

## Mirror Therapy and Repetitive Facilitation Exercise Improve the Upper Extremity Motor Recovery in Hemiparesis Patients

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### Abstract

**Introduction:** Stroke is a global epidemic and an important cause of morbidity and mortality. As defined by WHO stroke is “rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or longer or leading to death, no apparent cause other than that of vascular origin” [1]. Mirror therapy is a relatively new therapeutic intervention which is simple, inexpensive and most importantly patient directed treatment that focuses on moving the unimpaired limb. It was first introduced by Ramachandran and Roger Ramachandran to treat phantom limb pain after amputation [2]. In stroke patients, this technique involves performing of unimpaired limb while watching its mirror reflection superimposed over the (unseen) impaired limb, thus creating a visual illusion of enhanced movement capability of the impaired limb [2]. **Aim of the Study:** To analyze the effectiveness of combine motor rehabilitation protocol to improve upper extremity motor recovery in post stroke subjects. **Methods:** A total of forty subjects were selected based upon the inclusion and exclusion criteria. The 20 out of the 40 subjects were asked to maintain static joint posture for the neck. The postures included were flexion, extension, right and left side flexion and right and left rotation. The subjects were asked to maintain this posture in the sitting position. The remaining 20 subjects were asked to maintain the same static joint posture in sitting position for the neck but in reverse order. The first 20 subjects were then asked to maintain static joint posture for the low back in sitting position. The postures included were flexion, right and left side flexion and right and left rotation. The remaining 20 subjects were then asked to maintain the same static joint posture for the low back in sitting position but in the reverse order. **Discussion:** Mirror therapy and RFE relatively a new treatment techniques developed to promote upper extremity recovery in stroke patients. Previous studies in stroke suggested that MT and RFE may be beneficial for motor function and is a simple, inexpensive and most importantly patient directed treatment that improve upper extremity function. Hun-Chiaet 2010 and Gunes Yavuzer in 2008, supported that UEFI is a preferred upper limb regional tool due to its superior and comparable psychometric properties. The result of the study confirm that the MT and RFE has improved upper limb function as demonstrated with UEFI. Clinically this study demonstrated that by using MT and RFE as a treatment tool, the improvement was seen in upper extremity functional activity of post stroke hemiparetic subjects. **Conclusion:** Mirror therapy and repetitive facilitation was found to be effective in improving functional independence in upper limb post sub -acute stroke. When mirror therapy and repetitive is administered 3<sup>rd</sup> to patient suffering from sub-acute stroke over a period of 4 weeks, it results in an improvement in reaching forwards, grasping, manipulating objects and also improves other fine motor functions of the hand. **Limitations of the Study:** The duration of study was only 4 weeks, Home exercise were not prescribed to the subjects and Training depending on functional level of patients.

**Keywords:** Mirror box; Table; Chair; Ball; Jar; Bag; Comb; Suitcase; Treatment couch; Shirt with buttons and Shoes with laces.

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### Introduction

Stroke is a global epidemic and an important cause of morbidity and mortality. As defined by WHO stroke is “rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or longer or leading to death, no apparent cause other than that of vascular origin” [1].

The paretic upper limb is a common and undesirable consequence of stroke that increases activity limitation. A number of interventions have been published evaluating the effect of various rehabilitation methods improving upper extremity control and functioning [2].

Various physiotherapists have been developed to improve functional recovery in patients with a hemiplegic upper limb due to stroke or acquired brain injury, including the facilitation, the Brunnstrom approach, the Bobath approach, electromyography (EMG)-initiated electrical stimulation, increased intensity physiotherapy, constraint-induced movement therapy, computerized arm training, early and repetitive sensorimotor stimulation of the arm, transcranial magnetic stimulation (TMS) and thermal intervention for the hemiplegic upper limb to facilitate sensory and motor recovery. The standard neurophysiological facilitation techniques used for hemiplegic upper limbs have not been confirmed to promote the functional recovery of hemiplegic limbs [3].

Mirror therapy is a relatively new therapeutic intervention which is simple, inexpensive and most importantly patient directed treatment that focuses on moving the unimpaired limb. It was first introduced by Ramachandran and Roger Ramachandran to treat phantom limb pain after amputation [2].

In stroke patients, this technique involves performing of unimpaired limb while watching its mirror reflection superimposed over the (unseen) impaired limb, thus creating a visual illusion of enhanced movement capability of the impaired limb [2].

The principle of mirror therapy (MT) is use of a mirror to create a reflective illusion of an affected limb in order to trick the brain into thinking movement has occurred without pain. It involves placing the affected limb behind a mirror, which is sited to the reflection of the opposing limb appears in placing of the hidden limb [4].

The repetitive facilitation exercise (RFEs) using novel facilitation methods for the upper limb and finger, give sufficient physical stimulation, such as by the stretch reflex or skin - muscle reflex that is elicited immediately before or at the same time as when the patient makes an effort to move his hemiplegic hand or finger, in order to elevate the level of excitation of the corresponding injured descending motor tracts and it allows the patient to initiate movements of the hemiplegic hand or finger in response to his intension [3].

## Operational Definition

### 1. Stroke

Stroke is classically characterized as a neurological deficit attribute to an acute focal injury of the CNS by a vascular cause, including cerebral infarction, intracerebral hemorrhage (ICH) and subarachnoid hemorrhage and is a major cause of disability and death.

The current World Health Organization definition of stroke, introduced in 1970 and still used is rapidly developing clinical signs of focal disturbance of cerebral function lasting more than 24 hours or leading to death with no apparent cause other than that of vascular origin [5].

### 2. Mirror Therapy

Ramachandran originally hypothesized that paralysis following might have a learnt component, which would possibly be 'unlearned' by means of mirror illusion. Mirror therapy might be a form of visually guided motor imagery. Mirror illusion increases activity in precuneus and posterior cingulate cortex associated areas associated with awareness of self and spatial attention.

### 3. Hemiplegia

In medical jurisprudence. Unilateral paralysis, paralysis of one side of the body, commonly due to a lesion in the brain in the cerebral form, the hemiplegia is sometimes "alternate" or crossed, that is occurring on the opposite side of the body from the initial lesion.

## Objectives

### Statement of Question

Will mirror therapy and repetitive facilitation exercise improve the upper extremity motor recovery in hemiparesis patients?

### Research Hypothesis

**Experimental Hypothesis** - This hypothesis states that mirror therapy and repetitive facilitation exercise will improve the motor recovery of paretic upper extremity in post stroke hemi-paretic subjects.

**Null Hypothesis** - This hypothesis states that mirror therapy and repetitive facilitation exercise may or may not improve upper extremity function in stroke cases.

### *Need of Study*

As there decreased functional activity of upper extremity among stroke subjects so this study being done to improve the functional activity of upper extremity and to improve that quality of life in hemiplegic subjects.

### **Aim of the Study**

To analyze the effectiveness of combine motor rehabilitation protocol to improve upper extremity motor recovery in post stroke subjects.

### **Review of Literature**

- *Kazutoshi Tomioka et al. (2017)*; Did study on “short-term effects of physiotherapy combining repetitive facilitation exercise and orthotic treatment in chronic post-stroke patients”. Concluded that REF may be more effective than conventional rehabilitation in lessening impairment and improving upper-limb motor function during the subacute phase of stroke [6].
- *Uthra Mohan et al. (2017 Jun)*; Did study on “Effectiveness of mirror therapy on lower extremity motor recovery, balance and mobility in patient with acute stroke: A randomized sham - controlled pilot trial”. Concluded that MT early after stroke is not superior to conventional Rx in improving L/L motor recovery and balance, except for improvement in mobility [7].
- *Pervane Vurals et al. (2016 April)*; Did study on “Effect of mirror therapy in stroke patients with complex regional pain syndrome type 1: A randomized controlled study”. Concluded that MT is more effective improvement in motor of the upper limb and pain perception than conventional therapy without therapy [8].
- *Nigar Gurbuz, MD et al. (2016 Sep)*; Did a study on “Effect of mirror therapy on upper extremity motor function in stroke patients: a randomized controlled trial”. Concluded that mirror therapy in addition to a conventional rehabilitation program was found to provide additional benefit in motor recovery of the upper limb extremity in stroke [9].
- *Dr Charu Chopra et al. (2015 Jul)*; Did study on “Mirror therapy in stroke rehabilitation”, Concluded that the mirror therapy beneficial to the most post stroke and helps recovering function in hemiparesis but still it unclear [10].
- *Shahanawaz S.D. et al. (2015 Dec)*; International journal of neurologic physiotherapy; Did study on “Effect of mirror therapy on hand function in children with hemiplegic cerebral palsy: A case study”. Concluded that the pre-Rx and post-Rx scores showed significant change suggesting that mirror therapy has an effect incorporating use of affected hand for daily activities [11].
- *Holly E. Rossitter et al. (2014 Oct 17)*; Did study on “Cortical mechanism of therapy after stroke”. Concluded that the effect of Mirror Therapy on Motor cortex function in each hemisphere during bilateral hand movements was different in stroke patient compared to controls [12].
- *Holm Thieme et al. (2013)*; Did study on “Mirror therapy for improving motor function after stroke”. Concluded that the MT could be applied at least as an additional intervention in the rehabilitation of patients after stroke [13].
- *Sneha S.Khandare et al. (2013)*; Did study on “Compared task specific exercise and MT to improve upper limb functions in sub-acute stroke patients”. Concluded that MT can be added along with task specific exercise in the treatment of sub-acute stroke patient to improve upper limb function [14].
- *Philippa J. Clarke et al. (2000)*; Journal of stroke and cerebrovascular disease; Did study on “Changes in quality of life over the first year after stroke”. Concluded that the quality of life of stroke survivors exists throughout the first year of recovery [15].
- *L.R. Wilson, et al. (1999 Nov)*; Did study on “Muscle spindle activity in the affected upper limb after a unilateral stroke”. Concluded that any fusimotor dysfunction is likely to make a mirror contributions to the patients disability [16].

### **Methodology**

#### *Sample*

Thirty subjects were recruited from Shri Mahant Indresh Hospital, Patel Nagar, Dehradun (UK) and it is divided into two groups, Group A and

(15 subjects) and Group B i.e control group (15 subjects) were selected according to inclusion and exclusion criteria.

*Inclusion Criteria:* Hemiparetic patient, First ever stroke patient, Age 40-60, Both Male and Female, More MMSE > 24, MAS < 3, Stable patient (Good setting balance).

*Exclusion Criteria:* Unstable patient, Unco-operative patient, Any orthopaedic deformity, Aphasia, Any visual infection and Joints pain (shoulder, elbow, wrist, hip, knee, ankle)

*Instrumentation:* Mirror box, Table, Chair, Ball, Jar, Bag, Comb, Suitcase, Treatment couch, Shirt with buttons and Shoes with laces.

### Procedure

On the basis of inclusion and exclusion criteria 30 subjects were randomly divided into two group. 15 subjects in experimental group (Group A) and 15 subjects in controlled group (Group B). Consent was taken after explanation of the procedure and its outcomes. A pre treatment scoring was done via Upper Extremity Function Index (UEFI). In experimental group a pre scoring was done via UEFI and after scoring, the patient is seated close to a table in a which a mirror (33\*35 cm) was placed vertically. A 30 minute mirror box training session commenced. Subjects were seated on a chair close to a table on which a mirror box was placed vertically. The involved hand was placed behind the mirror and uninvolved in front of the mirror. The subjects were asked to perform forearm supination-pronation, wrist flexion-extension, finger flexion-extension, abduction, adduction, opposition, fisting on the paretic side while the subjects looked into the mirror watching the image of their non-involved hand thus, seeing the reflection of the hand movement projected over the involved hand. During the sessions subjects were asked to try and do the same movement with the paretic hand simultaneously.

One the other hand the eight new facilitation methods for the hemiplegic upper limb and fingers were applied as followed:

1. Shoulder flexion with 90° elbow flexion in the supine position. When the therapist said 'Flex' the patient attempted to flex the hemiplegic shoulder. Then, to facilitate shoulder flexion, the therapist tapped the anterior part of the deltoid muscle with his fingers and then pushed on the humeral head to avoid impingement in the shoulder.
2. Shoulder horizontal extension/flexion with elbow flexion in the supine position. When the therapist said 'Extend' or 'Flex' the patient attempted to extend or flex his shoulder, respectively. To facilitate shoulder horizontal extension/flexion, rapid stretching and rubbing of the deltoid muscle were applied by the therapist.
3. Shoulder flexion/adduction/external rotation with flexion of the elbow and forearm supination accompanied by wrist flexion, finger flexion and shoulder extension/abduction/internal rotation while extending the elbow and pronating the forearm accompanied by wrist dorsiflexion and finger extension in the supine position (two middle columns; modified PNF). When the therapist said 'Hold my hand and carry it to the top of your head', the patient attempted to perform this movement, which involves shoulder flexion/adduction/external rotation. When the therapist said, 'Extend your fingers and push my hand to the side of your torso', the patient attempted to perform this movement, which involves shoulder extension/abduction/internal rotation. To facilitate the movements, tapping, rubbing and rapid stretching of the muscles were applied by the therapist.
4. Shoulder flexion/abduction/external rotation with elbow extension accompanied by wrist dorsiflexion and finger extension (modified PNF). When the therapist said, 'Raise your hand over your head as if you were wiping your face with your forearm', the patient attempted to perform the movement, which involves shoulder flexion/abduction/external rotation. The therapist used his hand to hold the patient's upper limb in a posture of shoulder extension/adduction/internal rotation, elbow extension and forearm pronation. The therapist then quickly pulled the patient's upper limb to achieve shoulder extension/adduction/internal rotation and tapped and rubbed the inside of the deltoid muscle using his fingers to elicit shoulder flexion, while his thumb provided resistance to facilitate the shoulder external rotation. During these movements, the therapist supported the patient's arm with his other hand.
5. Forearm supination/pronation with 90° elbow flexion in the sitting position (right column). When the therapist said 'Turn your hand (palm) upward', the patient attempted to perform forearm supination and when the therapist said, 'Turn your hand (palm) downward', the patient attempted

to perform forearm pronation. To facilitate the movements, tapping, rubbing and rapid stretching of the muscles were applied by the therapist.

6. Wrist dorsiflexion and forearm pronation with extension of the fingers in the supine position. When the therapist said 'Turn your forearm as if you were fanning wind to your face with the back of your hand' or 'Turn your forearm and hand as if you were fanning wind to your face with the back of your hand', the patient attempted to perform wrist dorsiflexion and forearm pronation. The therapist held the abductor pollicis brevis in his hand and held fingers two-to-five in the wrist flexion position using the second and third fingers of his other hand. To facilitate forearm pronation and wrist dorsiflexion with finger extension, the therapist held the abductor pollicis brevis, quickly pulled the fingers, quickly supinated the forearm and tapped the ulnar side of the dorsal hand using his thumb. When the patient began to show wrist dorsiflexion and forearm pronation with extension of the fingers of his other hand, the therapist provided slight resistance to the patient's hand using thumb and fingers.
7. Finger extension with wrist flexion in the supine position. When the therapist said 'Extend', the patient attempted to extend his finger. This exercise was performed by each of the five fingers of the hemiplegic hand (right, and upper and middle rows). To facilitate isolated volar abduction of the thumb, tapping, rubbing and rapid stretching of the muscles were applied by the therapist.
8. Finger extension/flexion with wrist flexion in the sitting position. When the therapist said 'Flex your finger', the patient attempted to flex his finger and when the therapist said 'Extend your finger', the patient attempt to extend his finger. To facilitate isolated finger extension/flexion, tapping, rubbing, rapid stretching of the muscles and slight resistance against finger movements were applied by the therapist.

Neural block and electrical treatments were not administered during the study period. The dose of muscle relaxant was not changed during the study period.

While in controlled group general strengthening exercise of upper extremity for flexors and extensors with weights were carried out including active exercises and functional training.

Subject was asked to do the following activities.

1. Lifting a bag of groceries to the waist level.
2. Lifting a bag of groceries above your head.
3. Grooming your hair.
4. Dressing.
5. Opening a jar
6. Opening a jar
7. Opening door
8. Doing up buttons
9. Tying or lacing shoes
10. Throwing a ball
11. Carrying a small suitcase with you affected limb. [Fig. 1, 2, 3, 4 & 5].

After performing the activities we were asked the subjects to score each activity himself or herself according UEFI score.

0 = Extreme difficulty or unable to perform the activity

1 = Quite a bit of difficulty

2 = Moderate

3 = A little bit of difficult

4 = No difficulty



Fig. 1: Showing patient lifting a bag of groceries to waist level



Fig. 2: Showing patient throwing a ball



Fig. 3: Showing patient doing combing



Fig. 4: Showing patient doing exercises in mirror.



Fig. 5: Showing applying Repetitive facilitation exercise

## Results and Interpretation

### Statistical Analysis

The appropriate statistical analysis was conducted using the Statistical Package for Social Science 11.0. All data were entered into SPSS files from a standardized data from at the time of data collected. Prior to analysis, all entries were verified

by comparing the recorded data in each file to a printed copy of the data files entered into SPSS. All result were presented as mean standard deviation. All significant p values ( $-0.05$ ) were indicated in bolt type. Frequencies were used to test the data for normality around the mean (data not show).

### Hypothesis Testing For Comparing Two Related Samples

Paired t-test is way to test for comparing two related samples, involving small values n that do not require the variances of the two populations to be equal, but the assumption that the two populations are normal must continue to apply. For paired t-test, it is necessary that the observation in the two sample be collected in the form of what is called matched pairs i.e. "each observation in the one sample must be paired with an observation in the other sample in such a manner that these observation are somehow "matched" or related, in an attempt to eliminate extraneous factors which are not of interest in test". Such a test is generally considered appropriate in a before and after treatment study. For instance, we may test a group of certain student before and after training in order to know whether the training is effective, in which situation we may use paired t-test.

Descriptive Statistics Showing the Comparison of Mean and Total Sum of Pre and Post Scores of Experimental and Control Groups. In Experimental Groups the Mean-UEFI PRE-22.8667 and Mean-UEFI POST-32.5333; Std. Deviation-6.69613 and in Control Group (B)- the Mean-14.2667, Std. Deviation-6.65976. [Table 1] & [Graph 1].

T' Test Showing the Comparison of Mean and Total Sum of Pre and Post Scores of Experimental and Control Groups. Group-A UEFI Pre-UEFI; Post, Mean-9.667 and Std. Deviation-2.497; Group-B UEFI Pre-UEFI Post Mean-2.067 and Std. Deviation-1.579; Group-A UEFI Pre- Group-B UEFI Pre Mean-8.600 and Std. Deviation-8.998; and Group-A UEFI Post Group B- UEFI Post- Mean-16.200 and Std. Deviation-8.39. [Table 2] & [Graph 2].

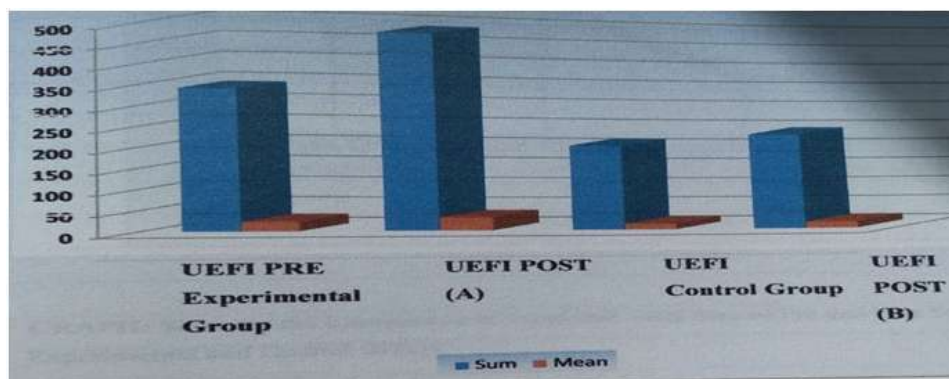
**Table 1:** Descriptive Statistics Showing the Comparison of Mean and Total Sum of Pre and Post Scores of Experimental and Control Groups

		N	Minimum	Maximum	Sum	Mean	Std. Error	Std. Deviation
Experimental Group (A)	UEFI Pre	15	6.00	37.00	343.00	22.8667	1.72893	6.69613
	UEFI Post	15	16.00	40.00	488.00	32.5333	1.45034	5.61715
Control Group (B)	UEFI Pre	15	7.00	34.00	214.00	14.2667	1.71954	6.65976
	UEFI Post	15	7.00	38.00	245.00	16.3333	1.78263	6.90411

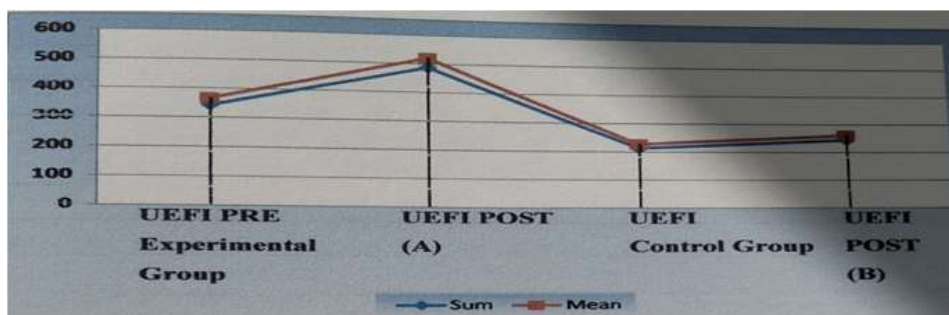


**Table 2:** 'T' Test Showing the Comparison of Mean and Total Sum of Pre and Post Scores of Experimental and Control Groups

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig. (2-tailed)
				Lower	Upper			
Group-A UEFI Pre-UEFI Post	-9.667	2.497	.6294	-11.016	-8.315	-15.34	14	.000
Group-B UEFI Pre-UEFI Post	-2.067	1.579	.4078	-2.941	-1.191	-5.07	14	.000
Group-A UEFI Pre Group-B UEFI Pre	8.600	8.998	2.328	3.617	3.583	3.70	14	.002
Group-A UEFI Post Group B-UEFI Post	16.200	8.394	2.147	11.594	20.805	7.54	14	.000



**Graph 1:** Showing the comparison of Mean and Total sum of pre & post scores of experimental & control groups



**Graph 2:** Showing the comparison of Mean and Total sum of pre & post scores of experimental & control groups

## Discussion

The paretic upper limb is a common and undesirable consequence of stroke that increase activity limitation. It has been reported that up to 85% of stroke survivors experience hemi paresis and that 55% -75% of stroke survivor has continued to have limitations in upper extremity functions. Many treatment are available to improve upper limb function of stroke such as mirror therapy, PNF, taping etc.

Mirror therapy and RFE relatively a new treatment techniques developed to promote upper

extremity recovery in stroke patients. Previous studies in stroke suggested that MT and RFE may be beneficial for motor function and is a simple, inexpensive and most importantly patient directed treatment that improve upper extremity function.

Hun-Chiaet 2010 and Gunes Yavuzer in 2008. Supported by UEFI is a preferred upper limb regional tool due to its superior and comparable psychometric properties. The result of the study confirm that the MT and RFE has improved upper limb function as demonstrated with UEFI.

There is a significant in post intervention in group A  $<0.05$  which approves improvement

in functional activity according to UEFI. The use of MT creates the mirror illusion of 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.

The effect of RFE used in novel facilitation technique that was developed on the isolation from synergy and the manipulation of objects of the hemiparetic upper limb were examined in 15 patients with sub-acute stroke. Improvement in isolation from synergy of upper limb and hand, as assessed by the UEFI score, were seen during the 4 weeks RFE sessions.

The statistical value obtained from above experiment shows that group 'A' (MT along with RFE) has better improvement in functional activity than group 'B' due to highly significant increase in value of group 'A' patients.

Clinically this study demonstrated that by using MT and RFE as a treatment tool, the improvement was seen in upper extremity functional activity of post stroke hemiparetic subjects.

#### *Clinical Relevance*

Functional limitation of upper extremity is very common in stroke patients. Various researches have shown effect of physical therapy measure like taping, mirror therapy, PNF etc. in improving functional activity of upper extremity in stroke subjects. Few researches have been published regarding the effectiveness of mirror therapy and repetitive facilitation exercise in stroke subjects. This study aims at finding out the effectiveness of mirror therapy and repetitive facilitation exercise in combination in improving the functional activity of upper extremity in sub-acute stroke patients. Hence combined treatment by mirror therapy and repetitive facilitation exercise should employ in upgrading rehabilitation protocol of hemiplegic subjects.

#### *Future Research*

1. Further studies are recommended to minimize these limitations in such a way that larger sample size of both the sexes that include various age groups of people are studied.
2. The duration of study can be increased.
3. The inclusion criteria can be improved so that all the subjects show similar functional

independence in upper limb at the beginning of the study.

4. Various outcome measure can be used in order to record that dunctional independence in a better way.
5. Study can also be done to improve lower extremity function
6. Study can be done on chronic patients.

#### *Limitations of the Study*

1. The duration of study was only 4 weeks, so further prognosis and long term benefits could not be recorded.
2. Home exercise was not prescribed to the subjects.
3. Training depending on functional level of patients.
4. Task specificity and stroke severity are important factors in rehabilitation of upper limb.

#### **Conclusion**

Mirror therapy and repetitive facilitation was found to be effective in improving functional independence in upper limb post sub-acute stroke. When mirror therapy and repetitive is administe 3<sup>rd</sup> to patient suffering from sub-acute stroke over a period of 4 weeks, it results in an improvement in reaching forwards, grasping, manipulating objects and also improves others fine motor functions of the hand.

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