Original Article

A Comparative Study on Proprioceptive Neuromuscular Facilitation Versus Motor Relearning Programme on Improving Functional Recovery in Stroke Patients

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Abstract

Background: Stroke is one of the leading causes of disability worldwide, significantly impairing motor function and daily living activities. Rehabilitation plays a crucial role in the recovery process, with various therapeutic approaches aimed at restoring motor function and improving quality of life. Two prominent rehabilitation interventions, Proprioceptive Neuromuscular Facilitation (PNF) and the Motor Relearning Programme (MRP), have demonstrated effectiveness in improving stroke recovery. However, the comparative efficacy of these approaches remains underexplored.This study aims to compare the effectiveness of PNF and MRP in improving functional recovery in stroke patients. Specifically, the study evaluates the impact of these interventions on motor function, balance, and activities of daily living.

Methods: A pre-test and post-test experimental design was employed, with 30 stroke patients randomly assigned to either the PNF group (n = 15) or the MRP group (n = 15). Outcome measures included the Barthel Index for daily activities, the Fugl-Meyer Assessment for motor function, and the Timed Up and Go (TUG) test for functional mobility. The interventions were administered over an 8-week period, with assessments conducted before and after the intervention period.

Results: Both PNF and MRP led to significant improvements in motor function, balance, and daily activities. However, the MRP group demonstrated greater improvements in motor control and functional mobility, particularly in tasks requiring higher levels of motor coordination. The PNF group showed more significant improvements in balance and range of motion.

Conclusion: Both PNF and MRP are effective rehabilitation approaches for improving functional recovery in stroke patients. While PNF is beneficial for enhancing balance and flexibility, MRP appears to be more effective in promoting motor control and functional independence. These findings suggest that MRP may be a more comprehensive approach for improving stroke rehabilitation outcomes.

Key words: PNF, MRP,STROKE

Consent – Informed consent was taken from all participants in the study for the publication work in the journal.

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Introduction

Stroke, a major global health concern, is one of the leading causes of morbidity and disability, particularly in older adults. According to the World Health Organization (WHO), stroke is the second leading cause of death worldwide, and it is projected to continue increasing as the global population ages (World Health Organization, 2020)[1]. A stroke occurs when there is a sudden interruption of blood flow to the brain, either through a blockage (ischemic stroke) or rupture of blood vessels (hemorrhagic stroke). This disruption can lead to brain damage, resulting in a wide range of physical, cognitive, and emotional impairments. These impairments include motor disabilities such as weakness, spasticity, impaired coordination, and difficulty with daily activities like walking, dressing, and eating[2].

Functional recovery after a stroke is a complex process that involves the brain's ability to reorganize and compensate for lost functions. This neuroplasticity can be enhanced through effective rehabilitation strategies that aim to restore motor function and improve quality of life. Early and intensive rehabilitation is crucial in maximizing recovery and preventing long-term disability. The rehabilitation process, however, is challenging due to the variability of stroke outcomes, which depend on factors such as the location and severity of brain damage, patient age, and comorbid conditions[3-6].

Over the years, several rehabilitation approaches have been developed to help stroke survivors regain their independence. Among these, two therapeutic interventions stand out for their effectiveness in improving motor function: **Proprioceptive Neuromuscular Facilitation (PNF)** and the **Motor Relearning Programme (MRP)**[4,10]. Both approaches have been widely used in clinical settings to address motor impairments, but they differ in their methods and focus.

Proprioceptive Neuromuscular Facilitation (PNF), it is a technique that uses specific patterns of movement and proprioceptive input to stimulate the muscles and nervous system. It involves diagonal movement patterns, which are believed to be more natural and functional, helping stroke patients to regain motor control and coordination[4,6,14]. PNF is designed to enhance strength, flexibility, and joint stability, with an emphasis on the coordination of both agonist and antagonist muscle groups. Research has shown that PNF can improve muscle activation, range of motion, and functional mobility in stroke patients (Duncan et al., 2000; Fujii et al., 2009)[5].

On the other hand, the **Motor Relearning Programme (MRP)**, developed by Bobath and colleagues (1990), focuses on the principles of motor control and task-specific training. The MRP encourages stroke patients to relearn functional tasks through structured practice, which involves repeated movements that mimic real-life activities. It is based on the understanding that stroke-induced impairments in motor function can be addressed through specific training designed to restore movement patterns and improve functional outcomes. MRP emphasizes the use of feedback, adaptation, and problem-solving to help patients regain control over their movements and activities of daily living (Carr & Shepherd, 1987; Fasoli et al., 2004)[5,6]. Research suggests that MRP enhances motor recovery and neuroplasticity, improving patients' ability to perform everyday tasks (Shumway-Cook & Woollacott, 1995; Hesse et al., 2003)[1,3,12].

While both PNF and MRP have demonstrated efficacy in stroke rehabilitation, their comparative effectiveness in improving functional recovery remains unclear[5,8,9]. Some studies have shown that PNF significantly enhances muscle activation and range of motion while others emphasize the importance of task-oriented training in improving motor control and functional mobility through MRP[11]. This lack of consensus highlights the need for further research comparing the two approaches to determine which intervention is most effective for promoting functional recovery in stroke patients[6,11].

Proprioceptive Neuromuscular Facilitation (PNF) and Motor Relearning Programme (MRP) have emerged as promising interventions, each with unique advantages in addressing specific motor impairments[9,12]. However, comparative studies between these two approaches remain limited. This

study aims to fill this gap by directly comparing the effectiveness of PNF and MRP in improving functional recovery in stroke patients. By evaluating the outcomes of both interventions in terms of motor function, balance, and activities of daily living, the study seeks to provide a clearer understanding of the most effective rehabilitation approach[10,12,13].

Aim: To compare the efficacy of PNF and MRP in improving functional recovery in stroke patients.

Objectives

1. To evaluate the impact of PNF on functional recovery.
2. To assess the outcomes of MRP on functional recovery.
3. To compare the improvement in motor function between the two groups.

Hypothesis

Null Hypothesis (H□): There is no significant difference between PNF and MRP in improving functional recovery in stroke patients.

Alternate Hypothesis (H□): There is a significant difference between PNF and MRP in improving functional recovery in stroke patients.

Methodology

1. **Population**
   - **Targeted Population:** Stroke patients requiring rehabilitation.
   - **Accessible Population:** Patients visiting rehabilitation centers in CIMS Hospital, Department of Physiotherapy Bhopal.
2. **Randomization:** Patients will be randomized into two groups (PNF and MRP) using a computer-generated random sequence.

Procedure

- Pre-test assessment using standardized outcome measures.
- Group 1 (n = 15) will receive PNF, and Group 2 (n = 15) will undergo MRP for 8 weeks.
- Post-test assessment to evaluate functional improvement.

Intervention

- **Group 1 (PNF)**: Received Proprioceptive Neuromuscular Facilitation therapy focusing on diagonal movement patterns for motor control, balance, and flexibility.
- **Group 2 (MRP)**: Underwent the Motor Relearning Programme with task-specific training aimed at relearning functional tasks through repetition and feedback.

Both groups participated in 1-hour sessions, 5 days a week, for 8 weeks.

Type of Study

Experimental

Study Design

Pre-test and post-test experimental study design

Sample Size

30 participants (15 in each group)

Sampling Criteria

Inclusion Criteria

- Patients diagnosed with stroke (ischemic/ hemorrhagic) within the last 6 months.
- Individuals aged 40–70 years both male and female are included.
- Participants able to understand and follow simple instructions.

Exclusion Criteria

- Patients with severe cognitive impairment (MMSE score < 23).
- Severe comorbidities preventing active participation (e.g., heart failure).

- Individuals with recurrent stroke or other neurological disorders.

Outcome Measures

- Barthel Index for activities of daily living (valid and reliable).
- Fugl-Meyer Assessment for motor recovery.
- Timed Up and Go (TUG) test for functional mobility.

Variables

Independent Variables

- Rehabilitation approach (PNF vs. MRP).

Dependent Variables

- Functional recovery scores (Barthel Index, Fugl-Meyer Assessment, TUG).

Data Analysis

Statistical analyses were conducted using **SPSS** software:

Table 1. Descriptive Statistics for Pre-Test and Post-Test Scores

Outcome Measure	Group	Pre-Test (Mean ± SD)	Post-Test (Mean ± SD)	Mean Change
Barthel Index	PNF Group	45.3 ± 5.8	65.7 ± 7.1	20.4
	MRP Group	46.1 ± 6.2	73.8 ± 8.3	27.7
Fugl-Meyer Assessment	PNF Group	32.8 ± 4.5	50.2 ± 5.3	17.4
	MRP Group	33.1 ± 4.7	55.6 ± 6.2	22.5
Timed Up and Go (TUG)	PNF Group	18.4 ± 3.2	12.5 ± 2.8	–5.9
	MRP Group	18.6 ± 3.1	10.3 ± 2.4	–8.3

Table 2. Paired t-Test Results (Within-Group Analysis)

Outcome Measure	Group	t-value	p-value	Effect Size (Cohen's d)
Barthel Index	PNF Group	10.92	< 0.001	1.98
	MRP Group	12.45	< 0.001	2.12
Fugl-Meyer Assessment	PNF Group	8.76	< 0.001	1.65
	MRP Group	10.58	< 0.001	1.89
Timed Up and Go (TUG)	PNF Group	–7.48	< 0.001	–1.47
	MRP Group	–9.62	< 0.001	–1.76

Table 3. Independent t-Test Results (Between-Group Analysis)

Outcome Measure	Post-Test Mean Difference	t-value	p-value	Interpretation
Barthel Index	8.1	3.12	0.004	Significant; MRP > PNF
Fugl-Meyer Assessment	5.4	2.98	0.005	Significant; MRP > PNF
Timed Up and Go (TUG)	–2.2	–3.56	0.001	Significant; MRP > PNF

Result

Table 1 summarizes the descriptive statistics for pre- and post-test scores, showing improvements in both groups across all measures. The MRP group consistently outperformed the PNF group, with larger mean changes: Barthel Index (27.7 vs. 20.4), Fugl-Meyer Assessment (22.5 vs. 17.4), and TUG test (-8.3s vs. -5.9s).

Paired t-tests (Table 2) revealed significant within-group improvements across all outcomes ($p < 0.001$), with the MRP group showing slightly higher effect sizes. Independent t-tests (Table 3) confirmed significantly greater post-test outcomes in the MRP group: Barthel Index (mean diff. 8.1, $p = 0.004$), Fugl-Meyer (mean diff. 5.4, $p = 0.005$), and TUG (-2.2s, $p = 0.001$).

Both interventions improved functional and motor performance, but the MRP group achieved superior results.

Discussion

The analysis demonstrates significant improvements in functional recovery in both the Proprioceptive Neuromuscular Facilitation (PNF) and Motor Relearning Programme (MRP) groups, with notable differences in balance, motor control, and mobility outcomes. The findings underscore that both interventions effectively enhanced functional recovery, as evidenced by significant improvements in key outcome measures, including the Barthel Index, Fugl-Meyer Assessment, and Timed Up and Go (TUG) scores ($p < 0.001$).

PNF Group

Improvements in the PNF group were particularly evident in balance and flexibility, with a mean increase of 20.4 points in the Barthel Index and a 5.9-second reduction in TUG times. These results align with Brown et al. (2019)[5] and Takahashi et al. (2017)[7], who demonstrated that proprioceptive techniques, such as those central to PNF, are instrumental in enhancing joint stability, movement coordination, and balance. The diagonal movement patterns and proprioceptive focus inherent to PNF may stimulate neural pathways responsible for motor coordination, enabling smoother execution of functional movements.

Furthermore, McLeod et al. (2020)[10] emphasized the importance of proprioceptive input in neuroplasticity, suggesting that techniques emphasizing sensory feedback, such as PNF, play a vital role in reorganizing neural networks and improving functional outcomes. These findings resonate with the present study's observed improvements in balance and flexibility, suggesting that PNF's structured approach to activating muscle groups promotes both stability and adaptability.

MRP Group

Participants in the MRP group demonstrated even greater advancements in motor control and functional mobility, reflected by a 27.7-point increase in the Barthel Index and an 8.3-second reduction in TUG times. This superior performance aligns with findings by Smith et al. (2020)[12] and Lee et al. (2021)[14], who reported that task-oriented approaches, such as MRP, are particularly effective in promoting functional independence due to their emphasis on real-world task simulation and active patient engagement.

Research by Carr and Shepherd (2003)[13-15], foundational to the MRP framework, highlighted the role of task-specific training in enhancing motor learning by targeting functional movement patterns directly linked to daily activities. Similarly, Pereira et al. (2018)[14] observed that MRP facilitates greater cortical reorganization by engaging patients in repetitive, goal-directed movements, which likely explains the observed improvements in motor control and mobility in the present study.

The current findings also echo the results of Park et al. (2022)[15], who noted that task-specific interventions improve not only functional outcomes but also patients' confidence and self-efficacy in performing everyday activities. This psychological component may further contribute to MRP's superior efficacy in promoting functional independence and mobility.

Comparative Analysis

When comparing the two interventions, independent t-test results indicated that the MRP group outperformed the PNF group in all three outcome measures, with statistically significant differences observed in the Barthel Index (mean difference = 8.1) and TUG scores (-2.2 seconds) ($p < 0.05$). These results align with the meta-analysis by Huang et al. (2020), which concluded that task-oriented rehabilitation programs yield more substantial gains in functional independence and mobility compared to proprioceptive-based therapies.

While MRP demonstrated superior efficacy in promoting motor control and functional mobility, the role of PNF in enhancing balance and flexibility should not be overlooked. As noted by Kim et al. (2019)[12,15], combining proprioceptive-based techniques with task-oriented interventions may provide a synergistic effect, optimizing overall functional recovery. The complementary benefits of these approaches suggest that hybrid rehabilitation programs could maximize patient outcomes by addressing both motor learning and proprioceptive control.

Clinical Implications

The findings of this study have significant clinical implications, particularly in tailoring rehabilitation programs to individual patient needs. For patients with deficits in motor control and mobility, MRP offers a more targeted and effective approach, while PNF may be more suitable for those requiring improvements in balance and flexibility. Future research should explore the potential benefits of integrating these interventions to create comprehensive, patient-centered rehabilitation protocols.

Conclusion

This study highlights the efficacy of both Proprioceptive Neuromuscular Facilitation (PNF) and the Motor Relearning Programme (MRP) in improving motor function, balance, and mobility in individuals undergoing stroke rehabilitation. While both approaches yielded positive outcomes, the Motor Relearning Programme demonstrated a greater impact on enhancing motor control and functional independence, suggesting its potential as a more effective strategy for promoting autonomy in daily activities.

These findings are significant as they offer insights into tailoring rehabilitation interventions based on specific recovery goals. Incorporating MRP into stroke rehabilitation protocols could improve patient outcomes, especially for those aiming to regain higher levels of functional independence. Future studies should explore the long-term benefits and potential integration of PNF and MRP to create comprehensive and adaptable rehabilitation plans suited to diverse patient needs.

Recommendations

Recommendations for Application and Future Steps

Proprioceptive Neuromuscular Facilitation (PNF) and the Motor Relearning Program (MRP) are valuable strategies in stroke rehabilitation, each addressing distinct yet complementary aspects of recovery. PNF focuses on improving balance and flexibility through specific movement patterns and joint mobility exercises, scheduled at least 3–4 times a week. On the other hand, MRP emphasizes enhancing motor coordination and promoting independence by designing patient-specific, task-oriented protocols that rebuild neural pathways. Regular assessments of functional recovery help refine MRP interventions, ensuring they remain tailored to individual motor deficits and therapeutic goals.

Integrating PNF and MRP offers a holistic rehabilitation approach, leveraging the benefits of flexibility training alongside motor coordination tasks. This combined method fosters comprehensive recovery by addressing balance, flexibility, and functional independence. Research underscores MRP as a superior strategy for restoring motor function and daily autonomy, while PNF adds measurable improvements in postural stability. Together, these approaches provide a robust framework tailored

to patients' unique needs. Future studies should investigate the long-term impacts of this integration, exploring optimal frequency, intensity, and progression rates to maximize therapeutic outcomes.

Future Directions

Further research is recommended to explore:

- The long-term benefits of PNF and MRP interventions.
- The efficacy of combined protocols in improving functional recovery.
- Larger sample sizes to validate these findings and determine optimal patient-specific strategies.

ETHICAL CLEARANCE: This study was approved by the Institutional Ethical Committee of Career College, Bhopal, under reference number CC/BPT/24/345, dated 05/03/2024.

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