

Comparison of Upper Limb Functional Outcomes in Stroke Patients Receiving Motor Relearning Programme (Mrp) vs. Proprioceptive Neuromuscular Facilitation (Pnf)

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ABSTRACT

Background: Upper-limb impairment is a major contributor to disability after stroke. Motor Relearning Programme (MRP) emphasizes task-specific motor control and learning, whereas Proprioceptive Neuromuscular Facilitation (PNF) uses proprioceptive stimulation and diagonal movement patterns to facilitate neuromuscular responses. The present study compared changes in upper-limb functional outcomes following MRP and PNF.

Methods: Thirty patients with first-ever ischemic middle cerebral artery stroke and impaired upper-extremity motor function were randomly allocated to Group I (MRP, n=15) or Group II (PNF, n=15). Treatment was provided for three consecutive weeks, five days per week (15 sessions). Upper-limb and self-care outcomes were assessed weekly using the Motor Assessment Scale (MAS) upper-extremity sections and Functional Independence Measure (FIM) self-care sections. Between-group comparisons used the unpaired t-test; within-group repeated measurements were analyzed using repeated-measures ANOVA with Bonferroni post-hoc analysis.

Results: The groups were comparable in age, sex, and involved side. FIM total scores increased from 6.73±1.53 to 17.20±6.23 in the MRP group and from 7.66±1.75 to 21.60±6.92 in the PNF group over three weeks; the between-group difference at week 3 was not statistically significant in the thesis analysis. MAS total scores increased from 1.13±1.76 to 8.93±3.39 in the MRP group and from 1.66±1.49 to 10.40±3.37 in the PNF group, with no significant between-group difference at week 3. Within-group analyses demonstrated significant overall improvement in both groups.

Conclusion: Both MRP and PNF were associated with improvement in upper-limb functional outcomes over the three-week intervention period. The thesis conclusion reported no statistically significant superiority of either technique over the other; combining approaches may therefore be considered within individualized rehabilitation, while recognizing the study's small sample and short intervention duration.

Keywords: stroke; upper limb; Motor Relearning Programme; Proprioceptive Neuromuscular Facilitation; Functional Independence Measure; Motor Assessment Scale; physiotherapy.

INTRODUCTION

Stroke commonly produces motor and sensory dysfunction, with upper-limb impairment contributing substantially to activity limitation and dependence in activities of daily living (ADL). Recovery may reflect neurological recovery, behavioral compensation, or both. The thesis notes that neurological recovery is particularly active during the first one to three months after stroke, while further recovery may continue beyond this period. Upper-limb recovery is clinically important because partial motor recovery does not necessarily translate into effective functional use. Rehabilitation therefore requires attention not only to impairment but also to functional performance and meaningful activity. Timing, intensity, organization of rehabilitation, and patient-specific factors can influence outcomes. The thesis compares two different rehabilitation concepts. PNF is described as a neurofacilitation approach that promotes or hastens neuromuscular responses through stimulation of proprioceptors. Its diagonal and spiral patterns are intended to facilitate coordinated movement. MRP is based on motor control and motor learning, emphasizing practice of specific functional tasks, controlled muscle activity, feedback, and reduction of unnecessary compensatory activity.

Rationale

Both approaches are used in stroke rehabilitation, but they differ in their theoretical emphasis. The study was designed to examine whether the functional changes produced by these two approaches differed when applied to

patients with recent ischemic MCA stroke and upper-limb motor impairment. Research Question Which is more effective, MRP or PNF, in improving upper-limb functions in stroke patients?

Hypothesis

The thesis hypothesized that the functional training technique MRP would significantly improve upper-limb function compared with PNF.

Operational Definitions

Stroke was defined in the thesis as an ischemic lesion in the cerebral hemisphere associated with MCA occlusion and resulting hemiplegia or hemiparesis of less than three months' duration. Upper-limb function was represented by the selected MAS and FIM domains. MRP involved specific training of muscle activity and functional movement with prevention of compensatory activity. PNF was defined as a method of promoting or hastening neuromuscular response through proprioceptor stimulation.

2. REVIEW OF LITERATURE

The thesis literature review identifies disability after stroke as multifactorial and influenced by stroke type and severity, time since onset, outcome measures, and pre-existing or co-morbid conditions. Functional dependence is often greatest early after stroke and generally decreases with recovery and rehabilitation.

Recovery and prognostic factors The reviewed literature describes rapid spontaneous neurological recovery during the first weeks to months after stroke. Factors discussed include initial severity, age, hemisphere and artery involved, continence, sitting balance, perceptual and sensory deficits, medical co-morbidities, family support, education, and the organization and timing of rehabilitation. Early specialized stroke care and higher-intensity rehabilitation have been associated in the cited literature with improvements in functional outcomes. The thesis also emphasizes that impairment-level improvement and functional-level improvement are related but not necessarily equivalent. Upper-limb rehabilitation The thesis reviews multiple approaches including Bobath, Brunnstrom, Rood, PNF, MRP, functional electrical stimulation, neuromuscular electrical stimulation, EMG biofeedback, and constraint-induced movement therapy. Earlier studies summarized in the thesis report mixed findings across techniques, reinforcing the importance of considering outcome measure, treatment intensity, timing, and patient characteristics. PNF

PNF is presented as an integrated treatment philosophy using positive reinforcement, functional goals, mass movement patterns, diagonal and spiral motions, timing, resistance, and proprioceptive input. Voluntary effort is encouraged whenever possible, with therapist-guided procedures selected according to the patient's problems and capacity. MRPMRP emphasizes specific motor control in everyday activities, beginning when medically stable. It uses task-specific practice, feedback, cognitive engagement, and controlled muscle action. The thesis describes a shift from nonspecific exercise/facilitation toward relearning of meaningful motor tasks.

Outcome measures The thesis used FIM to represent assistance required for selected self-care activities and MAS to represent selected upper-extremity motor functions. The reviewed literature supports the reliability and validity of these instruments for stroke-related functional and motor assessment.

3. MATERIALS AND METHODS

Study design and setting

The study was an experimental comparative study conducted through the Department of Physiotherapy at Institute of Applied Medicines & Research (IAMR), Duhai, Ghaziabad. The thesis reports recruitment over seven months, from December 2024 to June 2026, with 30 stroke patients enrolled.

Participants

Characteristic	Group I	Group II
Intervention	MRP	PNF
Sample size	15	15
Age, mean $\pm$ SD	59.26 $\pm$ 13.87 years	61.53 $\pm$ 14.46 years
Male/Female	6/9	10/5
Left/Right involved	7/8	4/11

Eligibility

Inclusion criteria were: first-ever ischemic infarct in the MCA territory confirmed by CT/MRI; impaired upper-extremity motor function; and informed consent. Exclusion criteria included complicated cardiac, pulmonary, orthopedic, or unrelated neurological history and deficits of consciousness, orientation, memory, understanding, or sensory aphasia.

Randomization and intervention

Subjects were randomly assigned by order of recruitment to Group I (MRP) or Group II (PNF), with 15 participants in each group. All participants received the respective upper-limb protocol. Lower-limb treatment was provided using Bobath-based treatment. Treatment was delivered five days per week for three consecutive

weeks, totaling 15 sessions. Upper-limb treatment duration varied according to fatigue, increasing from approximately 10 minutes initially to a maximum of 40 minutes.

Outcome assessment

Baseline and weekly measurements were recorded for three weeks. The researcher assessed MAS and FIM outcomes. The FIM self-care component included feeding, grooming, bathing, upper-body dressing, lower-body dressing, and toileting. Each item was scored from 1 (total dependence) to 7 (complete independence), giving a selected self-care range of 6–42. MAS included upper-arm function, hand movements, and advanced hand movements, with a combined range of 0–18.

4. STATISTICAL ANALYSIS

Descriptive and inferential statistics were used. The thesis reports use of the unpaired t-test for between-group comparisons. Repeated-measures ANOVA with Bonferroni post-hoc analysis was used for within-group comparisons. Data analysis was performed using STATA 8.0 under the supervision of an experienced statistician. Statistical significance was interpreted at $p < 0.05$. The manuscript retains the thesis' reported p-values and statistical interpretation. Some p-values in the narrative section of the thesis are presented in a way that appears inconsistent with conventional p-value formatting (for example, values greater than 1); therefore, this manuscript does not recalculate or reinterpret those values and instead relies on the thesis' summary tables for the principal between-group interpretation.

Baseline characteristics

There was no statistically significant difference reported between groups for age ($p = 0.6648$), sex distribution ($p = 0.143$), or involved side ($p = 0.256$). This indicates that the measured baseline demographic characteristics were broadly comparable between the two treatment groups.

Primary functional outcomes

The principal outcome domains were FIM self-care and MAS upper-extremity function. The main comparison was the change observed across the four assessment points: baseline, week 1, week 2, and week 3.

5. RESULTS

FIM: total score

Time	MRP mean $\pm$ SD	PNF mean $\pm$ SD	Between-group result
Baseline	6.73 $\pm$ 1.53	7.66 $\pm$ 1.75	NS
Week 1	10.26 $\pm$ 4.25	12.20 $\pm$ 4.53	NS
Week 2	12.93 $\pm$ 5.17	16.00 $\pm$ 4.65	NS
Week 3	17.20 $\pm$ 6.23	21.60 $\pm$ 6.92	NS

Both groups demonstrated marked increases in FIM total score over the intervention period. The thesis table reports no statistically significant between-group difference at any observation point.

FIM subscales at week 3

Domain	MRP mean $\pm$ SD	PNF mean $\pm$ SD	Between-group
Feeding	2.46 $\pm$ 1.30	2.86 $\pm$ 1.06	NS
Grooming	2.60 $\pm$ 1.45	3.40 $\pm$ 1.24	NS
Bathing	2.73 $\pm$ 1.53	3.46 $\pm$ 1.64	NS
Upper dressing	2.93 $\pm$ 0.59	3.80 $\pm$ 1.14	NS
Lower dressing	3.00 $\pm$ 0.65	3.53 $\pm$ 1.24	NS
Toileting	3.46 $\pm$ 1.64	4.53 $\pm$ 1.64	NS
Total	17.20 $\pm$ 6.23	21.60 $\pm$ 6.92	NS

The thesis reports significant within-group improvement in FIM total scores from baseline to week 3 in both groups. For individual FIM domains, improvement patterns varied across weekly intervals, with more consistent significant changes by the later treatment intervals.

5. RESULTS (CONTINUED)

MAS: upper-extremity outcomes

Time	MRP total mean $\pm$ SD	PNF total mean $\pm$ SD	Between-group
Baseline	1.13 $\pm$ 1.76	1.66 $\pm$ 1.49	NS
Week 1	2.80 $\pm$ 2.17	4.06 $\pm$ 1.98	NS

Week 2	5.60 ± 3.06	7.60 ± 2.87	NS
Week 3	8.93 ± 3.39	10.40 ± 3.37	NS

The MAS total increased progressively in both groups. The between-group table reports no significant difference at baseline, week 1, week 2, or week 3.

MAS subscales at week 3

Domain	MRP mean ± SD	PNF mean ± SD	Between-group
Upper arm	3.86 ± 1.35	4.33 ± 1.29	NS
Hand movements	3.53 ± 1.30	4.00 ± 1.00	NS
Advanced hand	1.53 ± 0.91	2.06 ± 1.43	NS
MAS total	8.93 ± 3.39	10.40 ± 3.37	NS

Within-group MAS findings

The thesis reports significant overall MAS improvement from baseline to week 3 in both groups. For upper-arm movements, both groups improved over 0–3 weeks. For hand movements, the PNF group showed significant improvement over 0–3 weeks, while the corresponding MRP comparison was reported as non-significant. For advanced hand movements, both groups showed significant improvement over 0–3 weeks. The pattern supports improvement within both treatment protocols without evidence of statistically significant superiority between protocols.

6. DISCUSSION

The present study compared a motor-control and motor-learning-oriented intervention (MRP) with a proprioceptive neurofacilitation-oriented intervention (PNF) in patients with recent ischemic MCA stroke and upper-limb impairment. The two groups were similar in the demographic characteristics reported in the thesis, reducing concern that age, sex, or involved side alone explained the observed outcome pattern.

A central finding was that both groups improved significantly over time on the principal functional measures. FIM total scores increased across successive assessments in both groups. This suggests that both treatment protocols were associated with gains in selected self-care activities during the three-week treatment period. The thesis discussion interprets PNF as potentially beneficial for early impairment-related components such as range, coordination, strength, and endurance, which may support performance of activities involving manipulation and transport.

The MAS results similarly showed significant improvement in total upper-limb motor function within both groups. The thesis notes that PNF-related movement patterns may facilitate coordinated use of the limb and may assist in addressing abnormal synergy patterns. At the same time, MRP specifically emphasizes practice of meaningful tasks and motor skill acquisition, which may explain the observed changes in advanced hand movements and fine motor task-related performance.

Importantly, the between-group analyses did not identify a statistically significant difference in the total FIM or MAS outcomes at the repeated measurement points. Thus, the results do not support the original hypothesis that MRP would be significantly superior to PNF under the conditions of this study.

Interpretation of the intervention models

MRP and PNF are conceptually different but may address overlapping rehabilitation goals. MRP emphasizes task-specific practice, feedback, cognitive involvement, and functional motor control. PNF emphasizes proprioceptive input, coordinated mass movement, timing, resistance, and diagonal patterns. The thesis discussion therefore proposes that the approaches may be complementary rather than mutually exclusive.

Relationship to previous literature

The thesis review cites previous comparative and rehabilitation studies showing mixed differences among specialized approaches. Some studies reported advantages of task-specific or repetitive practice, while others found comparable outcomes among different neurological treatment approaches. These findings are consistent with the present study's observation that both interventions produced improvement but no statistically significant superiority of one protocol in the selected outcomes.

7. CLINICAL AND RESEARCH IMPLICATIONS

Clinical implications

Within the population studied, both MRP and PNF can be considered structured physiotherapy approaches for addressing upper-limb function and selected self-care activities during early stroke rehabilitation. The results support continued emphasis on repeated, active practice and functional use of the affected limb.

The complementary features of the two approaches may be clinically relevant: PNF may be used to facilitate movement, coordination and active participation, while MRP may emphasize task-specific practice and motor learning. The thesis conclusion suggests that using the techniques as adjuncts to each other may help address different aspects of upper-limb rehabilitation.

Limitations

The principal limitations identified in the thesis were the small sample size (n=30), recruitment of treatment-seeking participants rather than a general population sample, exclusion of individuals who did not meet the criteria, and the short three-week treatment period. These factors limit the extent to which the findings can be generalized and make longer-term interpretation difficult.

The study also used selected FIM and MAS domains rather than a broad battery of upper-limb measures. The thesis reports that the same researcher performed repeated outcome assessment. The study therefore provides useful preliminary comparative information but should be interpreted within its methodological scope.

Recommendations

Future research should use larger samples, longer intervention and follow-up periods, clearly defined treatment dosage, blinded outcome assessment where feasible, and additional measures of upper-limb impairment, activity, dexterity, and participation. Future trials may also examine a combined MRP–PNF protocol against either approach alone.

8. CONCLUSION

The present study evaluated upper-limb functional outcomes in 30 stroke patients receiving either MRP or PNF for three weeks. Both groups showed improvement in FIM self-care scores and MAS upper-extremity scores across the intervention period. The thesis' between-group analyses did not demonstrate a statistically significant difference in total FIM or MAS outcomes at the measured time points.

Accordingly, the thesis concluded that neither technique was demonstrated to be more effective than the other in the studied sample. The original hypothesis that MRP would be more effective was not supported. Both approaches improved upper-limb function in different aspects, and the thesis proposed that their complementary use may be beneficial in rehabilitation.

These conclusions apply specifically to the study population, treatment duration, outcomes, and methods described in the thesis. The findings should not be interpreted as establishing equivalence of MRP and PNF in all stroke populations or at longer follow-up periods.

DECLARATIONS

Ethics approval: The thesis states that the research protocol was approved through the Department of Education & Research ethics process at the study setting.

Informed consent: Written signed informed consent was obtained from participants.

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Data availability: Not stated in the thesis manuscript source.

Author contribution: Afnan conducted the study under the supervision and guidance of Dr. Mansi Srivastava, as documented in the thesis.

9. Key Tables for Publication

Table 1. Participant characteristics

Variable	MRP (n=15)	PNF (n=15)	Between-group p
Age, mean $\pm$ SD (years)	59.26 $\pm$ 13.87	61.53 $\pm$ 14.46	0.6648
Male, n	6	10	0.143
Female, n	9	5	0.143
Right side, n	8	11	0.256
Left side, n	7	4	0.256

Table 2. FIM total scores over 3 weeks

Assessment	MRP mean $\pm$ SD	PNF mean $\pm$ SD	Reported result
Baseline	6.73 $\pm$ 1.53	7.66 $\pm$ 1.75	NS
Week 1	10.26 $\pm$ 4.25	12.20 $\pm$ 4.53	NS
Week 2	12.93 $\pm$ 5.17	16.00 $\pm$ 4.65	NS
Week 3	17.20 $\pm$ 6.23	21.60 $\pm$ 6.92	NS

Table 3. MAS total scores over 3 weeks

Assessment	MRP mean $\pm$ SD	PNF mean $\pm$ SD	Reported result
Baseline	1.13 $\pm$ 1.76	1.66 $\pm$ 1.49	NS
Week 1	2.80 $\pm$ 2.17	4.06 $\pm$ 1.98	NS
Week 2	5.60 $\pm$ 3.06	7.60 $\pm$ 2.87	NS
Week 3	8.93 $\pm$ 3.39	10.40 $\pm$ 3.37	NS

Abbreviations: MRP, Motor Relearning Programme; PNF, Proprioceptive Neuromuscular Facilitation; FIM, Functional Independence Measure; MAS, Motor Assessment Scale; SD, standard deviation; NS, non-significant.

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