

Effect of Mirror Neuron Therapy in Bilateral Cerebrovascular Accident - A Case Report

Mayuri Laddha¹, Dr. Komal Thorat (PT)²

¹PG I Student, Neuro Physiotherapy Department, Dr. APJ Abdul Kalam College of Physiotherapy, Pravara Institute of Medical Sciences

²Assistant Professor, Neuro Physiotherapy Department, Dr. APJ Abdul Kalam College of Physiotherapy, Pravara Institute of Medical Sciences

Abstract: *One 51 year old male diagnosed with Acute Ischemic infarct in right corona radiate with old gliotic cyst in the left external capsule due to occlusion of right MCA artery was referred to physiotherapy department for the treatment with symptoms of difficulty to form a grip and perform movement with left Upper limb since three months .Physiotherapy treatment was started with roods inhibitory training, task oriented exercise with semi purposeful movement , Facial exercise Phonation exercise with the help of mirror biofeedback, and action Imitation with the help of video clips of different daily Activity to improve the ADLS. Patient should significant improvement in the speech and Gripping.*

Keywords: Bilateral CVA, Mirror Neuron, Phonation exercises, Hand function, Action Imitation video

1. Introduction

Acute cerebrovascular events typically present as a constellation of unilateral neurological deficits coinciding to the appropriate unilateral ischemic event. Simultaneous bilateral cerebrovascular infarction is relatively rare. Bilateral cerebrovascular events occurring simultaneously are extremely rare and are often due to an alternative underlying etiology.

Different approaches have been employed to investigate post-stroke rehabilitation [1, 2]. It has been shown that the human brain is capable of significant recovery after this type of injury [3, 4]. Among its sequels, hemiparesis has-been treated with mirror-therapy which promotes cortical changes [5, 6]. In particular, sensorimotor disorders in post-stroke patients during the execution or observation of motor action have induced changes to the adjacent cortical penumbra area [7]. Moreover, motion imagination studies have demonstrated efficacies in treating the post stroke population [8]. The underlying hypothesis is that “mirror neurons” have been activated during such trainings. These cells were firstly discovered in the premotor cortex of rhesus monkeys by Rizzolatti and colleagues when they analyzed the monkeys observing the researchers’ act of eating up a fruit. These cells were then named because of their property to mirror the observed motor act inside the brain of monkeys [9, 10].

Further experiments have verified the existence of mirror neurons in the parietal-frontal circuit, when an animal was exposed to a task of observing a particular action or intention mad by another animal [11, 12]. Thus, researchers suggested that mirror neurons are part of a neural system where the observation of an action activates the cortical area of the observer’s brain [10, 13-15] Mirror neurons have been associated with various forms of human behaviors: imitation, mind theory, new skill learning and intention reading . Studies suggested that humans have a mechanism for copying mental notes of different behaviors, which partly explains how we learn to smile, talk, walk, dance or play tennis. This means that we mentally rehearse or imitate every action observed, whether a somersault or subtle smile,

indicating that these cells are used to learn everything from the first basic steps to more graceful accurate movements. Therefore, imitation is involved in learning through the transformation of visual inputs encoded into action by the observer.

Therefore, the purpose of this is to describe basic concepts about the current literature on mirror neurons and the major findings regarding the use of mirror Neuron therapy and Speech therapy as potential tools to promote cortical reorganization and functional recovery in post-stroke patients.

2. Need of Study

Patients who suffered from Stoke have reported secondary problems such as Aphasia, memory loss. Because of high prevalence and low mortality the more number of patients are enrolled under rehabilitative management in Stroke. There is less literature which target Mirror neuron therapy and rehabilitation associated with speech therapy in bilateral Cerebro Vascular Accident. Along with the medical line of management, effects of early physiotherapy intervention can be reported. Therefore to restore patients’ quality of life providing intervention in early stages becomes necessary. Hence, there is a need to report rare case having neurological complications following Bilateral Cerebro Vascular Accident with rehabilitative care.

3. Methodology

3.1 History

A 51 year old male mesomorphic in built with BMI 22.9kg/m², retired farmer came to Pravara Rural Hospital, Loni, Ahemdnagar with complaints of difficulty to form grip and perform movement with left upper limb and difficulty to speak since 31st July 2021 The weakness was more pronounced on left side as compared to right side. During the hospital patient gradually lost ability to speak and had difficulty in swallowing solid food. After the weakness patient was taken to kute hospital in sangamner where he

was immediately admitted MRI was done on 1st of august 2021 which should acute ischemic infarct in right corona radiata . the patient was medically treated there for 7 days and was later discharged after the discharge patient took physiotherapy at home for 15 days but was later discontinued by relatives as he was not cooperative the patient came to Neurophysiotherapy Department on 16th of October 2021 the patient was evaluated and taken regular physiotherapy since then. The patient had past history of CVA in November 2012 where he had a sudden vomiting and history of fall in the evening so he was taken in the hospital by his relatives where investigations were done CT scan showed left external capsular bleed he was also detected as the case of HTN during hospital stay in 2012. Since then he is on irregular medications for HTN the patient has suffered a hemorrhagic stroke causing hemiparesis of right upper limb and had suffered with Aphasia.

On Physiotherapy assessment we found that the Cranial Nerve assessment we found that Cranial Nerve assessment patient had minimal facial asymmetry on right side due to involvement of facial nerve. Muscle power tone on right and left side is right side shoulder extensors and abductors is grade 1+ and left side shoulder flexors and abductors is grade 1+ Elbow extensors on right side is Grade 1+ and flexors on left side is grade 1+ were as forearm supination is grade 1+ at left side and wrist and fingers Extensors are grade 1+ at right side and flexors are Grade 1+ at left side hip extensors and adductors are Grade 1+ on left side and knee flexors are grade 1+ at right side and knee extensors are grade 1+ at left side rest all the muscle tone was normal . Range of motion was taken and end feel was checked of

each joint. Hand function was checked of Grip and prehension which was affected. and coordination of equilibrium of standing with feet close together eyes open /close , standing with one leg, tandem standing, and tandem walking is affected. Balance in standing static and dynamic Rombergs test and one leg standing test is affected .Posture in standing left shoulder depressed in anterior view .Gait is circumduction gait with wide base of support and arm swing reduced .on VCR grading for right UE: 4B LL:4 and for left side UE:4A and LL:4 hand for right side is 5 and left side is 3. physiotherapy treatment was started which included Mirror Neuron therapy, Phonation exercise trunk control exercise and active ROM exercise for B/L upper and lower Extremity.

3.2 Diagnosis

Based on symptoms my patient Bhailal Jadhav aged 51 years is a case of acute ischemic infarct in right coronaradiata with old gliotic cyst in the left external capsule due to occlusion of right MCA artery with left capsule–basal ganglionic bleed, with acute hemorrhage in the left basal ganglia.

3.3 Outcome Measures

Used to assess Quality of life, Balance and Gait-

- 1) Functional Independence Measure for Quality of life
- 2) Barthel Index
- 3) FMA-UE

4. Intervention

Weeks	Exercises	Result
Week 1	Functional electrical stimulation : surged faradic (MS duration 0.01ms/frequency :1hz) -left biceps muscle belly (active elbow flexion) -right triceps belly, left wrist flexor group stimulation with videos of actions for performing the hand activity. -facial exercise clenching of jaw, opening of jaw, chintucks, tongue rolling exercise with the observation, imitation, and action understanding.	After initial 8 days, patient was able to perform the holding activity and the facial exercise by observation, imitation and action understanding. Hence progression for strengthening exercises was done with phonation exercise.
Week 2	Weight bearing activities with weight on the affected side. Eg-reachouts for bottle with non –affected arm extended and bearing weight. -task oriented exercise with semipurposful movement Eg-pointing at correct colours arranged in a sequence - aligning rings in proper order from bottom to top based on size all the activity was performed by mirror neuron therapy -Phonation exercise was performed with the help of video “Ah” “Ka” “E”	At end of 2 weeks, patient had improvement in terms of muscle tone and strength for bilateral upper, and was trying to hold the cylindrical grip. And was able to perform the jaw opening exercise and was trying for phonations Hence progression to gait training and balance training in standing was done.
Week 3	-Sit to stand with walker support -Marching on spot with walker -Bed side standing with eyes open and eyes closed for 10 seconds -Gait training with walker support (4 point gait) -Standing with functional reach-outs -Improve hand function and independence in functional activities Eg: Various grip size objects placed in front of patient like half filled cup, cell phone, bottles, marbles Various texture objects (sponge, stone, soft toy, steel glass) with patient therapist was also performing so that he can imitate the same action -Constraint induced language therapy	After 1 week of gait training and static balance training in standing patient was able to stand without support. So balance training for dynamic activities and gait training with parallel bars were initiated. And there was improvement in various grip size and motar activities.
Week 4 & Week 5	Balance training: -On Swiss ball: Pelvic tilts x 10 reps in anterior-posterior direction and lateral direction with mirror biofeedback -Functional diagonal reach-outs on Swiss ball x 10 reps -Obstacle walking (Cones, stepper) Gait training:	After 2 weeks of balance and gait training, patient was able to walk independently. Further balance and gait training were progressed to unstable surface. Patient was able to do the basic ADL, S, was progressed with walking.

	<ul style="list-style-type: none"> -Walking with resistance (1/2kg weight cuff tied on both legs) -Side walking with resistance on parallel bar(½ kg weight cuff tied on both legs) -Dual task training (walking while counting backwards) -Bilateral hand training was taught to the patients. Eg-Dressing, opening jar, pouring water from bottle in glass 	
Week 6	<ul style="list-style-type: none"> -Walking on foam surface with obstacles -walking with 1 kg weight cuff -Stepping up and down one flight of stairs with 1 Kg weight cuff -Tandem walking -Figure of 8 walking -with the help of mirror in front and imitation patient was performing and imitating. 	At the end 6 th week, significant improvement in muscle power, higher mental functions and balance were noted. Patient was able to perform all activities of daily living independently.



Figure 1: Patient performing phonation exercise



Figure 2: Patient performing action imitation

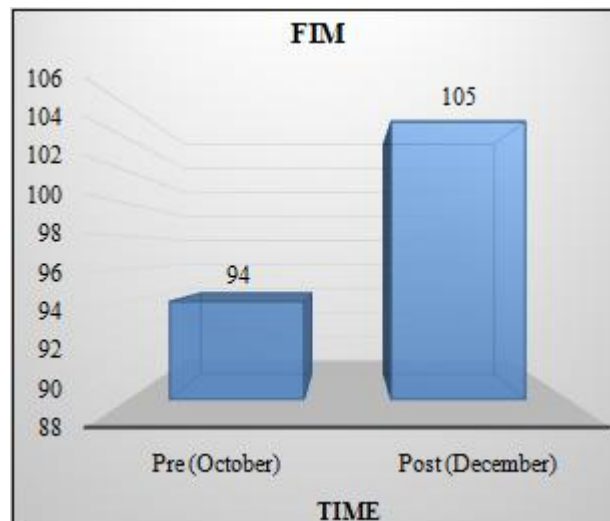


Figure 3: Patient is receiving electrical stimulation

5. Results

Table 1: Assessment of pre and post scores for FIM scale:

Outcome measure	Pre (October)	Post (December)
FIM	94	105

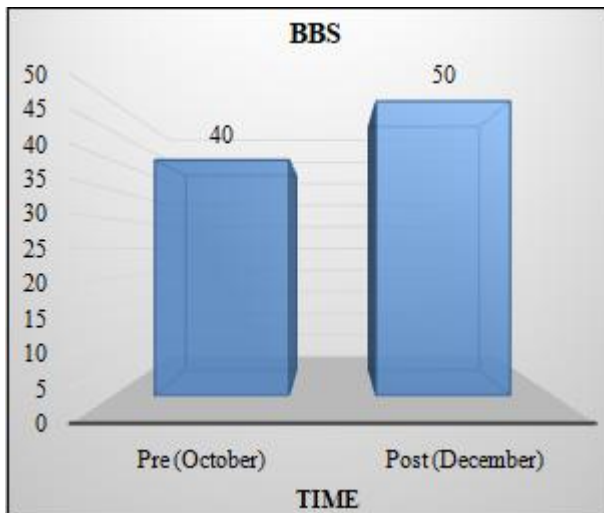


Graph 1: Comparison of pre and post scores for FIM

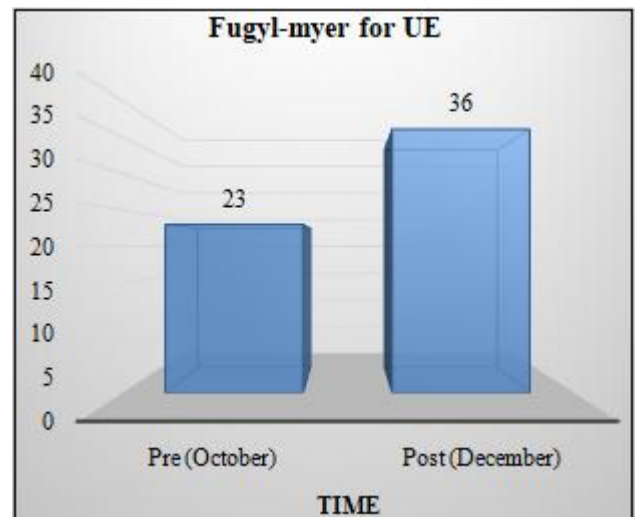
Interpretation: The FIM scores increased from 94 on pre assessment, i.e. Maximum independence to 105 on post assessment, i.e. complete independence. His quality of life and independence in performing activities improved significantly at the end of treatment.

Table 2: Assessment of pre and post scores for BBS

Outcome measure	Pre (October)	Post (December)
BBS	40	50



Graph 2: Comparison of pre and post scores for balance and gait

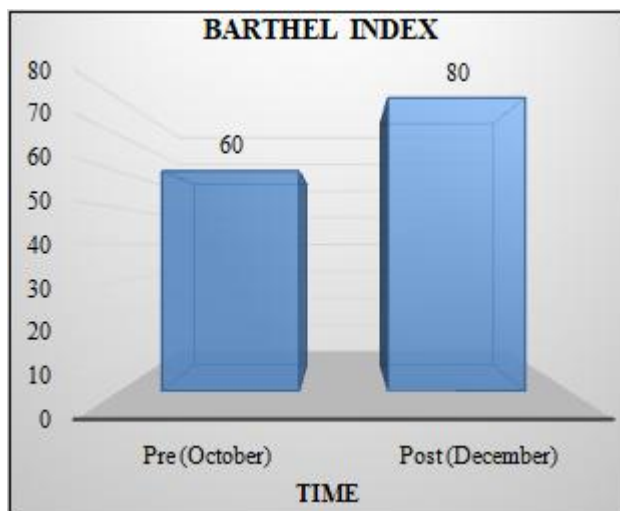


Graph 4: Assessment of pre and post scores for Fugyl-myer for UE

Interpretation: The BBS scores improved from 40 (maximum risk of fall) to 50 (minimum risk of fall) during the span of treatment. The patient’s functional balance improved significantly at the end of treatment.

Table 3: Assessment of pre and post scores for BARTHEL INDEX

Outcome measure	Pre (October)	Post (December)
BARTHEL INDEX	60	80



Graph 3: Assessment of pre and post scores for BARTHEL INDEX:

Table 4: Assessment of pre and post scores for Fugyl-myer for UE:

Outcome measure	Pre (October)	Post (December)
Fugyl-myer for UE	23	36

6. Discussion

Mirror therapy was described initially as a therapeutic modality for amputee’s phantom limb pain (Sathian et al., 2000). The treatment consists of a mirror being placed in the patient’s mid sagittal plane and reflecting the nonparetic side as if it was the affected one (Ramachandran et al., 1995). By this setup, movements of the non-paretic limb create the visual illusion of normal movements of the paretic limb (Oujamaa et al., 2009). Amongst the advantages of mirror therapy are its ease of administration, the possibility for self-administered home therapy and the applicability in patients with severe motor deficits. Some authors have described “mirror-like” video or computer graphic setups, where a video or computer graphic image of the moving limb is presented (Eng et al., 2007). The mechanisms underlying mirror therapy’s effects are supposed to be related to the activity of mirror neurons which discharge in both circumstances of performing a motor act or of simply observing it being performed by another individual (Rizzolatti and Sinigaglia, 2010). The precise mechanisms of mirror therapy in stroke patients remain speculative. It has been suggested that the mirror illusion may prevent or reverse a learned nonuse of the paretic extremity as the visual image of the paretic limb is perceived similarly to the patient’s own moving limb (Dohle et al., 2004). Furthermore, mirror therapy may stimulate motor recovery directly by modulating cortical excitability.

In the study, FIM, Fugl-Meyer scale and Barthel index were showed improvement. The results were supported by Mao H (2020).

Modified Barthel Index (MBI), Frenchay Arm Test (FAT) and Fugl Meyer (FM) were showed improvement at in the study before treatment (BT1 and BT2), at an interval of 15 days, then after treatment (AT1) and finally at a two-month follow-up (AT2) by Franceschini M (2010).

In order to examine the clinical effects of mirror therapy and cortical reorganization in 40 post-stroke patients, Michielsen (2011) et al divided the subjects into two groups: control and mirror therapy groups; they performed a task using the upper

limb one hour per day, five days per week, during six weeks. For such analysis, fMRI and Fugl-Meyer scale (FMS), which evaluates motor function, were used. The FMS results showed that the group with mirror therapy significantly improved its scores, but these changes were not sustained in the follow-up trials. On the other hand, a more balanced activity was observed in the primary motor cortex after fMRI.

7. Conclusion

The study showed that the use of mirror Neuron treatment as viable techniques to improve cortical remodeling and functional recovery in post-stroke patients.

References

- [1] Altschuler EL, Wisdom SB, Stone L, Foster C, Galasko D, Llewellyn DM, Ramachandran VS: Rehabilitation of hemiparesis after stroke with a mirror. *Lancet* 1999, 353(9169):2035–2036.
- [2] Michielsen ME, Selles RW, van der Geest JN, Eckhardt M, Yavuzer G, Stam HJ, Smits M, Ribbers GM, Bussmann JB: Motor recovery and cortical reorganization after mirror therapy in chronic stroke patients: a phase II randomized controlled trial. *Neurorehabil Neural Repair* 2011, 25(3):223–233.
- [3] Broderick J, Brott T, Kothari R, Miller R, Khoury J, Pacioli A, Gebel J, Mills D, Minneci L, Shukla R: The greater cincinnati/northern kentucky stroke study: preliminary first-ever and total incidence rates of stroke among blacks. *Stroke* 1998, 29(2):415–421.
- [4] Kalra L, Ratan R: Recent advances in stroke rehabilitation 2006. *Stroke* 2007, 38(2):235–237.
- [5] Umilta MA, Escola L, Intskirveli I, Grammont F, Rochat M, Caruana F, Jezzini A, Gallese V, Rizzolatti G: When pliers become fingers in the monkey motor system. *Proc Natl Acad Sci USA* 2008, 105(6):2209–2213.
- [6] Van Der Werf YD, Van Der Helm E, Schoonheim MM, Ridderikhoff A, Van Someren EJ: Learning by observation requires an early sleep window. *Proc Natl Acad Sci USA* 2009, 106(45):18926–18930.
- [7] Cacchio A, De Blasis E, De Blasis V, Santilli V, Spacca G: Mirror therapy in complex regional pain syndrome type 1 of the upper limb in stroke patients. *Neurorehabil Neural Repair* 2009, 23(8):792–799.
- [8] Garrison KA, Winstein CJ, Aziz-Zadeh L: The mirror neuron system: a neural substrate for methods in stroke rehabilitation. *Neurorehabil Neural Repair* 2010, 24(5):404–412.
- [9] Rizzolatti G, Craighero L: The mirror-neuron system. *Annu Rev Neurosci* 2004, 27:169–192.
- [10] Fadiga L, Craighero L, Olivier E: Human motor cortex excitability during the perception of others' action. *Curr Opin Neurobiol* 2005, 15(2):213–218.
- [11] Gazzola V, Rizzolatti G, Wicker B, Keysers C: The anthropomorphic brain: the mirror neuron system responds to human and robotic actions. *Neuroimage* 2007, 35(4):1674–1684.
- [12] Cattaneo L, Rizzolatti G: The mirror neuron system. *Arch Neurol* 2009, 66(5):557–560.
- [13] Buccino G, Binkofski F, Riggio L: The mirror neuron system and action recognition. *Brain Lang* 2004, 89(2):370–376.
- [14] Rizzolatti G: The mirror neuron system and its function in humans. *Anat Embryol* 2005, 210(5–6):419–421.
- [15] Williams JH, Waiter GD, Gilchrist A, Perrett DI, Murray AD, Whiten A: Neural mechanisms of imitation and 'mirror neuron' functioning in autistic spectrum disorder. *Neuropsychologia* 2006, 44(4):610–62.
- [16] Sathian K, Greenspan AI, Wolf SL. Doing it with mirrors: a case study of a novel approach to neurorehabilitation. *Neurorehabil. Neural Repair* 2000;14:73–76.
- [17] Ramachandran VS, Rogers-Ramachandran D, Cobb S. Touching the phantom limb. *Nature* 1995;377:489–490
- [18] Oujamaa L, Relave I, Froger J, Mottet D, Pelissier JY. Rehabilitation of arm function after stroke. Literature review. *Ann. Phys. Rehabil. Med.* 2009;52:269–293
- [19] Eng K, Siekierka E, Pyk P, Chevrier E, Hauser Y, Cameirao M et al. Interactive visuo-motor therapy system for stroke rehabilitation. *Med. Biol. Eng. Comput.* 2007;45:901–907
- [20] Rizzolatti G, Sinigaglia C. The functional role of the parieto-frontal mirror circuit:interpretations and misinterpretations. *Nat.Rev.Neurosci.* 2011;11:264–274
- [21] Dohle C, Kleiser R, Seitz RJ, Freund HJ. Body schemegates visual processing. *J. Neurophysiol.* 2004;91, 2376–2379.
- [22] Michielsen ME, Selles RW, van der Geest JN, Eckhardt M, Yavuzer G, Stam HJ, Smits M, Ribbers GM, Bussmann JB: Motor recovery and cortical reorganization after mirror therapy in chronic stroke patients: a phase II randomized controlled trial. *Neurorehabil Neural Repair* 2011;25(3):223–233
- [23] Mao H, Li Y, Tang L, et al. Effects of mirror neuron system-based training on rehabilitation of stroke patients. *Brain Behav.* 2020;10(8):e01729. doi:10.1002/brb3.1729
- [24] Franceschini M, Agosti M, Cantagallo A, Sale P, Mancuso M, Buccino G. Mirror neurons: action observation treatment as a tool in stroke rehabilitation. *Eur J PhysRehabil Med.* 2010 Dec;46(4):517-23.