Children with Cerebral Palsy had Their Fine Motor Abilities Tested Just after using a Revolutionary Hand Rehabilitation Board.

[1]Hariharan S, [2]Subha V.J, [3]Ishwarya R, [4]Ajay Sriram A

[1] Assistant Professor, Pediatrics, Meenakshi Medical College Hospital and Research Institute, Enathur, Kanchipuram

[2] Associate Professor, Microbiology, Meenakshi Medical College Hospital and Research Institute, Enathur, Kanchipuram

[3] Assistant Professor, Microbiology, Meenakshi Medical College Hospital and Research Institute, Enathur, Kanchipuram

[4] Associate Professor, Anesthesiology, Meenakshi Medical College Hospital and Research Institute, Enathur, Kanchipuram

Corresponding Author: Vaikunth N.R, Assistant Professor, General Medicine, Meenakshi Medical College Hospital and Research Institute, Enathur, Kanchipuram

ABSTRACT

BACKGROUND: Cerebral palsy (CP) limits a child's defecation abilities because of their impaired fine motor skills. their forearms and actively extend their elbows, wrists, or fingers while doing so. In order to enhance fine motor skills, it is essential to implement therapeutic interventions that concentrate on while also making it easier to perform active motions by increasing the range of motion at these joints.

OBJECTIVE: This pilot study aims to determine if children with cerebral palsy (CP) exposed to the Novel Hand Rehabilitation (NHR) Board will exhibit 1) enhancements in fine motor skills and 2) alterations in spasticity and passive range of motion (ROM) of the forearm and wrist/finger musculature.

METHODS: Between the ages of 49 and 72 months (65.33 6.355 months), Children diagnosed with spastic cerebral palsy (N = 15; M = 7, F = 8) were maintained on the NHR board until they attained their tolerance threshold limit or for at least half an hour. Additionally, the wrists and fingers of the kids were positioned on the board. The following outcome measures were recorded: Fine motor abilities (assessed by the PDMS-2 Fine Motor Scale), passive range of motion (PROM) of the wrist and fingers, and spasticity (evaluated using the Modified Ashworth Scale). All these measurements were recorded.

RESULTS: Forearm pronators (0.001) and wrist flexors (0.008) shown considerable results. reduced spasticity, but wrist extenders showed no reductions in spasticity. Both the ulnar deviation range of motion (p = 0.007) and the wrist extension (p = 0.005) were shown to have improved statistically significantly following the intervention. The improvements in the thumb's CMC flexion although there were statistically significant increases in extension (0.003), abduction (0.001), and MCP extension (0.004), and the results did not reach the criteria for statistical significance. Range of the MCP extension of motion (ROM) following the intervention was not significant for the PIP and DIP joints, but it was significant for the second (0.001), third (0.007), and fourth fingers (0.014). For the fingers that were impacted by the intervention, this was true. The PDMS-2 subtests for Grasping and Visual-motor Integration showed a percentage change of 11.03% (p = 0.002) and 5.09% (p = 0.001), respectively, following the conclusion of the intervention. These two modifications were both statistically significant.

CONCLUSION: In the immediate aftermath of the application being submitted to the National Health Research

Board, children who were diagnosed with cerebral palsy (CP) exhibited outcomes that were both positive and encouraging in terms of their fine motor skills. Therefore, the NHR board is a potential intervention that can be suggested to children who have cerebral palsy in order to improve their fine motor abilities. This is achieved by the use of the NHR board.

KEYWORDS: Cerebral palsy, therapeutic, enhancements, intervention.

INTRODUCTION

Children with cerebral palsy (CP) have issues with upper limb (UL) dexterity and fine motor skills that are connected to spasticity. According to Duruo¨z (2019), the changes caused by abnormalities in muscle tone are defined by factors such as position, posture, motion, and decreased muscular capabilities, impairments in motor control, abnormalities in the body's shape, and weakness. The thumb and fingers bend and extend in different directions as a result in a juvenile grasp; this leads to acute distal interphalangeal (DIP) flexion, wrist flexion, and metacarpophalangeal (MCP) flexion.Additionally, it causes forearm pronation, forearm rotation, elbow and wrist flexion, internal rotation of the shoulder, anterior tilting, medial rotation, and protraction of the scapula. Instead of using the palm of their hand, children with cerebral palsy learn to use all of their fingers collectively (Noronha et al., 1989). The capacity of a child to utilize their hand and wrist in a supine and pronated position—which is necessary for bilateral hand usage and comprehension—is compromised by these variances. This affects reaching and grasping tasks (Yasukawa, 1990).

Orthopedic treatments, botulinum toxin, and oral and intrathecal baclofen are among the frequently employed techniques. The standard measurements used to help children with cerebral palsy with their upper extremity motor skills include Important points of control, constraint-induced movement therapy (CIMT), biofeedback therapy, inhibitory orthosis, neuromuscular electrical stimulation, hand-arm bimanual intense training, and Johns tone pressure splints are all part of Bobath's neurodevelopment treatment (NDT) posture. Properly placing the limbs to prevent spasticity helps to desensitize the stretch receptors of the spastic muscles over extended stretches within the limits of a person's tolerance (Akbayrak et al., 2005). Stretching the muscles for a long duration helps one to achieve this. Therapeutic elongation should be daily given to non-neural components for a sufficient length of thirty minutes to promote muscular development by undoing the muscular shortening. This is so since therapeutic elongation reduces reflex sensitivity, hence lowering spasticity (Wilton, 2003). Akbayrak et al. (2005) claim that this is achieved by preventing the joints from shifting beyond their proper position with orthoses or splints. This reduces the actions of antagonists, so enhancing the functions of agonists. Autti-Ra¨mo¨ et al. (2006) claim that volar resting splints and positioning devices such as dynamic or fixed Orthoses help people with a variety of conditions, including those affecting their upper limbs, to do daily tasks with the proper use of their hands. These orthoses, which are based on Bobath's central point of control, consist of a wrist splint that inhibits reflexes and a neoprene splint that positions the thumb in abduction and the forearm in supination. This combination improves the ability to use both hands and prehension skills by reducing spasticity (Autti-Ra¨mo¨ et al., 2006; Reid, 1992; Wilton, 2003). The use of splinting devices in the treatment of spastic hands in children with cerebral palsy has had mixed results, since therapists have found that these devices have limited benefits (Neuhaus et al., 1981).

Given the general acceptance of the neuro physiological approach, one wonders whether hand splints are suitable for treating children with cerebral palsy. Rood claims that using splints directly goes against their intended use since it activates sensory inputs including touch, pressure, and strain, which finally causes the muscles to contract in unwanted manner. Rood and other authors suggested that continuous pressure be given on according to Math-iowetz et al. (1983), the long flexors are inhibited by the flexors of the wrist and fingers.

Every splint and positioning device that has been researched to help children with cerebral palsy enhance their hand capabilities has certain drawbacks. The Neuro-Sensory Development Section of Selected Tertiary Hospital created. The purpose of this board was to assist children with cerebral palsy (CP) in developing their fine motor abilities. Since the NHR Board tackles the concerns brought up by Rood's, children with cerebral palsy should particularly benefit from it. The clinical experience we have gained working with children who have cerebral palsy shows that the NHR board allows active flexion and progressive increase in range of motion (ROM) for forearm supination, wrist extension, and finger extension; passive extension of the fingers at the MCP, PIP, and DIP joints. Because they enable the kid to independently develop their fine motor skills, these motions are beneficial for children with cerebral palsy. According to Wang et al. (2006), the purpose of this study is to examine how the NHR board immediately impacts hand functions as measured by the PDMS-2 fine motor subgroup in children with cerebral palsy.

Methodology

Statement on ethics

The design of the pilot study was a quasi-experimental one and a suitable sampling technique was applied for this specific research. Approved by the scientific community's scientific and institutional ethics committees, the study conforms to the ethical standards and guidelines set. Parents and guardians of children with cerebral palsy were asked to sign informed permission after receiving an explanation of the aim of the study.

Participants

The following inclusion criteria were used to screen fifty-eight children with spastic cerebral palsy: a modified Mini Mental Status Examination score of 24, the ability to move one's upper extremities impaired either unilaterally or bilaterally in both sexes, and the age of three (for children aged three to five years) and 28 (for children aged six years). According to Jeevenantham et al. (1915). Children who had previously received NHR board treatment, received Botox injections within the previous six months, were taking muscle relaxants like baclofen and diazepam, had undergone upper limb surgery, or had active seizure disorders were among the candidates for exclusion, according to Akbayrak et al. (2005).

Visual-Motor Integration (72 items) and Grasping (26 items). According to the scoring criteria, a If a child's performance on an activity does not satisfy the criteria, it is given a score of 0; if it is similar but falls short, it is given a score of 1; and if it is successful, it is given a score of 2 (Stokes et al., 1990). Points are scored using a three-point system.

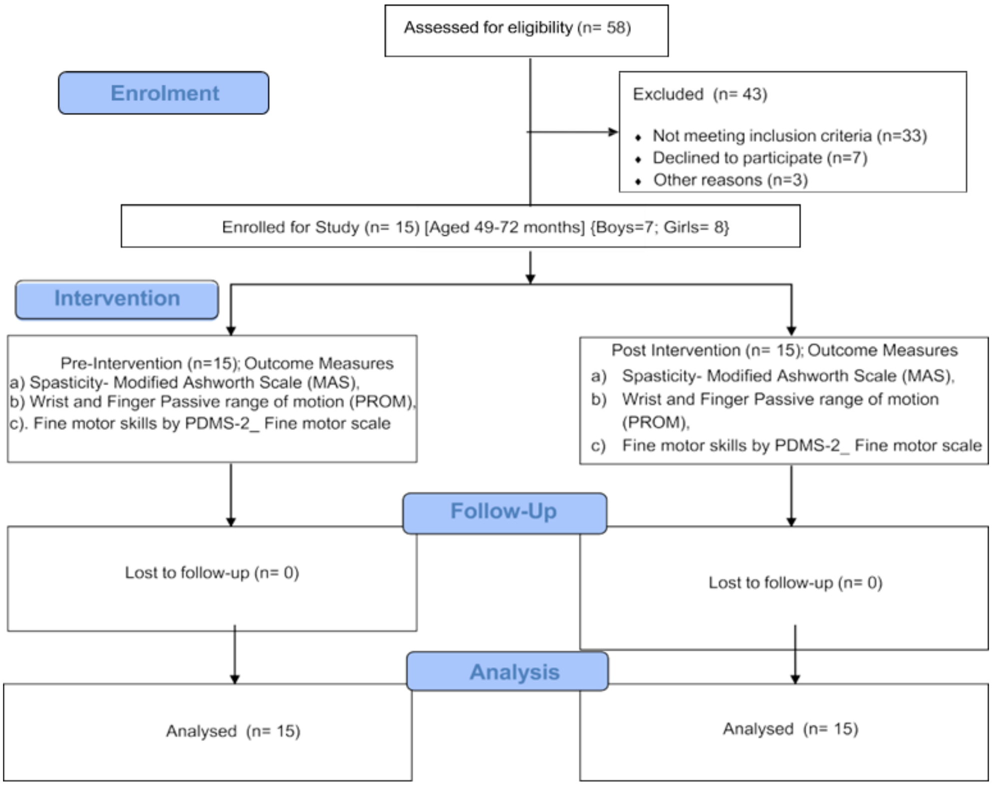
Procedure

In order to support the pelvis, children with cerebral palsy were sitting comfortably on a firm cushion on the floor, with their hips rotating in a neutral position and their trunks upright. Both scenarios were agreeable to the children. Both knees were supported while they were extended from this position by a small, gentle bolster beneath the popliteal Fossa. Additionally, both feet were on the ground; the heels were supported by a tiny, plush cushion. To maintain the NHR board in a straight, upright position while the trunk is aligned, a therapeutic bench of a proportionate height is positioned at a level approximately mid-thigh. The proximal radio-ulna is anchored junction with circular vertical holes inclined at 90 degrees starts this process. Arranging the affected ulna on the NHR board comes next. The forearm then was positioned in a supine posture with 101.9 (90 percent power). Using this method, fifteen spastic cerebral palsy diagnosed youngsters were selected.

We have the Peabody Developmental Motor Scale-2nd Edition (PDMS-2)

Due to its 45-degree angled holes that extend all the way up to the distal radio-ulna junction, the PDMS-2 is a very valid and dependable instrument that may be used to assess children's gross and fine motor abilities. Following that, vertical holes were used to place the wrist and fingers in a functional extension posture. that were 90 degrees slanted. An elastic band held the thumb's loops in abduction and neutral extension. An elastic band was also used to support the finger loops on all four fingers, allowing for active finger motions such as flexion and extension. This position was maintained for a minimum of half an hour, or until the youngster achieved their maximum capacity. After ten minutes of repose following the intervention, the hand was removed from the NHR Board.
Keeping track of outcome measures

Spasticity is assessed with the Modified Ashworth Scale (MAS), passive range of motion (PROM) is measured using a goniometer, and fine motor abilities are assessed using the PDMS-2. Prior to and following the usage of the NHR Board, the fine motor scale showed (Harb & Kish-ner, 2022; Jain & Passi, 2005; Wang et al., 2006). These measures resulted in the collection of data. Even though all children with cerebral palsy received scheduled therapy in compliance with NDT criteria, no treatment was given on the day the NHR board was used.



CONSORT diagram: Study Procedure.

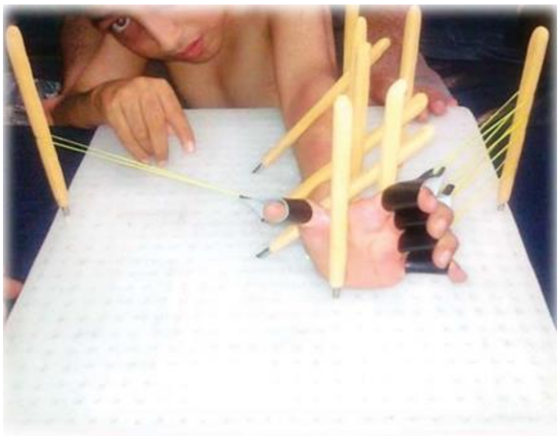


Fig. 1. A subject's involved hand positioned on the NHR Board.

Analysis of statistics

The statistical analysis was performed using the Statistical Package for Social Science (SPSS) version 17.0. Descriptive statistics were used to calculate the subject's demographic characteristics. To ascertain the differences between the pre- and post-intervention states, all variables, including the

MAS, the PROM assessment, and the PDMS-2 Fine Motor scale, were evaluated using the Wilcoxon signed-rank test, also referred to as the non-parametric T-test. For every variable, a correlation study was carried out using Spearman's rank correlation methodology. Considering a 95% confidence interval, the level of significance—$p < 0.05$—was considered statistically significant.

'*Results*

A total of fifty-eight children with cerebral palsy were evaluated in order to be eligible for the research. Out of them, fifteen children with spastic cerebral palsy, ranging in age from 49 to 72 months (mean age: 65.33 to 6.355 months), were selected for participation. An overview of the study's demographic information for the kids with spastic cerebral palsy.

Changes in spasticity of wrist and forearmmuscles

The MAS was used to analyze the wrist and forearm muscles' spasticity in order to look into the scientific foundation of functional changes in PDMS 2 Fine motor subtests. This significantly reduced the spasticity of the forearm pronators (0.001) and wrist flexors (0.008). The wrist extensors did not significantly better after the intervention.

Changes in wrist ROM

Among the few common traits of children diagnosed with cerebral palsy were wrist flexion and ulnar or radial surface deviation. These events originate in the spastic condition existing in the volar muscles. Table 2 shows the results, which show that following the intervention the range of motion (ROM) of ulnar deviation ($p = 0.007$) and wrist extension ($p = 0.005$) improved significantly. This means that the range of motion experienced at the wrist joint is affected by the posture one keeps for a long period.

Changes in finger joint ROM

Among the few common traits of children diagnosed with cerebral palsy were wrist flexion and ulnar or radial surface deviation. These events originate in the spastic condition existing in the volar muscles. Table 2 shows the results, which show that following the intervention the range of motion (ROM) of ulnar deviation ($p = 0.007$) and wrist extension ($p = 0.005$) improved significantly. This means that the range of motion experienced at the wrist joint is affected by the posture one keeps for a long period.

Conclusion

The first findings of the NHR Board's intervention on both of the fine motor subtests of the PDMS-2 (Grasping and VMI) were outstanding for children with cerebral palsy, therefore improving the participants' fine motor skills. Children with cerebral palsy also showed notable decreases in stiffness of forearm pronators and wrist flexors as well as increased wrist and finger range of motion (ROM). These results imply that the NHR board is strong enough to be advised as a good therapy approach to improve fine motor abilities in children with cerebral palsy.

References

1. Akbayrak, T., Armutlu, K., Gunel, M. K., & Nurlu, G. (2005). Assessment of the short-term effect of antispastic position- ing on spasticity. *Pediatrics International*, *47*(4), 440-445. https://doi.org/10.1111/j.1442-200x.2005.02086.x
2. Autti-Rämö, I., Suoranta, J., Anttila, H., Malmivaara, A., & Mäkelä, M. (2006). Effectiveness of Upper and Lower Limb Casting and Orthoses in Children with Cerebral Palsy. *Amer-ican Journal of Physical Medicine & Rehabilitation*, *85*(1), 89.
3. Duruöz, M. T. (Ed.). (2019). *Hand Function: A Practical Guide to Assessment*. Springer International Publishing.
4. Hanna, S. E., Law, M. C., Rosenbaum, P. L., King, G. A., Walter, S. D., Pollock, N., & Russell, D. J. (2003). Develop- ment of hand function among children with cerebral palsy:
5. Growth curve analysis for ages 16 to 70 months. *Devel- opmental Medicine & Child Neurology*, *45*(7), 448-455. https://doi.org/10.1111/j.1469-8749.2003.tb00939.x
6. Harb, A., & Kishner, S. (2022). Modified Ashworth Scale. In
7. *StatPearls*. StatPearls Publishing.
8. Jackman, M., Novak, I., & Lannin, N. (2014). Effectiveness of hand splints in children with cerebral palsy: A systematic review with meta-analysis. *Developmental Medicine & Child Neurol- ogy, 56*(2), 138-147. https://doi.org/10.1111/dmcn.12205

9. Jain, M., & Passi, G. R. (2005). Assessment of a Modified Mini- Mental Scale for Cognitive Functions in Children. *Indian Pediatrics*, *42*, 6.
10. Jeevanantham, D., Dyszuk, E., & Bartlett, D. (2015). The Manual Ability Classification System: A Scoping Review. *Pediatric Physical Therapy*, *27*(3), 236-241. https://doi.org/10.1097/PEP.0000000000000151
11. Makki, D., Duodu, J., & Nixon, M. (2014). Prevalence and pattern of upper limb involvement in cerebral palsy. *Journal of Children's Orthopaedics*, *8*(3), 215-219. https://doi.org/10.1007/s11832-014-0593-0
12. Mathiowetz, V., Bolding, D. J., & Trombly, C. A. (1983). Immedi- ate effects of positioning devices on the normal and spastic hand measured by electromyography. *The American Jour- nal of Occupational Therapy: Official Publication of the American Occupational Therapy Association*, *37*(4), 247-254. https://doi.org/10.5014/ajot.37.4.247
13. Mutsaarts, M., Steenbergen, B., & Bekkering, H. (2006). Antici- patory planning deficits and task context effects in hemiparetic cerebral palsy. *Experimental Brain Research*, *172*(2), 151-162. https://doi.org/10.1007/s00221-005-0327-0
14. Neuhaus, B. E., Ascher, E. R., Coullon, B. A., Donohue, M. V., Ein-
15. bond, A., Glover, J. M., Goldberg, S. R., & Takai, V. L. (1981). A Survey of Rationales For and Against Hand Splinting in Hemiplegia. *The American Journal of Occupational Therapy*, *35*(2), 83-90. https://doi.org/10.5014/ajot.35.2.83
16. Noronha, J., Bundy, A., & Groll, J. (1989). The Effect of Position-ing on the Hand Function of Boys With Cerebral Palsy. *The American Journal of Occupational Therapy*, *43*(8), 507-512. https://doi.org/10.5014/ajot.43.8.507
17. Reid, D. T. (1992). A Survey of Canadian Occupational Therapists' Use of Hand Splints for Children with Neuromuscular Dys- function. *Canadian Journal of Occupational Therapy*, *59*(1), 16-27. https://doi.org/10.1177/000841749205900104
18. Sakzewski, L., Ziviani, J., & Boyd, R. (2009). System- atic Review and Meta-analysis of Therapeutic Man- agement of Upper-Limb Dysfunction in Children With Congenital Hemiplegia. *Pediatrics*, *123*(6), e1111-e1122. https://doi.org/10.1542/peds.2008-3335Scheker, L. R., Chesher, S. P., & Ramirez, S. (1999). Neuro- muscular Electrical Stimulation and Dynamic Bracing as a Treatment for Upper-Extremity Spasticity in Children with Cerebral Palsy. *Journal of Hand Surgery*, *24*(2), 226-232. https://doi.org/10.1054/JHSB.1998.0002
19. Simon-Martinez, C., Jaspers, E., Mailleux, L., Desloovere, K., Vanrenterghem, J., Ortibus, E., Molenaers, G., Feys, H., & Klingels, K. (2017). Negative Influence of Motor Impair- ments on Upper Limb Movement Patterns in Children with Unilateral Cerebral Palsy. A Statistical Parametric Map- ping Study. *Frontiers in Human Neuroscience*, *11*, 482. https://doi.org/10.3389/fnhum.2017.00482
20. Steenbergen, B., Charles, J., & Gordon, A. M. (2008). Finger- tip force control during bimanual object lifting in hemiplegic cerebral palsy. *Experimental Brain Research*, *186*(2), 191-201. https://doi.org/10.1007/s00221-007-1223-6
21. Stokes, N. A., Deitz, J. L., & Crowe, T. K. (1990). The Peabody Developmental Fine Motor Scale: An Interrater Reliability Study. *The American Journal of Occupational Therapy*, *44*(4), 334-340. https://doi.org/10.5014/ajot.44.4.334
22. Wang, H.-H., Liao, H.-F., & Hsieh, C.-L. (2006). Reliability, Sensitivity to Change, and Responsiveness of the Peabody Developmental Motor Scales-Second Edition for Children With Cerebral Palsy. *Physical Therapy*, *86*(10), 1351-1359. https://doi.org/10.2522/ptj.20050259
23. Wilton, J. (2003). Casting, splinting, and physical and occupational therapy of hand deformity and dysfunction in cerebral palsy. *Hand Clinics*, *19*(4), 573-584. https://doi.org/10.1016/S0749-0712(03)00044-1