



Case Report

Effect of Mirror Therapy on Hand Functions in Children with Hemiplegic Cerebral Palsy: A Case Study

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To cite this article:

Shahanawaz S. D., Sayali M. Joshi. Effect of Mirror Therapy on Hand Functions in Children with Hemiplegic Cerebral Palsy: A Case Study. *International Journal of Neurologic Physical Therapy*. Vol. 1, No. 1, 2015, pp. 5-9. doi: 10.11648/j.ijnpt.20150101.12

Abstract: *Introduction:* Cerebral Palsy describes “group of disorders of the development of movement and posture, causing activity limitation that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain”. Children with hemiplegic cerebral palsy learn strategies [4] and techniques leading to learnt non-use of the affected hand. *Purpose of Study:* Out of total population of children with cerebral palsy, about 18% children [1] are diagnosed cases of hemiplegic cerebral palsy as per the statistical data available in the Indian Journal of Paediatrics. G. Cioni [15] in his study have shown that upper extremity involvement is more severe and the residual effects are prolonged. Hence, easy and suitable treatment technique is necessary that will help the patients in better recovery and early functional use of hand. *Aim of study:* To study the effect of mirror therapy on hand functions in children with hemiplegic cerebral palsy. *Methodology:* A 5year old female patient diagnosed as hemiplegic cerebral palsy was assessed for the QUEST [Quality of Upper Extremity Skills Test] and Box and Block test. Mirror therapy was taken for 30 minutes per day for 6 days a week for 3 weeks. Activities performed by the right hand included-Grasps of cylindrical, spherical and hook pattern, Gripping activities with theraputty of green colour, Arrangement of peg board, Peg link activities, Transfer of objects. *Conclusion:* the pre-treatment and post treatment scores showed significant changes suggesting that mirror therapy has an effect incorporating use of affected hand for daily activities.

Keywords: Cerebral Palsy, Mirror Therapy, Hemiplegia, Quest Scale

1. Introduction

Cerebral Palsy [CP] is primarily a disorder of movement and posture [1]. It describes “group of disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain” [2]. It involves affection of both sensorimotor function and is manifested by atypical muscle tone, posture and movement. It can be classified as spastic hemiplegic cerebral palsy, monoplegia, diplegia, quadriplegia as per the topographical presentation [1] of the disease The worldwide incidence of CP is 2 to 2.5 [3] per 1000 live births. Chitra Sankar and Nandini Mundkur in their study mentioned that spastic diplegia is the commonest form 30-40% followed by hemiplegic cerebral palsy 20-30% [1].

Mirror therapy activates the neurons in the motor cortex by mirror visual feedback mechanism. The activated neurons send the impulses through the ipsilateral pathways [6] of

corticospinal tracts resulting in the activation of the muscles in the specific limb. The reflection of the movement of the affected hand increases the amplitude of the motor evoke potential as seen in the study done by Fukumura K [19].

Clinical improvement in disabilities after stroke have been shown with the use of different techniques like electrical stimulation of muscles, electromechanical devices that assist in functional activities, stimulation of the peripheral nerve or motor cortex to enhance neural plasticity and learning during upper limb treatment techniques. These upper limb treatment techniques are either expensive or require personal attention by the therapists for several weeks. The mirror therapy is a simple, inexpensive and patient-directed treatment that may improve upper extremity functional ability. Incorporating mirror therapy into the conventional programme might prove to be beneficial for improving hand function.

Children with hemiplegic cerebral palsy learn strategies [4] and techniques to manage daily tasks and play with unaffected hand. Thus the other hand even if not affected to greater

degree is not used in functional activities. This is termed as learnt non use [5] of the affected hand. The affected hand is as good as absent or amputated. Ramchandran [6] et al pioneered in mirror box therapy by proving its efficacy in treatment of upperlimb amputation by reducing the phantom limb pain. In mirror therapy, the reflection movement occurring in unaffected extremity creates visual imagery that the affected hand is moving. Thus facilitating the activation of muscle of affected limb. Furukawa K [7] in his study noticed that motion of dominant hand induces a increasing in muscle activity of the non-dominant hand in Ramchandran's mirror-box therapy. The mirror-box therapy works by cortical reorganisation. Various studies have put forth different theories to prove these effects. Michielsen M [8] postulated that mirror therapy caused a shift in activation balance M1 that is Primary motor cortex toward the lesioned hemisphere, suggesting neural reorganization. Garry [9] et al also showed increased excitability of primary motor cortex of the hand behind the mirror by transcranial magnetic stimulation.

Altschuler et al [10] suggested that the mirror illusion of a normal movement of the affected hand may substitute for decreased proprioceptive information, thereby helping to recruit the premotor cortex and assisting rehabilitation through an intimate connection between visual input and premotor areas.

Another important factor is the presence of mirror movements. These occur when repetitive voluntary movements of one hand are accompanied by involuntary mirrored movements of the other hand [5].

There are various conventional methods like the use of modalities, splinting, casting, passive stretching, [11, 12, 13] the facilitation of posture and movement upper limb of children with hemiplegic cerebral palsy. In general, the primary aim of these therapies is to reduce muscle tone and spasticity, increase range of movement of the affected limb, and improve functional use of the limb. It has been suggested that mirror therapy is a simple, inexpensive and, most importantly, patient-directed treatment that may improve upper-extremity function.

Out of total population of children with cerebral palsy, about 18% children [1] are diagnosed cases of hemiplegic cerebral palsy as per the statistical data available in the Indian Journal of Paediatrics. G. Cioni [15] in his study has shown that upper extremity involvement is more severe and the residual effects are prolonged. Conventional therapy for improving hand functions include weight bearing on affected hand, functional activities performed with that hand. Incorporating a technique that will further enhance the use of affected extremity is important. Hence, easy and suitable treatment technique is necessary that will help the patients in better recovery and early functional use of hand.

2. Objectives of Study

The study was conducted with objectives of studying the effect of mirror therapy on gross motor hand functions and fine motor hand functions using the QUEST [20] [Quality of

Upper Extremity Skills Test] scale and Box and Block Test [BBT] pre and post treatment as objective outcome measures.

The assumptions of the case study are that either Mirror therapy has no effect on hand functions in children with hemiplegic cerebral palsy or that Mirror therapy is effective in improving hand functioning in children with hemiplegic cerebral palsy.

3. Methodology

A case study was performed in physiotherapy department of D. Y. Patil Hospital. A 5year old female patient, Sayali Wanjare, diagnosed as hemiplegic cerebral palsy was included in the study. She was cognitively normal and scored grade 3 on MAC [21] Scale (Manual Ability Classification System). A written consent was taken from her mother. Mother gave history of noticing the limited use of left upper limb in playing activities and difficulty in weight bearing on left foot in attempt of standing during developmental period. Now she had come to hospital for her routine checkup and physiotherapy treatment. The child was assessed for the QUEST [Quality of Upper Extremity Skills Test] and Box and Block Test [BBT] prior to the first session of the therapy. She was asked to perform activities with the unaffected hand while looking into the mirror. The mirror box was placed on table of appropriate height so that she was able to see the reflection with back supported. The forearm was supported on the table. Left upper limb was placed inside the mirror box with elbow supported. Activities performed by the right hand included-Grasps of cylindrical using club, bottle and pegs, spherical using plastic balls of various diameter and hook grasp using rings and handles pattern objects. Gripping activities with theraputty of green colour, arrangement of peg board for training pincer pattern, peg link activities including attaching and detaching the chains using pulp to pulp prehension pattern. Transfer of cubes from one box to other with only right hand as done in Box and Block Test [BBT] was also taken to improve the speed and efficiency of the movement patterns of extremity. The therapy sessions were taken 30 minutes per day for 6 days a week for 4 weeks. The therapy sessions included other playful activities for lower limb as Sayali was unable to concentrate on the mirror activity for continuously half hour. Care was taken to not involve any weight bearing on the left upper extremity during this process to avoid any kind of interference with the study design.

While performing the Box and Block Test [BBT] Sayali was asked to transfer the cubes from one box to other with right and left hand respectively. The total number of cubes used in the test was 150 and the total number of cubes transferred was calculated for each hand separately. This test was performed pre and post therapy duration.

For QUEST [Quality of Upper Extremity Skills Test] all the components were evaluated according to the criterion mentioned in the scale through playful activities to achieve the desired movement component. The child was allowed to perform the activities actively without any assistance and the

quality of movement was observed and noted. QUEST [Quality of Upper Extremity Skills Test] scale was performed for left upper extremity and evaluated for its four subscales including dissociative movements, grasps, weight bearing, protective extension respectively.

Preparation of mirror box-

Materials used in preparation of mirror box were 2 opaque acrylic sheets of 30cm x 15cm and 1 opaque acrylic sheet of 30cm x 30cm. A single side reflective mirror of 30cm x 30cm was taken. A rectangular box of 30cm height x 30cm width x 15cm breadth was made by attaching the acrylic sheets and mirror was held in a rectangular pattern using the Adhesive tape. The single side reflective mirror faced the outer side of the box. The covered part of the box was used to place the affected hand while the reflection of the activities performed by the unaffected extremity in front of the mirror were observed in the mirror. The covered part of the box enabled to keep the affected extremity away from the child's view.



Figure 1. Mirror Box a. Anterior View b. Lateral View.

4. Result

The age of Sayali was 5 years with weight 12 kg and height of 90 cm at the time of the study.

The pre score obtained from assessing the QUEST [Quality of Upper Extremity Skills Test] 6.04 and Box and Block Test [BBT] for right that is normal extremity was 74 and for left was 44 out of total score of 150 (Table 1).

Table 1. Pre and Post values of Quest and Block and Box Test.

	Pre	Post
QUEST	6.04	7.23
Block and Box Test	right = 74/150 Left=44/150	right=112/150 Left=60/150.

After 4 weeks the post score obtained for QUEST [Quality of Upper Extremity Skills Test] 7.23 (Figure 1) and Box and Block Test [BBT] for right that is normal extremity was 112 and for left was 60 out of total score of 150. Even if the pre and post values are not seen varied to a greater extent, the change observed was significant clinically. The subscales of dissociated movements and grasps were seen to be improved to a greater degree. And it also observed Components of dissociated movements that were to be performed with associated movements of wrist and finger extension showed improvement. Radial palmer and pincer grasp scored better on QUEST scale post therapy. The weight bearing activities including bimanual tasks showed improvement in movement pattern. The forward protective extension also showed improvement.

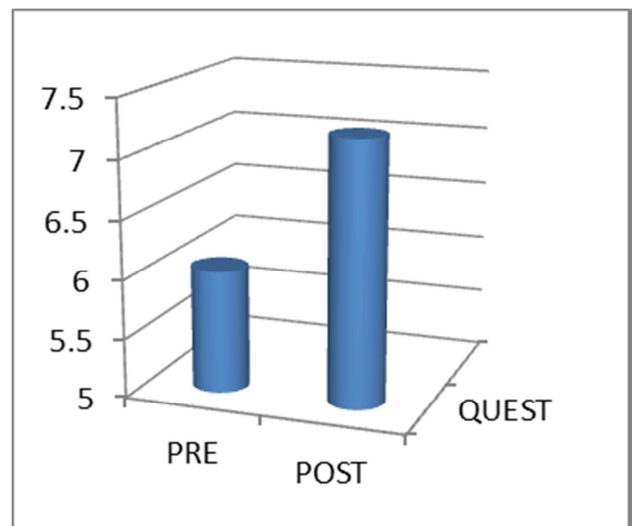


Figure 2. Depicts the improvement on the QUEST [Quality of Upper Extremity Skills Test] scale.

On comparing the results of pre and post values, [figure 3] we observe there is a significant change in number of blocks transferred by both right and left hands. Thus we can observe that mirror therapy helps to improve the ease of motor movement. Dominant hand, which is the right side, also shows significant improvement with training. Non-dominant or affected side also shows improvement to a degree.

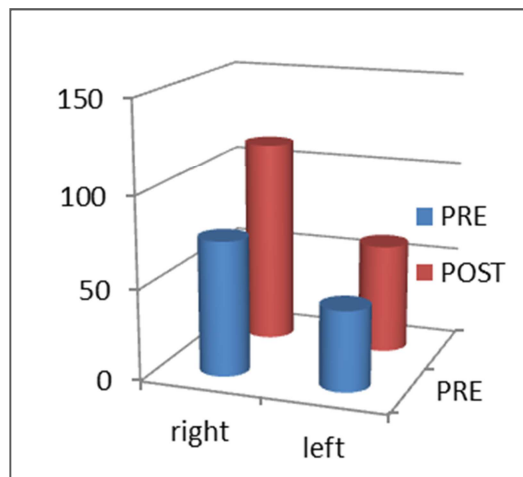


Figure 3. Shows the difference between the values obtained post mirror therapy.

5. Discussion

Efficacy of mirror therapy in reducing pain and improving functional quality of the limb was first proved in the treatment of phantom limb pain in cases of amputation. This triggered its use in various sections of treatment techniques used for hemiplegia or even for the comparison of functional quality of movement by dominant and non-dominant hand.

The activation of the neurons may it be sensory or motor may occur in the area adjacent to the area of stimulation of the specific part in the sensory or motor homunculus respectively.

The dormant neurons in the region of motor homunculus associated with hand region are seen to be stimulated with the visual feedback of normal movement with the affected extremity. In mirror therapy, this visual feedback is provided by the reflection or mirror image of the unaffected extremity. The perceived movement is that of the affected extremity.

The observations of the movements post therapy was improved significantly clinically. Gyax M. J [17]. et al. in their study has concluded that the mirror therapy when used in children with hemiplegia improves the strength as well as function of the affected limb using the visual imagery. Also it is a feasible technique of treatment on daily basis. The use of mirror box on daily basis was found to be easy and feasible treatment strategy. It interested the child to look into the mirror and perform the activities with the unaffected hand.

Carr L. J [18] through The focal magnetic stimulation showed that non damaged motor cortex send ipsilateral motor pathways to the hemiplegic hand. The limited uncrossed fibres of the corticospinal tracts was the pathway of the impulses travelling down the cortex resulting in the motor activation through the perceived sensory information [6].

Observation of reflection of unaffected hand in the mirror activates the action potential for the affected upper extremity in the motor cortex. The visual observation of the affected extremity also shows development of action potentials but to lesser extent. The motor-evoked potential [MEP] amplitudes increased during motor imagery with a mirror than without mirror and it was related to the synergic effects of afferent

information. This was shown by Fukumura K [19].

Mere observation of the hand activity performed even by the other individual increases the neuronal activity in the fronto parietal region. The motor neurons in the pre motor areas and primary motor cortex discharge collectively with the activity. This concept specifies that the characteristic Mirror neurons discharge with the specific motor activity rather than with simple task. Like, grasping or holding an object will activate more mirror neurons as compared to that of the simple movement performed without any task specificity. This concept was studied by Sgandurra G. [22] et al in their study.

The concept of Mirror system was also identified by using several techniques such as Positron Emission Tomography, functional Magnetic Resonance Imaging and Transcranial Magnetic Stimulation. The inferior parietal lobe and the ventral premotor cortex and the caudal part of the inferior frontal gyrus was seen to be activated with the visual feedback of the movement. These neural connections were thought to be transforming the sensory representations of observed motor movements into their motor representations. [22]

Mirror therapy was first used in children with hemiplegia caused due to any underlying cause. But the effectiveness of the therapy with the specific diagnosis holds importance because of the difference in underlying pathophysiology. The final result may be the same but the duration of treatment and the activities may be varied according to the specific diagnosis.

6. Conclusion

This research study was conducted to investigate Effectiveness of Mirror therapy on hand function in hemiplegic cerebral palsy. The Mirror therapy could possibly improve the overall use of affected upper extremity along with strength, prehension patterns. The pre score of QUEST [Quality of Upper Extremity Skills Test] was 6.04 and post treatment was 7.23 which showed maximum improvement in areas of grasps and upper extremity movement patterns. The speed and efficiency of the movement with the left upper extremity was also seen to be improved with box and block test.

The results of this case study pertains to the effects of Sayali, the effects may or may not be generalised to the population of hemiplegic cerebral palsy.

References

- [1] Sankar C and Mundkur N; Cerebral Palsy–Definition, Classification, Etiology and Early Diagnosis; 2005 Indian journal of paediatrics.
- [2] Hoare BJ, Wasiak J, Imms C, Carey L; Constraint-induced movement therapy in the treatment of the upper limb in children with hemiplegic cerebral palsy (Review); The Cochrane Library 2007, Issue 2.
- [3] Rosen MG, Dickinson JC; The incidence of cerebral palsy; Am J Obstet Gynecol 1992; 167: 417-423.

- [4] M Zampini, V Moro, S M Aglioti; Illusory movements of the contralesional hand in patients with body image disorders; *J Neurol Neurosurg Psychiatry* 2004; 75: 1626–1628.
- [5] Kuhtz-Buschbeck JP, Krumlinde-Sundholm L, Eliasson A-C, Forssberg H.; Quantitative assessment of mirror movements in children and adolescents with hemiplegic cerebral palsy; *Developmental Medicine and Child Neurology* 2000; 42: 728–36.
- [6] Ramachandran, V. S. and Rogers-Ramachandran, D; Synaesthesia in phantom limbs induced with mirrors; *Proc R Soc Lond B Biol Sci.* 1996; (2)63: 377–386.
- [7] Furukawa K, Suzuki H, Fukuda J; Motion of the drawing hand induces a progressive increase in muscle activity of the non dominant hand in Ramachandran's mirror-box therapy. *J Rehabil Med.* 2012 Nov 5; 44(11): 939–43.
- [8] Marian E. Michielsen, MSc, Ruud W. Selles, PhD, Jos N. van der Geest, PhD, Martine Eckhardt, MSc, Gunes Yavuzer, PhD, Henk J. Stam, PhD, Marion Smits, PhD, Gerard M. Ribbers, PhD, Johannes B. J. Bussmann, PhD; Motor Recovery and Cortical Reorganization After Mirror Therapy in Chronic Stroke Patients: A Phase II Randomized Controlled Trial.
- [9] M. I. Garry A. Loftus J. J; Summers Mirror, mirror on the wall: viewing a mirror reflection of unilateral hand movements facilitates ipsilateral M1 excitability *Exp Brain Res* (2005) 163: 118–122.
- [10] Altschuler EL, Wisdom SB, Stone L, Foster C, Galasko D, Lle - wellyn DME, Ramachandran VS (1999); Rehabilitation of hemiparesis after stroke with a mirror. *Lancet* 353: 2035–2036.
- [11] Boyd RN, Morris M, Graham HK. Management of upper limb dysfunction in children with cerebral palsy: A systematic review; *European Journal of Neurology* 2001; 8 (suppl. 5): 150–66.
- [12] Hoare BJ, Imms C. Upper limb injections of botulinum toxin-A in children with cerebral palsy: A critical review of the literature and clinical implications for occupational therapists. *The American Journal of Occupational Therapy* 2004; 58(4): 389–97.
- [13] Wasiak J, Hoare BJ, Wallen, M. Botulinum toxin A as an adjunct to treatment in the management of the upper limb in children with spastic cerebral palsy. *Cochrane Database of Systematic Reviews* 2004, (Issue 4).
- [14] G. Cioni, B. Sales, P. B. Paolicelli, E. Petacch, M. F. Scusa, R. Canapicchi; MRI and Clinical Characteristics of Children with Hemiplegic Cerebral Palsy.
- [15] Carol DeMatteo, Mary Law, Dianne Russell, Nancy Pollock, Peter Rosenbaum, and Stephen Walter; The Reliability and Validity of the Quality of Upper Extremity Skills Test; 1993, Vol. 13, No. 2, Pages 1-18.
- [16] Thomas Platz; Cosima Pinkowski; Frederike van Wijck; In-Ha Kim; Paolo di Bella; Garth Johnson; Reliability and validity of arm function assessment with standardized guidelines for the Fugl-Meyer Test, Action Research Arm Test and Box and Block Test: a multicentre study.
- [17] Gyax Marine Jequir; Schneider Patrick; Newman Christopher John; Mirror therapy in children with hemiplegia: a pilot study; *Developmental medicine and child neurology*; 2011.
- [18] Carr L. J.; Harrison L. M.; Evans A. L.; Stephens J. A; Patterns of central motor reorganization in hemiplegic cerebral palsy; doi: 10.1093/brain/116.5. 1223-1247. 1993.
- [19] Fukumura K; Sugawara K.; Tanabe S; Ushiba J; Tomita Y; Influence of mirror therapy on Human Motor Cortex; 2007, Vol. 117, No. 7, Pages 1039-1048 (doi: 10.1080/00207450600936841).
- [20] De Matteo C.; Law M.; Russel D.; Pallock N.; Rosenbaum P.; Walter S.; QUEST-quality of upper extremity skills test; CanChild Centre for Childhood Disability Research, McMaster University, Ontario, Canada. Viewed on October 11 2014 at www.canchild.ca/en/measure/quest.asp.
- [21] Eliasson A. C.; krumlinde S.; Roseblad B.;beckunge; Arner N.; Rosenbaum P.; The manual ability classification system (MACS) for children with cerebral palsy; Scale development and evidence of reliability and validity; *developmental medicine and child neurology*; 2006; 48; 549-554. www.macs.nu.
- [22] Sgandurra G., Ferrari A.; Cossu G.; Guzzetta A., Biagi L., Tosetti M.; Fogassi L.; Cioni G.; Upper limb children action-observation training (UP-CAT): a randomised controlled trial in Hemiplegic Cerebral Palsy; *BMC Neurol*; 2011; 11; 80.