Effectiveness of Sensory Integration Therapy (Vestibular & Proprioception Input) on Gross Motor Functioning in Developmental Delayed and Spastic Diplegic CP Children

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Abstract: **These clinical trials were aimed to study the effectiveness of specific vestibular and proprioceptive stimulation to improve gross motor function in cerebral palsy (CP) spastic diplegic children.**

Methodology: A sample of Twenty six cerebral palsy children was selected in this study. All children were evaluated with GMFM-88, QUEST and Modified Ashworth Scale before and after the intervention. The Sensory Integration Therapy (SIT) was applied for 50 min, 4 days per week for 48 sessions .The experimental SIT therapy was divided into 3 phases of 16 sessions each .i.e. proprioceptive phase, vestibular phase and mixed phase in which tactile stimulation is constant. The activities were selected to give proprioceptive input in phase one, vestibular input in phase two and mixed input of Proprioception and vestibular in phase three along with tactile input.

Results: Results indicated marked improvement in gross motor functioning in the enrolled children with p=0.00. Modified Ashworth Scale also showed improvement with p=0.00.Occupational Therapist follows different strategies and approaches in the treatment of Cerebral Palsy. SIT techniques gives the child opportunity to experience not only its body in different positions but also in relation to its environment which they does not do due to their restricted body movements. Conclusion: This study shows beneficial effect of sensory integration therapy on cerebral palsy spastic diplegic and developmental delay children. SIT intervention had a significantly positive effect on gross motor function in the children with CP spastic diplegic.

Keywords: **Vestibular, Sensory integration, Cerebral palsy, gross motor, proprioception**

I. INTRODUCTION

Cerebral Palsy is the most common motor disability of childhood. Cerebral palsy children are delayed in development and due to abnormal muscle tone have somatosensory issues, mainly posture and coordination problem. Posture enable person for anti-gravitational adaptation and ability to maintain their body against gravity. Various sensory inputs integrate and result of this reaction posture stable and adaptive responses occur. This all happen when vestibular, proprioceptive and visual system involved.[1] According to centers for disease control and prevention (CDC's) Autism and Developmental Disabilities Monitoring Network (ADDM) prevalence of CP ranges from 1.5 to more than 4 per 1,000 live births. [(2)]In Pakistan its prevalence is quite common among physical disability genera. CP is persistent, non-progressive disorder of the brain affecting movement and posture.[(2).] The cause of it is still unknown but it is believed that prenatal (e.g. infection, gestational diabetes), perinatal (e.g. asphyxia, birth injury) and postnatal (e.g. CVA, high fever, meningitis, encephalitis) damage to the CNS can be the causative factor. Abnormal muscular tone (spastic, flaccid and ataxic), Abnormal postural reflex mechanism, co-ordination and sensory motor problems are the clinical presentation of the disorder. [(3).] Presently many approaches are used in the treatment of children with CP such as drugs, surgeries physio-therapy, occupational therapy, speech therapy, Botox therapy, hydrotherapy, hippo therapy, domestic massages, sensory integration therapy (SIT) etc. among which SI shows promising effects and it is widely accepted around the world. SIT generates visible effect on CP specifically on gross motor functioning. Literature review reveals the effectiveness of SIT on gross motor functioning around the world. The SIT intervention had significantly positive effects on gross motor function in the children with Diplegic Spastic CP. Moreover the result showed that sensory integration and vestibular stimulation were effective in children with cerebral palsy. [(4,6)]"Another study revealed a significant improvement in motor abilities of all children in vestibular stimulation (linear stimulation in hammock) group as measured by GMFM & PEDI" [(5)] "Evidence proved that vestibular stimulation (hammock, upside down activities) was effective in improving postural control, movement, emotional well-being, and social participation of a child with hypotonic cerebral palsy." [(6)] Sensory integration therapy is a treatment approach that was originally developed by A. Jean Ayres which aims to provide the child with graded sensory experiences. [(4,9,10)]It is typically given by an occupational therapist with training and expertise in sensory integration.

SIT is an active therapy in which activities usually involve the use of large pieces of equipment such as barrel rolls and balls, swinging hammocks, which provide intense proprioceptive, vestibular experiences. [3, 17, 19] environmental participation in Cerebral palsy increases with functional skills and performance by keep them in appropriate positioning. [7] .It is a process occurring in the brain that enables the child to make sense of their world by receiving, registering, modulating, organizing and interpreting the information that comes to their brain from their senses. SIT helps to overcome problems experienced by many young children in absorbing and processing sensory information. Encouraging these abilities ultimately improves balance and steady movements. Although SIT is widely used by pediatric therapists in the treatment of children with CP, there is little research evidence regarding its efficacy. [3,4] These certain responses efficiently developed free higher cognitive system which stable postural control and develop conscious method to adapt functional skills. Continuous vestibular and proprioceptive input combine with tactile stimulation activate the alertness and response [1, 11] .This study design to measure that level of alertness which improve functioning in cerebral palsy children. Sensory integration processes delay or absent may cause problem in daily living function and gross motor functioning. The purpose of conducting this research in Pakistan is that a few works has been done on SIT for improving gross motor functioning in CP.

II. METHODOLOGY

Study Design and Sampling: This interventional study was done to investigate the effects of sensory integration therapy on gross motor functioning in children diagnosed with developmental delay and spastic diplegic cerebral palsy. A sample of 26 children diagnosed with cerebral palsy spastic diplegic and developmental delay (22 CP Spastic Diplegic,4-Developmental Delay) were selected by simple random sampling technique from a population of cerebral palsy or developmental delay attending occupational therapy services in Dow University of Health Sciences IPMR-Karachi Pakistan. The data collection was done in accordance to inclusion and exclusion criteria developed prior. The inclusion criteria was children of both gender between the age bracket 2 years to 9 years previously diagnosed with mild to moderate spastic diplegic cerebral palsy and developmental delay ,able to stand with support. While children with co morbidities such as epilepsy, hydrocephalus, autism, behavior issues, mental retardation was excluded. Fractures, contractures or conflicting concurrent treatment impacting gross motor functioning such as prior orthopedic surgery, recipient of botox injection or any other congenital deformity were also not included in the research. Parents of selected children were informed about the research process and their consent was documented.

Data Collection Tools: Initially history and assessment of selected children were obtained after which standardized tool Gross Motor Function Measure (GMFM-88) scales was used to evaluate gross motor function of children. It has 5 levels, rolling, lying ,sitting, standing and walking .standing. [30,31].Hand Functioning by QUEST mainly dissociative Movement ,Grasp ,Weight Bearing, Protective Extension assessed in detail.[13] Spasticity measured with Modified Ashworth scale after which children were enrolled. [6]Intervention. The Sensory Integration Therapy (SIT) was applied for 45 min, 4 days per week for 3 months. The selected children were not allowed to take conventional occupational therapy in order to observe the genuine effects of SI therapy. The experimental SI therapy was divided into 3 phases of 16 sessions each .i.e. Proprioceptive phase, Vestibular Phase and Mixed Phase. The activities were selected to give proprioceptive input in phase one, vestibular input in phase two and mixed input of Proprioception and vestibular in phase three.[15-23] Refer to the table 1,2 and 3.

Table: 1 Proprioception Phase-1

S. No	ACTIVITY	DURATION
2	Track walk/crawl	10 min
3	Kick the ball	5 min
4	Wheel barrow Relay	5 min
5	Sit ups	5min
6	Kids Yoga Downward dog Boat pose foot party	5 min
7	Wheel Barrow Walk	5 min
8	Pressure & Posture	10 min

Table: 2 Vestibular Phase- 2

S. No	ACTIVITY	DURATION
1	Hammock	5 min
2	Somersault	5 min
3	Rainbow pass	5 min
4	Scooter board Tummy glide(prone)	10 min
5	Rolling Log roll Barrel roll Wedge roll	10 min
6	Rocking On peanut ball	5 min
7	Astronaut training “Upside down bowling”	10 min

Table: 3 Mixed Phase- 3

S. No	ACTIVITY	DURATION
1	Wall stepping	5 min
2	Track walk/crawl	10 min
3	Sit ups	7 min
4	Kids Yoga Downward dog Boat pose foot party	15 min
5	Wheel barrow Walk	5 min
6	Hammock	5 min
7	Rainbow Pass & somersault	5 min
8	AB Twister	5 min
9	Rolling Log roll Barrel roll Wedge roll	10 min
10	Astronaut training "Upside down bowling"	10 min

Table: 4 Paired Samples Test

Ability	GMFM Mean score		SD	df	P-value
	Pre	Post			
Lying & Rolling	75.36	91.30	13.04	14	0.000
Sitting	61.73	81.96	14.75	14	0.000
Crawling & Kneeling	62.94	69.37	9.54	14	0.021
Standing	14.78	32.83	16.74	14	0.001
Walking, Running & Jumping	8.84	20.50	10.90	14	0.001
Total Score	42.25	59.27	7.99	14	0.000

III. RESULTS

The significant improvement was observed in Gross Motor Function and Muscle tone in Children enrolled in this study. Paired-t test was performed for comparison between pretreatment and post treatment measures of GMFM-88 score. An alpha level of $p < 0.05$ was the significance level for the test. The value of GMFM-88 shows improvement in rolling ($p=0.000$), sitting ($p=0.000$), crawling and kneeling ($p=0.021$), standing ($p=0.001$) and walking, running and jumping ($p=0.001$).Refer to the table 4. On the other hand functioning also shows significant improvement measured by Quest. Refer to the table 5. Muscle tone also showed significant improvement measured by Modified Ashworth Scale refer to the table 6.

Hand functioning also shows significant improvement measured by Quest. Refer to the table 5.

Table-5 Paired Samples Test

Ability	QUEST Mean score		SD	df	P-value
	Pre	Post			
Dissociative Movement	80.01	92.83	14.88	14	0.005
Grasp	41.61	71.14	46.39	14	0.027
Weight Bearing	48.34	78.00	25.14	14	0.000
Protective Extension	41.20	60.90	43.10	14	0.098
Total Score	51.28	75.78	18.10	14	0.000

Table-6 Paired Samples Test

Ashworth Mean Score		SD	df	P-value
Pre	Post			
1.87	0.93	0.594	14	0.000

IV. DISCUSSION

Neuro-rehabilitation approaches are important for treatment of a cerebral palsy child to prevent postural abnormalities, sensory deficits, gross motor dysfunction, and to increase functional capacity.The purpose of present study was to find out the effect of vestibular and proprioceptive stimulus on motor development of cerebral palsy children. Vestibular and proprioceptive activities develop sense of positioning and balance .Primarily two years of newborn life are crucial for sensory motor development in which child learns to coordinate large muscles of the legs, trunk, and arms, and the smaller muscles of the hands through different sensory experiences. Explore through sensory motor stimulation has a great impact on gross and fine motor functioning. [(4)] Sensory integration helps to build the mental and physical framework within an individual's nervous system to properly perceive sensory input, regulate its responses, and understand the significance behind a particular, texture, movement, or sound. Occupational Therapist follows different strategies and approaches in the treatment of Cerebral Palsy. Among which NDT is most accepted and practiced.(21,22,23) Along with it many therapist uses SIT techniques as it gives the child opportunity to experience not only its body in different positions but also in relation to its environment which they does not do due to their restricted body movements. The activities selected in the current study are joyful. The children enjoyed and actively participated in initiating and completing the movements. The activities were designed to give active stretch, strengthening of muscles and Weight bearing on hands, knees and feet. The child's body was brought into different positions such as in downward dog, wheel barrows walk and kids yoga which gave active stretch and improved bilateral coordination. [(19)]

In phase one the activities were selected to provide proprioceptive input. Proprioception helps to understands own

body, its relation to its environment and coordinated movements. The activities selected gave stretch to joints and muscles. It strengthened the core muscles which improved trunk stability.

In phase two the activities were selected to give brain vestibular input which is important for balance and movement. Rocking on peanut ball and linear slow stimulation on hammock improved the postural control, balance and ability to shift weight. Phase three activities gave mixed input of vestibular and Proprioception enhancing the skills learned in above two phases. This research is based on the same thought; the purpose of this study was to observe the effects of sensory integration therapy on the gross motor functioning of children diagnosed with cp spastic diplegic or developmental delay.(15) evidence showed in research, in which compare sensory integration with neuro-developmental approach same as in this research .result showed significant impact of SI on gross motor functioning.(6) Table 4 reveals that the mean pre and post assessment scoring of overall GMFM is 42.25 and 59.27 with p value .000.on other hands valuable difference can be seen in lying and rolling, sitting and standing . Gravitational insecurity due to postural abnormality is always very high in cerebral palsy diplegic. Action of Vestibular input to initiate neck and trunk musculature. This combination maintains posture and improves head control. That mechanism used in this research and through sensory inputs in three stages fear of falling reduce ,facilitate postural control .Table 5 revealed a significant improvement in QUEST scoring , pre and post scoring of Grasp and protective extension.Neuro rehabilitation approaches mitigate sensory deficits, gross motor dysfunction and improve postures and functional adaptability[1.] This adaptability increase tone normalization. Study emphasized the efficacy of sensory integration on cerebral palsy to improve their hand function and socialization.

V. CONCLUSION

This study shows beneficial effect of Sensory integration therapy on CP spastic diplegic and developmental delay children; SIT intervention had a significantly positive effect on gross motor function in the children with CP Spastic Diplegic. Moreover the results of the study showed that sensory integration therapy is effective in children with cerebral palsy and developmental delay in improving emotional well being and social participation.

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