Case Report

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Physiotherapy Section

Effect of Modified Constraint Induced Movement Therapy in Chronic Seizure Disorder and Infantile Hemiparesis: A Case Report

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ABSTRACT

Epileptic seizures in children have the highest rate in infants. The incidence rate reported from India ranges from 0.42 per year in West Bengal to 0.49 per year in rural areas and 0.27 per 1000 per year in urban areas. Intraventricular haemorrhage of a newborn, Transient Ischaemic Attack (TIA), congenital or perinatal injuries to the brain may lead to infantile hemiparesis. A seven-year-and-four-month-old female presented with difficulty eating with her right hand, an inability to maintain her grip on a pen for prolonged periods, and impaired gait. She was classified as Gross Motor Function Classification System (GMFCS) level II, Manual Ability Classification System (MACS) level III, and had a Quality of Upper Extremity Skills Test (QUEST) score of 29.30%. She was diagnosed with a chronic seizure disorder and right-sided hemiparesis. She was administered modified Constraint Induced Movement Therapy (mCIMT) for hand function three days a week for eight weeks. The constraint time of the left hand was two hours and 30 minutes per session. During the session, she went through intensive exercises for the right hand, like handling spherical and cylindrical objects, manipulating different shapes, and using a pegboard, etc. Within eight weeks, a significant change was seen in handling and manipulating objects. The MACS score improved to II, and the QUEST score increased to 47.95 ~ 48. While dissociated movement and grasp showed significant improvement, the tripod grasp remained unexecuted. The study concludes that mCIMT for upper limb function can significantly improve the quality of life for children with hemiparesis.

Keywords: Cerebral palsy, Epilepsy, Rehabilitation, Upper extremity motor skills

CASE REPORT

A seven-year-and-four-month-old female patient reported to the Outpatient Department (OPD) with her parents. They complained that the child had been unable to eat with her right hand, write properly, maintain her grip on a pen for a while, and walk properly since the child was four years old.

The child had a known history of seizure disorder and infantile hemiparesis, presenting with chronic right-sided motor impairment affecting feeding, writing, and gait, with no history of acute neurological deterioration. She had a history of epileptic seizures from eight months of life, lasting for more than 24 hours, managed with anti-convulsants during hospital admission Generalised Tonic-Clonic Seizures (GTCS). Currently, there have been no convulsions for more than two years. The prenatal and birth history of the child is unknown. The available prescription included syrup valproate, 200 mg/5 mL (7.5 mL per dose) BD and syrup Levipil, 100 mg/mL (3 mL per dose) BD. According to the parents, the developmental history indicates that the child's neck control appeared at six months, rolling occurred at 13 months, sitting was achieved at 16-18 months, standing with support was achieved at 26 months, and supported walking was achieved at 28 months. The Electroencephalogram (EEG) report revealed abnormal sleep with paroxysmal generalised sharp-wave discharge with tracing of epileptic seizures. The EEG tracing showed a background rhythm of 5-7 Hz and amplitude of 15-20 μV. Magnetic Resonance Imaging (MRI) of the brain revealed focal gray matter heterotopia in the left paraventricular region. The cerebellum and 4th ventricle appeared normal, the basal cisterns were normal, the craniovertebral junction appeared normal, the supratentorial ventricles, corpus callosum, brainstem and pituitary appeared normal. The septum was in the midline. The final diagnosis was seizure disorder, with right infantile hemiparesis probably due to Hypoxic Ischaemic Encephalopathy (HIE).

Physical Examination

The extensive evaluation revealed that the child had mild winging of the bilateral scapulae. The gait evaluation showed spastic hemiplegic gait with a tendency for inversion of the right foot. Spasticity evaluation in the Modified Ashworth Scale [1] showed a 1+ grade of spasticity in both the right upper and lower limb muscles. The GMFCS [2] score was calculated as Level II, which states that the child can walk with limitations. The MACS [3] score was also noted as III, stating that the child handles objects with difficulty and needs help preparing and executing activities with the right hand. Her performance was slow, but she was able to perform activities successfully with minimal environmental modification.

Diagnosis and Assessment

The patient had been visiting the physiotherapy OPD since seven years and four months of age once weekly for education on the home exercise programme for both upper and lower extremities. A thorough pre-intervention assessment was conducted on 1st October 2024. The QUEST [4] was administered by the primary investigator. During the assessment, the child was seated on a plastic chair without arms, beside a mat bed. The dissociated movement and grasp were measured in a sitting position, and the weight-bearing was measured in a prone position over the mat bed. The protective extension was not tested as the child did not cooperate with the test. In this procedure, a 1-inch cube and a black gram were used to measure the grasp. The total score of the QUEST was 29.30%, excluding protective extension. The details of the scores are shown in [Table/Fig-1].

Intervention

Parental informed consent was obtained. The treatment and data collection were executed in the exercise therapy laboratory by the primary investigator. The child was made to sit on a medium-height plastic chair in front of the therapeutic mat bed with legs hanging below. The child was prepared for the constraint by applying the local crepe bandage from the forearm to the palm and ensuring the closure with a micropore tape [Table/Fig-2] [5].

Movements	Score (Pre-op)	Score (Post-op)
Dissociated movements	61.00%	69.80%
Grasp	14.80%	40.05%
Weight-bearing	12.00%	34.00%
Total score	29.30%	47.95%

[Table/Fig-1]: Comparison of scores: Pre-intervention and post-intervention.

[Table/Fig-2]: Wrapping the crepe bandage on the uninvolved limb.

The equipment used was a triangle top (stacking rings), a geometric colour shapes stacker, clay, plastic small size colourful balls, and a basketball. The activities were carried out according to the child's interests [Table/Fig-3,4]. All the activities were encouraged to be completed, keeping in mind the grip needed for her. The treatment was done for two hours and 30 minutes per session, three days a week, for eight weeks [6]. An upper extremity protocol using mCIMT was designed, involving 2.5 hours of constraint of the left arm, with the initial 15 minutes allocated for warm-up activities, including sustained stretching of the right upper extremity muscles, followed by one hour of restraint (forced use) including play activities that include a triangle top, various shapes to pick and insert, alphabetical pegboards, clay, and different-sized balls, followed by a cooldown session for 15 minutes, including play-based activities and stretching. During the last one hour of constraint, the patient was given standard balance training in a weight-bearing position along with gait training and stretching of the right lower extremity. Initially, during the first two weeks, the child was helped to execute the activities, like picking up and dropping colourful balls, clay moulding, and reaching.

During the next 3-5 weeks, she was helped with the cylindrical grip and spoon holding activities. During weeks 6-8, the child was instructed to perform activities with hurdles in reaching and gripping. The progression and change in activities were done by achieving ≥80% efficiency of previous tasks, and upper extremity weight-bearing activities were practised throughout the course. The child was given positive reinforcement when she completed the activities within the time frame using her favourite snacks. The parents were instructed to maintain constraint for 2.5 hours per day during waking hours, incorporating general Activities of Daily Living (ADLs), on the remaining four days of the week at home.

Outcomes: Both baseline and post-intervention data were collected by the primary investigator. The initial score on the QUEST increased from 29.3% pre-operatively to 47.95% post-operatively, representing an absolute increase of 18.65% and a relative improvement of 63.6% was calculated using formula Relative improvement (%) = {(post-score − pre-score) / pre-score} × 100 as shown in [Table/Fig-1]. The dissociated movement score increased from 61% to 69.80%, grasp from 14.8% to 40.05% and weight-bearing from 12% to 34% with active Range of Motion (ROM) after the treatment, including wrist extension and supination. The MACS score also improved from III to II, which states that the child can manipulate most items, the execution is slow, and holding lacks precision or optimal quality. The child is now able to hold the spoon and can feed herself with the spoon. She does not have to hold a small glass with both her hands, and the holding of the pen has improved compared to earlier. The tripod grip of the child is still not complete, yet she can write her name on paper. The handwriting of the child is now recognisable. There was no trace of active seizures in the child, as she was on medication, and the execution of the intervention was medically and physically smooth during the eight weeks. There were no adverse effects encountered during the treatment.

[Table/Fig-3]: The child is trying to put a colourful ring on the stacking rings.

[Table/Fig-4]: The child is being helped to get a tripod grip.

Follow-up: A telephonic follow-up was taken from the parents after three months of intervention. They mentioned that the patient was able to maintain her grip and functional movements with greater confidence.

DISCUSSION

The scores of MACS and QUEST have improved notably in this case report, which implies that the child may improve more in the future. As Taub E et al., has stated, dealing with the 'learned non-use' and instigating use-dependent cortical reorganisation are the important mechanisms and basic principles of motor learning and strengthening new movements to perform an activity more effectively [7]. A case report conducted by Kong EJ et al., 2013 stated that after using mCIMT for four weeks of similar intensity but with more duration, resulted in a change in cerebral perfusion in both frontal lobes, left temporal lobe, both cerebellum and occipital lobes in the patient. Taking note of the study reveals that increased muscle activities in the elbow extensors were observed [8]. Similarly, in this current case report, the activities that have improved are wrist extension, forearm supination and pronation, grip, and functional improvement have been noted. The enhanced capacity for central nervous system plasticity in young children, relative to adults, suggests that this approach could be particularly effective in the paediatric age group [9]. Motor learning research indicates that mCIMT uses intensive practice to promote use of the affected limb, leading to activity-dependent functional reorganisation of the brain. In this case report, as well as the functional improvements, have also shown noteworthy results [10]. Early access to intensive therapy enables intervention during a period of increased nervous system plasticity in young children (Gelkop N et al., 2015) [11]. The present study is supported by Bakhat W et al., (2022), who stated that mCIMT may lead to greater improvements in isolated movements of the paretic arm compared with conventional training [12]. A study conducted by Yu J et al., with 24 hemiplegic CP children, showed a significant improvement in grip strength, mobility, self-care, and locomotion. Similarly, in this study, we observed the grip quality, movement of the affected upper limb function, and activities of daily living [13]. CIMT has consistently been shown to improve motor function, with all reviewed studies reporting superior post-intervention outcomes in experimental groups compared with controls. Alongside functional gains, CIMT induces measurable neurophysiological changes, including increased cortical activation and expanded cortical representation of the affected limb. Some evidence also suggests modulation of interhemispheric interactions, such as enhanced inhibition of the contra-lesional hemisphere, although findings related to intra-callosal inhibition are inconsistent [4,5,14,15]. Improvements in corticospinal excitability have been observed, reflected by favourable changes in motor evoked potential latency, resting motor threshold, conduction time, and amplitude, while other neurophysiological parameters, such as silent period duration, show limited or no change. Importantly, several studies [3-5] have demonstrated significant associations between motor recovery and underlying neurophysiological adaptations, supporting the role of cortical reorganisation in functional improvement following CIMT, although this relationship is not uniformly reported across all investigations [15].

Future studies with larger sample sizes and longer follow-up periods are recommended to further evaluate the effectiveness of modified constraint-induced movement therapy in children aged 7-8 years with hemiplegic cerebral palsy. Investigating different therapy durations and session frequencies may also help optimise functional outcomes.

CONCLUSION(S)

The mCIMT as a treatment tool has proven to be highly effective for the improvement of upper arm function, importantly for kids with disability. Analysing the results in this case report, the QUEST score increased to 47.95%. The difference between the scores was 18.65%, and the relative change in the score was 63.6%, which is a notable improvement. Therefore, it may be concluded that mCIMT can be used for a variety of patients with difficulty in upper limb functions. The parents of the child have been taught for home application of the procedure with limited facilities.

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