

Effect of Motor Imagery Training on Upper Limb Function among Patients with Stroke

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Summary

Stroke often leads to impaired upper limb function, reducing independence in daily activities. Motor imagery training is an emerging rehabilitation strategy that can enhance functional recovery. The present study aimed to assess the effect of a motor imagery training programme on upper limb function among patients with stroke. An experimental two-group pre-test post-test design was adopted with 40 subjects, randomly allocated into experimental and control groups. The Wolf Motor Function Test (WMFT) was used for assessment. The experimental group received motor imagery training for 30 minutes twice daily for 2-3 weeks, while the control group received conventional therapy. Results showed a statistically significant improvement in functional ability scores ($p = 0.000$) and a reduction in task completion time in the experimental group. A significant association was also found between education status and pre-test WMFT time. The study highlights that motor imagery training significantly improves upper limb function in stroke patients, supporting its integration into rehabilitation programmes.

Key words: Motor imagery, Stroke patients, Upper limb functions, Wolf Motor Function test

A stroke is a medical condition in which poor blood flow to the brain causes cell death. It is the rapid loss of brain functions due to a carotid artery block in the blood supply system (WHO, 2022). Studies conducted to examine the recovery of hemiplegic stroke patients show that up to 85 percent of patients have an initial deficit in the arm. While recovery of arm function is a poor in many patients, leg function has proven to be less of a problem. For upper limb rehabilitation, many therapeutic approaches are available. Recent studies have shown that motor imagery (MI) training can reduce arm impairment and activity limitations in people living with the effects of stroke; MI has had some degree of successful outcome in the acute, sub-acute and chronic populations of adults with stroke (Mulder, 2007).

One of the prospective randomised controlled trials recruited 42 subjects with chronic stroke. The intervention group received instruction regarding the Graded Motor Imagery (GMI) training and performed it at home over 8 weeks (30 minutes a day). The primary outcome measure was the change in motor function between baseline and eight weeks, assessed by the Manual Function Test (MFT) and Fugl Meyer Assessment (FMA). The secondary outcome measure was the change

in the Activity of Daily Living (ADL), assessed with the Modified Index (MBI). Results showed that 37 of the 42 subjects completed the 8-week programme (17 in the GMI group and 20 controls). All subjects showed significant improvements in the MFT, FMA and MBI over time ($p < .05$). However, the improvements in the total scores for the MFT, FMA and MBI did not differ between the GMI and control groups. The MFT arm motion score for the GMI and control group was significantly better than that of the controls ($p < 0.05$). They concluded that the motor imagery programme was useful for improving upper limb function as an adjunct to conventional rehabilitation for patients with chronic stroke (Ji et al, 2021).

Upper limb motor deficits were the most common problem among stroke survivors and most of the stroke survivors were unable to carry out the activities of daily living independently. To tackle the situation, it was felt that motor imagery training could effectively improve upper limb functions among patients with stroke.

Review of Literature

A prospective community-based study of stroke was conducted in Kolkata to determine the subtypes, prevalence, incidence, and case fatality rates of stroke. This longitudinal descriptive study comprised a two-stage, door-to-door survey of 52,377 individuals selected through stratified random sampling. The study showed that the overall case fatality rate was among the highest

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categories of stroke fatality in the world, with women having higher incidence and case fatality rates compared with men (Das et al, 2010).

A study assessed whether motor imagery might improve upper limb strength through an ecological approach and validation, using complex and multi-point exercises. Nine participants were included in the motor imagery group and 10 in the control group. The two-groups performed identical bench press and leg press exercises. The MI group was instructed to visualise and feel the corresponding contractions during the rest period, whereas the control group did a neutral task. The maximal voluntary contraction (MVC) and the maximal number of repetitions (MR) using 80 percent of the pre-test MVC weight were measured. Although both the MI and control groups enhanced their strength through the training, the leg press MVC was significantly higher in the MI group than in the control group ($p < 0.05$) (Carrasco & Cantalapiedra, 2016).

Objectives

1. Test the effect of motor imagery training on upper limb function among patients with stroke.
2. Find the association between upper limb function among patients with stroke and selected variables among patients with stroke.

Hypothesis

H₁- There is a significant difference between the mean improvement in the upper limb function score of the experimental and control group at the 0.05 level of significance.

H₂- There is a significant difference between the mean reduction in the time taken for the tasks performed by the experimental and control group at the 0.05 level of significance.

H₃- There is a significant association between upper limb function and selected patient variables at the 0.05 level of significance.

Materials and Methods

The research approach was quantitative and experimental, with two groups of pre-test and post-test design to assess the effect of motor imagery training on upper limb function among stroke patients.

Inclusion criteria: All patients, diagnosed with stroke with upper limb weakness, willing to participate in the study, knowing English or Malayalam, and with upper limb dysfunction were included.

Exclusion criteria: Patients having severe cognitive impairments, those with musculoskeletal problems, sensory aphasia, or hearing impairment and peripheral neuropathy were excluded.

Setting of the study: The study was conducted in the stroke rehabilitation units of Baby Memorial Hospital and Nirmala Hospital, Kozhikode (Kerala).

Sample size was calculated based on a previous study by Magdalena Ietswaart on motor imagery in stroke recovery ($n = 59.8 \approx 60$). However, due to feasibility, 40 participants were recruited, 20 each in the experimental and control group admitted to neurology wards and ICUs. Participants were selected using simple random sampling through a computer-generated allocation (A, C=experimental; B, D=control).

Data Collection Tools

(1) Personal and clinical data sheet; (2) Wolf Motor Function Test (WMFT) - a validated tool assessing upper limb strength, quality of movement, and task completion time; and (3) Motor activity record for documenting practice adherence.

Data collection procedure: Ethical approval was obtained from the concerned authorities of both hospitals. Informed consent was taken from patients and their relatives. Data was collected between 27 March 2023, and 22 April 2023. Pre-test assessments were conducted for both groups using WMFT.

The experimental group received motor imagery training for 20 minutes daily, starting from day 2 of admission and continued at home for two weeks post-discharge, guided by audio instructions. Participants maintained activity records and were contacted regularly by phone. The control group received only conventional therapy. Post-test assessments were done for both groups at the end of the third week. After the post-test, the control group was also provided with instructions and audio material for motor imagery training. Collected data were coded and analysed using descriptive and inferential statistics. Mean, standard deviation, frequency, and percentage were used for descriptive statistics. Independent t-test and paired t-test were applied to determine the effectiveness of the intervention, Chi-square test/ANOVA was used to find associations with selected variables significance level $p < 0.05$.

Results

The subjects were distributed across various age groups, with the majority in both the groups between 51-60 years. Only 10 percent of subjects in the experimental group were below 50 years. Out of 40 participants, 55 percent in the experimental group and 65 percent in the control group were males. (Results in Tables 1-5).

Most subjects in both groups had a middle cerebral artery stroke, while the rest had posterior cerebellar artery involvement. The majority of

participants in both groups had school-level education, and most were unemployed (65% in the experimental group and 50% in the control group). In both groups, the majority had ischaemic stroke (80% in the experimental group and 75% in the control group). Most subjects had comorbidities such as hypertension, diabetes mellitus, and dyslipidaemia. About 65 percent in both groups had diabetes; 55 percent in the experimental group and 75 percent in the control group had hypertension.

The effect of motor imagery training was assessed using WMFT. In the experimental group, the mean time for task completion reduced from 349.5 seconds (pre-test) to 202.3 seconds (post-test). Independent t-test analysis showed a significant reduction in time in the experimental group compared to the control group. Functional ability scores (mild, moderate, severe) also showed significant improvement in the experimental group after the intervention. Hence, motor imagery training was found highly effective in improving upper limb function among stroke patients. Analysis revealed a significant association between educational status and pre-test mean time taken to complete WMFT tasks.

Discussion

Our study found that the majority of the subjects (65%) were in the age group 50–60 years, and most were males (65%). The age-wise distribution indicated that stroke incidence was highest between 50–60 years, whereas only a few subjects (10%) were below 50 years of age. The study also revealed that the majority of patients in both the experimental (80%) and control (75%) groups had schematic stroke. Similar findings have been reported by Sridharan et al (2009).

Similar retrospective cohort study was conducted in a single centre stroke clinic in Navi Mumbai with the age groups 15–30 years, 31–45 years, 46–65 years and above 65 years. After the statistical analysis, a total of 1377 patients of acute stroke were identified, of which 12466 were ischaemic stroke, and 131 were haemorrhagic strokes. In this study, the mean age was 49.06 years, and 53 percent of males were affected. Their findings (Ekker et al, 2019; Kalita et al, 2023) were very similar to ours.

In our study, the functional ability scores of the experimental group, assessed using the WMFT, improved from a mean of 41.1 (pre-test) to 48.25 (post-test), indicating a significant improvement after motor imagery training. These findings show that motor imagery training effectively enhanced upper limb functional performance among stroke patients. Similar results were observed in a study that assessed whether motor imagery could improve upper limb strength through an ecological

approach. Participants in the motor imagery group were instructed to visualise and feel the corresponding contractions during rest periods, while the control group performed a neutral task. Although improvement was noted in both groups, the motor imagery group showed significantly greater enhancement in strength compared to the control group, supporting the effectiveness of motor imagery in rehabilitation (Hattem et al, 2016; Wolf et al, 2005).

Another similar study was conducted in SVNIRTAR, Odisha (India) with 15 subjects in each group. The control group received conventional occupational therapy only, while the experimental group received conventional therapy combined with a motor imagery programme. The experimental group showed significant improvement compared to the control group ($p < 0.004$ and $p < 0.001$).

In the present study, a post-test was conducted two weeks post-intervention. The pre-test mean functional ability score of the experimental group was 40.4, which improved to 50.0 in the post-test. The difference was tested using a paired sample t-test, and the calculated t-value was 13.186 with a p-value of <0.001 , confirming that motor imagery training was effective. Hence, it was concluded that there was a significant improvement in both time taken and functional ability scores of the experimental group who performed motor imagery training (Thankamani, 2015).

Table 1: Comparative improvement of upper limb functionality of experimental and control groups (n=20+20)

Group	Functional ability scores					
	Pre-test			Post-test		
	Range	Mean	SD	Range	Mean	SD
Experimental	18-70	34.3	9.62	19-72	50	9.22
Control	19-64	40.4	12.33	19-63	37.4	12.88

Table 2: Comparison of the mean reduction in the time taken by the upper limb for completion of tasks among the experimental and control groups (n=20+20)

Group	Time comparison						
	Pre-test time in seconds			Post-test time in seconds			Mean reduction
	Range	Mean	SD	Range	Mean	SD	
Experimental	104-475	349.5	86.06	102-418	202.3	78.26	147.2
Control	147-461	313.60	99.23	101-442	281.20	119.82	32.4

Table 3: Significance of the difference between the experimental and control group in the mean reduction of time taken for task performance (n=20+20)

Group	Mean Time in seconds	SD	t value	p value
Experimental	147.2	53.51	6.357	<0.001
Control	32.4	60.49		

Level of significance 0.05

Table 4: Comparison of the functional ability score of pre- and post-test among the experimental and control groups (n=20+20)

Group	Mean FA	SD	t value	p value
Experimental	15.7	5.37	6.378	<0.001
Control	-3	11.96		

Level of significance 0.05

Table 5: Association between educational status and pre-test mean time among subjects with stroke (n=20+20)

Educational status	Mean time seconds	SD	F	p value
School	321.2	87.79		
Degree	421.5	67.49	4.352	0.02
No formal education	274.25	99.20		

Level of significance 0.05

Nursing Implications

Nursing practice: Motor imagery training improves upper limb function in stroke patients, prevents disuse, and promotes early independence in daily living. The training protocol developed can serve as a resource for health professionals and caregivers, and as reference material for home-based care.

Nursing administration: Nurse administrators can promote awareness and integration of motor imagery training into stroke care, collaborate with healthcare bodies to adopt evidence-based practices to improve patient outcomes.

Nursing education: Nurse educators must update their knowledge on complementary therapies and foster research-based practice. Students should be encouraged to engage with stroke patients.

Nursing research: Administrators and managers should support studies exploring its benefits and use findings to guide future action plans.

Limitations: Small sample size (40 patients) limits generalisation. Grip strength assessment was difficult due to the lack of a dynamometer. Follow-up through telephone and post-test participation was inconsistent.

Recommendations: Replicate the study with larger samples in varied settings; Assess long-term effects of motor imagery therapy; Conduct periodic follow-up studies and comparative studies with other rehabilitative techniques; Explore centre-based motor imagery programmes; Conduct qualitative studies on the lived experiences of stroke patients receiving motor imagery.

Conclusion

Motor imagery training is effective in improving upper limb motor functions and can be incorporated into stroke rehabilitation. Nurses can play a crucial

role in training patients to perform motor imagery, and this practice can also be effectively carried out at home under the guidance of a caregiver. Patients with mild functional deficits can perform the activity independently. The study also revealed a significant difference when outcomes were compared with selected variables.

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