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Snehankini Priyadarshini Naik  
MOT Student, MGOTC,  
Jaipur, Rajasthan, India

Dr. Neha Jain  
Associate Professor, MGOTC,  
Jaipur, Rajasthan, India

Dr. Surendra Kumar Meena  
Principal, MGOTC, Jaipur,  
Rajasthan, India

## To study the comparison of cross education training and PNF exercise combined with mirror therapy on upper limb rehabilitation in sub acute-stroke

Snehankini Priyadarshini Naik, Dr. Neha Jain and Dr. Surendra Kumar Meena

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### Abstract

Proprioceptive Neuromuscular Facilitation techniques have been used in stroke rehabilitation since decades. Cross education training, a recent advancement, yet a very effective tool that is being used in stroke rehabilitation in which recovery is achieved on the affected side by training the non-affected side using the theory of Motor learning and Neuroplasticity. Mirror therapy has also been used in stroke rehabilitation which has got a positive outcome in many studies which is based on the theory of Biofeedback. Previously these techniques have been used mostly individually in studies. Very few studies have been done to see the combined effect by adding mirror therapy either with PNF or with Cross education training. By far, no study has been done to compare the better combination out of these two. So, this study will focus on the comparison of the two combined techniques to find out the combination with better outcome.

**Keywords:** PNF techniques, mirror therapy, cross education, stroke

### Introduction

After reviewing so many articles Stroke is a global epidemic and an important cause of morbidity and mortality. As defined by WHO, "stroke is rapidly developing clinical signs of focal (Or global) disturbance of cerebral function, with symptoms lasting 24 hours or longer or leading to death, no apparent cause other than that of vascular origin"<sup>[1]</sup>.

Stroke often results in a paretic upper limb, which can severely limit a person's ability to perform daily activities. To address this issue, numerous interventions have been developed to improve upper extremity control and function through rehabilitation methods. These interventions have been evaluated through various studies and have shown promise in enhancing upper limb control and function among stroke patients<sup>[2]</sup>.

A stroke occurs when the blood flow to the brain is disrupted, resulting in brain cell damage or death. There are two main types of stroke:

**Ischemic stroke:** This is the most common type of stroke, accounting for about 85% of all strokes. Ischemic strokes occur when a blood clot blocks or narrows an artery that supplies blood to the brain, reducing or cutting off the blood flow to that area of the brain.

**Hemorrhagic stroke:** This type of stroke occurs when a blood vessel in the brain ruptures, causing bleeding (Hemorrhage) in the brain tissue or the area surrounding the brain. The bleeding can compress and damage brain cells, leading to permanent brain damage or death. There are two types of hemorrhagic stroke: intracerebral hemorrhage and subarachnoid hemorrhage.

- **Intracerebral Hemorrhage:** This occurs when a blood vessel within the brain ruptures, causing bleeding directly into the brain tissue. This type of stroke is usually caused by high blood pressure and can be fatal.
- **Subarachnoid Hemorrhage:** This occurs when there is bleeding in the space between the brain and the thin tissues that cover the brain.

Corresponding Author:  
Snehankini Priyadarshini Naik  
MOT Student, MGOTC,  
Jaipur, Rajasthan, India

In addition to these two main types, there is also a third type of stroke called a transient ischemic attack (TIA), which is sometimes referred to as a "mini-stroke." TIAs occur when there is a temporary disruption of blood flow to the brain, usually caused by a blood clot or narrowed blood vessel. TIAs typically resolve on their own within minutes to hours and do not cause permanent brain damage, but they are still considered medical emergencies and require prompt evaluation and treatment.

### Incidence and Prevalence

Stroke is a major public health issue worldwide. In 1990, the Global Burden of Diseases (GBD) study found stroke to be the second leading cause of death globally. Later updates to the GBD study in 2010 showed that stroke deaths had risen from 4.66 million in 1990 to 5.87 million, marking a 26% increase in global stroke deaths over the past two decades. Despite efforts to decrease mortality rates, stroke continues to be the second leading cause of death globally. Low- and middle-income countries (LMICs) bear the majority (over 85%) of the global burden of stroke, and due to inadequate reporting mechanisms and disease or death registration systems, this burden is likely underestimated in LMICs. A systematic review of population-based stroke studies has shown that the incidence rate of stroke in LMICs has more than doubled from 56/100,000 person-years in 1970-1979 to 117/100,000 person-years in the period 2000-2008. In contrast, high-income countries (HICs) have seen a decline in stroke incidence from 163 per 100,000 person-years in 1970-1979 to 94 per 100,000 person-years in 2000-2008, representing a 42% decrease in stroke incidence in HICs over the past four decades. Overall, stroke remains a significant global health concern<sup>[3,4]</sup>.

CVA, sometimes called stroke, shock, or apoplexy, is caused by some pathology in cerebral vasculature. A compromise in the blood supply to the brain caused by thrombus, embolus, or hemorrhage results in cerebral ischemia and ultimately, in secondary brain abnormality. The onset of often unanticipated and sudden<sup>[5]</sup>.

Cerebral anoxia and aneurysm also can result in hemiplegia. Vascular disease of the brain can result in completed CVA or transient ischemic attacks (TIAs). A TIA occurs as mild isolated or repetitive neurologic symptoms that disappear within 24 hours. The TIA is seen as a sign of impending CVA. Most TIAs occur in those with atherosclerotic disease. As estimated 25% to 40% of patient who experience TIAs go on to completed stroke within 5 years<sup>[5]</sup>. If the TIA is caused by extracranial vascular disease, surgical intervention to reestablish patency of arteries may be effective in preventing the CVA and the resultant disability<sup>[5]</sup>.

### Methods

Qualitative studies were included in the review based on the objectives of the current review inclusion and exclusion criteria were prepared and based on that various database were used in selection of the study. The collected studies were checked for clarity and contain and used for review.

### Criteria for sample collection

Two criteria via inclusion and exclusion criteria were used for selection of sample.

### Inclusion Criteria

- Participants must be stroke patients.
- Age-40-60years
- Subacute Stroke
- Both Males and Females
- Brunnstrom Scale 3 or more than 3
- Upper Limb-Flexion Synergy

### Exclusion Criteria

- Acute Stroke.
- Patient showing in availability throughout the course of study.
- Patient unwilling to participate in study.

### Electronic database searching

The database searched

PubMed

Online journals

Access open

Goggle scholar

Research gate

### Data collection and quality assurance

The process of selecting articles for the review involved using a PRISMA flow diagram. Eligibility criteria were assessed to determine which studies were suitable for inclusion, and those that did not meet the criteria were excluded. The included studies were evaluated based on their relevance, appropriateness, clarity, and methodology. Two independent reviewers assessed the selected articles for review, and data was extracted, including information on the participants, year of publication, study method, types of intervention, and outcome.

### Analysis

#### Steps of analysis

1. The data obtained were organized into a table that included information such as the author, study design, year of publication, setting method, sample size, type of intervention, components of intervention, and outcome.
2. The studies were identified based on their setting methods, sample size, type of intervention, and components of intervention.
3. The findings of the studies were categorized under the heading of the comparison of cross-education training and PNF exercise combined with mirror therapy on upper limb rehabilitation in sub-acute stroke.

### Results

The review study began with 250 potentially relevant articles, out of which 200 were excluded as duplicates. Another 25 studies were excluded as they did not meet the inclusion and exclusion criteria, and 15 articles did not mention the intervention being studied. As a result, 10 studies were ultimately included in the review.

### Characteristics of the articles

All 10 of the studies included in the review were qualitative studies. The majority of these studies were conducted in hospital settings. They were published between the years 2010 and 2023.

S.N	Study/Author	Year of publication	Research design	Number of participants	Sample character	Theme	Sub theme
1	Gabrielle Scronce <i>et al.</i>	2023	A Pilot Study	12	Post Stroke	Based on this pilot study, it appears that combining self-directed therapy at home with subsensory Thera Bracelet stimulation can lead to improved upper extremity recovery outcomes in stroke survivors. These findings suggest that it is important to effectively promote adherence to prescribed home exercise programs (HEPs). Furthermore, additional research is needed to investigate the effectiveness of Thera Bracelet in facilitating recovery among a larger sample of stroke survivors.	The aim of this study was to investigate the impact of adhering to self-directed therapy and using Thera Bracelet (which involves subsensory random-frequency vibratory stimulation) on hand function in stroke survivors. To achieve this, a double-blind, randomized controlled pilot trial was conducted with 12 chronic stroke survivors who were divided into either a treatment group or a control group.
2	Destaw B. Mekbib <i>et al.</i>	2021	Single blind Randomized Parallel group design	23	Stroke	The MNVR-Rehab is a virtual reality-based rehabilitation setting designed based on the neuroscience hypothesis of the MNs. The setting offers an immersive and customizable environment for functional task training with multiple options. Preliminary results from clinical trials suggest that the MNVR-Rehab is a promising tool for improving upper extremity functional capabilities in subacute stroke patients with moderate-to-severe impairments. The tool encourages highly repetitive functional tasks to facilitate the development of motor skills and support the rehabilitation process.	The goal of this project was to create a new rehabilitation protocol utilizing virtual reality technology that can fully immerse patients and utilize off-the-shelf VR devices to stimulate and activate MNs, with the ultimate aim of facilitating poststroke recovery.
3	Hamza Y. Madhoun <i>et al.</i>	2020	Randomized controlled trial		Subacute stroke	The results of this study demonstrate that combining conventional rehabilitation treatment with TBMT is an effective approach to enhance functional recovery in stroke patients with upper limb impairments.	The aim of this study was to compare the effects of TBMT with occupational therapy on motor function and activities of daily living in subacute stroke patients with moderate to severe upper limb impairment.
4	Thierry Paillard <i>et al.</i>	2020	A Review	NA	Stroke	The study revealed that cross-over fatigue can negatively impact postural control and impair contralateral monopodal postural control after both fatiguing electro-induced and voluntary contractions. These findings can be applied in the field of therapy as rehabilitation sessions post-lower limb surgery often involve such exercises. Therapists should consider the harmful effects of cross-over fatigue on postural control while designing their therapeutic programs.	This study found that cross education has an impact on the ability of the opposite limb to maintain balance while standing on one foot.
5	D. Simpsons <i>et al.</i>	2019	A Case Study	NA	Post stroke	This case report represents the first attempt to explore the application of lower limb cross-education strength training in combination with MT for a stroke patient. The results of the study suggest that the combination of cross-education and MT has the potential to enhance ankle dorsiflexion strength, reduce lower limb spasticity, improve motor function, and enhance the patient's perception of their participation in activities following a stroke. What makes this combination therapy novel is that it is easy to apply and can produce rehabilitative effects in the less affected limb by training the more affected limb only.	This case report aimed to investigate the feasibility of using a combination of both therapies as an intervention to improve lower limb impairments and functional ability in a post-stroke individual.
6	Sudha Dharmi <i>et al.</i>	2019	Comparative study	40	Stroke	The combination of mirror therapy and repetitive facilitation has been proven effective in enhancing functional independence of the upper limb in individuals who have had a sub-acute stroke. A 4-week treatment using this	This study aims to enhance the motor recovery of the upper extremities in patients with hemiparesis through the use of mirror therapy and repetitive facilitation exercises.

						approach has been shown to improve reaching, grasping, manipulation of objects and other fine motor functions of the hand.	
7	Jung-Hu Kim <i>et al.</i>	2017	A Randomized pilot study	19	Stroke	The results of this study suggest that mirror therapy can have a positive impact on the motor recovery of the upper extremity, and that the mirror therapy program used in this study was effective in promoting functional recovery of the upper extremity after stroke.	The objective of this study is twofold: first, to verify the effectiveness of mirror therapy in promoting the motor recovery of the upper extremity; and second, to propose a standardized mirror therapy program that can be used for stroke patients.
8	David Parezcruzado <i>et al.</i>	2016	Systematic review	NA	Stroke	In terms of the primary variables for promoting recovery, mirror therapy (MT) alone demonstrated superior results in upper limb functioning for both acute and chronic stroke patients compared to either conventional rehabilitation (CR) or CR combined with MT.	This study aimed to compare the effectiveness of motor therapy (MT) and conventional rehabilitation (CR) in improving upper extremity function in stroke survivors. The primary variable for measuring the effectiveness was upper limb functioning. The results showed that MT alone was more effective than either CR or CR plus MT in promoting recovery in upper extremity function in stroke patients.
9	Dilip Khanal <i>et al.</i>	2013	Experimental study.	30	Stroke	This four-week study found that the Pelvic Proprioceptive Neuromuscular Facilitation (PNF) group showed greater improvement compared to the conventional physiotherapy group in terms of trunk performance, trunk lateral flexion range of motion, balance, and gait. Therefore, these results suggest that the pelvic PNF technique is effective in improving trunk movement in hemiparetic stroke patients.	The aim is to investigate how Pelvic Proprioceptive Neuromuscular Facilitation (PNF) technique impacts the improvement of trunk movement in patients with hemiparetic stroke.
10	Esther MJ Stenltjens <i>et al.</i>	2003	Systemic review	NA	Stroke	This analysis found that comprehensive occupational therapy (OT) has a positive impact on the primary activities of daily living (ADL), extended ADL, and social participation, although the effect sizes are small. This is consistent with a systematic review of intensified rehabilitation for stroke patients. However, there is limited evidence regarding the effectiveness of specific interventions. To establish evidence-based OT for stroke patients, further research is necessary.	Occupational therapy for stroke.

## Conclusion

Cross education training, mirror therapy, and PNF are all established rehabilitation techniques that have been used individually to aid stroke recovery. Cross education training involves training the non-affected limb to improve function in the affected limb, while mirror therapy uses the reflection of a mirror to create the illusion of movement in the affected limb. Proprioceptive neuromuscular facilitation (PNF) involves exercises that target specific muscle groups to improve strength and flexibility. There is increasing interest in the potential benefits of combining these techniques in stroke rehabilitation. Some researchers have hypothesized that combining these techniques could lead to a synergistic effect, resulting in greater improvements in motor function and greater gains in quality of life. To date, there has been limited research into the combined use of these techniques, and further studies are needed to determine the effectiveness of this approach. Overall, these techniques represent important tools in the rehabilitation of stroke patients. By engaging both the affected and non-affected limbs and promoting the brain's ability to rewire and learn new motor

skills, they have the potential to improve function, independence, and quality of life in stroke survivors.

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