SYSTEMATIC REVIEW

EFFECT OF MOTOR RELEARNING PROGRAM ON QUALITY OF LIFE AMONG STROKE PATIENTS: A SYSTEMATIC REVIEW

ABSTRACT

BACKGROUND
Stroke is one of the problems that can lead to either disability or death and this will increase the social and economic burden.
OBJECTIVE
To analyze the effects of motor relearning program (MRP) in comparison with other treatment technique on quality of life (QoL) among stroke patients
DATA SOURCES
This systematic review includes Randomized Controlled Trials (RCT) for patients suffering from stroke. The articles were retrieved from Google Scholar, research gate, HEC digital library, ProQuest, lingenta and PubMed. Articles were also accessed from Journals.
STUDY SELECTION
Data belonged from 2000 to 2015 were included. RCTs that focus on motor relearning program or its task-oriented activity as rehabilitation program of stroke patients were included in this review.
RESULTS
Total 12 studies were included in this review with 378 patients. Among them, 191 had received MRP, whereas, 187 had received any other treatment technique for stroke rehabilitation. Analysis of Berg Balance Scale (BBS) and Barthel Index shows that studies favor MRP, while result is slightly insignificant (0.008) with BBS and not significant (0.67) for Barthel Index.
LIMITATIONS
RCTs used different outcome measurement tools, their items or scores. Multiple accessible RCTs with results of individual items of scales are negligible. More RCTs focusing on individual item of scales are needed to better assess the effects of MRP in comparison with other treatments by review studies.
CONCLUSION
Effect of MRP on Quality of Life is not significant from selected studies, after assessing BBS and Barthel Index.

KEYWORDS
Motor Relearning Program (MRP), Stroke, Quality of Life, Task-oriented Activity, Activities of Daily Living (ADL), Systematic Review

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INTRODUCTION

Stroke or cerebrovascular accident occurs due to impairment of blood supply of brain and results in paralysis. Stroke can be either hemorrhagic or ischemic depending on the problem in blood vessels[1,2]. Stroke is one of the problems that can leads to either disability or death and this will increase the social and economic burden. According to report of American Heart Association, approximately 01/19 deaths occurred due to stroke in 2010 in United States. Average estimation showed that one person got stroke every 40 seconds and one person died by stroke every 4 minutes[3]. 17.3 million death occurred due to cardiovascular diseases in 2008. Among them, 7.3 million deaths were from heart attacks and 6.2 million deaths were from stroke[4]. The global disease burden of disability-adjusted life years (DALYs) due to cardiovascular diseases was 10% in 2011[4]. The contribution of stroke to global cardiovascular diseases burden was 29% in males and 33% in females[4]. Stroke is the main public health problem among developing countries of South Asia too[5]. In low-income and middle-income countries, it is one of the leading causes of disability[4]. Pakistan lies in lower middle income countries[6]. Stroke is also common in our population. However, unfortunately the studies that highlight National stroke burden are negligible[7,8]. The estimation given by the Pakistan Stroke Society about the incidence of stroke is about 250 for every 100000 population and furthermore, 350000 new patients are adding every year[9]. A study of 2003 shows that 596 stroke patients were registered in a known tertiary care hospital of Karachi during an interval of 22 months[10].

Stroke not only affects the physical and mental state of patients but also have emotional and economic impact on their families[11]. It also affects the quality of life (QoL) of patients[12]. Motor impairment is the main and most common problem for stroke patients. As a result of that they have problem in accomplishing their activities of daily living and in mobility[13,14]. A study of Portugal assessed life satisfaction of patients after two years of stroke. They stated that patients with impaired motor functions have lower life satisfaction level[15]. The goal of stroke rehabilitation is to achieve functional independence during activities of daily living, along with the improvement in balance, movement and walking[13,16]. For this purpose, early physical therapy intervention is important for patients suffering from acute stroke. It will also help them in decreasing their disability and restoring movements[17,18]. Hence, selection of appropriate interventions and rehabilitation techniques are very important for early and better recovery[17]. Different treatment techniques that can be used are the Bobath, the Brunnstrom and Rood, the Proprioceptive Neuromuscular Facilitation (PNF), the Motor Learning or Relearning Program.

Motor Relearning Program (MRP) was proposed by Carr in 1980s. It focuses on active participation of patient[13]. These patients are capable to relearn the motor tasks that they were performing before stroke[19]. Physical therapists identify the problem in different individual tasks and then help the patient to learn them, through task specificity, task repetition, type of practice, type of feedback, retention testing[20-22]. There are four sequential steps in MRP: 1) identification of the missing performance components, 2) training using remedial exercises, 3) training using functional task components, 4) transfer of skills to functional task performance[20,21]. Examples of those tasks are catching things, picking up objects, feeding, buttoning, wearing clothes, bathing, grooming in sitting or standing, balance, sit to stand, indoor walking, outdoor walking, stair climbing and so on[20,23,24]. Different assessment tests and methods are used to assess the motor function, movements, strength, functional independence and quality of life of these patients. Some of them are Motor Assessment Scale (MAS), Sodring Motor Evaluation Scale (SMES), Functional Independence Measure (FIM), Berg Balance Scale (BBS), Barthel ADL Index, Instrumental Activities of Daily Living (IADL) test, Nottingham Health Profile (NHP), Fugl-Meyer Assessment (FMA) score, Timed Up and Go Test, modified Ashworth scale, Stroke Rehabilitation Assessment of Movements (STREAM) Scale, Purdue Pegboard test score, grip strength by Dynamometer, and more over[25-31].

The one of the main feature of neurological rehabilitation is the application of theory of motor learning. Helm stated that literature is less about task related training to illustrate better neural plasticity and locomotion of stroke patients[32]. Furthermore, a study conducted on monkeys with brain ischemia, showed improved neural repair, regeneration, angiogenesis and neurological function in them after using motor relearning program[33]. Multiple studies or Randomized control trials (RCT) compared motor relearning program or any task-oriented activity with other interventions. This systematic review aims to analyze the effects of motor relearning program in comparison with other treatment technique on quality of life among stroke patients.

METHODOLOGY

Data Sources and Search Strategy

The literature was searched by reviewers using Google Scholar. The initial search was done by using keywords of Stroke, Motor Relearning program, Quality of Life. The articles were retrieved from Google Scholar, research gate, HEC digital library, ProQuest, Ingenta and PubMed. Articles were also accessed from Journals. Literature was searched from inception to 2015. We have used PRISMA

guidelines.

Study Selection and Data Extraction
Searched literature was filtered by time frame. Data belonged from 2000 to 2015 were included. Eligibility criteria for the studies that were to be included in this review were Randomized Controlled Trials (RCT) for patients suffering from stroke. It included those studies who address motor relearning program as rehabilitation program. However, all 4 parts of motor relearning program or task-oriented activities were the main focus among all studies. We included RCTs comparing two types of interventions techniques, in that one would be MRP. The RCTs that compared motor relearning program or its any task-oriented activity with control group were also considered. Completely reviewed trials were addressed rather than summary of the articles. The quality of life was assessed through functional goals, activities of daily living, postural control, use of assistive devices, length of stay in hospital, physical mobility, and social interaction. Therefore, our outcome measures of interest were motor functions, quality of movement, functional independence, activities of daily living, social interaction, activities of arm or leg, sitting, standing, walking, Motor Assessment Scale (MAS), Barthel ADL Index, Berg Balance Scale, Ashworth scale, Sodring Motor Evaluation Scale (SMES). The assessment time or follow up can be varied in studies, such as 2 weeks, 6 weeks, 3 months, one year, or four year.

The groups of all these studies that had received MRP or any task related MRP are considered as Experimental group. Those who received any treatment other than MRP are taken as Control group in this systematic review.

Quality Appraisal
Reviewers analyze the quality of data and risk of bias. They assessed the source of article, patient blindness, dropouts and intervention details.

Statistical Analysis
This systematic review was conducted to compare the outcomes of motor relearning program and other treatment technique using Review Manager (RevMan) Version 5.3 for windows (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen). It was conducted to assess the common outcomes of studies. Heterogeneity among the studies was assessed using Cochrane's Q test and I^2. The mean difference of an outcome was calculated by the finding the difference between follow-up and baseline mean. Standard deviations (SD) for the mean differences were calculated using Cochrane Handbook for Systematic Reviews of Interventions[34] and using 0.5 conservative correlation of coefficient (r) [35]. Weighted mean difference was used for continuous outcomes at 95% confidence interval (CI). P-value <0.05 was considered as significant. Forest plots were plotted to show the analyses of common outcomes of interventions.

RESULTS

Study Selection
Initial search using keywords of Stroke, Motor Relearning program, Quality of Life, showed 6710 articles from beginning till 2015. This data was filtered by time frame that is from 2000 to 2015. The available data during this time frame was 5762 articles. This search was further narrow down by focusing on outcome measures, such as, motor functions, quality of movement, functional independence, activities of daily living, social interaction, activities of arm or leg, sitting, standing, walking, Motor Assessment Scale (MAS), Barthel ADL Index, Berg Balance Scale, Ashworth scale, Sødring Motor Evaluation Scale (SMES). The available data having any of these outcome measures was found 264. Excluding researches other than Randomized Control Trial (RCT), there were 197 citations. After reviewing the abstracts or titles, the researches that were found irrelevant, were excluded. Researches that found relevant from abstract but their full text was not available were also excluded from our review. 34 full texts were screened for final selection. When we selected and reviewed the study by Langhammer et al, published in 2011[24], we had to go through their previous studies published in 2000[25] and 2003[26]. Due to the continuation of the same work, all reviewers decided to incorporate all these studies[24-26] in this review. Hence, total 12 studies were included in this review after the decision of all reviewers. Summary of study selection is shown in Figure 1.

Study Characteristics
Study characteristics include participants' characteristics, interventions and outcome measures, shown in Table 1,2,3.

• Participants' Characteristics:
As the selected 12 studies were done on stroke patients, the most of the included studies had mentioned in inclusion criteria that patients who had first stroke were the part of the study[2,20,21,24-27,29].

Post stroke duration was also mentioned in inclusion criteria of 6 studies, but it varies among them. One study mentioned maximum post stroke duration (12 months[20]), two mentioned minimum post stroke duration (6 months[21,23]), whereas, three studies set the range for inclusion (10 days to 2 months[1], 1 month to 6 months[2], 6 weeks to 6 months[28]).

Among all these studies, 8 studies showed stages or scores of different scales in inclusion criteria. 7 studies had mentioned range of age in inclusion criteria. The overall ranges of these studies for selec-

tion criteria were vary between 21 to 70 years. Brief inclusion criteria of the studies were shown in Table 1. The mean age of the patients that were participated in the individual study ranges from 47.4 to 74.3 years.

Total 378 patients were participated in 10 studies. Among them, 191 had received MRP or any task relation MRP, whereas, 187 had received any other treatment technique for stroke rehabilitation. Out of 12 studies, 3 studies were done by Birgitta Langhammer and Johan K Stanghelle[24-26] on same stroke patients. That's why these patients were counted once in total number of patients.

The gender representation among 366 patients illustrates that there were 171 females and 195 males. 12 patients of study of Rehani P et al[2] are not included in this gender distribution because they stated percentages only without describing the frequencies. Table 2 shows the summary of demographical results of individual studies.

• **Intervention:**
In the included studies, motor relearning program was compared with other intervention techniques among stroke patients. A summary of these interventions for both groups is shown in Table 2. Frequency of treatment sessions and assessment timelines are also mentioned in Table 1.

The intervention of the Experimental group of this systematic review was MRP. Studies vary in tasks or body regions that were involved in MRP. For example, studies focused on arm[1,2,21,27-29], hand[30], 5 tasks[23], 24 remedial and 10 functional tasks[20], or drinking task[21]. The intervention of the control group of this systematic review varies, including any one from Bobath Technique[21,24-26], Constraint Induced Movement Therapy[27] (CIMT), Thermal stimulation[28], Brunnstrom hand manipulation[30], Mirror therapy[2], or Conventional or Usual therapy[1,20,23,29],. An individual study, done by Batool S et al[27], applied MRP to control group in comparing CIMT and MRP.

• **Outcome Measures:**
Different outcome measures were used in the selected studies, mentioned in Table 2. Table 3 summarizes the outcome measures that are common in them.

Figure 1: Study Selection Process

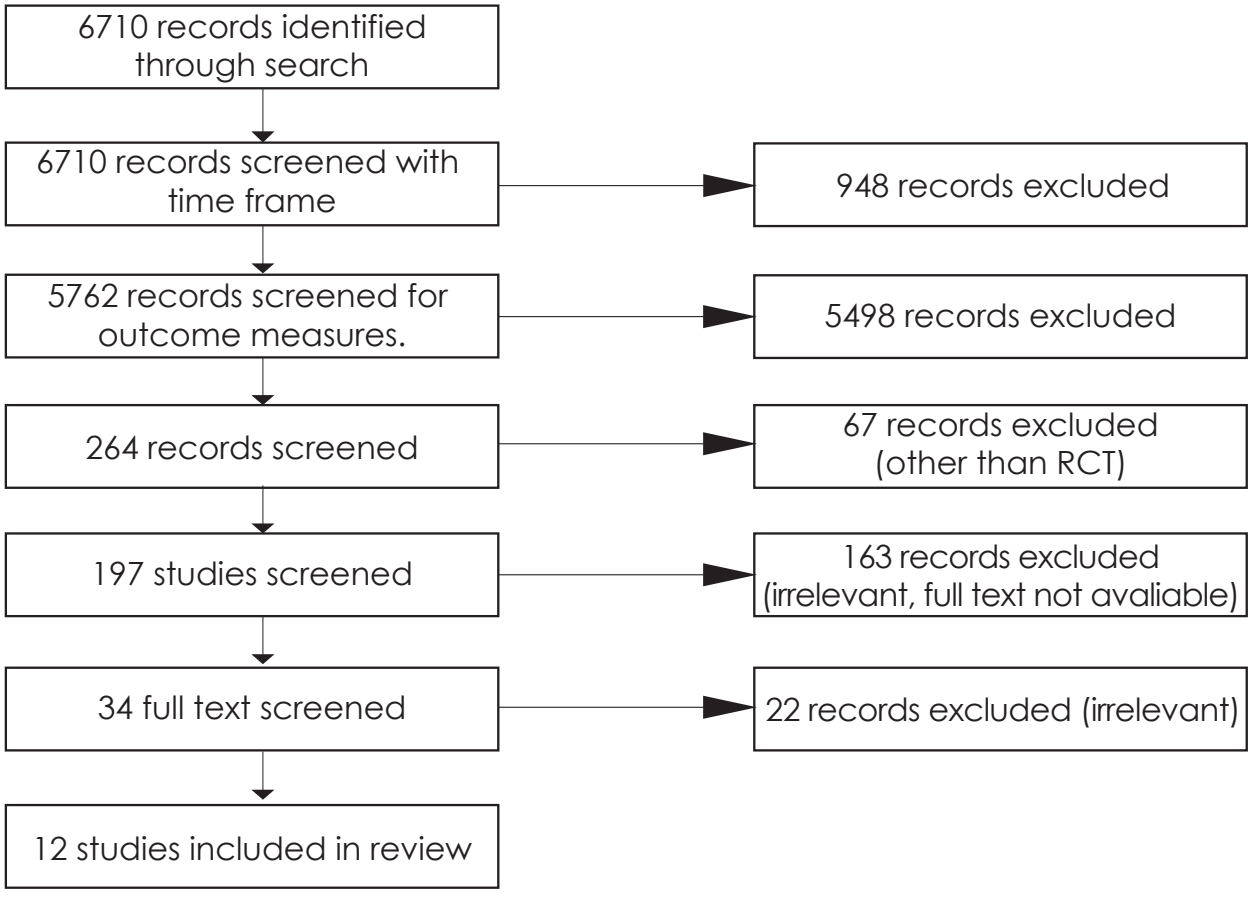

Table 1: Basic summary of included studies

STUDY	INCLUSION CRITERIA	STUDY DESIGN	n	ASSESSMENT	TREATMENT SESSIONS
Chan DY etal[20] 2006	Age 21-65 years, First stroke, ≤12 months of stroke	RCT between 2 groups: -MRP Group -Control Group	52	Baseline, 2nd,4th,6th week	Total 18 session 6 weeks, 2hr/session, 3 session/week
Batool S et al[27] 2015	Age 35-60 years, First stroke, Hemiplegic upper extremity, Functional level (≥20^0 wrist extension, ≥10^0 digits extension)	RCT between 2 groups: -Experimental or CIMT Group -Control or MRP Group		Baseline, After 3 weeks	Sessions for 3 weeks
Paul J et al[25] 2014	Age 50-70 years, Right MCA infract, 6weeks-6months of stroke, ≥20 score in Stroke Rehabilitation Assessment of Movement (STREAM)	RCT between 2 groups: -Group A or MRP -Group B or Thermal stimulation	20	Baseline, After 6 weeks	Total 30 sessions in 6 weeks 5 sessions/week 30min/session
Immadi SK et al[29] 2015	First-ever stroke Age 40-65 years, No Proprioceptive deficits or visual problems, Motor recovery of hard Brunnstom stages 3 or 4.	RCT between 2 groups: -Motor relearning programme or (Group B) -conventional physiotherapy programme(Group A)	60	Baseline, After 8 weeks	Total 40 sessions in 8 weeks 5 sessions/week 60min/session
Langhammer B et al 2000[25],2008[26], 2011[24]	First stroke, Hemipanesis	RCT between 2 groups: -Motor Relearning Programme -Bobath	61	2000[2] 3 days after admission to hospital, 2 weeks thereafter, 3 months post stroke 2003[25] 3 months, 1 year, 4 year	5 sessions/week 40min/session
Desroslers J et al[1] 2005	Unilateral stroke, Subacute phase, ≥10 days to ≤ months of stroke, Cognitive functioning within normal limits, Minimal upper extremity motor function (stage 2 for the hand and stage 3 for the arm on Chedoke-Mc Master Stroke Assessment)	RCT between 2 groups: -Experimental Group (Arm Therapy Programme) -Control Group	41	Baseline, 5th week	Total 15-20 sessions in 5 weeks, 4 sessions/week 45min/session
Choi JU et al[23] 2015	Stroke, Hemipleia, ≥6 months of stroke, ≥25 on K-MMSE, ≤Stage 2 on Modified Ashworth Scale	RCT between 2 groups: -Experimental or Task oriented group -Control or PT group	41	Baseline, After 4 weeks of training	Total 20 sessions in 4 weeks, 4 sessions/week 45min/session

Table 1: Basic summary of included studies

STUDY	INCLUSION CRITERIA	STUDY DESIGN	n	ASSESSMENT	TREATMENT SESSIONS
El-Bahrawy MN et al[21] 2012	First stroke, Age 40-60 years, Stroke>6 months, Brunnstrom recovery stage 3 of hand, Mini Mental State Examination score ≥ 26	RCT between 2 groups: -Experimental or MR group -Control or BT group	40	Baseline, after 6 weeks	Total 18 sessions in 6 weeks 3 sessions/week 1hr 15min/session (45min MRP or BT + 30 min electrical stimulation)
Pandian S etal[30] 2012	Stroke, Age 35-60 years, Brunnstrom recovery stage 3 of the hand (BRS-H), Intact cognition & perception	RCT between 2 groups: - Group A: Brunnst rom hand manipulation (BHM) - Group B: Motor Relearning Program (MRP)	30	Baseline, after 4 weeks	Total 12 sessions in 4 weeks 3 sessions/week 60min/session
Rehani P et al[2] 2015	Age 45-65 years, First stroke, Ischemic & Hemorrhagic, 1-6 months of stroke, score>23 Mini-mental status examination (MMSE), Brunnstrom Stage 4&5	RCT between 2 groups: - Group A: Motor Relearning Program (MRP) - Group B: Mirror therapy	12	Baseline, after 4 weeks	Total 24 sessions in 4 weeks 6 sessions/week 60 min/session

Table 2: Summary of interventions and groups of induded studies

STUDY	INTERVENTION	n	GENDER (n)	AGE Mean (SD) years	SIDE (n)	CO INTERVENTION	OUTCOME MEASURES
Chan DY et al[20] 2006	2 groups:	52			Hemiplegic side:	Both groups: Physical therapy in the form of lower limb strengthening and trunk balance exercises	• Berg Balance Scale • Timed Up and Go Test • Functional Independance Measure(FIM)-Motor items • modified Lawton Instumental Activities of Daily Living (IADL) test • Community Interation Questionnaire
	• **MRP** - 4 sequential s teps - Total 24 re media tasks and 10 functional tasks, designed to cover deficits in static and dynamic sitting balance, and static and dynamic standing balance	26	14F 12M	53.8(15.4)	12 Right 14 Left		
	• **Conventional therapy program** - Practice the remedical tasks without: drawing the patient's attention to his/her deficits. - Practice the functional tasks without explidty relating the skills learned in the remedical tasks	26	14F 12M	54.4(13.7)	12 Right 14 Left		
Batool S et al[27] 2015	2 groups:	42	14F 28M		—	—	• Upper arm section of Monitor Assessment scale (MAS) • Self Care item of Functional Independence Measure (FIM)
	• **Conventional Induced Movement Therapy (CIMT) Group** - Perform tasks only with hemiplegic upper extremity - Unaffected hand restraint in a mitt	21		49.57(7.01)			
	• **MRP** - Perform tasks with both affected and unaffected upper extremities - Tasks were attempted in different positions	21		49.47(8.19)			

Table 2: Summary of interventions and groups of induded studies (cotd..)

STUDY	INTERVENTION	n	GENDER (n)	AGE Mean (SD) years	SIDE (n)	CO INTERVENTION	OUTCOME MEASURES
Paul J et al[28] 2014	2 groups:	20			Right Middle Cerebral Artery Stroke	-	• Modified motor assessment scale (MMAS) • Stroke Rehabilitation Assessment of Movements (STREAM) Scale
	• Group A or MRP - Motor relearning program in task oriented manner for upper limb	10	5 F 5 M	60.00 (3.71) Range: 55-65 yrs			
	• Group B or Thermal stimulation - Thermal stimulation provided with cold and hot packs for upper limb	10	4 F 6 M	60.60 (4.14) Range: 55-66 yrs			
Immadi SK et al[29] 2015	2 groups:	60	29 F 31 M	-	-	-	• Fugl-Meyer Assessment (FMA) for upper extremity • Wolf Motor Function Test (WMFT)
	• Motor relearning programme or (Group B) - 4 steps of motor relearning program	30					
	• Conventional physiotherapy programme (Group A) - Positioning - Passive movements - Weight bearing - Electrical stimulations. - Active movements	30					
Langhammer B et al 2000[25], 2003[26], 2011[24]	2 groups	61		78 (9) Range: 49–95	Hemisphere side:	Treatment from doctors, nurses, occupational therapists, speech therapists	• Motor Assessment Scale (MAS) • Sødring Motor Evaluation Scale (SMES) • Barthel ADL Index, • Nottingham Health Profile (NHP) • Length of stay in hospital (days)
	• Motor Relearning Programme - Task-oriented strategies - According to protocol by Carr & Shepherd	33	13 F 20 M		16 Right (6F, 10M) 17 Left (7F, 10M)		
	• Bobath Programme - Facilitation/inhibition strategies - According to protocol by Bobath	28	12 F 16 M		11 Right (4F, 7M) 17 Left (8F, 9M)		
Desrosiers J et al[1] 2005	2 groups	41		73.2 (10.4)	Stroke side	usual occupational therapy and physical therapy treatments for retraining the affected arm	• Fugl-Meyer Assessment (0-66) • Grip strength • Box & Block Test Purdue Pegboard Test (30s) • Finger-to-Nose Test (20s) • Unilateral tasks TEMPA (0-12) • Bilateral tasks TEMPA (0-15) • Unilateral + Bilateral tasks, TEMPA (0-27) • Functional Independence Measure (FIM) - Self care • Instrumental ADL (IADL)-Assessment of Motor and Process Skills (AMPS)
	• Experimental or Arm Therapy Programme - Repetition of unilateral and symmetrical & asymmetrical bilateral tasks - Task training based on motor learning model principle	20	11 F 9 M	72.2 (10.8)	7 Right 13 Left		
	• Control or Usual Arm Therapy - functional activities and exercises to enhance strength, active, assisted and passive movements, and sensorimotor skills of the arm	21	11 F 10 M	74.3 (10.1)	11 Right 10 Left		
Choi JU et al[23] 2015	2 groups	20			Hemiplegic side:		• Berg Balance Scale (BBS) • Modifed Barthel Index (MBI) • Self-Efficacy Scale (SES)
	• Experimental or Task-oriented group - participated in the task-oriented training program - 5 tasks: indoor walking, outdoor walking, staircase climbing, wearing clothes, picking up objects - 4 stages in each task - If in 1 week, patient was unable to complete the tasks, then did the same in next week	10	4 F 6 M	61.5 (7.2)	4 Right 6 Left		
	• Control or PT group - traditional rehabilitation therapy - general physical therapy, including exercises aimed at improving gait ability and balance	10	4 F 6 M	66.4 (9.3)	4 Right 6 Left		

Table 2: Summary of interventions and groups of induded studies (cotd..)

STUDY	INTERVENTION	n	GENDER (n)	AGE Mean (SD) years	SIDE (n)	CO INTERVENTION	OUTCOME MEASURES
El-Bahrawy MN et al[21] 2012	2 groups:	40			Hemisphere side:	30 min electrical stimulation (square-wave electrical pulses, 0.1ms duration, 10-30 mA stimulus intensity) to wrist and finger extensors	• Hand grip strength • Resting angle of ulnar deviation • Purdue Pegboard test • Modifed Ashworth scale for wrist flexor spasticity
	• Motor Relearning (MR) group - four sequential steps of MRP - Drinking task through grasping a cup, moving the cup toward the mouth, reaching down toward the table then releasing the cup on the table	20	9 F 11 M	50.7 (2.618)	12 Right 8 Left		
	• Bobath Treatment (BT) group - Sensory and proprioceptive input - Direct manual facilitation - Key point control - Visual and verbal feedback. - Recruitment of arm activity in functional situations with various positions	20	7 F 13 M	49.45 (2.892)	11 Right 9 Left		
Pandian S et al[30] 2012	2 groups:	30			Paretic side:	Conventional occupational therapy for upper (excluding hand) and lower extremities	• Brunnstrom recovery stage of the hand (BRS-H) , • Fugl- Meyer Assessment for wrist and hand (FMA-WH)
	• Group A: Brunnstrom hand manipulation (BHM)	15	5 F 10 M	47.4 (8.35)	8 Right 7 Left		
	• Group B: Motor Relearning Program (MRP) for hand - 4 steps sequence of MRP	15	01 F, 14 M	51.67 (12.55)	6 Right 9 Left		
Rehani P et al[4] 2015	2 groups:	12			Side affected	Conventional physiotherapy treatment: Neutral Warmth with Moist heat pack (35°-37°C) for 10 min , Stretching of wrist flexors (30 Sec hold, 3 Repetitions), Electrical Stimulation for wrist extensors.	• Chedoke arm and hand activity inventory (CAHAI)
	• Group A: Motor Relearning Program (MRP) - Training of Wrist Extensors, Extension of wrist and holding objects, supination of forearm, opposition of thumb, cupping of hand, manipulation of objects	6	38.5% F, 61.5% M	54.77 (6.392)	53.8% Right 46.2% Left		
	• Group B: Mirror Therapy - patient seated close to the table in front of mirror - Place involved hand behind the mirror and practice exercises with non-paretic hand - During the session, try to do the same movement with the paretic hand along with non-paretic hand	6	46.2% F 53.8%M	57.85 (4.375)	38.5% Right 61.5% Left		

Table 3: Outcome measures of included studies

Study	Motor Assessment Scale (MAS)	Functional Independence Measure (FIM)	Berg Balance Scale (BBS)	Sodring Motor Evaluation scale (SMES)	Barthel Index	Instrumental Activities of Daily Living (IADL)	Nottingham Health Profile (NHP)	Fugl-Meyer Assessment (FMA)	Purdue Pegboard Test	Grip Strength
Chan DY et al[20] 2006	X	✓	✓	X	X	✓	X	X	X	X
Batool S et al[27] 2015	✓	✓	X	X	X	X	X	X	X	X
Paul J et al[28] 2014	✓	X	X	X	X	X	X	X	X	X
Immadi SK et al[25] 2015	X	X	X	X	X	X	X	✓	X	X
Langhammer B et al[25] 2000	✓	X	X	✓	✓	X	✓	X	X	X
Langhammer B et al[26] 2003	✓	X	X	✓	✓	X	✓	X	X	X
Langhammer B et al[24] 2011	✓	X	X	✓	X	X	✓	X	X	X
Desrosiers J et al[1] 2005	X	✓	X	X	X	✓	X	✓	✓	✓
Choi JU et al[23] 2015	X	X	✓	X	✓	X	X	X	X	X
El-Bahrawy MN et al[21] 2012	X	X	X	X	X	X	X	X	✓	✓
Pandian S et al[30] 2012	X	X	X	X	X	X	X	✓	X	X
Rehani P et al[2] 2015	X	X	X	X	X	X	X	X	X	X

Results of Individual Studies

Table 4 summarizes the results of included studies for different outcome measures.

Chan DY et al[20], Paul J et al[28] , Choi JU et al[23] and Immadi SK et al[29] found MRP better than other treatments. Desrosiers J et al[1] reported the similar results in both groups. Whereas, Rehani P et al[2] found statistically insignificant results, but found improvement in patients of both groups. Pandian S. et al[30] showed that Brunstorm technique was better than MRP. Batool S. et al[27] found CIMT statistically significant than MRP.

Most of the results were reported as Mean (SD). Study by Immadi SK et al[29] shown their before-treatment results in form of Mean only. Whereas, SD were mentioned in after-treatment results.

The longitudinal study conducted by Langhammer B and Stanghelle JK was based on two treatment methods, MRP and Bobath. The study published in 2000[25] focused on acute stroke patients. The outcome measures of the patients were assessed three times that were, 3 days after admission to hospital (results shown as 'Baseline' in Table 4), 2 weeks thereafter, and then 3 months after it (results shown as 'At end' in Table 4). They found MRP better than Bobath in this study. Their research published in 2003[26] was the continuation of the same study. The outcome measures of the patients were reported at 3 months (results shown as 'Baseline' in Table 4), 1 year, 4 year (results shown as 'At end' in Table 4). They found decline in both groups when compared their results. They also observed the mortality rate in long-term follow-up. The number (no.) of patients in the study were 33 (MRP group) and 28 (Bobath group) in the starting. The number of patients existed at three months, were 29 (MRP group) and 24 (Bobath group) because of the death of 4 patients in each group. At 1 year, 6 and 7 patients died from MRP and Bobath groups, respectively. At 4 years, further 12 patients had been died from each group. As it was a long-term study, therefore they compared scores of 4 years from baseline. Therefore, they stated that there were no significant differences between the groups in any of the tests, and the scores at 4 years were similar to their first scores. In their study published in 2011[24], there was detail about Mean ± SD of items of MAS and SMES that were assessed at three follow-up occasions (at admission, after 3 weeks and after 3 months). Thus, they found MRP better than Bobath technique, as in study of 2000[25]. Statistical analyses of items of Nottingham Health Profile were also included in that study. Due to result of individual items, this result is not shown in Table 4.

El-Bahrawy MN et al[21] conducted a research on motor relearning (MR) in comparison with Bobath (BT) for improving hand function in chronic stroke patients. They showed mean of outcome measures through figures (graphs) instead of tables. Therefore, the mean values showed in Table 3 were estimated from those figures. They stated that there were significant differences in mean values of hand grip strength, Purdue pegboard test and the resting angle of ulnar deviation before and after treatment of MR and BT. Whereas, in modified Ashworth scale, there was no significant difference with BT, and significant difference with MR. When comparing after treatment means of both groups, there was significant result (P=0.0001) of MR group in improving hand grip strength and the resting angle of ulnar deviation. Moreover, results with Purdue pegboard test and modified Ashworth scale were not significant (P>0.05).

They concluded that MR method was better than BT for improving hand functions of stroke patients.

Synthesis of Results

Statistical analysis of outcomes of interventions was done by assessing Heterogeneity among the studies and shown by Forest plots (Figure 2, 3 and 4).

Analysis of Berg Balance Scale (BBS) in MRP (Experimental Group) and Others (Control Group) was shown by Forest plot in Figure 2. Both studies[20,23] favor MRP. Study by Choi JU et al[23] weighted more in its favor than study by Chan DY et al[20]. Furthermore, p-value (0.008) shows that the result is slightly insignificant.

Analysis of Barthel Index in MRP (Experimental Group) and Others (Control Group) was shown by Forest plot in Figure 3. Both studies[23,25] favor MRP. Study by Choi JU et al[23] weighted more in its favor than study by Langhammer B et al[25]. Furthermore, p-value (0.67) shows that the result is not significant.

Analysis of Motor Assessment Scale (MAS) in MRP (Experimental Group) and Others (Control Group) was shown by Forest plot in Figure 4. Studies of Batool S. et al[27] and Paul J et al[28] favor control group. Whereas, study of Langhammer B. et al[25] favors experimental group with wider CI and very small size of box. But their items for scores are not similar.

Table 4: Summary of outcome measures showing Mean (SD) of included studies

Study	Outcome Measures	Experimental Group (MRP)		Control Group (Other Techniques)	
		Baseline	At end	Baseline	At end
Chan DY et al[20] 2006	Berg Balance Scale	28.2 (8.0)	45.8 (3.7)	27.9 (7.8)	37.4 (17.5)
	Timed Up and Go Test	60.5 (22.3)	36.4 (15.5)	62.8 (22.2)	58.2 (26.1)
	Functional Independence Measure (FIM)-) - Motor items	61.2 (12.7)	80.0 (5.3)	60.7 (13.2)	66.3 (10.5)
	Modified Lawton 'Instrumental Activities of Daily Living (IADL) test	54.2 (13.1)	82.2 (12.1)	47.4 (14.7)	54.4 (19.7)
	Community Integration Questionnaire	26.9 (17.7)	73.0 (19.9)	21.5 (16.1)	36.3 (17.0)
Batool S et al[27] 2015	Motor Assessment Scale (MAS)	2.43 (0.81)	10.62 (1.20)	2.57 (1.16)	7.14(1.56)
	Functional Independence Measure Scale (FIM)	6.43 (1.56)	18.86 (1.52)	6.52±1.72	14.19 (1.47)
Paul J et al[28] 2014	Modified Motor Assessment Scale (MMAS)	1.10 (0.74)	6.50 (0.97)	1.00 (0.67)	4.10 (0.88)
	Stroke Rehabilitation Assessment of Movements (STREAM) Scale	28.00 (5.87)	65.50 (3.69)	27.50 (6.35)	58.50 (4.12)
Immadi SK et al[29] 2015	Fugl-Meyer Assessment (FMA) for upper extremity	20.7	43.80 (43.80)	20.7	32.27 (5.03)
	Wolf Motor Function Test (WMFT)	35.80	71.45 (16.02)	33.7	39.80 (4.88)
Langhammer B et al[25] 2000	Motor Assessment Scale (MAS)	24 (14)	37 (12)	19 (15)	33 (15)
	Sødring Motor Evaluation Scale (SMES)	12 (5)	17 (5)	11 (5)	16 (6)
	Barthel ADL Index	56 (28)	83 (25)	46 (36)	72 (34)
	Nottingham Health Profile (NHP)	-	22 (18)	-	24 (21)
	Length of stay in hospital (days)	-	21	-	34
Langhammer B et al[26] 2003	Motor Assessment Scale (MAS)	37 (12)	21 (21)	33 (15)	19 (20)
	Sødring Motor Evaluation Scale (SMES)	17 (5)	9 (9)	16 (6)	8 (9)
	Barthel ADL Index	83 (25)	45 (44)	72 (34)	42 (44)
	Nottingham Health Profile (NHP)	22 (18)	20 (15)	24 (21)	16 (11)
Desrosiers J et al[1] 2005	Fugl-Meyer Assessment (score 0-66)	42.9 (20.0)	46.1 (18.4)	47.0 (16.1)	51.3 (14.1)
	Grip strength by Martin Vigorimeter (KPa)	24.8 (23.5)	26.4 (25.4)	29.1 (24.8)	31.1 (28.8)
	Box & Block Test (no. of blocks)	15.7 (14.3)	23.5 (14.3)	20.4 (16.5)	26.6 (16.5)
	Purdue Pegboard Test (no. of pegs per 30s)	2.2 (2.6)	3.2 (3.1)	4.3 (6.9)	4.3 (3.2)
	Finger-to-Nose Test (no. of movements in 20 s)	6.5 (4.4)	8.1 (5.8)	6.9 (5.1)	10.2 (7.4)
	Unilateral tasks, affected side, TEMPA (score 0-12)	7.6 (4.0)	4.8 (4.4)	5.6 (4.6)	4.0 (3.7)
	Bilateral tasks, , TEMPA (score 0-15)	4.1 (2.3)	2.9 (2.1	3.3 (2.9)	1.6 (2.1)
	Unilateral + Bilateral tasks, TEMPA (score 0-27)	11.8 (5.4)	7.8 (6.3)	8.8 (7.0)	5.6 (5.4)
	Functional Independence Measure (FIM) - Personal care (score 7-42)	31.0 (7.0)	35.6 (4.7)	28.3 (9.3)	33.2 (9.0)
	Instrumental ADL (IADL) – Assessment of Motor and Process Skills (AMPS)	0.42 (0.8)	1.3 (0.9)	0.45 (0.9)	1.2 (1.0)
Choi JU et al[23] 2015	Berg Balance Scale (BBS)	35.0 (5.8)	36.8 (5.6)	33.3 (4.4)	34.1 (4.3)
	Modifed Barthel Index (MBI)	58.4 (11.5)	62.4(11.0)	50.5 (10.1)	52.5(0.4)
	Self-Efficacy Scale (SES)	49.4 (12.1)	55.6 (9.6)	45.5 (11.5)	47.7 (10.2)
El-Bahrawy MN et al[21] 2012	Hand grip strength by Dynamometer (pounds)	3.6	4.5	3.6	4
	Resting angle of ulnar deviation (degrees)	9.8	5.2	10.6	8.4
	Purdue Pegboard test score (no. of pegs per 30sec)	0.55	1.65	0.55	1.55
	modified Ashworth scale for wrist flexor spasticity	2.10	1.40	2.25	1.95
Pandian S et al[30] 2012	Brunnstrom recovery stage of the hand (BRS-H) * Median (Min-Max)	3 (1-6)	4 (3-6)	3 (1-6)	4 (3-6)
	Fugl- Meyer Assessment for wrist and hand (FMA-WH)	12.33 (3.266)	14.13 (3.18)	14.67 (6.102)	18.47 (4.38)
Rehani P et al[2] 2015	Chedoke arm and hand activity inventory (CAHAI) scores	27.5	57.5	27.667	59.33

Study or Subgroup	MRP (Experiment Group) Mean	SD	Total	Others (Control Group) Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
Chan DY et al 2006	17.6	6.93	26	9.5	15.19	26	32.4%	8.10(1.68,14.52)	
Chal JV et al 2015	1.8	5.7	10	0.8	4.35	10	67.6%	1.00(-3.44,5.44)	
Total (95% CI)			**36**			**36**	**100%**	**3.30(-0.35 ,6.95)**	

Hetrogeneity: Ch^2 =3.18, df = 1(P=0.07); I^2 = 69%

Test for overall effect: Z = 1.77 (P=0.08)

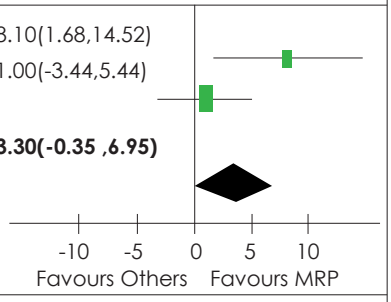

Figure 2: Forest plot for analysis of Berg Balance Scale (BBS) in MRP (Experiment Group) and others (Control Group)

Study or Subgroup	MRP (Experiment Group) Mean	SD	Total	Others (Control Group) Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
Chan JU et al 2015	4	11.26	10	2	9.91	10	74.4%	2.00(-7.30,11.30)	
Langhammer B et al 2000	27	26.63	33	26	35.04	28	25.6%	1.00(-14.84,16.84)	
Total (95% CI)			**43**			**38**	**100%**	**1.74 (-6.27 ,9.76)**	

Hetrogeneity: Ch^2 =0.01, df = 1(P=0.92); I^2 = 0%

Test for overall effect: Z = 0.43 (P=0.67)

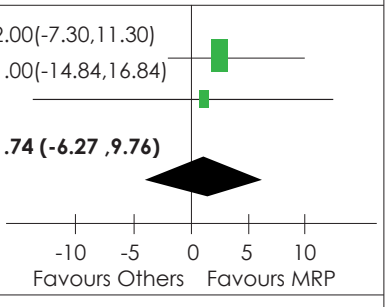

Figure 3: Forest plot for analysis of Barthel Index (BBS) in MRP (Experiment Group) and others (Control Group)

Study or Subgroup	MRP (Experiment Group) Mean	SD	Total	Others (Control Group) Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
Batool S et al 2015	8.2	1.06	21	4.6	1.4	21	44.5%	3.60(2.85,4.35)	
Langhammer B et al 2014	13	13.11	33	14	15	28	0.5%	-1.00(-8.13,6.13)	
Paul J et al 2014	5.4	0.74	10	3.1	0.8	10	55.0%	2.30(1.62,2.98)	
Total (95% CI)			**64**			**59**	**100%**	**2.86 (2.36,3.36)**	

Hetrogeneity: Ch^2 =7.49, df = 2 (P=0.02); I^2 = 73%

Test for overall effect: Z = 11.20 (P<0.00001)

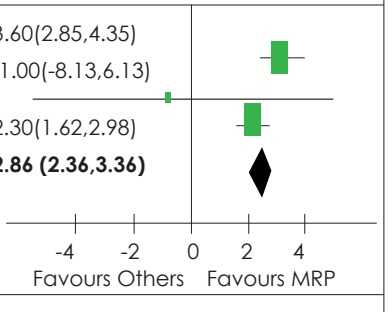

Figure 4: Forest plot for analysis of Motos Assessment Scale (MAS) in MRP (Experiment Group) and others (Control Group)

DISCUSSION

The selected 12 studies were done on stroke patients. Hence, most of them included first stroke patients. Other 4 studies did not mention this in selection criteria, but their text reflects that they had also included first stroke patients.

El-Bahrawy. et al[21] showed mean of outcome measures through figures (graphs) instead of tables. The mean values showed in Table 3 were estimated from those figures after keen focusing on level of bars and may vary from exact values of the study. Outcome measures that were used in two or more studies should be compared statistically. But actually we couldn't able to do. There was a difference in outcome measures and their scores, as shown in table 3 and 4. Due to this, there was a problem in selecting the data for statistical analysis and forest plot. When we found an assessment scale in more than one study, the scale was either used in a modified form or its selected items were applied. For example, Functional Independence Measure (FIM) scale is used by three studies. Desrosiers J. et al[1] used FIM scores for self-care assessment. Self-care comprises 6 items and score of 6 items can range from 6-42. Chan DY. et al[20] used 13 motor items, whereas Batool S. et al[27] used 5 item of self-care. FIM[36] is 7 point scale consisting 18 items and score ranges from 18 to 126. All three studies used selected items of FIM instead of using all items and even did not use the same items. Therefore their results cannot be compared statistically.

Berg Balance Scale (BBS)[23] is a 5 point scale and contains 14 items (score 0-56). Score less than 5 shows the risk of fall, which is a major problem in stroke patients. See figure 2 for the analysis of BBS. Both studies[20,23] favor MRP. Study by Choi JU et al[23] weighted more in its favor than study by Chan DY et al[20] with bigger size of box. The diamond for overall result crosses the 'line of no effect' a little and p-value (0.008) is slightly higher than >0.05, therefore it is slightly not significant.

Barthel Index is used for ADL assessment. As we assessed we found that both Choi JU et al[23] and Langhammer B. et al[24] used same Barthel Index of score 0-100. Moreover, Choi JU. et al[23] stated that he used Modifed Barthel Index (MBI) of Shah version. See figure 3 for the analysis of Barthel Index. Both studies[23,25] favor MRP. Study by Langhammer B et al[25] weighted less in its favor with comparatively wider CI and small size of box than study by Choi JU et al[23]. The diamond for overall result crosses the 'line of no effect' and it shows that calculated difference between groups is not significant. P-value (0.67) also shows that the result is not significant.

Modified forms of scales can be used in RCTs to analyze the outcomes. But they are not helpful when you want to compare them statistically for review studies. The mean values of Motor Assessment Scale (MAS) of study of Batool S. et al[27] and Paul J et al[28] lies between 1-11. Batool S. et al[27] stated that they used 3 items whereas Paul J et al[28] stated it as modified. Langhammer B et al[25,26] used all 8 item and their mean scores lie in 19-37. Their study published in 2011[24] also showed scores for individual items. We plotted one forest plot to see how it shows when these type of scales are compared. See figure 4 for the analysis of MAS. It shows that studies of Batool S. et al[27] and Paul J et al[28] favors control group. Whereas, study of Langhammer B et al[25] favors experimental group with wider CI, very small size of box and values shows that it has less influence on overall result. Furthermore, this study[25] applied all items of scale, irrespective of both other studies[27,28].

Another scale, Fugl-Meyer Assessment (FMA) was used by three studies, Immadi SK et al[29], Desrosiers J et al[1], Pandian S. et al[30]. Immadi SK. et al[29], Desrosiers J et al[1], used FMA for Upper extremity motor assessment (score 0-66). Whereas, Pandian S. et al[30] used FMA for only wrist and hand (score 0-30). But we cannot compare statistically the results of both studies[1,29] because Immadi SK et al[29] did not show SD for before treatment means.

Upper extremities are mostly affected after stroke, leading to motor deficits and decreased ability to perform activities of daily living. Motor recovery of upper extremity is crucial for patients to become independent in performing their self-hygiene and grooming activities. In the selected studies, we found that most of the studies focused on upper extremity[1,2,27-29] or task involving upper extremity[21] or only hand[30].

RCTs used different outcome measurement tools, their items or scores. Multiple accessible RCTs with results of individual items of scales are negligible. More RCTs focusing on individual item of scales are needed to better assess the effects of MRP in comparison with other treatments by review studies.

More review studies focusing on individual item of scales are recommended. Unfortunately, multiple accessible RCTs with results of individual items of scales are negligible. For this reason further RCT studies should be conducted to assess the effects of MRP in comparison with other treatments. These RCTs should draw their results from individual items of measurement scales. A better review can be conducted after comparing statistically the results and scores of same items of the multiple studies, and hence, a clearer picture can be drawn about MRP in comparison with other treatments.

CONCLUSION

Effect of MRP on Quality of Life is not significant from selected studies, after assessing Berg Balance Scale (BBS) or Barthel Index, and further researches are suggested.

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