## INTRODUCTION

Cerebral palsy is a non-progressive disorder. It is an umbrella term used for any type of damage to the immature brain. It may result in a wide range of neurological disorders involving both motor and sensory systems. It happens in the first 3 years of age. Cerebral palsy results in damage to the development of the brain which control balance, posture, and motor control.(1, 2)

The problem leading to cerebral palsy is main actor in pregnancy. However, it may occur during birth or short time after birth. Mostly the cause of cerebral palsy is unknown. There are many risk factors which include preterm birth or difficult labor or delivery process. Any underlying maternal infection may lead also lead to cerebral palsy.(3)

Several classifications exist based on neurological signs and topography, on motor function loss, on associated impairments, on severity of the clinical pattern and on the neuroimaging findings. For example if a child have stiff muscles it is called spastic cerebral palsy, if there is problem with balance and coordination it is called ataxic cerebral palsy. If the child has flaccid muscle tone it is labeled as flaccid cerebral palsy which is very uncommon. All the symptoms and pattern of cerebral palsy may get worse over time but the damage to the brain is permanent and do not progress with time. Cerebral palsy can be further divided into hemiplegia, diplegia and quadriplegia.(4)

Quadriplegic cerebral palsy which is also called tetraplegia is a form of cerebral palsy. In this type of cerebral palsy all four limbs, trunk and face is affected. As compared to other forms quadriplegia it is not total paralysis, instead all four limbs present with every movement associated with non-coordinated, jerky, or stiff patterns. Therefore, it is more like hypertonia as compared to typical paralysis. Even among all four limbs, some limb may present with most variety of movements as compared to the other in the same patient.(5)

Although the exact cause CP cannot be traced town, however, the reasons which may lead to quadriplegic CP include hypoxia, bleeding in the brain, abnormal development of brain and damage to the developing brain. Spastic quadriplegia can be

diagnosed in the early days of development. A presence of primitive reflexes or delays in a baby milestone such as rolling or sitting may be suggestive of spastic quadriplegia. MRI and CT scans can detect the damaged areas in the brain and can be correlated with clinical presentations. Cerebral palsy can result in a number of associated complications. These complications include issues with balance, gait, bone development, eating disorders, language disorders, and sleep disorders.(6, 7)

Balance is the fundamental component of motor control which enables to maintain a functional posture both static and dynamic. So whether it is standing or sitting or any static posture it is related to dynamic activities such as walking and running. Therefore a well-placed balance system should be there to achieve this. It is the system to maintain the center of gravity into base of support. There are many factors that contribute in establishing balance. Among these, the mechanical and neural systems are most important. In quadriplegic cerebral palsy the neural system is affected due to brain damage. Therefore, it is very important to improve or rehabilitate the balance issues in order to achieve any level of static or dynamic posture.(8, 9)

The mechanical system of balance mainly includes the vestibular system. The vestibular system is very important to achieve balance and any kind of coordinated movement. In cerebral palsy due to damage to the brain it is very unlikely that there can be any progress in damaged brain and so does its supply. However, the condition can be improved by minimizing complications and stimulating the mechanical system which is the vestibular system to enhance available balance and coordination. Therefore vestibular rehabilitation or vestibular stimulation becomes a very important parameter for improvement in quadriplegic cerebral palsy.(10-12)

## METHODOLOGY

It was quasi experimental study. There was single group with a pre-post testing approach. It was made ensured that all assessors were masked from treatment protocols the patients were receiving. So, it was a single blind study. The study was conducted

at Mobility Quest and Rehabilitation Center, Lahore. Convenience sampling technique was employed. The ample size was 44 calculated by using online epitool sample size calculator. The diagnosed patients with cerebral palsy of quadriplegic type of both genders with age range between 8-12 years were recruited while Patients with associated neurogenic conditions which may be aggravated with vestibular stimulation such as epilepsy, Patients having score more than level III gross motor function classification system, Patients having mixed symptoms from cerebral palsy types, Patients without response ability to auditory and visual stimuli, Patients with marked mental retardation that can interfere with response process and patients having VP shunt were excluded. All the patients were cerebral palsy and were assessed before the start of the intervention and after a 6-week intervention for every patient. An independent assessor completed the assessment process for every patient included in the trial. The assessment was based on the pediatric evaluation disability index and gross motor function scale. In addition to these gross motor classification scales was employed at the beginning in order to classify levels of independence in cerebral palsy patients.

The data analysis was performed by using a statistical package for Social Sciences i.e. SPSS 20.0 version. Paired samples t-test was used for pre and post-testing of all the variables.

**RESULTS**

The histogram with normal curve for age showed that mean and standard deviation was found to be 9.84±1.446 while the curve was normally distributed (Fig-1). The results regarding gender showed that there were 35(79.5%) male children and those of 9 (20.5%) females (Table-I).

The descriptive statistics of paired samples regarding Gross Motor Function Measure showed mean and standard deviation to be 49.61±1.75 and 64.54±1.04 before and after treatment, respectively. Paired sample testing for pre-post treatment measurement of mean score of Gross Motor Function Measure showed that mean difference and standard deviation found to be 14.93±1.90 with a significant p value 0.00 (Table-II).

The descriptive statistics of paired samples regarding Total PEDI score showed mean and standard deviation to be 42.88±0.86 and 51.47±1.24 before and after treatment, respectively. Paired sample testing for pre-post treatment measurement of mean score of Total PEDI showed that mean difference and standard deviation found to be 8.59±1.48 with a significant p value 0.00 (Table-III).

Table-1: Gender distribution of participants

	Frequency	Percent	Valid Percent	Cumulative Percent
Male	35	79.5	79.5	79.5
Female	9	20.5	20.5	100.0
Total	44	100.0	100.0	

The results regarding gender showed that there were 35(79.5%) male children and those of 9 (20.5%) females.

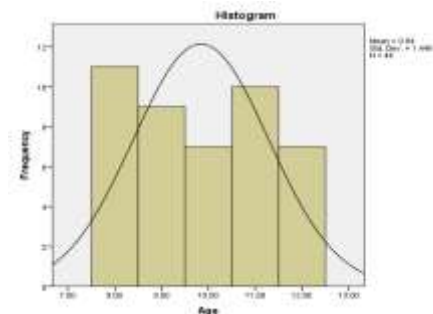


Fig-1: The histogram with normal curve for age (years) showed that mean and standard deviation was found to be 9.84±1.44 while the curve was normally distributed.

Table-2: Statistics for Gross Motor Function Measure (GMFM)

	Mean	N	Std. Deviation	Std. Error Mean
Before Treatment: Gross Motor Function Measure	49.61	44	1.75	0.26
After Treatment Gross Motor Function Measure	64.54	44	1.04	0.15

Table-3: Statistics for Total Pediatric Evaluation Disability Inventory (PEDI)

	Mean	N	Std. Deviation	Std. Error Mean
Before Treatment: Total PEDI	42.88	44	0.86	0.13
After Treatment Total PEDI	51.47	44	1.24	0.18

**DISCUSSION**

In this study the effect of vestibular stimulation has been tested in addition to routine physical therapy being provided in quadriplegic cerebral palsy patients. This was a 6-week plan in which vestibular stimulation was applied in a variety of ways. The patients were assessed in their motor and balance performance on gross motor function measure (GMFM) and pediatric evaluation of disability inventory (PEDI). The primary aim of the study was to enable the quadriplegic children to perform their daily activities living up to any level better than current status. The basics of the study were taken from literature which suggests that change in position may affect Labyrinth signal which in turn affect balance and functional challenges.

Khuldoos S.Ahmed et.al conducted a study in 2017 on the effect of vestibular stimulation on children with hemiparetic cerebral palsy. The study was conducted in younger children up to the age of 8 years. Both standard males and females were included in the study. The patients were divided into two groups. One group was receiving vestibular stimulation along with conventional physical therapy while the other group was receiving only conventional physical therapy. The treatment sessions were given for 2 months. Biodex system of balance control was used to assess balance before treatment and after two months of the treatment session. It was seen that the patients in vestibular stimulation showed a significant improvement in balance. (13) The results of current study are in concordance with this study.

Although there is no literature suggesting the exact mechanism of improving motor control and balance of cerebral palsy children with vestibular stimulation. Therefore it is hypothesized that vestibular stimulation can impact every type of sensory input which is dormant otherwise in patients of cerebral palsy to activate dormant synapsis of brain. In early studies regarding vestibular stimulation scooter board, toy horse, swing, tilting board and bolster therapy ball were used for providing vestibular stimulation. It was noticed that children with fair balance control who were using vestibular stimulation, there was a significant improvement in balance, coordination, motor control and functions of both hands and lower legs. With children who have low muscle tone, improved muscle tone was noticed by vestibular stimulation. It was observed that vestibular stimulation is an excellent motivator towards rehabilitation. Due to its neurological in nature and permanent damage to the brain, it takes time the effects of therapy can appear. (14-16)

Another study by Sun Joung Leigh was conducted in 2015 with a single subject design. In this study, a five-year-old child was taken who was diagnosed with hypotonic cerebral palsy. In this study, the effect of vestibular stimulation was seen on hypertonia in Cerebral palsy. The child was given three sessions per week for 10 weeks. He was evaluated with the Bayley scale and toddler scale. It was seen that his motor control improved significantly after taking the session of vestibular stimulation. Moreover, his overall movements and social interaction were also improved. (17) The results of our study are in line with this study.

This study was versatile in its scope and Measurement. It was noticed that there was an improvement in speech as well. Through vestibular stimulation children started to show improvement in joy and anxiety and other emotions which directly

or indirectly related to movement science. The Other adjacent improvement which was noted included improvement in sleep, decreased frequency of crying and less irritability. these changes have a potential impact on motor control and balance which in turn improved quality of life of children and its family members.(18, 19)

In short, it was seen that after adding vestibular stimulation, children with cerebral palsy showed significant improvement in all areas which were measured such as balance, motor function, gross motor function, mental and behavioral evaluation and even speech related and emotional domains also showed a marked improvement. Although, more sample size can reasonably let the results generalized, moreover, there were insufficient resources to make a thorough examination and assessment such as IQ level of children, their personality such as introvert or extrovert, because it also impact overall interaction and improvement in motor control related functions.(20, 21)

## CONCLUSION

The findings of study concluded that vestibular stimulation has significant effect on balance in quadriplegic cerebral palsy. Moreover, there were seen significant improvement in other domains such as behavior, emotions, psychology and interactive learning.

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