

# Efficacy of Repetitive Peripheral Magnetic Stimulation In Improving Hand Function Among Sub-Acute Stroke Patients

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## *Abstract-*

**Background:** Stroke is a leading cause of death and disability worldwide, often resulting in impaired hand function. Conventional rehabilitation techniques have shown limited efficacy in improving hand function post-stroke. Repetitive peripheral magnetic stimulation (rPMS) has emerged as a promising intervention, but its effectiveness in improving hand function among sub-acute stroke patients remains underexplored.

**Objective:** This study aimed to investigate the efficacy of Repetitive peripheral magnetic stimulation in improving hand function in sub-acute stroke patients.

**Methods:** A randomized controlled trial was conducted using a computer generated randomized table involving 50 sub-acute non haemorrhagic stroke patients recruited from a physiotherapy department. Participants were randomly assigned to either an experimental group receiving rPMS in addition to conventional physiotherapy or a control group receiving (NMES) Neuromuscular electrical stimulation and conventional physiotherapy. Hand function was assessed using the Motricity Index (Arm) score and the Box and Blocks Test pre- and post-intervention.

**Results:** Both groups showed significant improvements in hand function within themselves after the intervention. However, the experimental group demonstrated greater improvements compared to the control group, as evidenced by significant differences in post-intervention Motricity Index and Box and Blocks Test scores favoring the experimental group.

**Conclusion:** The findings suggest that rPMS, when combined with conventional physiotherapy, effectively improves upper limb impairment in sub-acute non haemorrhagic stroke patients. Further research is warranted to elucidate the specific mechanisms underlying these improvements and explore the long-term effects of rPMS on upper limb function post-stroke.

## INTRODUCTION

Stroke is referred to as a cerebrovascular accident. However, it's crucial to emphasize that a stroke is not an accidental incident but rather aptly described as a "brain attack." Strokes are primarily classified into two types: ischemic and hemorrhagic. Hemorrhagic strokes can be further categorized into intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH), specifically nontraumatic (spontaneous) ICH and nontraumatic (spontaneous aneurysmal) SAH. Ischemic strokes occur when there is a blockage in a blood vessel, leading to a diminished blood supply to the brain.

In contrast, hemorrhagic strokes occur when a blood vessel ruptures, causing blood to leak into the intracranial cavity.[1]

Stroke stands as the second most prevalent cause of mortality globally and plays a significant role in causing disabilities.[2][3][4] The financial strain posed by stroke is substantial, encompassing expenses related to prehospital, hospital, and posthospital care.[5][6][7]

Ischemic strokes account for approximately 62% of all strokes, followed by ICH at 28% and SAH at 10%.[2][3][4] Although ischemic strokes are more prevalent, hemorrhagic strokes result in more fatalities and lost disability-adjusted life-years (DALYs).[3]

Between 1990 and 2019, ICH and SAH demonstrated more significant reductions worldwide in age-standardized rates per year, compared to ischemic stroke, for incident and prevalent strokes, deaths resulting from stroke, [8]and Furthermore, both men and women globally encounter an estimated lifetime risk of stroke of 25%, commencing from the age of 25. This risk is particularly elevated in regions such as East Asia and Central and Eastern Europe.[9] A prevalent enduring outcome of stroke is impaired hand function.

Impaired hand function is one of the most frequently persisting consequences of stroke. [10] Paralysis of the hand or upper limb occurs acutely in up to 87% of all stroke survivors. [11] [12] Some recovery of motor control after a stroke is typical, occurring most rapidly during the first 3 months and usually plateauing by 6 months.[13][14] Yet, 40% to 80% of all stroke survivors have incomplete functional recovery of the upper extremity at 3 to 6 months post-stroke. [11][12][15]

Advanced Enhanced rehabilitation strategies could potentially enhance hand functionality in individuals who have experienced a stroke, even beyond the initial

6-month period. Studies in humans[16][17] suggest that active, repetitive, task-specific movement of the impaired limb is important in facilitating motor recovery after stroke. Constraint-induced movement therapy,[18][19] robot-assisted movement, [20][21]and EMG-triggered neuromuscular electrical stimulation (NMES) of paretic muscles [22][23] are among several relatively new rehabilitation strategies that attempt to improve motor recovery by Promoting repetitive, self-initiated, functional movement of the affected upper limb is encouraged. Additional therapies shown to reduce motor impairment include bilateral symmetric exercise of the paretic and nonparetic upper limbs [24][25] and motor imagery techniques, [26][27] including the use of a mirror [28][29] or virtual reality environments [30][31] to create the perception of restored motor control. However, many of these emerging therapies require some residual movement of the impaired hand and therefore are not applicable to severely disabled stroke survivors. Moreover, certain methods necessitate extensive therapy sessions or costly equipment, posing challenges to their integration within the current healthcare environment.

Over the past few decades, Functional electric stimulation (FES) or Neuromuscular electrical stimulation (NMES) has proven to be a mean of augmenting neurological recovery, especially in the acute and sub-acute stages post-stroke [32]. However, the disadvantages includes pain at high intensities, and relatively shallow penetration, causing insufficient stimulation of the deep, and/or the spastic muscles. [33]

Several studies researched the effect of rPMS on motor recovery post-stroke[34,35,36,37] and is now considered as one of the most innovative therapeutic options in rehabilitation [38], causing selective stimulation of a nerve or a muscle as in NMES, but with a stronger, deeper and nearly painless penetration and, hence, more tolerable [39]. In numerous instances of stroke, The introducing of repetitive transcranial magnetic stimulation (rTMS) during the acute and early sub-acute phases carries potential risks, particularly in cases of hemorrhagic strokes. Consequently, rPMS and NMES emerge as the optimal choices for mitigating the risk of learned non-use and maladaptive plasticity, thereby averting long-term disability. [40, 41,42,43,44]

Repetitive peripheral magnetic stimulation generating deep muscle stimulation, repetitive peripheral magnetic stimulation boosts proprioceptive afferent input, triggering movement in muscles lacking central drive and replicating lost voluntary action patterns. This results in cerebral activation and induction of plasticity [44]. This plastic cortical reorganization is regarded as fundamental to motor relearning and adaptive plasticity [45,46], facilitating the coordinated control of movements across various joints through the integration of proprioception into motor drive[44]

rPMS therapy involves generating a magnetic field in the vertical direction by passing an electric current through a magnetic coil and selectively stimulating a nerve or muscle. The concept behind rPMS is like NMES, but rPMS can reach deeper muscles and is almost painless, with hardly any side effects.The repetitive contraction–relaxation cycles produced by rPMS have been shown to both enhance proprioceptive input from the affected extremity, and to increase neuroplasticity[47,48,49]

Recently the study has shown that rPMS is potentially effective in improving motor recovery post-stroke, especially in the subacute stage. [53] A Randomized Controlled Trial study on Repetitive Peripheral Magnetic Stimulation applied in Early Subacute Stroke: Effects on Severe Upper-limb Impairment conclude that In patients with no functional arm movement, rPMS Enhancing the upper limb extensors enhances arm function and muscle strength for gripping and extending and flexing the elbow.[54] But lack of literature on improving hand function. So, our study aims to check the efficacy of Repetitive peripheral magnetic stimulation in improving hand function among sub-acute non haemorrhagic stroke.

## OBJECTIVES

**Aim:** This study aims to investigate the efficacy of rPMS in improving handfunction in the treatment of patients with sub-acute non haemorrhagic stroke.

**Primary Objective:**

- To check the effectiveness of the rPMS in improving hand function.

**Secondary objective:**

- Does the rPMS is useful for sub-acute stroke patients.
- To examine changes in hand function within both the experimental and control groups after the intervention

**METHODOLOGY**

**Study area :** Physiotherapy department, Mazumdhara Shah Medical Center (MSH).

**Study population:** Subject with sub-acute non haemorrhagic stroke

**Study design:** Randomized Controlled Trial (RCT) design

**Sample size:** 50

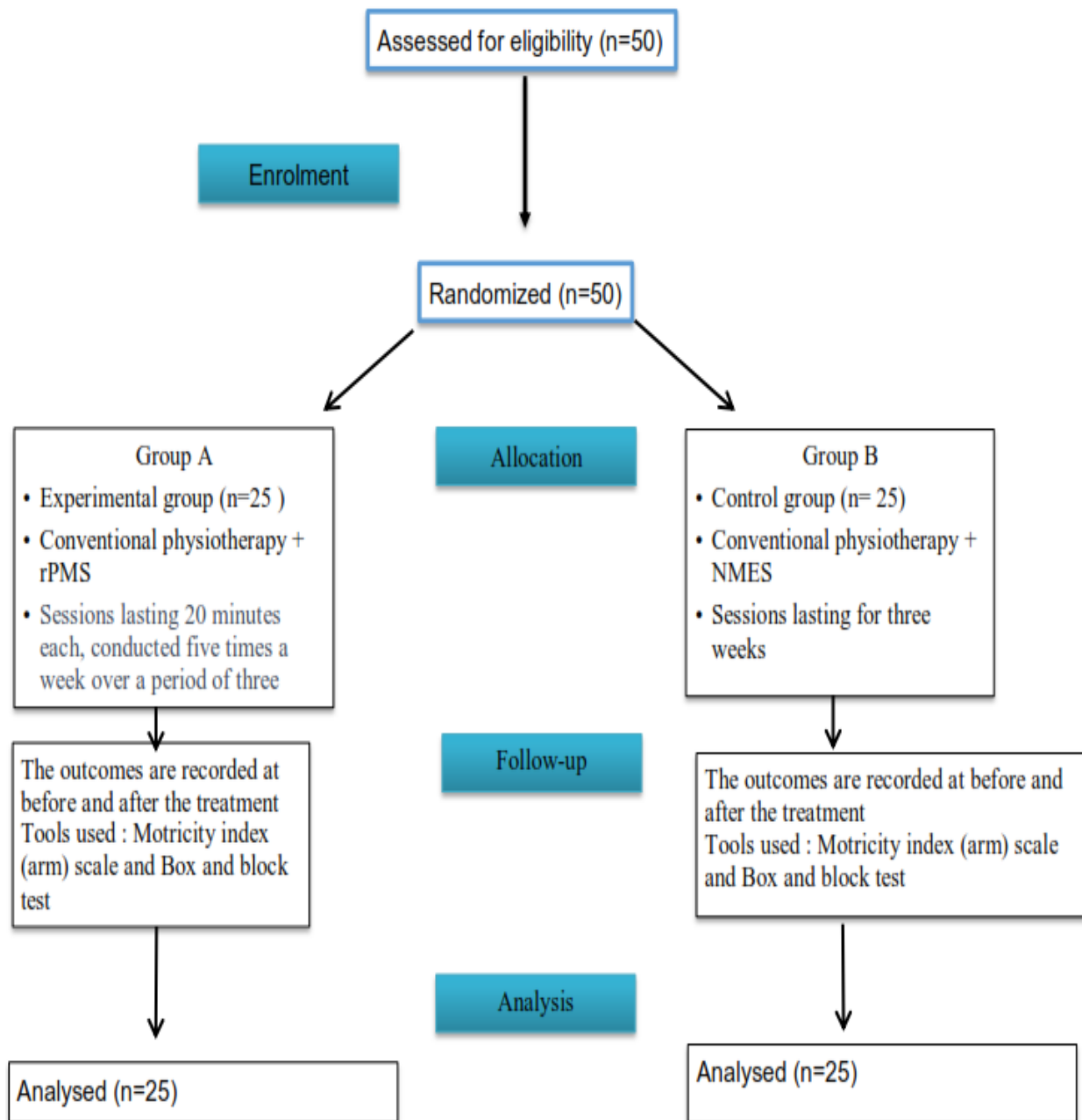
**Sampling technique:** Simple random sampling

**Inclusion criteria:**

- Adults aged 18-75 years.
- Individuals diagnosed with sub-acute stroke. Sub-acute stroke typically refers to the period between a few days to several weeks after the onset of the stroke.
- Patients who have impaired hand function as a result of the stroke.
- Medically stable and cleared for participation by a physician.
- Adequate cognitive function to follow instructions and participate in assessments.
- No previous history of upper limb musculoskeletal or neurological disorders.
- Patients who are willing and able to participate in the study and comply with the treatment regimen.

**Exclusion criteria:**

- Presence of severe cardiac, respiratory, or other medical conditions that could contraindicate physical activity.
- Patients with contraindications to magnetic stimulation.
- Patients with other neurological conditions or comorbidities that could significantly impact hand function.
- Patients who are pregnant or breastfeeding.
- Recent history of seizures or epilepsy.
- Current participation in another upper limb rehabilitation program.
- Severe cognitive impairment or communication difficulties that prevent participation.
- Patients with metal implants or devices that are incompatible with magnetic stimulation.



### Procedure

Recruitment involved a total of 50 participants who had recently experienced a stroke in the sub-acute phase. The selection process was conducted randomly through a computer-generated randomized table, considering specific inclusion and exclusion criteria. Participants expressed their willingness to participate in the study and were recruited after obtaining written informed consent to ensure a homogeneous study population. The participants were divided into two groups named the control and experimental groups, with each group consisting of 25 individuals. Both groups underwent conventional physiotherapy, specifically designed for upper extremity and hand rehabilitation. In addition to this standard intervention, the experimental group received repetitive Peripheral Magnetic Stimulation (rPMS) sessions lasting 20 minutes each, conducted five times a week over a period of three weeks. Conventional physiotherapy includes one session per day of conventional physical therapy, occupational therapy for 3 weeks. Daily physical therapy and occupational therapy regimens comprised muscle stretching, passive and passive-assisted mobilization, progressive neuromuscular facilitation training, and task-oriented training lasting 40 minutes, administered by a team of two therapists.

To evaluate the effectiveness of the interventions, a pre-and post-treatment assessment of hand function was conducted using established metrics, namely the Motricity Index (Arm) score and the Box and Blocks Test.

The participants scores on both the above outcome measures were assessed pre-test and post-test and the values were analyzed. The data was managed by MS word 2016 and analyzed by SPSS version 27.

## RESULTS

### Between Group Comparison

Table-1

S. No	Parameter	Mean $\pm$ Standard Deviation		t	P-Value
		Experimental Group	Control Group		
1	Baseline Motricity Index	50.56 $\pm$ 9.350	48.20 $\pm$ 5.477	1.089	0.282
2	Post Motricity Index	58.96 $\pm$ 7.850	54.68 $\pm$ 4.347	2.385	0.021*
3	Baseline Box and Block Test	42.36 $\pm$ 8.025	39.24 $\pm$ 5.349	1.618	0.112
4	Post Box and Block Test	51.96 $\pm$ 10.458	43.44 $\pm$ 7.012	3.383	0.001*

Statistical Software- SPSS Version 27; Statistical Test: Independent T test; P-Value <0.05- Significant\*

### Within Group Comparison (before and after change)

Table-2

S. No	Parameter	Mean $\pm$ Standard Deviation		t	P-Value
		Pre-Test	Post-Test		
<b>Experimental Group</b>					
1	Motricity Index	50.56 $\pm$ 9.350	58.96 $\pm$ 7.850	1.089	<0.001*
2	Box and Block Test	42.36 $\pm$ 8.025	51.96 $\pm$ 10.458	2.385	<0.001*
<b>Control Groups</b>					
3	Motricity Index	48.20 $\pm$ 5.477	54.68 $\pm$ 4.347	1.618	<0.001*
4	Box and Block Test	39.24 $\pm$ 5.349	43.44 $\pm$ 7.012	3.383	<0.001*

Statistical Test: Paired T test; P-Value <0.05- Significant\*

### Between Groups (Table 1):

- **Baseline:** There were no significant differences between the experimental and control groups in either the Motricity Index (strength and coordination) or the Box and Block Test (manual dexterity) at the beginning of the study (baseline). This suggests both groups started at a similar level.

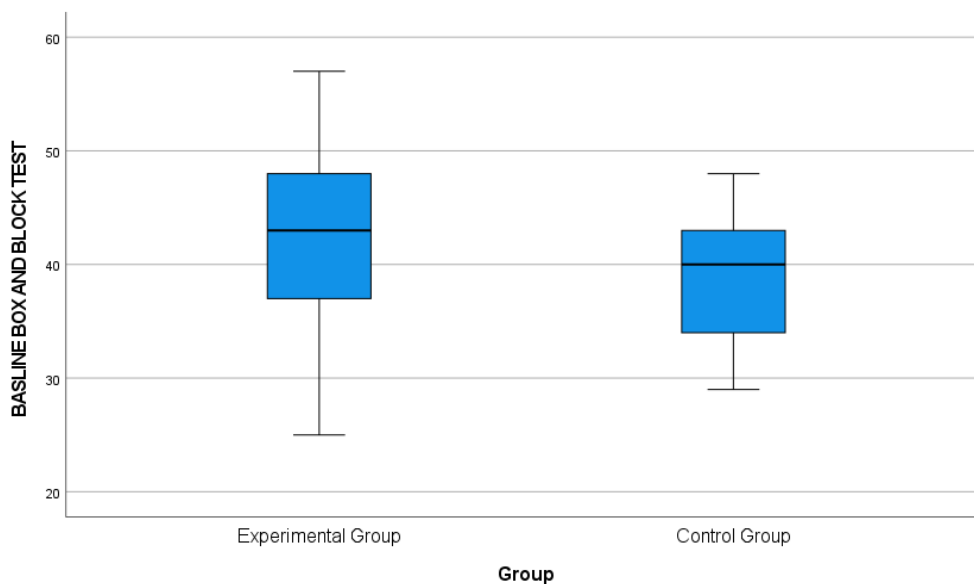
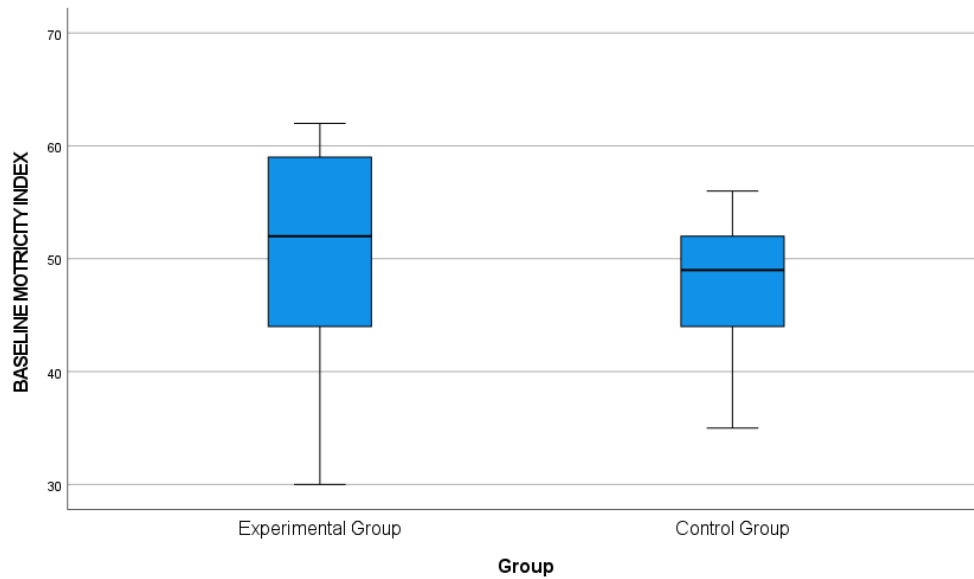
- **Post-Intervention:**

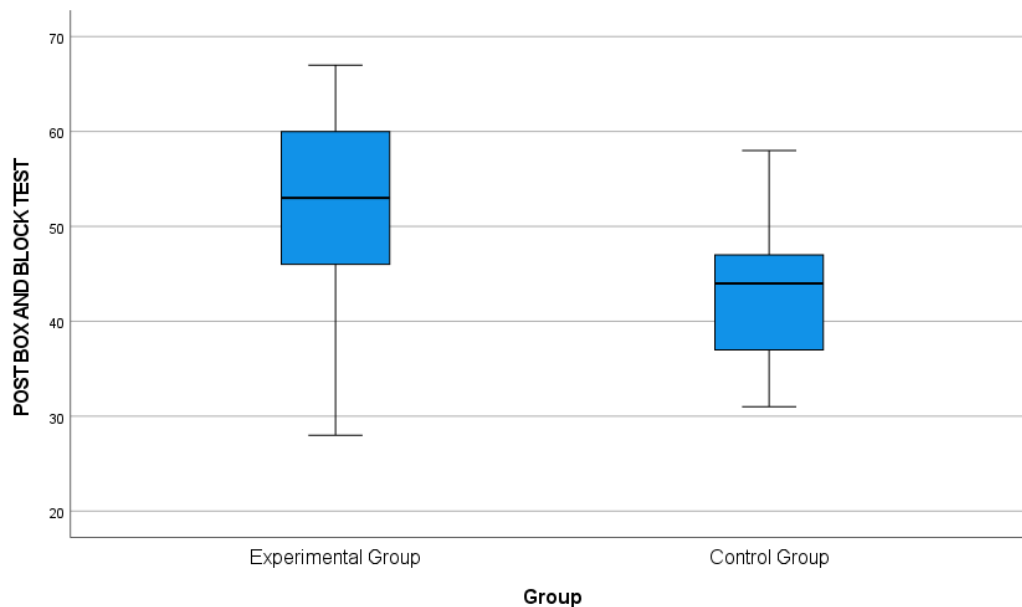
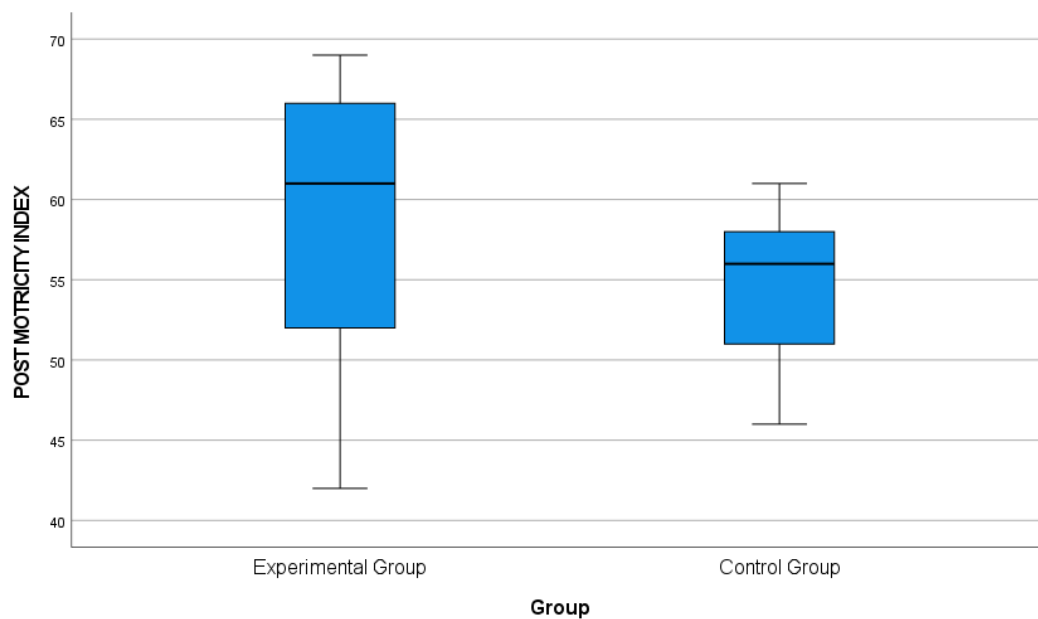
**Motricity Index:** The experimental group showed a significant improvement compared to the control group after the intervention (p-value = 0.021\*). This indicates the intervention might have positively impacted motor function in the experimental group.

**Box and Block Test:** Similar to the Motricity Index, the experimental group showed a significant improvement compared to the control group after the intervention (p-value = 0.001\*). This suggests a positive effect of the intervention on manual dexterity as well.

### Within Groups (Table 2):

- Both the experimental and control groups showed significant improvements in **both** the Motricity Index and Box and Block Test scores **within themselves** after the intervention ( $p$ -value  $< 0.001^*$  in all cases). This means participants in each group generally improved their motor skills regardless of being in the experimental or control group.





## DISCUSSION

The Box and Block Test (BBT) and Motricity Index (MI) are two measures that meet all psychometric criteria for assessing upper limb impairment [61]. MI demonstrates a strong correlation with arm motor tests and the hemispheric stroke scale used for measuring upper limb paresis [62]. Both BBT and MI exhibit high validity when compared to the Fugl-Meyer Motor Assessment, with correlation values of 0.9 and 0.86 respectively. Furthermore, both measures demonstrate high inter-rater reliability and test-retest reliability [63]. Therefore, BBT and MI were chosen as outcome measures.

In the experimental group, the mean differences between pre-test and post-test values for MI and BBT were 8 and 9.6 respectively. In the control group, the mean differences for MI and BBT were 6.4 and 4.2 respectively. Both the experimental and control groups showed significant improvements in both the Motricity Index and Box and Block Test scores within themselves after the intervention ( $p$ -value  $< 0.001^*$  in all cases). This indicates that participants in each group generally improved their motor skills regardless of group assignment. However, between-group comparison reveals significant differences in post-intervention Motricity Index and Box and Block Test scores, favoring the experimental group.



**CONCLUSION:**

the findings suggest that the rpms employed in the study effectively improves upper limb impairment, as measured by the Motricity Index and Box and Block Test. Further research could explore the specific components of the intervention contributing to these improvements and investigate its long-term effects on upper limb function.

**CONFLICTS OF INTEREST**

The authors declare no conflicts of interest.

**ETHICAL APPROVAL**

The study was approved by the research committee and a formal permission was obtained from concerned authorities of the hospital and associated departments.No ethical issues arouse during the study.

**STATEMENT OF INFORMED CONSENT**

Informed consent was obtained during the study. The subjects were informed that the confidentiality of the data was maintained. The subjects were informed that their participation was on voluntary basis and can withdraw from the study at any time.

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