ORIGINAL ARTICLE

Influence of rehacom system programme on hand function in spastic hemiplegic children

Sara Yousef. Elsebahy[1], Yomna Farag Ahmed[2], Abdelaziz Ali Sherief[3]

Abstract

Objectives: To assess the impact of cognitive therapy with the rehacom visual-motor module on the hand function in hemiplegic cerebral palsy children.

Method: The randomised case-control study was conducted at Kafrelsheikh University, Egypt, from September 2021 to February 2022, and comprised children aged 6-8 years with spastic hemiplegic cerebral palsy. They were randomised into control group A and intervention group B. Subjects in group A received designed physical therapy and hand function training, while those in group B additionally received visual-motor coordination training with the help of rehacom system. The groups were evaluated for both visual-motor coordination and fine motor skills at baseline and after 6-month training. SPSS version 26 was used to analyse the raw data of the current study.

Results: Of the 40 subjects, 20(50%) were in each of the two groups. There were 13(65%) boys and 7(35%) girls with mean age 66±4.01 months in group A, and 9(45%) boys and 11(55%) girls with mean age 67±4.06 months in group B ($p>0.05$). Both groups showed improvement related to grasping, visual-motor integration and fine motor quotient post-intervention, but improvement in group B was significantly higher on each count($p<0.05$).

Conclusion: The addition of visual-motor integration programme by rehacom system was found to be more effective than the effect of routine physiotherapy training alone.

Keywords: Cerebral palsy, Hemiplegia, Motor skills, Muscle spasticity, Psychomotor performance.

DOI: 10.47391/JPMA.EGY-S4-9

Introduction

Children with cerebral palsy (CP) have impairment to the motor system during neonatal or infantile phase. As a result, the child has poor balance, poor coordination, aberrant movement patterns, or a combination of these traits.[1] Hemiplegic CP is found in >39% of CP children.[2] Children with hemiplegic CP have central deficiencies in their ability to integrate several skills. They have significant debilitated in visual-motor integration (VMI) which rebound the interaction of main items motor, visual perceptual, and visual skills.[3] The degree of coordination between visual recognition and finger-hand development is what defines visual-motor integration.[4] Since it is linked to the execution of many practical skills, VMI is crucial for children's development.[5] Effective eye-hand coordination is essential for the productive execution of visual and spatial activities of everyday living.[6] The most widely recognised issue in hemiplegic children is visual perception.[7] Visual perception, eye-hand coordination, fine motor skills, speed, and VMI are just a few of the many elements that make up the visual-motor function.[8] As a result, assessing visual-motor performance can be challenging because poor visual-motor execution might be caused by deficiencies in one or more of these areas. Hand affliction in hemiplegic CP is distinguished by excessive thumb adduction and flexion, and minimal active wrist extension. Hand function problems are exacerbated by somatosensory, visual and developmental disorders. Progressive soft tissue and bone alterations may occur as a result of a lack of practice, culminating in contracture, which further impairs the hand function. Early intervention can delay or stop this process, but the quality of intervention has to be carefully examined.[9]

Rehacom incorporates 3 basic treatment strategies: psycho-education and awareness of cognitive functions, enhancement of motivational functions, and training of compensatory and adaption skills. It is designed to improve attention, concentration, learning and executive functions. This results in better control of adaptive abilities.[10]

The current study was planned to determine how cognitive treatment combined with the rehacom visual-motor module affects the hand function of children with hemiplegic CP.

Materials and Methods

The randomised case-control study was conducted at Kafrelsheikh University, Egypt, from September 2021 to

[1,3] Department of Paediatric Physical Therapy, Kafrelsheikh University, Egypt.
[2] Department of Physical Therapy for Basic science, Modern University for Technology and information, Cairo, Egypt.
Corrospondience: Sara Yousef. Elsebahy email: drsaraelsebahy@gmail

February 2022. After approval from the institutional ethics review committee, the ample size was calculated using G*power 3.0.10 calculator with effect size 0.9, which was worked on the basis of a pilot study comprising 10 subjects. Power level was set at 80% and alpha level at 0.05.[11]. In order to make the sample comprehensive, all patients who met the study criterion were included. All children aged 6-8 years with spastic hemiplegic CP were assessed randomly at the outpatient clinic of the Faculty of Physical Therapy. The assessment included visual-motor coordination and fine motor skills. Spasticity was evaluated using the modified Ashwar Scale (MAS)[12], while level of attention and concentration was assessed according to the rehacom system[10]. Those included had values ranging 1-3, were able to sit alone with good equilibrium reactions with considerable co-contraction around shoulder joints, did not demonstrate significant perceptual defects, had no surgical interventions on the affected side, and the upper limbs were free from any structural deformities or contractures. The rest were excluded and so were those whose parents did not volunteer to participate in the study.

After taking informed consent from parents/caregivers, the subjects were randomised using closed-envelope method into control group A and intervention group B. Subjects in group A received designed physical therapy and hand function training, while those in group B additionally received visual-motor coordination training with the help of rehacom system. Each subject was assigned an identity number to ensure confidentiality.

The rehacom system comprised a patient panel, a mouse and a central processing unit (CPU) that ran a variety of software programmes. A unique input panel with a very basic keyboard and large, sturdy reaction keys enabled safe operation even for anyone with limited or insufficient manual dexterity. The panel consisted of 6 big keys, special keys, and 1 joystick. Evaluation of visual-motor coordination abilities of hemiplegic children was carried out through the application of the rehacom system attention and concentration programme. The subjects were given instructions on how to use the device and the right application so that they could use the test and provide accurate answers while seated comfortably.

With every level, it became more difficult to pick the right image in the matrix. According to the degree of difficulty, the matrix had 3, 6 and 9 photographs. The difficulty level is automatically adjusted. At the time, the technique has 448 images. There were 8 phases, each with several records of 16 images, ranging from minimal item similarity (easy work) to high resemblance (hard task). There were 24 levels of difficulty altogether. The computer report showed the amount of focus and attention used as well as the speed of the response.

Evaluation of fine motor skills was done using the Peabody Developmental Motor Scale-2 (PDMS-2)[13] which evaluates motor abilities in children from birth to five years of age. It has 6 subtests. The first is 'Reflexes' (birth to 11 months) which assesses the child's ability to automatically react to environmental events. The second was 'Stationary' (all ages) which assesses the child's ability to maintain balance and control of the body inside its centre of gravity. The third is 'Locomotion' (all ages) which measures crawling, walking, running, hopping and jumping forward. The fourth is 'Object manipulation' (12 months and older) which measures the child's abilities to catch, throw and manipulate the ball. The fifth is 'Grasping' (all ages) which measures the child's abilities to use hands to hold an object, and progress to the use of finger of both hands. The sixth subset is 'VMI' (all ages) which measures the child's abilities to perform eye-hand coordination tasks, such as reaching, grasping and copying designs. The subjects were given a thorough description of the processes while sitting in a comfortable position. The subjects were seated on a chair in front of an adjustable table. Factors of height, back support, seat depth and seat to floor armrest were considered to provide the proper and comfortable sitting position for the child. The examiner was positioned adjacent to the children or opposite them. The table only included the items needed to administer a single process, and extraneous objects were kept out of the child's line of sight.[13]

After taking informed consent from parents/caregivers, the subjects were randomised using closed-envelope method into control group A and intervention group B. The intervention lasted 6 months during which the two groups were given the prescribed training three days per week. Each subject was assigned an identity number to ensure confidentiality. Subjects in group A received designed physical therapy and hand function training, while those in group B additionally received visual-motor coordination training with the help of rehacom system. The screen was divided into two parts; one part contained a picture of an object, while the other represented a matrix of pictures containing a number of pictures according to the level of difficulty. The separate picture was to be compared to the matrix, and the one picture resembling it in every detail was to be found. The matrix comprised symbols, abstract figures and animals. The selection was to be made by means of big buttons. After selecting a picture, the system evaluated the choice and showed up a green sign if the choice was correct or a red sign if the choice was not correct. The performance bar changed according to the reaction quality. The performance bar grew or shrank with every correct or incorrect answer. This continued till three incorrect trails or time >30 minutes.

Both the groups were evaluated for visual-motor coordination and fine motor skills at baseline and all the assessments were repeated after the 6-month intervention. SPSS version 26 was used to analyse the raw data of the current study

Baseline and post-intervention data were expressed as mean and standard deviation. Level of significance between the two sets of readings within each group was evaluated using paired t-test. Intergroup differences were assessed using unpaired t-test. P<0.05 was considered statistically significant.

Results

Of the 70 subjects initially assessed, 40(57%) were included; 20(50%) in each of the two groups (Figure). There were 13(65%) boys and 7(35%) girls with mean age 66±4.01 months in group A, and 9(45%) boys and 11(55%) girls with mean age 67±4.06 months in group B (p>0.05). There was no significant variation with respect to age, weight and height between the groups (Table 1).

Both groups showed improvement related to grasping, VMI and fine motor quotient post-intervention, but improvement in group B was significantly higher on each count (Tables 2-4).

Table-1: General characteristics of the patients control and study groups.

Items	control	study	*p-value*	*t-value*
Age (months)	Mean ± SD	Mean ± SD	0.4	0.7837
	66 ± 4.01	67±4.06		
Weight(kg)	26.9±0.85	26.8±0.95	0.72	0.3508
Height(cm)	116±4.05	117.37± 4.5	0.3179	1.0120
		n (%)		**n (%)**
Gender	Female	13 (65)	Female	11 (55)
	Male	7 (35)	male	9 (45)
Affected side	Right	11 (55)	Right	11 (55)
	Left	9 (45)	Left	9 (45)

SD: Standard deviation.

Table-2: Pre- and post-intervention differences for grasping.

	Experimental group Mean ± SD	Control group Mean ± SD	*t-value*	*p-value*	Level of significance
Pre- treatment	20.50±1.94	19.55±1.03	1.9342	0.0606	NS
Post -treatment	33.07±2.5	28.45±1.04	7.6306	<0.0001	S

SD: Standard deviation, NS: Non-significant, S: Significant.

Table-3: Pre- and post-intervention differences for visual motor integration.

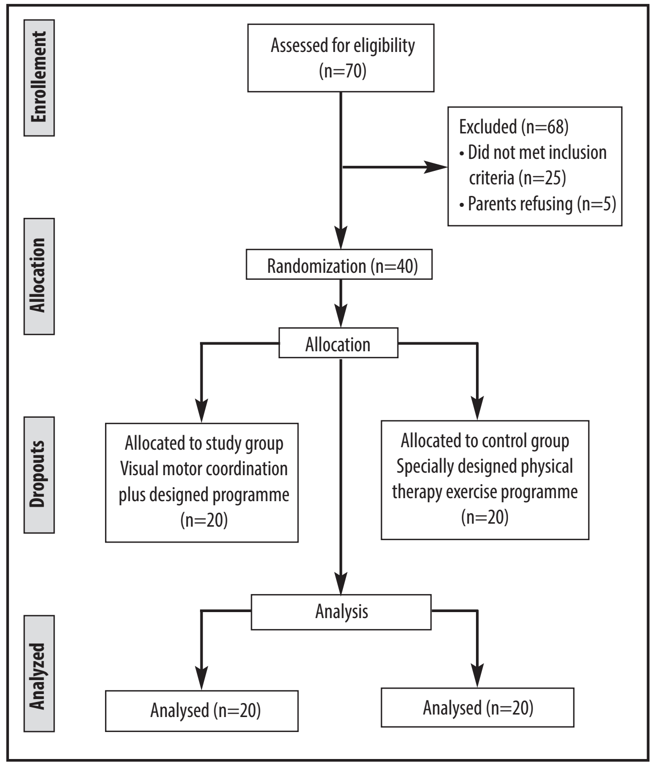
	Experimental group Mean ± SD	Control group Mean ± SD	*t-value*	*p-value*	Level of significance
Pre -treatment	21.45±1.14	22.05±1.05	1.7313	0.0915	Ns
Post-treatment	34.5±1.07	28.3±1.02	18.7565	<0.0001	*

SD: Standard deviation, NS: Non-significant, S: Significant.

Table-4: Pre- and post-intervention differences for fine motor quotient.

	Experimental group Mean ± SD	Control group Mean ± SD	*t-value*	*p-value*	Level of significance
Pre- treatment	2.5±1.4	2.7±1.4	0.4518	0.6540	Ns
Post- treatment	14.05± 2.3	10. 7±1.7	5.2382	<0.0001	*

SD: Standard deviation, NS: Non-significant, S: Significant.



Discussion

The post-intervention findings in both groups showed significant increase in standard scores of VMI which may be attributed to improvement in the sensory integration process; the ability to promote optimal neuronal integration, organise, and connect with the environment with sensory inputs. Using tools of different textures and sizes during treatment gave the children continuous sensory information. This sensory information is critical for adapting and acclimatisation of movements and is used to correct errors during the execution of movements, ensuring accuracy during the final portions of the movements.[14]

The age range of the children in the present study was 6-8 years, which was similar to earlier reports[15,16]. A child may assume a hand grasp with a regular effort by the time they are 5-7 years of age to lift or grab an object without letting it slip through their fingers[17]. Tarakci et al.[18] concluded that children aged 5 months to 2 years can develop the ability to detect the various features that make objects unique. They develop the ability to discriminate and reorganise various objects and begin to notice the similarities and differences among them.

CP children frequently have difficulty reaching, grasping, moving, releasing and manipulating things, which is critical for the quality and performance of activities of daily living (ADLs).[19] Children with hemiplegic CP have a limited ability to connect with others and their surroundings, which limits involvement and participation. Motor dysfunction in CP children impair physical activities and result in a lack of general experience.[20,21]

Deficits in fine motor abilities in the current study's hemiplegic children could be attributed to abnormal motor control, abnormal muscle tone, poor synchronisation with motor techniques, and diminished cutaneous sensation. Furthermore, the upper limb proprioception is altered, and the visual system is affected. It has been discovered that repeating certain motor activities improves visual-motor coordination as well as the ability to anticipate individual patterns of movement. It has also been demonstrated that visuospatial abilities are required for visual-motor skills to work correctly. When an individual is unable to judge the distance and location of the point where the object is to be placed, hand-eye coordination improves.[22-24]

The delayed development of gripping and VMI activities in hemiparetic children may be due to diminished muscular strength and motor control of the upper limb, which affects task performance and interferes with the children's development.[25] The child's upper limb movement is asymmetric, and the affected limb moves slower than the non-affected arm, with a delay in movement initiation.[25]

The performance of the upper limbs was enhanced by combining cognitive training, which stimulates several functions with upper limb therapy. This was demonstrated by the fact that the therapy recipients outperformed the controls, who only got normal rehabilitation techniques. When combined with standard motor training, Rehacom-based cognitive therapy may engage many cortical areas at the same time. This speeds up compensatory processes, resulting in faster improvement of a patient's motor capabilities, and, as a result, a shorter rehabilitation period for hemiplegic CP patients.

The current study's findings were consistent with those of a study[26], which hypothesised that bilateral manipulative abilities were more significantly impacted by the visual perceptual disorder than the child's fundamental apprehension pattern. This impacted the child's ability to use tools and release materials to other children. Cutting, colouring and building with different types of blocks were all impacted by this problem with visual perception.[26]

In all age groups there were a strong relation between visual motor integration and cognitive development, therefore the improvement of VMI after the training programme caused eye and hand movements to interact with and influence each other, that help the child meet all of ADL requirements perceived.[27]

Conclusion

The addition of VMI programme by rehacom system was found to be more effective than the effect of routine physiotherapy training alone in children with hemiplegic CP.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

References

1. 1. Miller F, Bachrach SJ. Cerebral palsy: A complete guide for caregiving, 3rd ed. Baltimore, Maryland: Johns Hopkins University Press, 2017; pp 3.
2. Bingöl H, Günel MK. Comparing the effects of modified constraint-induced movement therapy and bimanual training in children with hemiplegic cerebral palsy mainstreamed in regular school: A randomized controlled study. Arch Pediatr 2022;29:e105-15. Doi: 10.1016/j.arcped.2021.11.017.
3. Alwhaibi RM, Alsakhawi RS, ElKholi SM. Augmented Biofeedback Training with Physical Therapy Improves Visual-Motor Integration, Visual Perception, and Motor Coordination in Children with Spastic Hemiplegic Cerebral Palsy: A Randomised Control Trial. Phys Occup Ther Pediatr 2020;40:e134-51. Doi: 10.1080/01942638.2019.1646375.
4. Ng M, Chui M, Lin L, Fong A, Chan D. Performance of the Visual-Motor Integration of Preschool Children in Hong Kong. Hong Kong J Occup Ther 2015;25:e7-14. Doi: 10.1016/j.hkjot.2015.06.002.
5. Lim CY, Tan PC, Koh C, Koh E, Guo H, Yusoff ND, et al. Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery-VMI): Lessons from exploration of cultural variations in visual-motor integration performance of preschoolers. Child Care Health Dev 2015;41:e213-21. Doi: 10.1111/cch.12190.
6. Tanner K, Schmidt E, Martin K, Bassi M. Interventions Within the Scope of Occupational Therapy Practice to Improve Motor Performance for Children Ages 0-5 Years: A Systematic Review. Am J Occup Ther 2020;74:e1-40. Doi: 10.5014/ajot.2020.039644.
7. Alsakhawi RS, Alsakhawi RS. The effect of camera mouse system program on visual motor integration in spastic hemiplegic children. Int J Ther Rehabil Res 2017;6:e116-24. Doi: 10.5455/ijtrr.000000252.
8. Ibrahimi D, Mendiola-Santibañez JD, Gkaros AP. Analysis of the potential impact of strabismus with and without amblyopia on visual-perceptual and visual-motor skills evaluated using TVPS-3 and VMI-6 tests. J Optom 2021;14:e166-75. Doi: 10.1016/j.optom.2020.04.002.
9. Rathinam C, Mohan V, Peirson J, Skinner J, Nethaji KS, Kuhn I, et al. Effectiveness of virtual reality in the treatment of hand function in children with cerebral palsy: A systematic review. J Hand Ther 2019;32:e426-34. Doi: 10.1016/j.jht.2018.01.006.
10. Pawlukowska W, Dobrowolska N, Szylinska A, Koziarska D, Meller A,

Rotter I, et al. Influence of RehaCom Therapy on the Improvement of Manual Skills in Multiple Sclerosis Subjects. Ann Rehabil Med 2020;44:e142-50. Doi: 10.5535/arm.2020.44.2.142.

11. Faul F, Erdfelder E, Buchner A, Lang AG. Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. Behav Res Methods 2009;41:1149-60. Doi: 10.3758/BRM.41.4.1149.
12. Meseguer-Henarejos AB, Sánchez-Meca J, López-Pina JA, Carles-Hernández R. Inter- and intra-rater reliability of the Modified Ashworth Scale: a systematic review and meta-analysis. Eur J Phys Rehabil Med 2018;54:e576-90. Doi: 10.23736/S1973-9087.17.04796-7.
13. Abd El-Aty F, Shokry K, El-Talawy H, Abdel-Azim F. Effect of Cognitive Rehabilitation on Hand Functions in Spastic Hemiplegic Children. Doctoral Degree. Faculty of Physical Therapy, Cairo University. Thesis: 2006; pp 145-150.
14. Berk LE, Meyers AB. Infants and Children: Prenatal through Middle Childhood, 8th ed. London, UK: Pearson, 2015; pp 457-60.
15. Thabet NS, Shenouda MMSS, Shehata SS. Effect of Open and Closed Kinetic Chain Exercises on Wrist Proprioception and Hand Function in Children with Hemiparesis. Bull Fac Ph Th Cairo Univ 2011;16:111-25.
16. Abd-Elfattah HM, Aly SM. Effect of Core Stability Exercises on Hand Functions in Children With Hemiplegic Cerebral Palsy. Ann Rehabil Med 2021;45:e71-8. Doi: 10.5535/arm.20124.
17. Jain T, Bisen R, Ranade P. Effectiveness Of Modified Constraint-Induced Movement Therapy Compared To Hand-Arm Bimanual Intensive Therapy On Quality Of Upper Extremity Function In Hemiplegic Cerebral Palsy Children-An Experimental Study. Natl J Integr Res Med 2021;12:45-50.
18. Elsepaee MI, Elhadidy EI, Emara DHAAM, Nawar EAE. Effect of Mirror Visual Feedback on Hand Functions in Children with Hemiparesis. Int J Physiother 2016;3:147-53. Doi: 10.15621/ijphy/2016/v3i2/94869.
19. Tarakci E, Arman N, Tarakci D, Kasapcopur O. Leap Motion Controller-based training for upper extremity rehabilitation in children and adolescents with physical disabilities: A randomized controlled trial. J Hand Ther 2020;33:e220-28. Doi: 10.1016/j.jht.2019.03.012.
20. Maciver D, Rutherford M, Arakelyan S, Kramer JM, Richmond J, Todorova L, et al. Participation of children with disabilities in school: A realist systematic review of psychosocial and environmental factors. PloS One 2019;14:e0210511. Doi: 10.1371/journal.pone.0210511.
21. Lee BH, Kim YM, Jeong GC. Mediating effects of the ICF domain of function and the gross motor function measure on the ICF domains of activity, and participation in children with cerebral palsy. J Phys Ther Sci 2015;27:e3059-62. Doi: 10.1589/jpts.27.3059.
22. Pashmdarfard M, Richards LG, Amini M. Factors Affecting Participation of Children with Cerebral Palsy in Meaningful Activities: Systematic Review. Occup Ther Health Care 2021;35:e442-79. Doi: 10.1080/07380577.2021.1938339.
23. Fiehler K, Brenner E, Spering M. Prediction in goal-directed action. J Vis 2019;19:10. Doi: 10.1167/19.9.10.
24. Manning T. Neural Mechanisms of Smooth Pursuit Compensation in Heading Perception. [Online] 2019 [Cited 2022 June 03]. Available from URL: https://www.proquest.com/openview/349ac352221d55d44cf864284a552d08/1.pdf?pq-origsite=gscholar&cbl=18750&diss=y
25. Hoare BJ, Wallen MA, Thorley MN, Jackman ML, Carey LM, Imms C, et al. Constraint-induced movement therapy in children with unilateral cerebral palsy. Cochrane Database Syst Rev 2019;4:e004149. Doi: 10.1002/14651858.CD004149.pub3.
26. De los Reyes-Guzmán A, Dimbwadyo-Terrer I, Trincado-Alonso F, Monasterio-Huelin F, Torricelli D, Gil-Agudo A, et al. Quantitative assessment based on kinematic measures of functional impairments during upper extremity movements: A review. Clin Biomech (Bristol, Avon) 2014;29:e719-27. Doi: 10.1016/j.clinbiomech.2014.06.013.
27. Gbonjubola YT, Muhammad DG, Elisha AT. Physiotherapy management of children with cerebral palsy. Adesh Univ J Med Sci Res 2021;3:64-8. Doi:10.25259/AUJMSR_29_2021.
28. El-Deeb HAESM, Salem EE, Abdelhamid KS, Mohamed MN. The Relation between Visual Motor Integration and Cognitive Development in Full Term versus Preterm Infants. Egypt J Hosp Med 2020;81:1151-5. Doi: 10.21608/EJHM.2020.110514.