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**EFFECT OF GRADED MOTOR IMAGERY TECHNIQUE ON HAND
GRIP STRENGTH ON SUBACUTE STROKE PATIENTS – A
RANDOMIZED CONTROLLED TRIAL**

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ABSTRACT

Aim: To find out the effect of graded motor imagery technique on hand grip strength in subacute stroke patients.

Background: Majority of stroke patients have dependency in performing ADL activities requiring gripping as there is hand function impairment. Hence, they need to be dependent on others to accomplish a task. There is residual weakness in hand is seen in most of post stroke patients even if they are ambulatory. Graded motor imagery is a physical rehabilitation approach which activates the brain by mental practice.

Methodology: Patients were randomly divided into Group A (Experimental) and Group B (control group) they were evaluated for baseline using hand dynamometer for grip strength. Both the groups were given intervention for 4 week 5 days/ week. 36 patients completed the treatment. Group A was given graded motor imagery technique in addition to conventional treatment.

Result: Data was analysed on SPSS software. Pre-intervention and Post-intervention test data were compared. Mann whitney and wilcoxon signed rank test was done. The result for Group A (Experimental group) ($p = 0.012$) and for Group B (control group) ($p = 0.042$).

Conclusion: Graded motor imagery was significant in improvement of hand grip strength post-intervention.

Keywords: Hand grip strength, hand dynamometer, hand function, graded motor imagery

INTRODUCTION

Stroke is a severe neurological condition that is the primary cause of disability worldwide [1] 85–87 percent of all stroke cases are ischemic strokes. The remaining occurrences were caused by hemorrhagic strokes, which include subarachnoid and spontaneous intracerebral hemorrhages [2]. Alves *et al.* defined disability as a dynamic process that includes physical, mental, and emotional conditions [3]. Because stroke victims depend on others for daily needs, their quality of life will decline and they may experience severe problems with physical, mental, and social well-being. Prior studies have demonstrated that stroke patients have a significantly decreased quality of life than healthy subjects, and their daily activities are significantly limited [4]. While only 5–20% of those affected continue to perform functional activities that involve their upper extremities, 83% of stroke survivors are still able perform ADL with their lower limbs [5]. Hemiparesis, a long-term disability of the arm and hand, is one of the most common deficits after a

stroke. It significantly affects one's ability to perform daily activities [6]. Upper limb function depends on the strength of the fingers and the hand [7]. Treatment for patients with stroke involves a variety of rehabilitative strategies. Motor imagery is one of them. MI was initially developed to help athletes perform better, and it has since been incorporated into stroke rehabilitation programs to aid in motor recovery [8]. Mentally replicating or imagining a component, scene, or sense as though it were is happening in overt, physical reality' the definition of mental imagery (MI) [9]. Graded Motor Imagery (GMI) is a therapeutic approach that aims to progressively activate various neural networks. Graded motor imagery focuses on the brain as its target organ. Through neuroplasticity, mental imagery enhances cortical reorganization by gradually involving the cortical neural networks [10]. It consists of three individual parts that are presented in increasing complexity over time and difficulty levels.

Graded motor imagery focuses on the brain as its target organ. Through neuroplasticity, graded motor imagery improves cortical reorganization by progressively involving the cortical neural networks. A study on investigation using electroencephalography to carried out to examine IMI and EMI confirmed that the somatosensory cortex is similarly activated in both types of images in terms of both spatial and temporal frequency. IMI has been shown to be associated with sub-threshold stimulation of primary motor cortex cells [11]. It has been identified in a study by Eun Kyu *et al* to be helpful for rehabilitation for upper limb [12].

METHOD

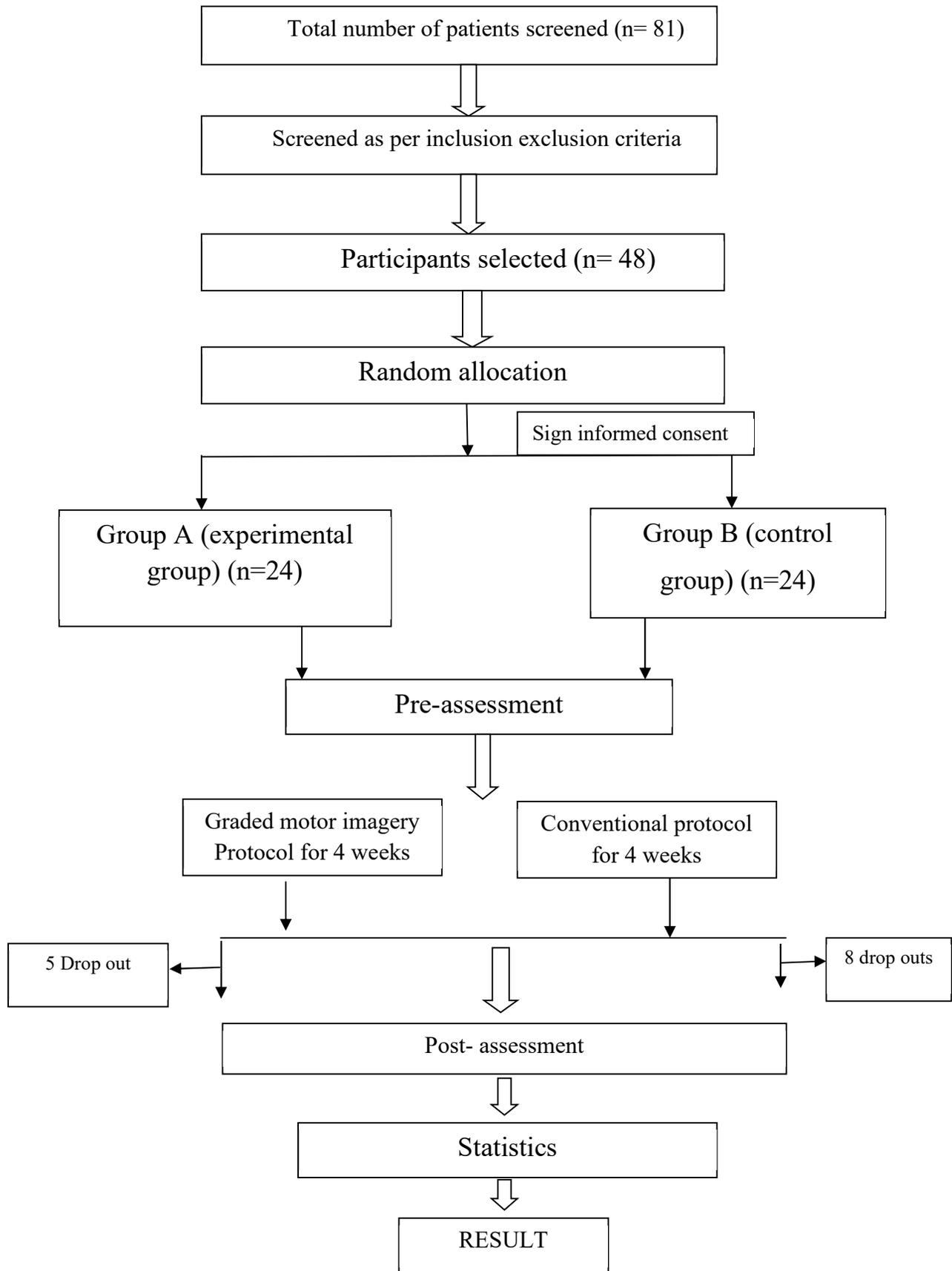
Inclusion and exclusion criteria: Subjects – Patients with Age between 40 to 60 years,

having subacute stroke, first episode of stroke, MMSE >24, Brunnstorm grade 3 onwards, Able to do finger movements. Patients who were having shoulder subluxation or upper limb contractures, visual and auditory impairment, severe spasticity with modified ash worth scale or with musculoskeletal problems were excluded.

Ethical clearance: As the study includes human subjects' ethical clearance was obtained from Parul University Institutional Ethical Committee for human research (PU-IECHR).

Method: Simple random sampling was done and patients were divided in control and experimental group accordingly.

Outcome measure: Hand dynamometer was used to evaluate grip strength. The strength was evaluated in kilograms (kg) unit.



Intervention:

Group A (Experimental group)

- GMI Included three consecutive steps: Implicit Motor Imagery (IMI), Explicit Motor Imagery (EMI) And Mirror Therapy (MT).
- **Laterality recognition / Implicit motor imagery**

Photographs were displayed in different postures of hand and were asked to identify Left/Right Hand Judgment Task. The random presentation of 25 images of right or left hands was oriented in various positions and degrees of rotation randomly displayed. For each image, the patients were required to choose whether the images shown were right or left hand. First familiarisation session, using 20 images of different body part and was given with no time limits. After the familiarisation session, the actual IMI (implicit motor imagery) task was started. Accuracy and reaction times of responses was recorded by Orientate application using a smartphone.

Patients were asked to complete the task as quickly as possible. Actual movement of the hands were not be permitted as the task is meant to rely only on mental capacity. Patient performs in the test with non affected hand. Each session, the patients completes the IMI (implicit motor imagery) task for at least four times within the hour of treatment. IMI

(implicit motor imagery) trained until the patient achieved accuracy and reaction time (i.e. accuracy $\geq 80\%$; reaction time $= 2.0 \pm 0.5$ seconds). If the patient were not able to reach these values within six sessions, then were continued IMI (implicit motor imagery) training for two more sessions. In order to progress treatment. Explicit motor imagery was gradually introduced in 6th session regardless of the respective IMI (implicit motor imagery) scores.

- **Explicit Motor Imagery**

EMI (Explicit motor imagery) was introduced during the sixth IMI (implicit motor imagery) session and gradually complexity of motor skills to be imagined was increased. Patients, were asked to be sitting in a relaxed position, with close their eyes and imagining themselves sitting in a familiar place. They were asked to execute the movement as if in real in all its aspects, including the timing taken to move. Images from the implicit motor imagery stage were asked for imagining movements. Patients executed two series of 20 repetitions for every imagined movement in each session. They performed 6 to 8 different movements in each session.

- **Mirror therapy**

In Mirror therapy section of GMI visual feedbacks were provided placing a mirror in front of the subject, on his/her midline, so that

when the patient looks into the mirror can see his/her unaffected limb reflected. The patient was told to move the unaffected hand while looking in the mirror. This gives the illusion that a “new” strong hand has replaced the affected one. Mirror exercises was began with

simply watching the reflection of the unaffected hand in the mirror and then was progressed from static to active movements. Three series of 12-15minutes were performed in each session, with 5 minutes between sessions to allow for resting and relaxing [11].



Patient performing mirror therapy in image A and implicit motor imagery in image B

- **Group B control**

The control group was given only conventional exercises. Both the group received conventional exercise which includes pegboards, fine motor activity, hand grip exercise, proprioceptive neuromuscular facilitation of upper limb and putty exercise. Group A experimental group was additionally given motor imagery technique. Both the groups received the given treatment for total

duration of 4 weeks 5 days a week

RESULTS

Data was analysed using SPSS software (version 27.0). Mann-whitney test showed a negative Z-value, indicating that the observed difference deviates from the null hypothesis. For within group wilcoxon signed rank test was used for control group ($p = 0.042$) was obtained and in for experimental group ($p = 0.012$) was obtained.

The mean age of 36 participants was 51yrs.

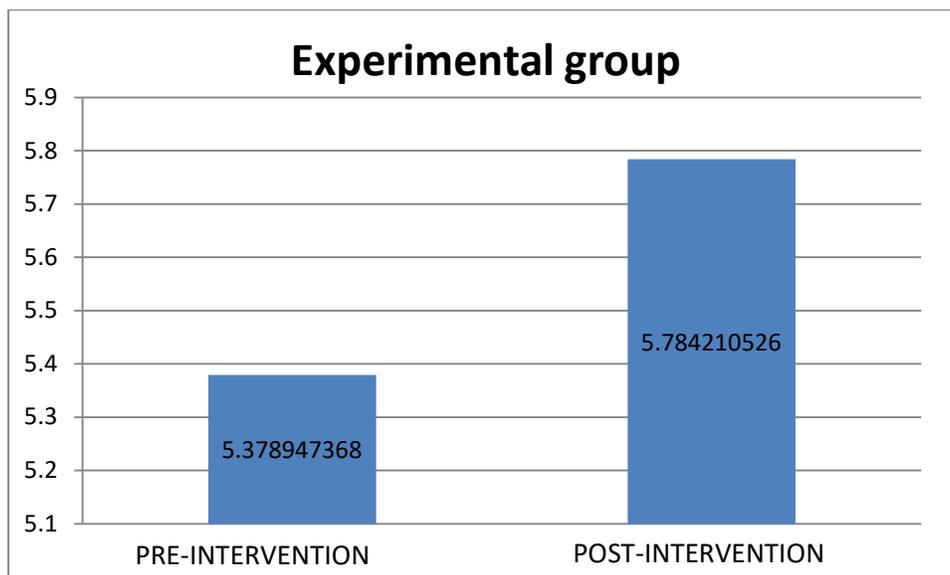
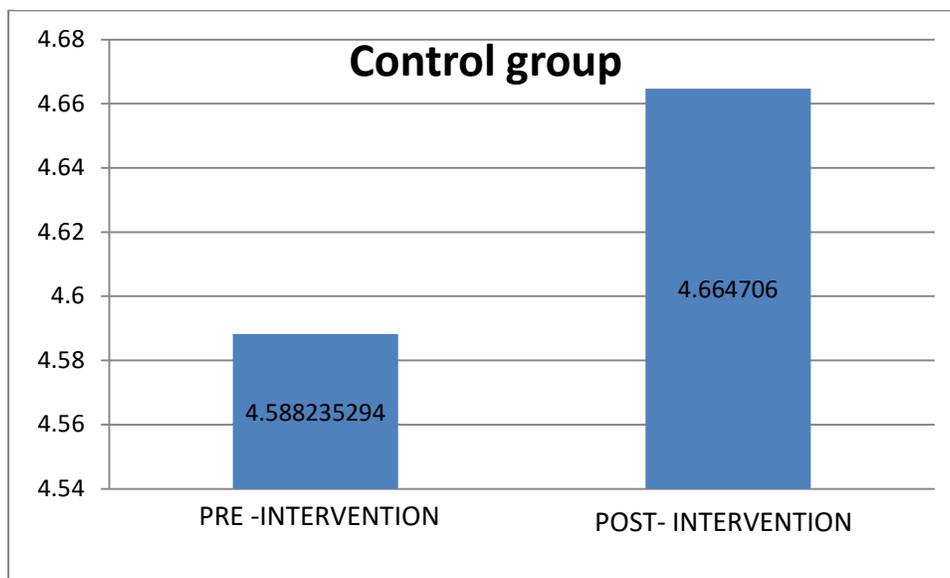
Gender	Group A	Group B
Male	13	10
Female	6	7

Wilcoxon Signed Ranks Test

	N	Mean	Std. Deviation	p-value
Control pre-intervention (Group B)	17	4.5882	2.31675	0.042
Control post-intervention (Group B)		4.6647	2.34466	
Experimental Pre-intervention (Group A)	19	5.3789	2.98526	0.012
Experimental post-intervention (Group A)		5.7842	3.11328	

Mann – Whitney test

	N	Mean	Std Deviation	Z value	P - Value
Control (Group B)	17	0.0765	0.13477	-1.492	0.136
Experimental (Group A)	19	0.4053	0.53590		



DISCUSSION

Strong grips are necessary to hold, grip, and manipulate surfaces and objects in order to carry out daily tasks effectively [13]. Similar to physical training, mental imagery has been shown to improve skillful movement performance; motor cortex neuron adaptation (Guillot and Collet, 2005). This impact is associated with an increase of time locked cortical potentials and has been interpreted in terms of greater cortical signals to muscles, created by repeated mental effort at maximal muscular activation (Ranganathan *et al.*, 2004) [14]. The GMI is a term for brain training used to enhance motor behavior following an injury, and brain training is the application of both visual and motor imagery. The inferior premotor cortex, dominant left supplementary motor area, superior premotor area, and limb-specific supplementary motor area shows an increase in blood flow during the initial stage of GMI; the primary motor or primary somatosensory cortices there is no increase observed. Graded motor imagery has shown to be effective in improving hand function [15]. In a study by Limakasto graded motor imagery has shown to be improvement of upper limb function [16]. In a systemic review by Louise Ada 2006 strengthening exercises and other interventions biofeedback, electrical stimulation, muscle re-education,

progressive resistance exercise including graded motor imagery showed increased strength and improved grip activity [17]. In a study by Frenkel *et al* demonstrated that mental exercise increased the ROM measurement during the immobilization phase [18]. The literature, however, is divided on the connection between motor imagery and muscular strength. Nonetheless, some research highlights how effective motor visualization is for increasing muscle strength. In a study published in 1992, Guang Yue found that the practice effect of central motor programming led to muscle activation following the application of mirror therapy with the unaffected hand in motion in an experimental study was beneficial so, in the last stage mirror was introduced as a part of it [19]. In a review by Bushra Candiri 2023 mentioned about the degree of pain was significantly reduced, and grip strength increased, but the extremity's functional ability remained unchanged by the application of GMI in orthopedic conditions. The findings of the study are significant because they show that mirror treatment was applied and is incorporated into the motor imagery phase. One condition that leads to movement difficulties after a stroke is cortical disinhibition. Consequently, GMI that targets cortical disinhibition was improves the

function in stroke patients with their motor function [20]. In a Study by Alan Sunderland in 1989 there is relationship between grip strength and performance, difficult motor tasks may be explained by the possibility that grip strength serves as a general indicator of the degree of arm weakening [21]. In a systemic review by Raquel *et al.* Mirror therapy increases shows appropriate interventional strategy to improve hand function in post stroke [22]. In this study it was evident that graded motor imagery showed improvement in grip strength for subacute stroke patients.

CONCLUSION

Graded motor imagery technique (group A) shown to be more beneficial than conventional physiotherapy (group B). It is effective in improving hand grip strength in subjects suffering from subacute stroke. However between the two groups the data was not highly statistically significant for improvement in experimental group. But there was statistically improvement post intervention in experimental group (Group A) given graded motor imagery.

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Further Recommendation: The study with larger sample size can be carried out.

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Conflict of interest: None

Ethical clearance: Parul University Institutional Ethics Committee for Human Research (PU-IECHR).

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