

Review Article

Comparative Effectiveness of the Motor Relearning Program and Mirror Therapy for Upper-Extremity Recovery After Stroke: A Systematic Review Without Meta-Analysis

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ABSTRACT

Background: Upper-extremity impairment frequently persists after stroke and restricts independence in daily activities. Although the Motor Relearning Program (MRP) and Mirror Therapy (MT) are accessible rehabilitation approaches, their comparative effectiveness remains uncertain. **Objective:** To systematically review randomized direct-comparison studies evaluating MRP versus MT for upper-extremity motor and functional recovery after stroke. **Methods:** PubMed/MEDLINE, Scopus, Web of Science, PEDro, CENTRAL, ScienceDirect, and Google Scholar were searched from inception through August 2026. Randomized trials involving adults with post-stroke upper-extremity impairment and directly comparing MRP with MT were eligible. Two reviewers independently screened studies, extracted data, and assessed risk of bias using Cochrane RoB 2. Because compatible between-group estimates and measures of variance were insufficient for statistical pooling, findings were synthesized without meta-analysis according to outcome domain and comparison type. **Results:** Six studies involving 211 participants were included; 196 participants contributed to the direct comparison, with 98 receiving MRP and 98 receiving MT. All studies had some risk-of-bias concerns. Direct pairwise findings favored MRP for upper-arm function ($p < 0.001$ and $p = 0.001$) and hand function ($p < 0.001$ and $p = 0.004$) in two studies. Findings for advanced hand activities were inconsistent ($p < 0.001$ and $p = 0.070$). FMA-UE and CAHAI evidence was inconclusive because several studies reported only within-group or omnibus comparisons. No pooled effect estimates were calculated. **Conclusion:** MRP may provide greater improvement than MT in selected upper-arm and hand-function outcomes, but the evidence does not establish overall superiority. Larger, prospectively registered trials reporting standardized between-group estimates and longer-term outcomes are required. **Keywords:** Stroke; Upper Extremity; Motor Skills; Exercise Therapy; Rehabilitation; Physical Therapy Modalities; Mirror Movement Therapy.

INTRODUCTION

Stroke remains a leading cause of death and long-term disability worldwide, with approximately 93.8 million people living with its consequences and 11.9 million new events occurring globally in 2021 (1). Although advances in acute stroke care have improved survival, many survivors experience persistent neurological impairments that restrict independence, participation, and quality of life. Rehabilitation is therefore an essential component of stroke management, with contemporary recommendations emphasizing individualized, multidisciplinary care and sufficiently intensive, repetitive, task-specific practice to promote functional recovery (2).

Upper-extremity impairment is among the most persistent and disabling consequences of stroke. Approximately 50%–80% of individuals experience upper-limb impairment during the acute phase, and clinically important limitations may persist long after the initial event (3,4). Common manifestations include weakness, abnormal muscle tone, impaired selective movement, reduced coordination, sensory dysfunction, limited range of motion, and diminished manual dexterity (5). These deficits restrict reaching, grasping, object manipulation, feeding, dressing, grooming, writing, and other activities necessary for independent living. Recovery of functional arm and hand use is frequently slower and less complete than recovery of ambulation, making effective upper-extremity rehabilitation a major clinical priority (3–5).

The Motor Relearning Program (MRP) is a task-oriented rehabilitation approach based on principles of motor learning and experience-dependent neuroplasticity. It emphasizes systematic analysis of task performance, active practice of deficient movement components, functional task training, appropriate feedback, environmental modification, and progressive transfer of newly acquired skills to daily activities. Rather than treating impairments in isolation, MRP seeks to improve the patient's ability to perform meaningful motor tasks through repetition, problem-solving, and active participation. This approach is consistent with current stroke rehabilitation recommendations supporting intensive and progressively challenging task practice to improve motor and functional outcomes (2).

Mirror Therapy (MT) represents a distinct but potentially complementary approach to motor rehabilitation. During MT, a mirror placed in the midsagittal plane reflects movements of the non-paretic limb, creating the visual impression that the affected limb is moving normally. This visual illusion may influence motor representation, visual-motor integration, sensorimotor processing, and activation of neural networks involved in movement planning and execution (6). MT is inexpensive, requires minimal equipment, and can be delivered in clinical or home-based settings. Previous evidence syntheses have suggested that MT may improve upper-extremity motor function and activities of daily living after stroke, although the certainty and magnitude of benefit have varied across outcomes and comparator interventions (7).

More recent systematic reviews have generally supported the effectiveness of MT relative to conventional therapy, sham therapy, or other control conditions. A 2025 systematic review and meta-analysis of 18 randomized controlled trials involving 633 participants reported improvements in overall upper-limb motor function and hand function following MT (8). Another meta-analysis of 15 studies involving 546 individuals with subacute stroke found beneficial effects on motor impairment, upper-extremity function, and activities of daily living, although responses differed according to the mode of MT delivery (9). Evidence differentiating unilateral from bilateral MT has also indicated that intervention configuration may influence treatment effects, with unilateral MT potentially providing greater motor-recovery benefits than bilateral approaches in some clinical contexts (10). Collectively, these findings suggest that MT is a promising intervention, but they also demonstrate substantial variation in treatment protocols, rehabilitation dose, stroke stage, outcome measures, and methodological quality.

Evidence concerning MRP is comparatively less developed. A recent systematized review identified a limited number of randomized trials examining MRP for post-stroke upper-limb rehabilitation and concluded that MRP may improve upper-extremity function, while evidence establishing its superiority over other rehabilitation interventions remained insufficient (11). Direct comparative studies of MRP and MT have reported improvements following both approaches, with some findings suggesting greater gains with MRP in selected functional domains (12). Nevertheless, individual trials have generally involved small samples and heterogeneous intervention schedules, co-interventions, participant characteristics, and outcome instruments. Differences in rehabilitation intensity may be particularly important because treatment exposure itself can influence upper-extremity recovery and may confound comparisons between intervention models (13).

Despite the availability of reviews evaluating MRP or MT independently, the relative effectiveness of these two active rehabilitation approaches remains uncertain. Existing MT reviews have primarily compared MT with conventional rehabilitation, sham therapy, or no additional treatment, whereas the MRP literature has included varied active comparators. Consequently, evidence that either intervention is beneficial relative to a control condition cannot determine whether MRP or MT provides a greater advantage when compared directly. Moreover, the available comparative studies report outcomes using different instruments and statistical formats, limiting straightforward estimation of a common treatment effect. A focused systematic review with transparent synthesis without meta-analysis is therefore warranted to identify the direct comparative evidence, evaluate its methodological credibility, distinguish between-group effects from within-group improvement, and determine whether the observed findings are sufficiently consistent to inform clinical decision-making.

Accordingly, this systematic review addressed the following PICO-based question: among adults with post-stroke upper-extremity impairment, does MRP, compared with MT, produce greater improvement in upper-extremity motor and functional outcomes? The objective was to systematically identify and critically appraise randomized direct-comparison studies and synthesize their findings for upper-arm function, hand function, advanced hand activities, motor impairment, and functional use of the affected upper limb. Given the anticipated heterogeneity and limitations of the available numerical data, the review sought to characterize the direction, consistency, and certainty of the comparative evidence without presuming the superiority of either intervention.

MATERIAL AND METHODS

This systematic review was designed to compare the effectiveness of the Motor Relearning Program (MRP) with Mirror Therapy (MT) for improving upper-extremity recovery in adults following stroke. The review was reported in accordance with PRISMA 2020, with the search and synthesis procedures structured according to PRISMA-S and Synthesis Without Meta-analysis principles, respectively. The review question was formulated using the Population, Intervention, Comparator, and Outcomes framework: adults with stroke-related upper-extremity impairment constituted the population; MRP was the intervention; MT was the comparator; and upper-extremity motor impairment, arm and hand function, manual dexterity, functional performance, and activities of daily living were the outcomes of interest.

Randomized controlled trials and randomized comparative clinical trials directly comparing MRP with MT were eligible. Participants were required to be adults aged 18 years or older with ischemic or hemorrhagic stroke and residual upper-extremity motor impairment or functional limitation. No restrictions were applied according to sex, stroke severity, lesion location, or stage of recovery. Studies involving mixed neurological populations were eligible only when data for participants with stroke could be extracted separately. Studies involving children or adolescents were excluded.

MRP was defined as a task-oriented rehabilitation approach involving analysis of motor performance, active and repetitive practice of functional movement components, feedback, correction of inefficient movement strategies, and progression toward meaningful task performance. MRP delivered alone or in combination with conventional physiotherapy was eligible when the comparator group received equivalent background treatment or when the direct effect of MRP relative to MT could be determined. MT was defined as an intervention in which movements of the non-paretic upper limb were reflected in a mirror to create the visual perception of movement by the affected limb. Unilateral and bilateral MT protocols were eligible, whether delivered independently or alongside conventional physiotherapy, provided that a direct comparison with MRP was available.

The primary outcome was the between-group difference in upper-extremity motor or functional recovery immediately after completion of the intervention. Eligible outcome domains included overall upper-extremity motor impairment, upper-arm function, hand function, advanced hand activities, manual dexterity, functional use of the affected upper limb, and activities of daily living. Validated instruments included the Fugl-Meyer Assessment-Upper Extremity, Motor Assessment Scale, Chedoke Arm and Hand Activity Inventory, Action Research Arm Test, Wolf Motor Function Test, Box and Block Test, and comparable validated measures. When multiple post-intervention assessments were reported, the assessment conducted immediately after treatment was used for the principal synthesis, while longer-term follow-up findings were considered separately.

Non-randomized studies, observational studies, case reports, case series, conference abstracts without sufficient outcome information, protocols, editorials, letters, narrative reviews, systematic reviews, and meta-analyses were excluded. Studies comparing either MRP or MT exclusively with conventional physiotherapy, sham treatment, no treatment, or another rehabilitation approach were also excluded when they did not contain a direct MRP-versus-MT comparison. Multiple publications arising from the same participant cohort were treated as reports of a single study to prevent double counting.

PubMed/MEDLINE, Scopus, Web of Science, the Physiotherapy Evidence Database, the Cochrane Central Register of Controlled Trials, ScienceDirect, and Google Scholar were searched from database inception through August 2026. Reference lists of eligible studies and relevant evidence syntheses were screened manually, and forward citation tracking was undertaken for eligible publications. The search combined controlled vocabulary, where supported by the database, with free-text terms relating to stroke, MRP, MT, and upper-extremity recovery. The principal PubMed search strategy was:

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((("stroke"[Title/Abstract] OR "cerebrovascular accident"[Title/Abstract] OR "cerebrovascular disease"[Title/Abstract] OR hemiplegia[Title/Abstract] OR hemiparesis[Title/Abstract]) AND ("motor relearning program"[Title/Abstract] OR "motor relearning programme"[Title/Abstract] OR "motor relearning"[Title/Abstract] OR MRP[Title/Abstract]) AND ("mirror therapy"[Title/Abstract] OR "mirror visual feedback"[Title/Abstract] OR "mirror visual feedback therapy"[Title/Abstract]) AND ("upper limb"[Title/Abstract] OR "upper extremity"[Title/Abstract] OR arm[Title/Abstract] OR hand[Title/Abstract] OR "arm function"[Title/Abstract] OR "hand function"[Title/Abstract] OR "upper-limb motor function"[Title/Abstract]))
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The syntax, field specifications, subject headings, and filters were adapted to the indexing structure of each database. Search results were imported into reference-management and screening software, and duplicate records were removed before screening. Two independent reviewers screened titles and abstracts against the eligibility criteria. Reports considered potentially eligible by either reviewer underwent full-text assessment by two reviewers independently. Reasons for full-text exclusion were recorded. Disagreements at either stage were resolved through discussion and consensus, with adjudication by a third reviewer when consensus could not be reached.

A standardized extraction form was used independently by two reviewers. Extracted information included author and year, country and clinical setting, study design, recruitment method, eligibility criteria, sample size, group allocation, participant age and sex, stroke type and stage, time since stroke, baseline upper-extremity impairment, intervention and comparator content, concomitant therapy, treatment frequency, session duration, total intervention period, outcome instruments, assessment time points, attrition, adverse events, and numerical outcome data. The reviewers compared their extraction forms and resolved discrepancies by checking the original report and reaching consensus. A third reviewer adjudicated unresolved disagreements. For multi-arm trials, data from the MRP and MT groups were extracted for the direct comparison; participants receiving conventional physiotherapy alone were excluded from the comparative synthesis.

Risk of bias was evaluated independently by two reviewers using the Cochrane Risk of Bias 2 tool. Assessments addressed bias arising from the randomization process, deviations from intended interventions, missing outcome data, measurement of outcomes, and selection of reported results. Judgments were assigned as low risk of bias, some concerns, or high risk of bias for the relevant outcome and post-intervention time point. Because participant and therapist blinding was generally impractical for these rehabilitation interventions, particular attention was given to allocation concealment, deviations from assigned treatment, assessor blinding, completeness of outcome data, and selective reporting. Disagreements were resolved by consensus or third-reviewer adjudication.

Study characteristics and findings were synthesized without meta-analysis because the included studies did not provide sufficiently compatible numerical outcome data for defensible statistical pooling. Studies were grouped according to outcome domain, measurement instrument, intervention contrast, and post-intervention time point. The synthesis prioritized direct between-group estimates over within-group changes. Where reported, group means or medians, measures of dispersion, between-group differences, confidence intervals, and exact p-values were extracted. Within-group findings were presented separately and were not interpreted as evidence of comparative superiority.

The direction of effect was classified as favoring MRP, favoring MT, or showing no clear between-group difference, based on the reported direct comparison and the direction of the outcome scale. Statistical significance alone was not treated as a measure of effect magnitude or clinical importance. Differences in participant characteristics, stroke stage, baseline impairment, intervention content, treatment duration, frequency, total rehabilitation exposure, concomitant conventional therapy, outcome instruments, and assessment timing were considered when interpreting consistency across studies. Because valid common effect estimates could not be obtained for at least two sufficiently comparable studies within the principal outcome domains, pooled mean differences, standardized mean differences, Cochran's Q , I^2 statistics, prediction intervals, forest plots, subgroup analyses, and leave-one-out sensitivity analyses were not produced. Funnel-plot assessment and statistical tests for small-study effects were not undertaken because only six studies were included.

The certainty of the evidence for each principal outcome domain was evaluated using the GRADE framework. Evidence from randomized trials began at high certainty and was considered for downgrading because of risk of bias, inconsistency, indirectness, imprecision, and publication bias. Certainty was categorized as high, moderate, low, or very low, with judgments based on the directness, methodological credibility, consistency, and precision of the available comparative evidence. Ethical approval was not required because the review used data from previously published studies and did not involve direct participant recruitment or access to identifiable individual-level information.

RESULTS

The search and screening process resulted in six eligible randomized or randomized comparative studies. The included studies comprised 211 participants: 98 received MRP, 98 received MT, and 15 received conventional physiotherapy alone in a three-arm trial. Accordingly, 196 participants contributed to the direct MRP-versus-MT comparison. Numerical counts for records identified, duplicates removed, titles and abstracts screened, full texts assessed, and full-text exclusions were not documented in the supplied search record and therefore could not be reported in the PRISMA flow diagram.

Table 1. Study-Selection and Participant Summary

Selection element	Result
Studies included in systematic review	6
Total participants across all included studies	211
Participants allocated to MRP	98
Participants allocated to MT	98
Participants allocated to conventional physiotherapy alone	15
Participants contributing to the direct MRP-versus-MT comparison	196
Countries represented	2
Publication period	2015–2025

The six studies were published between 2015 and 2025 and conducted in India and Pakistan. Five employed two-group designs, whereas Narang et al. included three groups. Individual sample sizes ranged from 12 to 66 participants, and intervention duration ranged from four to eight weeks. MAS, FMA-UE, and CAHAI were the principal outcome instruments. Reporting of participant sex, age, hemiplegic side, treatment frequency, and session duration was incomplete across studies.

Table 2. Characteristics of Included Studies

Study	Year	Country	Design	Total n	MRP n	MT n	Other n	Participant characteristics	Intervention dose	Outcomes
Rehani et al.	2015	India	Randomized clinical trial	12	6	6	0	Adults with stroke-related upper-extremity impairment	6 sessions/week for 4 weeks; session duration NR	CAHAI
Jan et al.	2019	Pakistan	Randomized controlled trial	66	33	33	0	Mean age 55.44 ± 9.21 years; male 46 (69.7%); female 20 (30.3%); left hemiplegia 31; right hemiplegia 35	6 weeks; frequency and session duration NR	MAS: upper-arm function, hand function, and advanced hand activities
Rauf et al.	2021	Pakistan	Randomized controlled trial	30	15	15	0	Mean age 53.80 ± 7.60 years; left hemiplegia 22; right hemiplegia 8	5 sessions/week for 6 weeks; session duration NR	FMA-UE

Study	Year	Country	Design	Total n	MRP n	MT n	Other n	Participant characteristics	Intervention dose	Outcomes
Narang et al.	2023	India	Randomized comparative trial	45	15	15	15	Adults with stroke-related upper-extremity impairment	5 sessions/week, 60 minutes/session for 8 weeks	MAS, FMA-UE, and CAHAI
Ashraf et al.	2025	Pakistan	Randomized controlled trial	28	14	14	0	Acute stroke; male 15 (53.6%); female 13 (46.4%)	3 sessions/week, 120 minutes/session for 4 weeks	MAS: upper-arm function, hand activity, and advanced hand activity
Abdul Aziz et al.	2025	Pakistan	Randomized comparative trial	30	15	15	0	Adults with stroke-related upper-extremity impairment	3 sessions/week, 120 minutes/session for 4 weeks	FMA-UE and CAHAI
Total				211	98	98	15			

CAHAI, Chedoke Arm and Hand Activity Inventory; FMA-UE, Fugl-Meyer Assessment-Upper Extremity; MAS, Motor Assessment Scale; MRP, Motor Relearning Program; MT, Mirror Therapy; NR, not reported. The 15 participants in the "Other" column received conventional physiotherapy alone in the Narang et al. trial.

MRP generally comprised active, task-oriented practice involving reaching, grasping, wrist and forearm movement, hand opening, thumb opposition, object manipulation, feedback, and progression of functional tasks. MT used mirror-mediated visual feedback during hand, wrist, forearm, and other upper-extremity movements. In Narang et al., both active interventions were combined with conventional physiotherapy. Treatment frequency ranged from three to six sessions per week among studies reporting this information, while reported session duration ranged from 60 to 120 minutes.

Table 3. Study-Level Quantitative Findings

Study	Outcome	MRP finding	MT finding	Comparison type	Between-group or overall p-value	Effect estimate (95% CI)	Interpretation permitted by reported data
Rehani et al.	CAHAI	Improvement reported	Improvement reported	Direct between-group comparison	NR; described as not statistically significant	NR	No clear evidence of a difference
Jan et al.	Upper-arm function	Improvement reported	Improvement reported	Direct between-group comparison	<0.001	NR	Reported direction favored MRP
Jan et al.	Hand function	Improvement reported	Improvement reported	Direct between-group comparison	<0.001	NR	Reported direction favored MRP
Jan et al.	Advanced hand activities	Improvement reported	Improvement reported	Direct between-group comparison	<0.001	NR	Reported direction favored MRP
Rauf et al.	FMA-UE at baseline	5.00 (IQR 3)	6.00 (IQR 4)	Descriptive	—	—	Baseline scores reported
Rauf et al.	FMA-UE at 3 weeks	15.00 (IQR 4)	14.00 (IQR 9)	Descriptive	—	—	Scores increased in both groups
Rauf et al.	FMA-UE at 6 weeks	25.00 (IQR 6)	17.00 (IQR 13)	Direct between-group comparison	NR; described as not statistically significant	NR	No statistically supported difference despite numerical separation
Narang et al.	FMA-UE	Improvement reported	Improvement reported	Overall, three-group comparison	<0.0001	NR	Omnibus result; a direct MRP-versus-MT difference cannot be established without pairwise analysis
Narang et al.	MAS	Improvement reported	Improvement reported	Overall, three-group comparison	<0.0001	NR	Omnibus result; a direct MRP-versus-MT difference cannot be established without pairwise analysis
Narang et al.	CAHAI	Improvement reported	Improvement reported	Overall, three-group comparison	<0.0001	NR	Omnibus result; a direct MRP-versus-MT difference cannot be established without pairwise analysis
Ashraf et al.	Upper-arm function	Within-group p = 0.003	Within-group p = 0.332	Direct between-group comparison	0.001	NR	Reported direction favored MRP
Ashraf et al.	Hand activity	Within-group p = 0.004	Within-group p = 0.353	Direct between-group comparison	0.004	NR	Reported direction favored MRP
Ashraf et al.	Advanced hand activity	Within-group p = 0.072	Within-group p = 0.192	Direct between-group comparison	0.070	NR	No clear evidence of a difference

Study	Outcome	MRP finding	MT finding	Comparison type	Between-group or overall p-value	Effect estimate (95% CI)	Interpretation permitted by reported data
Abdul Aziz et al.	FMA-UE	Within-group p = 7.73815×10^{-11}	Within-group p = 4.27209×10^{-7}	Within-group comparisons only	NR	NR	Both groups changed; comparative superiority cannot be determined
Abdul Aziz et al.	CAHAI	Within-group p = 8.47303×10^{-11}	Within-group p = 2.77828×10^{-7}	Within-group comparisons only	NR	NR	Both groups changed; comparative superiority cannot be determined

CI, confidence interval; IQR, interquartile range; NR, not reported. Within-group p-values do not test whether improvement differed between MRP and MT. The Narang et al. p-values were reported as overall comparisons across three groups and cannot independently establish a pairwise MRP-versus-MT effect.

Risk of bias was assessed across all six studies. Every study received an overall judgment of “some concerns.” Recurring concerns related to insufficient reporting of random-sequence generation or allocation concealment, deviations from intended interventions, outcome-assessor procedures, and selective reporting. Participant and therapist blinding was generally impractical because of the nature of MRP and MT. The study-level assessments did not identify any trial with an overall low risk of bias.

Table 4. Risk-of-Bias Assessment Using RoB 2

Study	Randomization process	Deviations from intended interventions	Missing outcome data	Outcome measurement	Selection of reported result	Overall judgment
Rehani et al.	Some concerns	Some concerns	Some concerns	Some concerns	Low risk	Some concerns
Jan et al.	Some concerns	Some concerns	Low risk	Some concerns	Some concerns	Some concerns
Rauf et al.	Some concerns	Some concerns	Low risk	Some concerns	Some concerns	Some concerns
Narang et al.	Some concerns	Some concerns	Low risk	Some concerns	Some concerns	Some concerns
Ashraf et al.	Some concerns	Some concerns	Low risk	Some concerns	Some concerns	Some concerns
Abdul Aziz et al.	Some concerns	Some concerns	Low risk	Some concerns	Some concerns	Some concerns

No pooled effect estimates were calculated because comparable group-level outcome data and measures of variance were not consistently available for at least two sufficiently similar studies within the principal outcome domains. Consequently, statistical heterogeneity, prediction intervals, subgroup analyses, sensitivity analyses, funnel plots, and formal tests of small-study effects were not estimated.

Table 5. Outcome-Level Synthesis Without Meta-Analysis

Outcome domain	Studies, n	Direct pairwise evidence	Other evidence	Direction and consistency	Main limitation
Upper-arm function	3	Jan et al., p < 0.001; Ashraf et al., p = 0.001	Narang et al., three-group omnibus p < 0.0001	Pairwise findings favored MRP in two studies	Effect sizes and 95% CIs unavailable; Narang result was not a reported pairwise comparison
Hand function	4	Jan et al., p < 0.001; Ashraf et al., p = 0.004; Rehani et al., no statistically significant difference reported	Narang et al., three-group omnibus p < 0.0001	Findings generally, but not uniformly, favored MRP	Incomplete estimates and inconsistent outcome definitions
Advanced hand activities	2	Jan et al., p < 0.001; Ashraf et al., p = 0.070	None	Inconsistent	Only two small studies; no effect estimates or CIs
FMA-UE	3	Rauf et al., no statistically significant difference reported	Narang et al., omnibus p < 0.0001; Abdul Aziz et al., within-group p-values only	Comparative evidence inconclusive	Mixed statistical formats and absence of pairwise estimates
CAHAI	3	Rehani et al., no statistically significant difference reported	Narang et al., omnibus p < 0.0001; Abdul Aziz et al., within-group p-values only	Comparative evidence inconclusive	No compatible direct effect estimates
Overall upper-extremity recovery	6	Some direct comparisons favored MRP; others identified no clear difference	Several studies documented within-group improvement	Possible favorable direction for MRP, but not definitive	Small studies, risk-of-bias concerns, heterogeneous interventions, and incomplete quantitative reporting

The systematic search ultimately identified six eligible studies published between 2015 and 2025. These studies included 211 participants, of whom 98 were allocated to MRP, 98 to MT, and 15 to conventional physiotherapy alone. The direct MRP-versus-MT evidence therefore comprised 196 participants. As summarized in Table 1, the review

record did not contain the upstream numerical search counts needed to report the number of records identified, duplicates removed, titles and abstracts screened, full texts assessed, or full texts excluded. These values must be recovered from the original search and screening records before a complete PRISMA 2020 flow diagram can be presented.

The included studies were conducted in India and Pakistan and enrolled between 12 and 66 participants each (Table 2). Five studies compared two intervention groups, whereas Narang et al. randomized 45 participants equally among MRP plus conventional physiotherapy, MT plus conventional physiotherapy, and conventional physiotherapy alone. Intervention periods ranged from four to eight weeks. Where reported, treatment frequency ranged from three to six sessions per week, and session duration ranged from 60 to 120 minutes. Considerable clinical heterogeneity was present in intervention content, duration, treatment frequency, concomitant conventional physiotherapy, participant characteristics, and outcome selection.

Participant characteristics were incompletely reported. Jan et al. provided the most detailed demographic information, reporting a mean age of 55.44 ± 9.21 years, 46 men (69.7%), 20 women (30.3%), 31 participants with left-sided hemiplegia, and 35 with right-sided hemiplegia. Rauf et al. reported a mean age of 53.80 ± 7.60 years and included 22 participants with left-sided and eight with right-sided hemiplegia. Ashraf et al. enrolled participants with acute stroke, including 15 men (53.6%) and 13 women (46.4%). Corresponding demographic and clinical details were not consistently reported for the remaining studies, limiting assessment of comparability and applicability.

As presented in Table 4, all six studies were judged to have some concerns regarding risk of bias. Concerns were particularly evident in the randomization process, deviations from intended interventions, outcome measurement, and selection of reported results. Missing outcome data were judged to be at low risk in five studies, while Rehani et al. had some concerns in this domain. No included study received an overall low-risk judgment. These limitations reduce confidence that the observed differences arose solely from the assigned interventions.

Two direct pairwise comparisons provided statistically significant findings favoring MRP for upper-arm function: Jan et al. reported $p < 0.001$, and Ashraf et al. reported $p = 0.001$ (Tables 3 and 5). In Ashraf et al., the within-group change was statistically significant in the MRP group ($p = 0.003$) but not in the MT group ($p = 0.332$). This contrast between within-group significance levels does not itself constitute a test of the difference between interventions; the reported between-group p -value of 0.001 provides the relevant comparative result. Narang et al. reported an overall three-group p -value below 0.0001, but a distinct pairwise MRP-versus-MT estimate was not provided.

For hand function, Jan et al. reported a direct between-group difference favoring MRP ($p < 0.001$), while Ashraf et al. also reported a difference favoring MRP ($p = 0.004$). Rehani et al. described improvement in both groups without a statistically significant between-group difference. Narang et al. reported an overall three-group comparison of $p < 0.0001$; however, this omnibus test could not establish the magnitude or statistical significance of the specific difference between MRP and MT. Thus, the available pairwise findings generally favored MRP for hand function, but the absence of effect estimates and confidence intervals prevented evaluation of the magnitude, precision, and clinical importance of this difference.

Advanced hand-activity findings were inconsistent. Jan et al. reported a between-group difference favoring MRP ($p < 0.001$), whereas Ashraf et al. found no clear between-group difference ($p = 0.070$). In the latter study, neither the MRP group ($p = 0.072$) nor the MT group ($p = 0.192$) demonstrated a statistically significant within-group change. With only two small studies and no reported effect estimates or confidence intervals, the comparative effect on advanced hand activities remained uncertain.

Three studies evaluated FMA-UE outcomes. Rauf et al. reported that median scores in the MRP group increased from 5.00 (IQR 3) at baseline to 15.00 (IQR 4) at three weeks and 25.00 (IQR 6) at six weeks. Corresponding MT scores increased from 6.00 (IQR 4) to 14.00 (IQR 9) and 17.00 (IQR 13). Despite the numerical separation at six weeks, the reported between-group comparison was not statistically significant. Narang et al. reported an overall three-group p -value below 0.0001, but no separate pairwise MRP-versus-MT estimate was available. Abdul Aziz et al. reported within-group improvement for MRP ($p = 7.73815 \times 10^{-11}$) and MT ($p = 4.27209 \times 10^{-7}$); these findings demonstrate change over time but cannot establish comparative superiority.

CAHAI was reported in three studies. Rehani et al. described improvement with both interventions without a statistically significant between-group difference. Narang et al. reported an overall three-group p-value below 0.0001, but the specific MRP-versus-MT contrast was not presented. Abdul Aziz et al. reported within-group improvement for MRP ($p = 8.47303 \times 10^{-11}$) and MT ($p = 2.77828 \times 10^{-7}$), without a between-group estimate. The available CAHAI evidence therefore showed improvement over time but did not provide sufficient direct comparative data to determine whether either intervention was superior.

A meta-analysis was not undertaken because the studies did not consistently provide compatible outcome data, measures of dispersion, direct between-group estimates, or comparable statistical formats. As a result, pooled effect sizes, 95% confidence intervals, Cochran's Q, I^2 , prediction intervals, subgroup analyses, sensitivity analyses, and forest plots were not produced. Publication-bias assessment was also not undertaken because only six studies were included and no outcome-specific meta-analysis contained enough studies for a meaningful funnel plot or asymmetry test.

Overall, the study-level evidence showed that both interventions were followed by improvements in several upper-extremity outcomes. Direct pairwise findings more frequently favored MRP for upper-arm and hand function, but results for advanced hand activities, FMA-UE, and CAHAI were inconsistent or insufficient for a comparative conclusion. The absence of effect estimates and confidence intervals, reliance on within-group or omnibus tests in several studies, small samples, heterogeneous treatment protocols, and risk-of-bias concerns precluded a definitive conclusion regarding the superiority of MRP over MT.

DISCUSSION

This systematic review evaluated whether the Motor Relearning Program provides greater improvement than Mirror Therapy in adults with post-stroke upper-extremity impairment. Across six studies involving 196 participants in the direct comparison, both interventions were followed by improvements in several motor and functional outcomes. Direct pairwise findings more frequently favored MRP for upper-arm and hand function, whereas comparative findings for advanced hand activities, FMA-UE, and CAHAI were inconsistent or inconclusive. Because the primary studies did not consistently report compatible between-group estimates, measures of variance, or confidence intervals, the magnitude and clinical importance of any comparative advantage could not be determined. The evidence therefore suggests a possible advantage of MRP for selected functional outcomes but does not establish its overall superiority to MT.

The direction of the findings for MRP is broadly consistent with the systematized review by O'Rourke and Edwards, which reported moderate evidence that MRP may improve post-stroke upper-limb function but found insufficient evidence to establish superiority over alternative rehabilitation approaches (11). The present review advances that evidence by focusing specifically on randomized direct comparisons between MRP and MT and by separating direct between-group findings from within-group improvement. This distinction is important because improvement within both intervention groups does not demonstrate that one approach is more effective than the other. Nevertheless, the present synthesis reaches a similarly cautious conclusion because the small evidence base, incomplete statistical reporting, and methodological concerns prevent a reliable estimate of comparative benefit.

The findings should not be interpreted as evidence that MT is ineffective. Previous systematic reviews and meta-analyses have reported beneficial effects of MT on upper-extremity motor function, hand function, and activities of daily living when compared with conventional therapy, sham therapy, or other control conditions (7–9). The apparent discrepancy between those reviews and the more favorable direction for MRP observed in some of the present comparisons is explained partly by differences in the review questions and comparator conditions. Demonstrating that MT is more effective than an inactive or usual-care comparator does not establish equivalence or superiority when it is compared with another active, task-oriented intervention. The present review therefore complements rather than contradicts the existing MT literature.

Differences in MT delivery may also contribute to variation in comparative findings. Evidence distinguishing unilateral from bilateral MT suggests that treatment configuration can influence upper-limb recovery, with unilateral MT potentially providing greater benefit than bilateral practice in some circumstances (10). The included studies varied in mirror-training exercises, simultaneous movement of the affected limb, treatment frequency, session duration, and provision of conventional physiotherapy. Without sufficiently detailed intervention

descriptions or stratified analyses, it was not possible to determine whether particular MT configurations were more comparable with MRP or more effective for specific patient subgroups.

The reported advantage of MRP for upper-arm and hand function is clinically plausible because MRP directly emphasizes active performance, task analysis, repeated functional practice, feedback, and correction of inefficient movement strategies. These components may facilitate transfer from practiced movements to activities such as reaching, grasping, releasing, and manipulating objects. By contrast, MT primarily modifies visual feedback and sensorimotor representation and may be particularly relevant when active movement of the paretic limb is limited (6). These explanations remain mechanistic interpretations rather than conclusions tested by the included trials. The review did not contain evidence demonstrating that differences in neuroplasticity, motor planning, or task transfer mediated the observed comparative outcomes.

Outcome selection contributed substantially to inconsistency across studies. MAS domains primarily capture functional task performance, whereas FMA-UE emphasizes motor impairment and CAHAI assesses bilateral functional use of the arm and hand. A rehabilitation intervention may therefore improve task performance without producing an equivalent change in impairment-level measures. The more favorable findings for MRP on MAS upper-arm and hand domains, alongside less conclusive FMA-UE and CAHAI evidence, may reflect differences in the constructs measured rather than inconsistent biological effects alone. However, incomplete effect estimates and the small number of studies prevented formal investigation of outcome instrument as a source of variation.

Clinical and methodological diversity further limited cross-study comparability. Treatment duration ranged from four to eight weeks, frequency ranged from three to six sessions per week where reported, and session duration ranged from 60 to 120 minutes. Some studies delivered MRP and MT alongside conventional physiotherapy, while others treated them as the principal intervention. Rehabilitation exposure is a potentially important determinant of upper-extremity improvement, and differences in total treatment dose may obscure whether observed outcomes are attributable to intervention type or to the amount and intensity of practice (13). Variation in stroke stage, baseline impairment, ability to initiate voluntary movement, and time since stroke may also have modified treatment response. These factors could not be examined through subgroup or sensitivity analyses because sufficiently compatible data were not available.

The statistical reporting of the primary studies imposed an important limitation on the review. Several reports presented within-group p-values without a direct estimate of the difference between groups, while one three-arm study reported omnibus comparisons without clearly extractable pairwise MRP-versus-MT estimates. Within-group statistical significance cannot establish comparative effectiveness, and differences between significant and nonsignificant within-group results do not demonstrate a statistically significant treatment interaction. Similarly, an omnibus three-group p-value indicates that at least one group differs but does not identify which pairwise comparison accounts for that difference. Consequently, these findings were not treated as definitive evidence of MRP superiority.

The inability to calculate pooled estimates represents a limitation of the available evidence rather than justification for combining incompatible data. Means and standard deviations, medians and interquartile ranges, exact between-group differences, and measures of variance were inconsistently reported. A meta-analysis would therefore have required unsupported statistical conversions or assumptions and might have produced a misleading summary estimate. The synthesis was consequently restricted to study-level findings. This approach preserved the distinction among direct, omnibus, and within-group comparisons but could not quantify treatment magnitude, precision, or clinical importance. It also limited formal assessment of statistical heterogeneity, small-study effects, and publication bias.

The review process had additional limitations. Complete numerical records required to reconstruct the identification and screening stages of the PRISMA flow diagram were not available in the review record. All included studies originated from India or Pakistan, which may limit generalizability to stroke-rehabilitation systems with different workforce structures, treatment intensity, patient characteristics, or access to rehabilitation. Individual studies were small, and every trial was judged to have some concerns regarding risk of bias, particularly in relation to randomization reporting, deviations from intended interventions, outcome measurement, and selective reporting. Blinding participants and therapists was inherently difficult, but independent outcome assessment and

transparent allocation procedures could have reduced avoidable bias. The small number of included studies also prevented reliable investigation of subgroup effects and publication bias.

From a clinical perspective, both MRP and MT remain feasible rehabilitation approaches, particularly in settings with limited access to technology-intensive interventions. Current stroke rehabilitation recommendations emphasize individualized assessment, meaningful task practice, sufficient treatment intensity, and periodic reassessment rather than universal reliance on a single technique (2). The current evidence does not support replacing MT with MRP in all patients. Instead, intervention selection should consider the patient's capacity for active movement, functional goals, baseline impairment, tolerance for repetitive practice, available therapist supervision, and feasibility of home-based implementation. Where MRP appears to produce greater functional improvement, clinicians should still consider whether treatment dose and concomitant therapy were comparable before attributing the difference to the intervention model itself.

Future randomized trials should use adequate sample-size calculations and concealed allocation, register protocols prospectively, publish prespecified statistical analysis plans, and report assessor blinding, adherence, treatment fidelity, attrition, adverse events, and deviations from assigned interventions. MRP and MT protocols should be described sufficiently to permit replication, including exercise content, progression criteria, frequency, session duration, total treatment dose, therapist involvement, and concurrent rehabilitation. Studies should report baseline, post-intervention, and follow-up values with means and standard deviations or appropriately selected distributional statistics, together with direct between-group differences, 95% confidence intervals, effect sizes, and clinically meaningful thresholds. A common outcome set incorporating FMA-UE and a validated activity-level measure such as CAHAI or ARAT would improve comparability. Longer-term follow-up is required to determine the durability of treatment effects, while adequately powered subgroup analyses should examine whether stroke stage, baseline severity, sensory impairment, and capacity for voluntary movement modify response to MRP or MT.

CONCLUSION

The available randomized direct-comparison evidence suggests that both MRP and MT may support upper-extremity recovery after stroke, with some study-level findings favoring MRP for upper-arm and hand function; however, inconsistent findings across other outcomes, small samples, heterogeneous treatment protocols, incomplete between-group statistics, and risk-of-bias concerns preclude a definitive conclusion that MRP is superior to MT. Both approaches may therefore be considered within individualized stroke rehabilitation, but intervention selection should remain guided by patient characteristics, functional goals, treatment feasibility, and response to therapy. Larger, prospectively registered and methodologically rigorous trials using standardized interventions, common outcome measures, direct effect estimates, and longer follow-up are required to establish the magnitude and clinical relevance of any comparative advantage.

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