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EFFICACY OF AUGMENTED BIOFEEDBACK TRAINING WITH CUSTOMARY PHYSICAL THERAPY ON HAND FUNCTION IN IMPROVING VISUAL MOTORINTEGRATION SKILLS IN SPASTIC CEREBRAL PALSY CHILDREN

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ABSTRACT

BACKGROUND: *Cerebral palsy (CP) is a disorder of movement and posture which is non-progressive in nature, originates from the neural lesions (with static nature of brain injury) during perinatal period occurred during fetal or developing brain and associated with activity limitation and wide range of comorbidities which makes the child's life difficult even when performing his ADL . In other words, as nervous system is structurally disordered, the normal flexibility and plasticity is impaired resulting in restriction of range of motor patterns, finally resulting in weaker motor performance and stereotyped and impaired functionality. The motor disorders of CP are often associated with sensory, perceptual, cognitive, feeding, communication, epilepsy, behavioral issues and also with secondary musculoskeletal impairments. It is the common disability of childhood (during which brain has got maximum potential for reorganization and plasticity) with the prevalence of 2.1 per 1000 in high income countries and prevalence can go up to 8-40 % in high risk population like EP babies, whereas data from countries with low to mid socio-economic status is not available.*

OBJECTIVE: *The objective of the study is to investigate the efficacy of combining Augmented biofeedback with customary physical therapy for improving visual-motor integration skills in children with spastic cerebral palsy*

METHOD: *Participants were 20 subjects, 7-13 years of age, with spastic CP were selected according to the inclusion criteria. They received both augmented biofeedback training andcustomary physical therapy for a treatment duration of 10 weeks and undergone pre and post test of Developmental Test of Visual Perception-2(DTVP) Scale and Bruininks-oseretsky Test (BOT-2) Scale. andManual Ability Classification System (MACS)Scale.*

RESULT: *The statistical analysis revealed thatthe subjects have showed significant changes in visual motor integration skills after the intervention applied.*

CONCLUSION: *Results of the study provide useful evidence supporting the possibility of combined effects of augmented biofeedback training with customary physical therapy for subjects with spastic cerebral palsy.*

KEY WORDS: *Spastic cerebral palsy, visual-motor integration, Augmented biofeedback training, Developmental Test of Visual Perception-2 and Bruininks-Oseretsky test-2*

INTRODUCTION

Cerebral palsy (CP) is an umbrella term covering a group of non-progressive but often changing motor impairment syndrome that may or may not involve sensory deficits that are caused by a non-progressive defect lesion oranomaly of the developing brain.

CP is a primary disorder in the building up of the patterned structure of the movement which results in a limitation of the freedom of choice of movement and posture. In other words, as nervous system is structurally disordered, the normal flexibility and plasticity is

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impaired resulting in restriction of range of motor patterns, finally resulting in weaker motor performance and stereotyped and impaired functionality.

The motor disorders of CP are often associated with sensory, perceptual, cognitive, feeding, communication, epilepsy, behavioral issues and also with secondary musculoskeletal impairments. It is the most common motor disability in childhood. The etiology of cerebral palsy is very diverse and multifactorial. The causes are congenital, genetic, inflammatory, infectious, anoxic, traumatic and metabolic. The injury to the developing brain may be prenatal, natal or post-natal.

According to WHO, in India3.8% of population has some form of disability due to different causes. The cerebral palsy is classified on the basis of muscle tone (spastic, dyskinetic, ataxic and mixed) and on the basis of number of distribution of the affected limb (monoplegia, diplegia, hemiplegia, tetraplegia and quadriplegia).

Spastic Cerebral palsy(SCP) is the most common type. It's about 77.45%.The increase of spastic CP is predominantly a Result of higher survival rates for very small premature babies. Spasticity can cause secondary disorders such as hip dislocation, scoliosis, knee contractures and torsional malalignment of the femur and tibia. These changes often have significant effects on function, including effortful gait pattern, difficulty assuming and sustaining seated positioning and difficulty performing self-care activities such as toileting, bathing, dressing and self-feeding.

The signs and symptoms of cerebral palsy may be apparent in early infancy. Infants presenting with abnormal muscle tone, atypical posture and movement with persistence of primitive reflexes may be diagnosed earlier than 2 years of age. Evaluation of the child's motor skills, neuroimaging and evidence that symptoms are not progressing are key elements of this diagnosis. Neuroimaging of the brain, such as cranial ultrasound, computed tomography and magnetic resonance imaging can show the location and type of brain damage.

Cerebral hemorrhages may be associated with cerebral palsy. These hemorrhages are labeled as intraventricular hemorrhage, bleeding into the ventricles, germinal matrix hemorrhage, bleeding into the tissue around the ventricles and periventricular hemorrhage bleeding into both areas. Hemorrhages are graded in increasing severity from 1 through 4. The grade of bleed along cannot predict the development of severity of cerebral palsy:

RELEVANT ANATOMY: The brain is composed of cerebrum, cerebellum, and the brainstem. Cerebrum is the largest part of the brain and is composed of right and left hemispheres. It performs higher functions like interpreting touch, vision, and hearing as well as speech, reasoning, emotions, learning and fine control of movement. Cerebellum is located under the cerebrum. Its function is to coordinate muscles movement, maintain posture and balance. Brainstem acts as a relay center connecting the cerebrum and cerebellum to the spinal cord. The cerebral hemisphere has distinct fissures which divide the brain into 4 lobes: frontal, temporal, parietal and occipital. The surface of the cerebrum is called the cortex. The blood supply is carried to the brain by two paired arteries: the internal carotid arteries and the vertebral arteries. The internal carotid artery supply most of the cerebrum and the vertebral artery supply to cerebellum and brainstem:

PATHOPHYSIOLOGY OF SPASTICITY

Spasticity is a motor disorder characterized by velocity-dependent increase in tonic stretch reflexes with exaggerated tendon jerks resulting from hyper excitability of stretch reflex. Spasticity is classified to:

- Intrinsic Tonic spasticity: exaggeration of tonic component of stretch reflex
- Intrinsic Phasic spasticity: exaggeration of phasic component of stretch reflex
- Extrinsic spasticity: exaggeration of extrinsic flexion or extension spinal reflexes

Afferent input from internal organ, the musculoskeletal afferent input from internal organs, the musculoskeletal system and the skin converge on the medulla spinalis, activates the stretch reflex. The same afferent information goes to the cerebellum and the somatosensory cortex. It is processed in centers of basal ganglia as well. The resulting motor response is relayed to the lower motor neuron through the pyramidal and extra pyramidal system tracts.Spasticity arises from prolonged inhibition of spinal reflexes as a result of UMN lesion. These spinal reflexes include stretch, flexor and extensor reflexes and are under supraspinal control by inhibitory andexcitatory descending pathways. Stretch reflexes are proprioceptive reflexes and are either phasic or tonic. The tonic stretch reflex

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arises from a sustained muscle stretch and is the cause of spasticity. It occurs only when the lesion involves pre-motor and supplementary motor areas.

SYMPTOMS OF SPASTICITY: Mild muscle stiffness to severe painful muscle spasms, Muscle over activity, Flexor, and extensor spasm, Hyper reflexia, clonus, Extensor plantar response
The modified Ashworth scale is the widely used assessment tool to measure resistance to limb movement. Its scores exhibit better reliability when measuring upper extremity than lower extremity. The physical therapy management for spasticity include stretching, splinting, postural management, strengthening exercises and physical modalities.

TREATMENT: Biofeedback is an alternative medicine approach that teaches people to change the way their bodies function. It is a mind body therapy that may improve our physical and mental health. It can improve motor outcomes for people with CP. If given too frequently, biofeedback may prevent from learning autonomously. Consistent and concurrent feedback is used to improve specific motor activities.

Customary physical therapy is defined as the treatment of movement disorders caused by impairments of joints and the muscle that move the joints. Mobilization, strengthening and stretching constitute the three main treatment approaches in conventional physical therapy.

VISUAL MOTOR INTEGRATION

Visual motor integration (VMI) is a complex skill set which encompasses many underlying skills such as visual perception, motor control and eye-hand coordination.

It refers to the ability to translate a visual image, or a visual plan into an accurate motor action. VMI involves visual perception skills-the ability to correctly perceive a form in order to correctly replicate it. Examples are;
Correctly perceiving and copying shapes,correctlyperceiving, and copying letters and numbers.

MATERIALS AND METHODOLOGY

This study was Quasi Experimental design- pre and post nature, has conducted at Cherraans Institute of Health Science- Out patient department, Coimbatore and Jeyam's special school, Coimbatore, the study population was pediatricpopulation, and the target Population was Spastic Cerebral Palsy children, The sample size has 20 subjects who fulfilled the inclusion and exclusion criteria asConvenient sampling method the subject has selected and underwent 10 weeks of treatment.

INCLUSION CRITERIA: Age of 7-13years,both genders were selected,Spastic cerebral palsy children's diagnosed by Neurologists (spasticity score of 1, 1+ and 2 according to modified Ashworth scale, Ability to understand verbal commands,Children's without assistive device

EXCLUSION CRITERIA: Children's with any neurodegenerative diseases, Children's with traumatic brain injury
Children's with visual and hearing impairments, Children's with musculoskeletal injuries,

7-13years old children'swas selected. Informed consent was taken from the selected children's parents and the basic instructions were given to the children's. The following exclusion was above 13years and disagreement to participate in the study.

Both augmented biofeedback training and the conventional physical therapy were received to the subjects' for the hand functions. The conventional physical therapy included exercise like grasping objects like ball by stretching arms while sitting with the trunk perpendicular to the floor. The idea is to maintain the body's centerline, grasp objects by stretching arms while breaking away from the centerline, return back to the original position. Gentle stretching and strengthening of upper limb.

The biofeedback training included basic exercise involved movements of hand. Exercise based on program, forexample, hitting targets using one or both hands while sitting in a posture, taking account of the engagement and movement of subject, moving in direction according to instructions, discerning pictures, reach out activities and hand movements.

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Assessments were conducted to identify changes in visual motor integration skills (VMI). The DTVP-2 and BOT-2 was used specificallyto assess the changes. The DTVP-2 was used to assess the visual perception function related to visual motor integration. The BOT-2 was used to assess the motor function of visual motor integration.

The treatment duration lasted for 10 weeks, 60 minutes per day and 3 sessions per week. During the treatment if the examiner feels like the subject is either not cooperating or getting tired, the examiner is advised to give some rest to the subject.
Relevant medical records and history is taken for each subject. All data is stored on separate hard drive, keeping it confidential and will be discarded once the study has been completed as per the policies of the University and the Institutions. Data gathered will be analyzed using statistical software.

Table 1:Characteristics of participants(N=20).

Sl.No	Characteristics	N
1	GENDER Male Female	 10 10
2	DOMINANT HAND Right Left	 20 0

Table 2: Age Distribution

Sl. No	Age Distribution	Frequency	Percentage
1	>9	4	20
2	9-11	11	55
3	<11	5	25

Graph 1: Graphical representation of age distribution

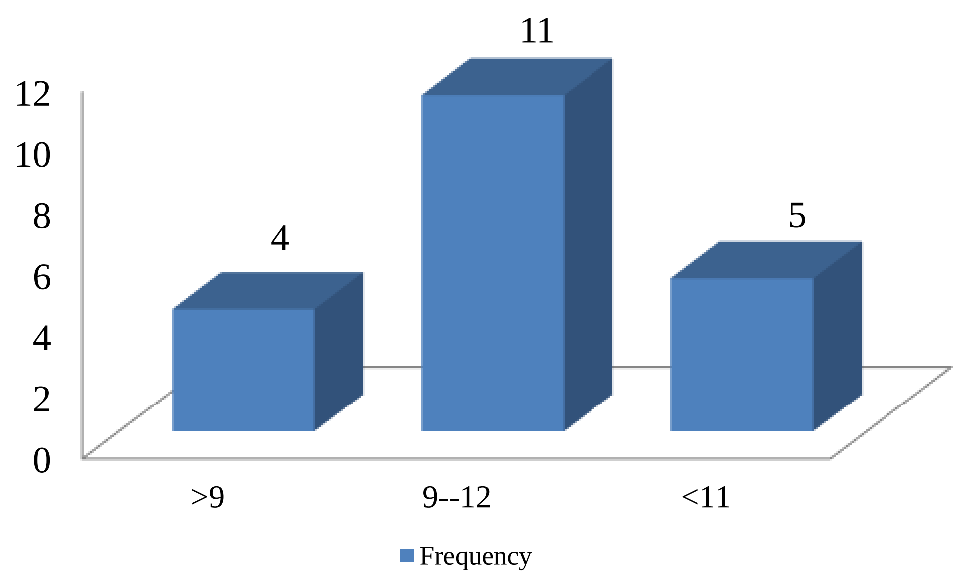

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Table 2: Pre-post scores in DTVP-2

Sl. No	Variable	Pre	Post	p-value
1	Eye-hand coordination(EHC)	9.65±1.18	10.90±1.33	<0.00008
2	Copying(CO)	9.75±1.52	10.85±1.63	<0.00014
3	Figure ground(FG)	9.75±1.16	10.90±1.17	<0.00008
4	Visual closure(VC)	9.85±1.76	10.90±1.59	<0.00014
5	Form constancy(FC)	9.95±1.54	11.05±1.54	<0.00008

Graph 1: Graphical display of pre and post DTVP-2 assessment

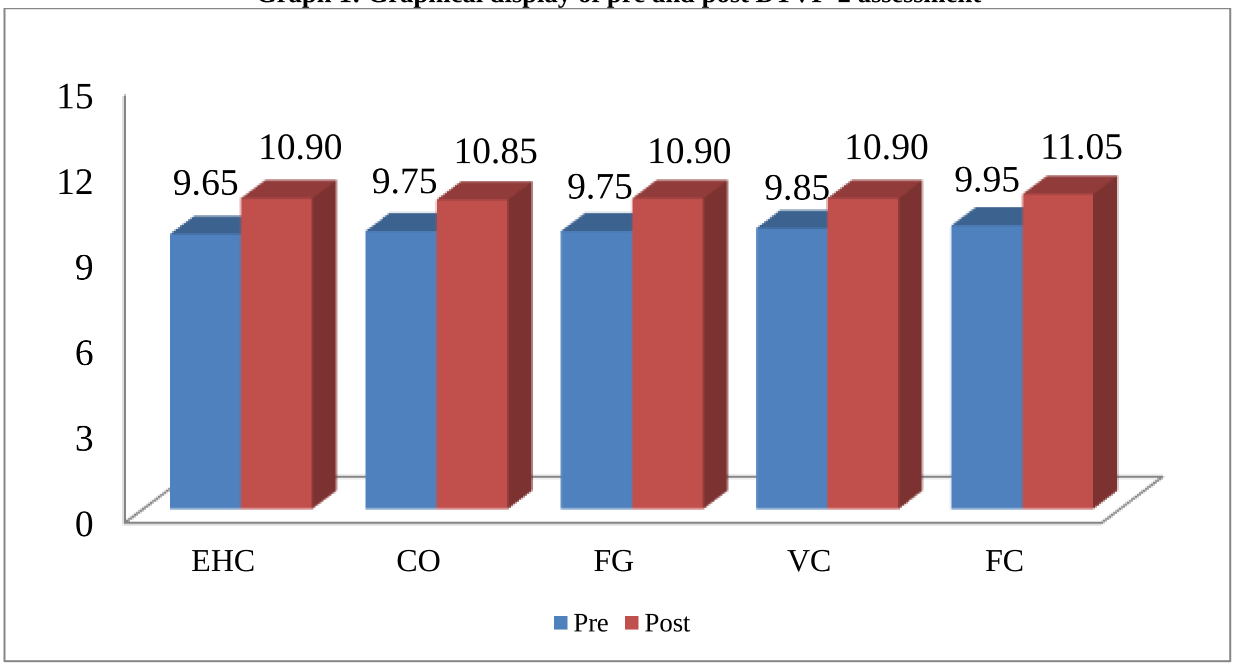


Table 3: Pre-post scores of BOT-2

Sl. No	Variable	Pre	Post	p-value
1	Fine motor precision(FMP)	14.35±3.12	15.55±2.98	<0.00008
2	Upper limb coordination(ULC)	13.40±3.82	14.50±3.69	<0.00008
3	Balance	12.10±3.09	13.15±3.08	<0.00008
4	Strength and Agility	10.55±3.20	11.65±3.07	<0.00008

Graph 2: Graphical display of pre and post BOT-2 assessment

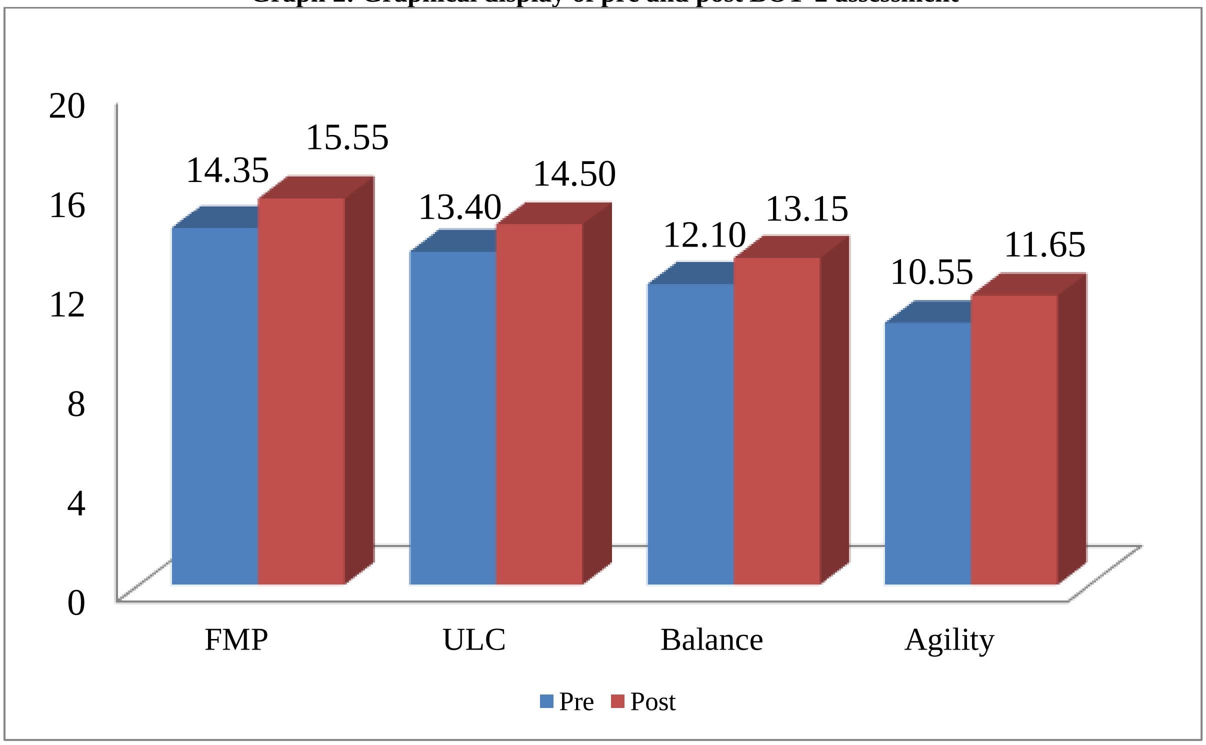
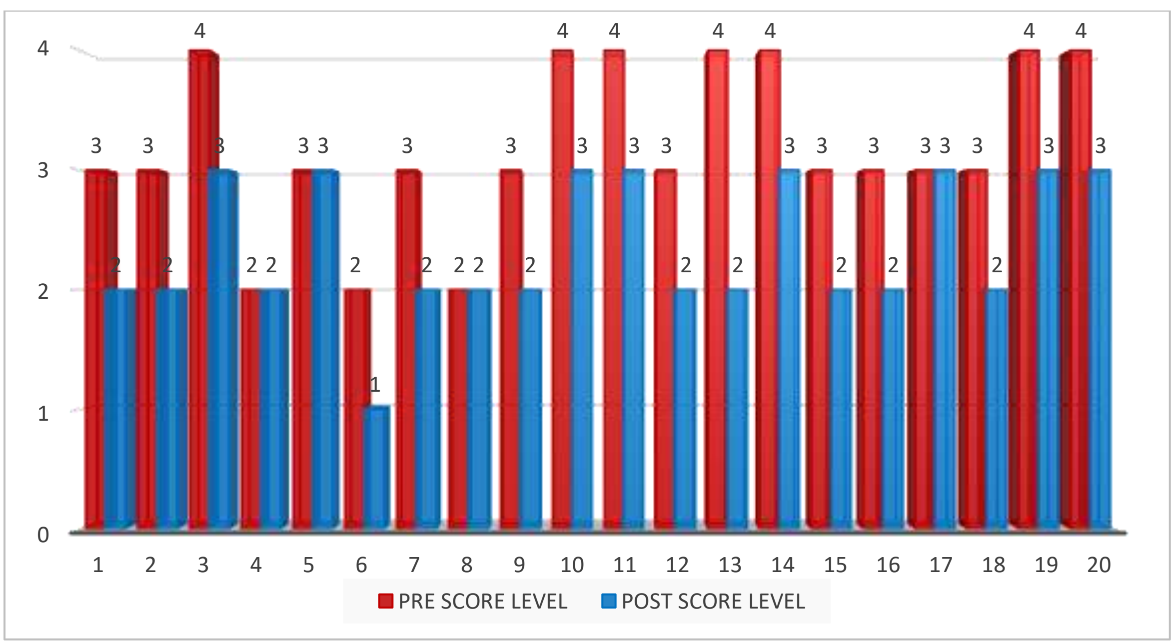


Table 4: Pre – post scores of Manual Ability Classification System (MACS):

Graph 4: Graphical display ofPre-post scores of MACS



RESULT

A total of 20 subjects participated in this study. The score was evaluated by DTVP-2 scale and BOT-2 scale.
The subjects have showed significant changes in visual motor integration skills after the intervention.

- In the study, the pre mean eye-hand co-ordination (EHC) was 9.65 with standard deviation of 1.18 was improved to post mean EHC to 10.90 with standard deviation of 1.33 which was statistically significant (p-value<0.00008).
- In the study, the pre mean copying (CO) was 9.75 with a standard deviation of 1.52 was improved to post mean of 10.85 with a standard deviation of 1.63 which was statistically significant (p-value <0.00014).
- In the study, pre – mean figure ground(FG) was 9.75 with standard deviation of 1.16 was improved to post mean figure ground 10.90 with standard deviation of 1.17 which was statistically significant (p- value <0.00008)
- In this study, pre-mean visual closure(VC) was 9.85 with standard deviation of 1.76was improved to post mean visual closure of 10.90 with standard deviation of 1.59 which was statistically significant (p-value <0.00014)
- In this study, pre-mean form constancy(FC) was 9.95 with standard deviation of 1.54 was improved to post mean form constancy of 11.05 with standard deviation of 1.54 which was statistically significant (p-value <0.00008).
- In this study, the pre mean fine motor precision(FMP) was 14.35 with standard deviation of 3.12 and improved to post mean FMP of 15.55 with standard deviation of 2.98 which was statistically significant(p-value<0.00008).
- In this study, the pre mean of upper limb coordination(ULC) was 13.40 with a standard deviation of 3.82 and improved to post mean of 14.50 with standard deviation of 3.69 which was statistically significant(p-value<0.00008).
- In this study, the pre mean balance was 12.10 with standard deviation of 3.09 which was improved to post mean of 13.15 with a standard deviation of 3.08 which was statistically significant(p-value<0.00008).
- In this study, the pre mean strength and agility was 10.55 with standard deviation of 3.20 and improved to post mean of 11.65 with a standard deviation of 3.07 which was statistically significant(p-value <0.00008).

DISCUSSION

This study aimed to look at the changes in visual motor integration of children with cerebral palsy by combining both conventional physical therapy and augmented biofeedback training. Visual motor integration skills are dependent on intact visual perception, sustainedattention, fine motor coordination and motor inhibition. In this study the evaluation of visual motor function was evaluated byBOT-2 and visual motor perception was evaluated by DTVP-2. The pre and post values were recorded in this study. Impact of augmented biofeedback with conventional physical therapy was assessed using these tests.

- In the study, the pre mean eye-hand co-ordination (EHC) was 9.65 with standard deviation of 1.18 was improved to post mean EHC to 10.90 with standard deviation of 1.33 which was statistically significant (p-value<0.00008).
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- In this study, the pre mean strength and agility was 10.55 with standard deviation of 3.20 and improved to post mean of 11.65 with a standard deviation of 3.07 which was statistically significant(p-value <0.00008).

The pre and post intervention comparison showed significant changes in the total score. VMI is defined as fine motor and coordination of visual perception. All subjects in this study had lower than average motor skills. It is proposed that the improvement of visuo-motor control by augmented biofeedback with conventional physical therapy occurs at higher level in terms of the efficiency of sensorymotor system in processing visual information for motor control.

Since this study provided both augmented biofeedback with conventional physical therapy, it is thought that it was an intervention method that could further compensate for cognitive deficit of children with intellectual disabilities. According to results of this study, augmented biofeedback with conventional physical therapy is an intervention method for children with intellectual disabilities, with moderate to strong impacts on visual perception and motor function.

There occur many changes in children with cerebral palsy after early childhood. They are faced with many self-help activities of daily living and exposed to self-study environment following intensive play and care at home. Also the program used in this study can be used as a home exercise program.

CONCLUSION

As per statistical data augmented biofeedback combined with conventional physical therapy for improvement in visual motor integration skills on hand function is an effective training method for children with cerebral palsy that promote visual perception and motor function.

RECOMMENDATION AND LIMITATIONS OF THE STUDY

LIMITATIONS

- The psychological aspects of the subjects were not assessed.
- This study contained small number of participants,

RECOMMENDATION

- Future studies should include randomized controlled trials involving large number of participants,
- It should also investigate whether augmented biofeedback with conventional physical therapy have long term result

Acknowledgment
We would like to thank all the participants who participated in this study

Declarations
Conflicts of interest: Nil
Funding sources: Self
Ethical clearance: Verbal consent and written consent were taken from each subject who participated in the study and Ethical clearance from our Institutional Ethical committee (IEC)

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