

Comparing Mirror Therapy and Neurodevelopmental Therapy on Improving Hand Function for Stroke

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Abstract:

Introduction: Brain damage or stroke can lead to severe physical and mental health problems and impact human quality of life. One of the most important rehabilitation goals is maintaining hand functional activities in stroke subjects. Stroke survivors have some degree of upper limb impairment, up to 80% currently.

Objective: This study evaluated the power, coordination and functional activity of the hand for stroke individuals while comparing mirror therapy and neurodevelopmental therapy with stimulation.

Methods: 30 participants in the age group of 35 - 60 years were purposefully selected. The Fugl-Meyer score of hand and wrist and the Chedoke Hand Activity Inventory (CHAI) is used to measure hand functional activities of stroke patients.

Results: The result of the study shows significant improvement in power, speed, co-ordination and functional activities of the hand in Group A. Mirror therapy with electrical stimulation, and (Group B) neurodevelopment therapy with electrical stimulation at the end of the 4 weeks. Statistical analysis confirmed the average change in Fugl-Meyer score is 8.00 (SD = 11.76) and the Chedoke Hand Activity score is 8.47 (SD = 12.22) in group A.

Conclusion: We conclude that the treatment "mirror therapy with electrical stimulation" is more effective than "neurodevelopmental therapy with electrical stimulation" in outcome measures such as the Fugl-Meyer score and the Chedoke Hand Activity Inventory scale.

Keywords: Stroke, mirror therapy, neurodevelopmental therapy.

1. INTRODUCTION:

A stroke, or cerebrovascular accident, is a vascular lesion leading to focal neurological cerebral dysfunction, like hemiplegia. For motor recovery, rehabilitation begins within 24 hours. Classification of stroke depends on pathological type (thrombosis, embolism, or haemorrhage) or factors, such as completed stroke, transient ischaemic attacks (TIAs).¹ The WHO defines stroke as a clinical syndrome characterised by suddenly developing clinical signs and focal neurological deficits and symptoms, as well as cerebral function loss at the same time, symptoms present with duration of more than 24 hours or leading to death, by vascular origin with no other causes.² Worldwide, the ischaemic stroke accounts for 50%–85% of all strokes, and stroke is the second reason cause of death and the third root cause of disability.^{3,4} Indian studies estimated that the incidence increased range from 152/100,000 in between the

ages of 35-44 years old to 1116/100,000 in the age 75+. When compared with high-income countries, the prevalence of stroke in younger individuals is high (18-32%) in India. 1.4 to 1 is the male-to-female sex ratio. ⁵ Most of the stroke subjects have contralateral hemiplegia, sensory impairments, impaired balance and gait disturbances, and homonymous hemianopia. Following a middle cerebral artery stroke, subjects present with weakness of distal muscles of the hand, which leads to difficulty in ADL (washing, grooming, feeding, dressing, etc.) and other instrumental activities (shopping, home/financial management, etc.).⁶ Various physiotherapeutic managements are in practice for the treatment of stroke. Therefore, this study was designed to compare the effectiveness of mirror therapy and neurodevelopmental therapy, which was measured by the Fugl-Meyer Assessment (FMA) scale and the Chedoke Hand Activity Inventory scale. Muscle stimulation (Electrical Muscle Stimulator) produced electrical impulses that stimulate muscle contraction, used to reduce muscle spasms and prevent disuse atrophy of muscle. Theoretically stimulation is maintaining the motoneuronal innervations, when stimulus passed through the skin it activates the Ia muscle afferents, Ib afferents of Golgi tendon organs, and cutaneous afferent nerve fibres.⁷ In mirror therapy, inhibit the view of the (affected) limb, that is positioned behind the mirror box, the position of patient is sitting in front of a mirror that is 'parallel to his midline orientation'. When locking into the mirror, the patient views the reflection of the unaffected limb positioned as the affected limb. This setting is focused to create a visual illusion whereby motion of or touch to the normal limb is perceived. Mirror therapy has been used to treat subjects with stroke (Altschuler et al., 1999; Yavuzer et al., 2008; Dohle et al, 2009; Cacchio et al., 2009b).⁸ In neurorehabilitation techniques creates positive feedback to the motor cortex by using the non-paretic limb while watching its mirror reflection, which creates a "visual illusion" superimposed over the (unseen) affected limb.

Dr Karel Bobath and Berta (physiotherapist) described *Neurodevelopmental Treatment (NDT)*, developed in the late 1940s, to analyse patients with neurological dysfunction (cerebral palsy and stroke). These groups were identified as having tone abnormality (spasticity) and primitive spinal cord and brainstem reflexes from higher centre CNS control with resulting loss of postural reflex such as righting, equilibrium, and protective extension reactions and movements. The NDT is designed to improve function based on analysis of sensorimotor function and carefully planned interventions. The planning process is guided by principles of motor control, motor learning, and motor development. 1011 To improve the development of gross motor skills, balance, quality of movement, hand skills, and daily tasks such as mobility and self-care for individuals with movement disorders.

Methods:

A comparative study the subjects selected based on inclusion criteria by 30 stroke subjects divided into Group A and Group B. Informed consent received prior to the conduct of the treatment procedure. The 15 subjects allocated in group A (Experimental) were treated with Mirror Therapy and Electrical Muscle Stimulation and the remaining 15 patients in group B (Control) were treated with Neuro Developmental Therapy and Electrical Muscle stimulation. Evaluate the functions of the hand before and after the treatment by the using Fugl Meyer Scores of Hands and Wrist Chedoke Hand Activity Inventory Scale. This experiment was undertaken in the Department of (Physiotherapy) at Jaya College of Paramedical Sciences and followed ethical guidelines with reference number of EC/JCP/SEP/16/2025. 30 stroke subjects were selected for the study. The study included individuals with stroke who had a Mini-Mental Status Examination (MMSE) score greater than 23. The subjects with age groups 35-60 yrs. Both males and females, diagnosed with a middle cerebral artery infarct, with a spasticity level of grade 3 or less as per the modified Ashworth scale, Ability to understand and follow simple verbal instructions. exclusion

criteria included the subjects whose vital signs are unstable, having other neurological and musculoskeletal problems such as Cerebellar lesion, Painful or subluxed shoulder, either contracture or deformities of the upper extremity due to other neurological disorder, any fracture in the upper extremity, and no sitting balance were excluded from the study. Sensory impairment, Visual impairment, non-cooperative patients.

Study procedure:

A treatment procedure for providing mirror therapy and neurodevelopment therapy with electrical stimulation, "Participants completed a total of 20 sessions over a four-week period (5 sessions/week)."

Group A: Mirror Therapy for Hand. The subject was made to sit in a chair, and a mirror was placed in front of the subject, "The paralytic limb was hidden back of the mirror while the unimpaired limb was kept in front, allowing subjects to observe the reflection of their normal hand performing tasks—including wrist flexion/extension, finger movement, and grasping—to create an illusion of movement."¹²

Group B: NDT WITH ELECTRICAL STIMULATION: Participants in the NDT group performed structured neurodevelopmental therapy for 6 sessions/week for 4 weeks. Patients were told to hold their injured hand with the other hand and move the injured arm above their head in a way that keeps the elbow of the injured side straight. Hold the affected side hand with the normal hand from side to side. Place your hand on the affected side with the elbow extended position. Holding a stick in the hand that is affected, the person is asked to rotate their forearm supination (turning of the forearm upward) & pronation (downward). Thirteen Subjects were asked to stand on their front legs (quadruped position) & rock forward and backward. while lying down, the patient was asked to hold injured hand above his head. The flexor muscles in the wrist and fingers of the affected hand were gently stretched to move the wrist into an extended position, within the range where there was no pain. At the same time, both groups received electrical stimulation on the affected limb. One electrode was placed over the lateral epicondyle, which is where the common extensor muscle originates. This electrode was positioned on the lower part of the forearm and then stuck in place with tape.¹⁴¹⁵¹⁶

Outcome measures:

The Fugl-Meyer Assessment (FMA) is widely recognized as a "gold standard" evaluative tool for measuring motor recovery after stroke, demonstrating excellent inter-rater and intra-rater reliability for upper and lower extremities. Inter-rater Reliability ranging from 0.98–0.99 for the Upper Extremity (FMA-UE)¹⁷

Intra-rater reliability ranged from 0.95 to 1.0 for motor assessments, indicating its effectiveness in measuring hand functions. It uses a 3-level scale where 0 means person can't do it, 1 means they can do it partially, and 2 means they can do it completely. "Maximum total score is 226, with a sub-score of 66 for the upper limb" (FMA-UE)¹⁸

The Chedoke Arm and Hand Activity Inventory is designed for stroke Assessment, demonstrating interrater Reliability ranging from of 0.96 to 0.99, and Test-Retest Reliability: Excellent, ranging from 0.97 to 0.98. The Chedoke Arm and Hand Activity Inventory–9 (CAHAI-9) is an assessment of upper limb ability that assesses nine real-life functional tasks (Barreca et al, 2005).

The items of the test is involve opening a jar of coffee, calling 911 using a phone, drawing a straight line with a ruler, pouring a glass of water, squeezing out a washcloth, fastening five buttons, applying toothpaste to a toothbrush, drying off with a towel, and cutting medium resistance putty with a knife and fork. The CAHAI -9 assesses ability to using a 7 -point scale, resulting in a total raw score that ranges

from a maximum of 9 to a maximum of 63 (Barreca et al 2005). the standardisation studies for reliability and validity are rated as excellent (Rowland and Gustafsson,2008.)²⁰²¹²²

Data interpretation:

In this study find data interpretation for both groups conducted using statistical analysis software highly recommended for social sciences and health research. It has a dedicated “paired t -test” analysis option that also performs normality tests. The Paired T test used to measure the pre and post-test values OF Group A and Group B, unpaired T test was used to measure the post-test values of each the groups.

Results:

In this study, results show (Table 1) both groups significantly reduction in functional impairment after 4 weeks of intervention (p<0.001 within groups). between-group comparison Mirror Therapy showed more improvement than NDT, confirming statistical relevance of the findings. this result confirmed by mean scores, standard deviation, p-value and T-value are “mention” and “column” organised for use in Tables 1 and 2

Pre and post-test values for Group A and Group B:

GROUPS	PRE TEST	POST TEST	T VALUE	P ALUE
FMA				
GROUP A	15.73± 4.67	23.73 ±15.45	2.63	0.0098
GROUP B	14.73±3.90	17.27±3.94	7.87	0.0000
CAHAI				
GROUP A	25.73 ±9.81	34.20±15.24	2.68	0.0089
GROUP B	31.73±12.28	33.40±12.05	10.46	0.0000

Table 2: post value differences in between Group A and Group B

GROUPS	MEAN	SD	T VALUE	P VALUE
FMA				
GROUP A	8.000	11.759	1.79	0.0421
GROUP B	17.27	1.246	1.79	0.0421
CAHAI				
GROUP A	8.464	12.223	2.15	0.0201
GROUP B	1.667	0.617	2.15	0.0201

Discussion:

A total number of 30 subjects analysed from the O.P. department of Jaya College of Physiotherapy with stroke. 30 subjects fulfilled the inclusion criteria and were already diagnosed with stroke. 30 Subjects were split into 2 groups, 15 each. After stimulation done group A received Mirror therapy, and Group B received neurodevelopmental therapy for stroke.

In this study results show that (Group A) Mirror therapy with electrical stimulation showed significantly improvement in the functional activities of the Hand in stroke, then the (Group B) Neurodevelopment therapy with electrical stimulation at the end of the 4 weeks. The outcome measure used in the study was

the FUGL MEYER SCALE AND CHEDOKE HAND INVENTORY SCALE for pre- and post-test. In this study, the statistical data analysis was measured using the trial version of the statistical package social science (SPSS) paired t- test for intragroup and an independent sample t-test among the groups.

The aim of this study was to determine the effectiveness of (Group A) Mirror therapy with electrical stimulation, in stroke, for improving functional activities of the Hand. In this study Group A, received Mirror therapy following stimulation, shows overall effectiveness after 24 sessions, from table 2 the Output of the Paired t-test within the group ($t = 2.63, p = 0.0098 < 0.05$) the statistical value of test shows improvement in FUGL MEYER score, with the mean score of FUGL MEYER before the test is 15.73 with the standard deviation of 4.67 and that of FUGL MEYER after the test is 23.73 with the standard deviation of 15.45²³.

In this study, mirror therapy is used to improved functional activities in stroke, which was supported by another study which can be classified into two common mechanisms for the improvement in mirror therapy: a primary motor cortex mechanism and a mirror neuron system mechanism²⁴. The action execution supporting mirror theory shows that the same side motor regions of the brain are activated during as during action observation. Motor planning and execution are involved in the production of intended actions based on observed actions. Additionally, research indicates that seeing the motions of undamaged brain tissue may help injured portions of the motor cortex.^{25,26} **Ramachandran and Rogers-Ramachandran et al** suggested that the use of these “visual illusions” created by a mirror for the treatment of hemiplegia after a stroke²⁷

The idea behind mirror therapy is to mislead the brain into believing that movement has happened painless by using a mirror to create a reflecting illusion of a damaged limb. The paretic limb is positioned behind a mirror so that the opposing limb's reflection takes the role of the hidden limb.²⁸

In this study, electrical stimulation improves the functional activities in stroke (Group A: MIRROR THERAPY WITH ELECTRICAL STIMULATION), which was supported by **Merletti et al**. **Electrical** stimulation provide feedback on muscle contraction and increased sensory input for the development of motor control. The muscle contraction of force improved by electrical stimulation. So, we found contractile ability of stimulated muscles will be improved.²⁹

CHEDOKE HAND INVENTORY SCALE:

According to statistical analysis, electrical stimulation with mirror therapy Group A, measure efficacy after 24 sessions [4 weeks] from Table 1 (Output of Paired t-test). The value of statistics result shows an increase in the **Chedoke Hand Activity Score** from pre to post test ($t = 2.68, p = 0.0089 < 0.05$). Hence, the evidence is adequate to conclude that there is a significant effect of Treatment A, with the mean score of Chedoke Hand Activity before the test being 25.73 with a standard deviation of 9.81, and that of Chedoke Hand Activity after the test being 34.20 with a standard deviation of 15.20.

Similar results were found by **Sanes JN, Koki Ikuno et al** concluded that significant improvement of function in patient with stroke treated by electrical stimulation with mirror therapy. In this study, the electrical stimulation was given to the wrist of the paretic hand, which influences cortical reorganization. Electrical stimulation afferent sensory nerve fibres have been shown to lead to organisational changes in the cortex. stimulation of peripheral nerves in longer duration can induce changes in the human cortex motor pathway. Previous studies have re-vealer that the afferent feedback provided by electrical stimulation temporally coupled with task-related motor execution could facilitate brain plasticity.

Oujamaa L et al: Mirror therapy produced mechanisms such as improved self-awareness and superior temporal gyrus activation leads to increase spatial attention in precuneus (parietal cortex) and proposed posterior cingulate cortex. The superior temporal gyrus plays an important role in recovery from neglect and is activated by observation of biological motion.³⁰

The second purpose of this study is to find the efficacy of stimulation with Neurodevelopment treatment in stroke in terms of functional activity. Electrical stimulation is one of the physical therapy modalities suggested for the Management of stroke for improvement of function in spastics such as Hemiplegics. When the loss of motion is due to over-pulling by the spastic muscles, faradic type current is applied to the antagonistic muscles, producing motion in the direction of restriction, which also helps in reducing spasticity.³¹

According to statistical analysis in group B, which received electrical stimulation with Neuro development therapy, shows overall effectiveness after treatment [4 weeks] from table 4 (Output of Paired t-test) the value of statistics result shows **an increase in the FUGL MEYER Score** from pre to post test ($t = 7.87, p = 0.000 < 0.05$). Hence, this score enough to finalise that there is a significant effect of Treatment B, with the mean score of FUGL MEYER before the test is 14.73 with a standard deviation of 3.90. And that of FUGL MEYER after the test is 17.27, with the standard deviation of 3.94. previous studies showed methodological differences in the parameters of stimulation and found that a positive effect on motor outcome by stimulation.

Bar-Haim S et al: The NDT approach is focus on maintain muscle tone and altering movement patterns as a foundation for performance, was replaced with emphasis on activity-related impairments and client-directed functional activities. Neurodevelopment treatment is the positive changes in gross motor performance because of intensive NDT intervention³¹.

CHEDOKE HAND INVENTORY SCALE:

According to statistical analysis in group B who received electrical stimulation with Neuro development therapy, shows overall effectiveness after treatment [4 weeks] from the value of test, is statistics improve function. The **Chedoke Hand Activity Score** from pre to post test in table 6 (Output of Paired t-test) shows ($t = 10.46, p = 0.000 < 0.05$). Hence, the **evidence is sufficient** to conclude that there is a significant effect of Treatment B, with the mean score of Chedoke Hand Activity before the test being 3.73 with a standard deviation of 12.38, and that of Chedoke Hand Activity after the test is 33.40 with a standard deviation of 12.05. So, this current study shows a result of improvement in functional activities in stroke after the treatment of neurodevelopmental therapy with electrical stimulation in stroke, and it is measured by the Chedoke Hand Activity Score.

It is supported by **Brouwer B et al (1978):** stimulation given with the patient's ability to move; to improve the muscle contract and provide feedback of muscle contraction. The stimulation promotes development of motor control by enhanced sensory input. He found that the force of muscle contraction and contractile ability of the stimulated muscle with the electrical stimulation will be improved. We found another study showed by Church et al stating that improve motor recovery in stroke patients after a 4-week session of treatment³².

The results of the present study are supported by a study conducted by **Brown GT, Burns, SARast M et al:** conducted study on the effect of neurodevelopmental therapy on motor and functional activity in stroke. Who reported that this approach to inhibit atypical reactions and improve facilitation normal muscle tone

and movement. The assumption was that encouraging more normalised automatic movement patterns would lead to functional carryover³³

Sharkey M Banaitis D, Giuffrida C, Mullens P et al described that the Neurodevelopment Therapy is target on goal-oriented task and functional ability skills. It is based Motor learning principles including verbal reinforcement, more repetition, action facilitation of error awareness (trial and error learning), learning process, promote the patient/client/family and ensuring motivation. The role of Neurodevelopmental therapy (NDT) is promoting the functional recovery of stroke by inhibition of abnormal rhythmic reactions and normal movement patterns facilitation.³⁴

Comparing the effect of Treatments Mirror therapy and Neuro development therapy in terms of improvement in Chedoke Hand Activity Score and Fugl Meyer score: In statistical results of present study showed in FUGL MEYER score is the p-value (0.0421) of the test statistic is less than 0.05, from table 6 the outcome of Independent Sample t-test ($t = 1.79, 0.0421 < 0.05$). Hence, the evidence is enough to conclude that there is a significant difference between Groups A and B in terms of changes in Fugl Meyer Score from pre to post test. The moderate change in Fugl Meyer score by Treatment A is 8.00 (SD = 11.76), and the minimal changes in FUGL MEYER score by Treatment B is 2.53 (SD = 1.25).

According to the results of the statistical analysis of this study, changes in the Chedoke Hand activity inventory in treatment A (Mirror therapy with electrical stimulation for stroke) than in treatment B (Neurodevelopment treatment with electrical stimulation for stroke) after 4 weeks of treatment sessions ($t = 2.15, p = 0.0201 < 0.05$). Hence, the evidence is enough to conclude that there is a notable difference between Group A and B in terms of moderate change in Chedoke Hand Activity Score from pre to post test. The average change in Chedoke Hand Activity score by Treatment B is 1.67 (SD = 0.62). So, this study concluded that the mirror therapy with electrical stimulation is better than neurodevelopmental therapy with electrical stimulation for improvement in functional recovery of the hand in stroke..

This present study supported by YavuzerG, Selles R et al found that Mirror therapy (MT) is applied with a mirror box placed in between the upper limbs in sagittal plane to developed visual and kinesthetics illusion by activating the mirror-neuron system, pyramidal tract, and cortical recognition to promote functional recovery of stroke.³⁵ Finally, we reviewed that the mirror therapy is effective in stroke rehabilitation and it can be used with any of the neurotherapeutic approaches for functional recovery of stroke.

LIMITATION:

Sample size is small within the groups, the duration of the study may be shorter that patients had no long term follow up, Works mainly through visual illusion, so less effective in patients with cognitive deficits or neglect, severe visual -perceptual deficits .and not suitable for poor sitting balance, Focus on normal movement patterns which may reduce task -specific exercise so it may be slow recovery of function in neuro developmental therapy, Less repetition and intensity which are key for neuroplasticity.

RECOMMENDATIONS:

we can take large sample size. This study can compare any other techniques of task- oriented training, repetitive practice, functional activities (ADL-based training), and the longer duration of study should follow-up can we make to benefits in long-term and also studied differences in-between non dominant and dominant side. Need low-cost, home-based intervention. Patients have good cognition and attention.

CONCLUSION:

The study suggested both interventions are showed improvement in Fugl Meyer Score and Chedoke Hand Activity Inventory from pretest to post-test. But on comparing the efficacy of the two treatments in terms of two measures, FMA Score and Chedoke Score, we found that Treatment A, mirror therapy with electrical stimulation, is more effective than Treatment B, neurodevelopmental therapy with electrical stimulation, which helps to reduce pain and improve motor function. Overall, we conclude that the treatment "Mirror therapy with electrical stimulation" is more effective than "Neuro Development therapy with electrical stimulation" in standard measures such as Fugl Meyer Score and Chedoke Hand Activity Inventory Scale. Based on the statistical analysis results showed both treatment improving motor functional recovery of the hand by reduced functional impairment in stroke.

Acknowledgements

We sincerely express our gratitude to everyone who helped to complete this study and extend our heartfelt thanks to our mentors and advisors for their guidance and support throughout this research. We are also deeply grateful to the participants who dedicated their time and effort to this study. Their cooperation made this work possible.

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