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Review article

The Effectiveness of Mirror Therapy on Lower Extremity Motor Function among Stroke Patients: A review

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Abstract.

Objective: Lower-extremity motor (LEMF) function is considerably reduced following stroke, resulting in functional mobility limitations. Exercise is typically used in the weeks after a stroke for people with hemiparesis. This review aimed to investigate the effect of mirror therapy (MT) on LEMF in stroke patients.

Materials and Methods: The papers in this review were chosen by two authors (S.B. and H.A.) independently to identify the available data and to evaluate thoroughly between 2007 and 2020.

Results: In this review, eight papers were identified based on the pre-determined inclusion and exclusion criteria. The results of the study revealed that MT significantly improved LEMF and recovery. The improvement in mobility in subacute stroke patients is more prominent, particularly enhanced walking speed and LEMF in stroke patients.

Conclusion: When compared to Cg in the stroke patient, MT was demonstrated to be a beneficial and risk-free intervention for improving walking velocity, balance capacity, motor function, passive range of motion (PROM) for ankle dorsiflexion and step length.

Keyword: Stroke, exercise, mirror therapy

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Introduction

Stroke

Stroke is a chronic disease characterized by the sudden loss of blood circulation to an area of the brain, resulting in a corresponding loss of neurologic function with no apparent reason other than vascular roots, lasting for longer than 24 hours and can lead to serious and fatal outcomes.[1] It is the main cause of long-term disability in adults, with over 60% of the survivors from stroke suffering from persistent neurologic deficits that decrease quality of life.[2] Stroke is found to be a significant cause of treatment failure and, a major cursor of long-term injury in the USA, UK and Australia that can further be accentuated and sustained by reduced walking ability.[3]

Stroke patients and mirror therapy

Lower-extremity motor function (LEMF) is substantially reduced after a stroke, resulting in functional mobility limitations.[4] Exercise therapy based on neuromuscular re-education has long been used in the weeks following a stroke for people with hemiparesis. Affected patients would be asked to engage in pre-walking functional tasks such as weight shifts in sitting or standing-transfer activities.[5]

Mirror therapy (MT) or visual mirror feedback is defined as the therapy for pain or disability that may improve one side or both sides of the patient-by focusing on moving the unimpaired limb.[6] MT has been recommended as a successful intervention for the regeneration of the lower limb after stroke.[7] MT in its typical form is a cost-effective and simplistic adjunct therapy to existing stroke therapies.[8]

The individual view the reflection of the unaffected limb in a mirror during MT in their mid-sagittal plane, thus putting their affected limb out of the sight behind the mirror. The optical perception or mirror feedback shows how a fully functional limb successfully triggers the brain to activate the sensorimotor regions to enhance motor rehabilitation.[9] Todorov et al, indicated that visual mirror feedback helps decrease asymmetric activation between hemispheres and facilitate cortical improvement within the primary motor cortices of the ipsilateral and contralateral of the brain.[10]

Altschuler et al., stated that the ability to improve lower limb function and a range of motion and accuracy of arm motor function was tremendously enhanced with MT.[11] According to an intervention review that comprised 14 trials including 567 individuals, MT enhanced mobility of the affected limb and the capacity to carry out everyday activities. After a stroke, mirror treatment decreased pain, but only in individuals with complicated regional pain syndrome.[12] Also, Sathian et al, stated that two weeks of active MT in stroke patients showed significant improvement in the paretic arm's grip strength and hand movement.[13]

MT has been indicated as a therapy for limb pain in amputee patients,[14] and in stroke patients with brachial plexus avulsion, peripheral nerve injury, and complex regional injury pain.[15]

Finally, to date, most of the study related to stroke patients using MT has focused more on the upper extremity in the last few years.[16] Hence, this review aims to investigate the effect of MT on LEMF in stroke patients.

Materials and Methods

The studies included in this review were carefully selected independently by two authors (S.B and H.A) on the freely available data. The studies were selected by identifying all relevant studies by searching through the different databases including PubMed, Cochrane Central Database and Google

Table1: Inclusion and exclusion criteria used for this review

Study characteristics	Inclusion criteria	Exclusion criteria
Period	**2007- 2020**	**Studies outside these dates**
Type of studies	Original studies from	Non-peer-reviewed or non-original research Editorials, opinions, and discussions
Publication type	Full-text articles available Available in English	Studies without full-texts In a language other than English
Participants	Stroke patients have pain in the lower limb	Patients having any other diseases. And study about upper limb
Study design	RCT Experimental study	Systematic review Meta-analysis Another study

Scholar for the published papers, using the keywords to screen carefully from 2007- 2020. The details were imported from the citation manager of EndNoteX9. The papers were then checked and chosen based on their applicability to the purpose of the study. Then final screening was carried out. The following search words were employed to include all relevant studies: "Mirror therapy", “hypertension”, “stroke”, “rehabilitation”, and “lower limb”. Initially, 100 articles were identified, and after a careful evaluation according to our pre-defined inclusion and exclusion criteria shown in Table 1, eight studies were finally included in the study.

Results

The results of the current study revealed that MT improved LEMF and motor recovery significantly.The increase in mobility in subacute stroke patients is more noticeable, as it improves walking speed and motor recovery in stroke patients. In addition, MT -not only improve ambulation and LEMF, but it also improves balance and gait in the paretic lower limb post-stroke as showed in Table 2.

Table 2: Studies included in the review with general characteristics and key findings

Authors	Number of patients/ Time of the intervention	Method	Result	Summary findings
Sütbeyaz S [6]	-40 patients -4 weeks intervention with 6 months follow up	-RCT -30 minutes a day of the MT intervention containing nonparetic ankle and dorsiflexion or sham therapy. -In addition to the rehabilitation program, 5 days per week, 2 - 5 hours a day, for 4 weeks	-There were significant differences between groups after the intervention, FIM motor score (mean, 21.4 in MT group vs 12.5 Cg). -The Brunnstrom stages (mean, 1.7 in the MT group vs mean 0.8 in Cg)	MT and a conventional rehabilitation program improved LEMF and motor recovery in stroke patients
Mohan U[17]	-22 patients. -2 weeks of intervention	-RCT -MT group underwent 30 minutes of functional synergy movements of the non-paretic lower extremity -control group underwent sham therapy for 30 minutes. -Both groups were subjected to a conventional stroke rehabilitation regime. -Al together 90 minutes session per day, 6 days a week	-MT group indicated significant differences in FAC. -Conventional and MT groups presented a significant improvement in FMA and BBA	MT and traditional care offer similar to improve in lower limb motor regeneration and balance
Xu Q[18]	-69 patients -4 weeks of intervention	-RCT -Three groups: Cg, MT, and MT+neuromuscular electrical stimulation. -All groups conducted interventions for 0.5hours/day and 5 days/week	-There were significant improvements between patients in the MT and control group. -Brunnstrom stage (10-meter walk test and passive range of motion, MT plus neuromuscular electrical stimulation group exhibited better results than those in the MT group in the 10-meter walk test)	Compared to the control group patients, the MT+neuromuscular electrical stimulation group revealed a substantial decline in the spasticity

Salem HM[19]	-30 patients. -4 weeks of intervention	-RCT -2 groups: MT and Cg. -MT underwent traditional treatment for 5d/wk 2-5h/d, and 30 minutes	-MT group showed significant improvement in 1.passive ankle range of motion. 2.walking speed (mean + 0.083 in MT group vs - 0.025 in Cg). 3.Brunnstrom stages (mean + 0.69 in MT group vs. + 0.36 in Cg)	MT combined with a traditional rehabilitation program in stroke patients enhance walking speed and lower extremity motor recovery in stroke patients
Lee HJ [20]	-35 patients -6 weeks intervention	The AOTA group underwent observation therapy using video for 15 minutes a day and physical training as the observed ones for 15 minutes per day. -The MTA group conducted MT for 15 minutes a day and physical training without a mirror for 15 minutes a day. -The AOT group received action observation-only, without physical training, for 30 minutes/day. -All groups received conventional physical therapy 2/week for 30 minutes/ day	1. Improvement in balance an d gait function was noted. 2. Significantly improved subjects' static balance in the (AOTA) group. 3. The AOT and (MTA) groups significantly improved subjects' gait ability	The study showed that activation of mirror neurons combined with a traditional stroke physiotherapy program was able to improve LEMF and motor recovery in stroke patients
Ikizler MayH [21]	-42 patients. -12 weeks of intervention	-RCT -Cg conducted a traditional rehabilitation program for 4 wk, 60-120 minutes/day for 5 days a wk. -MT group conducted MT for 30 minutes in addition to the traditional therapy	-There was a significant improvement in the - Berg balance scale - motricity index - a six-minute walking test - functional ambulation category and - modified Ashworth scale	These findings showed that in addition to the traditional rehabilitation program, MT yielded greater enhancement in the ambulation and LEMF, which is sustained for a limited period following treatment
Deshpande MaFN [22]	-30 patients -4 weeks of intervention	-RCT -2 groups: Conventional therapy and MT+ conventional therapy group. -Both groups received conventional treatment for 40 minutes/ day, 6 days/week. -MT+ Conventional Therapy group performed an additional exercise (non-affected extremity, against the reflecting surface of the mirror)	-There were significant changes in the FMA scores in the Cg and Experimental group. -There was a significant improvement in the conventional and MT group in the FMA-LE score	Incorporating MT as an assistant to convention al therapy can improve motor recovery as a home-based program.
Vaidya [23]	-30 patients. -3 weeks intervention	-An experimental study -Two groups; -The group 1 patient received proprioceptive neuromuscular facilitation along with conventional treatment. -Group 2 patients received MT along with conventional treatment -15 sessions for 3 weeks	-There was a significant improvement in gait and balance in both groups	-Both groups (Proprioceptive neuromuscular Facilitation group and MT group) were able to improve gait and balance. -Comparing both of the techniques, there was a significant difference shown between the groups. -Proprioceptive neuromuscular facilitation is more operative for improving balance and gait in paretic lower limb poststroke

AC: Functional ambulation categories, RCT: Randomized controlled trial, AOTA: Action observation therapy with activity, MTA: Mirror therapy with activity, AOT: Action observation therapy, BRS: Brunnstrom recovery stages, FMA-LE: Fugl-Meyer assessment lower extremity, RVGA: Rivermead visual gait assessment, 10-MWT: 10-metre walk test, FMA: Fugl Meyer Assessment, PROM: Passive range of motion, M: Months, Cg: Control group

Discussion

Stroke is regarded as one of the leading causes of high dysfunction in the home and community [24.] A significant concern is the recovery of compromised post-stroke lower limb function, and over 30% of patients with chronic stroke experienced an ongoing struggle with independent ambulation. This review investigates the effect of MT on LEMF in stroke patients. Findings from our included studies showed that MT had a significant improvement on the LEMF and motor recovery in stroke patients,[6] with enhancement in the walking speed and improved balance and gait in paretic lower limb post-stroke in the experimental group compared to the control group.[25] Furthermore, Kim et al., illustrated that MT helps improve the effects of stroke on gait ability and improve LEMF.[26] MT also yields greater enhancement in ambulation in post-stroke patients.

It is concluded from our study results that MT provided a substantial decline in spasticity and, is beneficial in improving motor recovery as a home-based program.[22] Previous studies have emphasized these similar findings that MT is an important technique that can benefit post-stroke patients because it significantly improves balance capacity, speed, PROM and step length compared to control interventions.[27] Lim et al, concluded in a recent study that MT for the lower extremity has significant improvement for gait speed and a small positive outcome of MT for motor recovery and mobility in post-stroke patients.[28] It is generally known that increasing the inflow of signals from sensory modalities in different ways can improve brain plasticity.[29] It was reported that sensory methods such as visual and auditory feedback can help to mediate feedback information obtained from movement.[30] The mechanism of MT creates mirror illusions that generate neuro-transitory signals to the brain which in turn stimulate motor and sensory activity, this act provides certain positive feedback to the central nervous system thus, stimulating Musculoskeletal muscle reflexes such as LEMF and recovery.[31,32] In stroke patients, MT provides visual input of normal movement of the affected limb, which may compensate for a lack of proprioceptive input that culminates in brain waves and activities.[33] Another hypothesis is that the mirror neuron system is involved.[31] However, the exact mechanisms of MT in stroke patients are unknown.[12] Pandian et al, explained that among chronic post-stroke hemiparetic patients, MT facilitated the lower limb's motor recovery and decreased gait deviations.[34] Another study identified that MT greatly improves activities of daily living and reduces pain perception in poststroke patients. Besides, MT combined with conventional rehabilitation therapy for 4 weeks could be the most effective treatment method for improving lifestyle, motor-function, and pain sensitivity in post-stroke patients.[35] The mechanism is that presenting a physiologic image of the afflicted region might help to normalize central sensory processing,[36] which in turn would lead to wide stimulation of attention and cognitive centers, bilateral motor cortices, certain areas within the mirror neuron center as well as reducing the intracortical inhibition to the affected hemisphere.[37] Nevertheless, MT may be recommended for post-stroke patients, but more studies on MT are needed to confirm these beneficial effects.

Balance impairments have been demonstrated to impede the capacity of people with stroke to improve their balance, especially while walking, hence, tolerable sitting exercise is encouraged to improve gait and balance. This would eventually enhance the patient's quality of life and reduce the need for frequent supervisory support while walking could be an accessible way for patients to enhance their walking without supervision.

Further research is required to investigate the long-term benefits of MT on spasticity and functional activities in spastic patients as well as additional studies should be conducted to address the issue of appropriate treatment dose and adequate recovery phase in connection to treatment administration.

Conclusion

In comparison to Cg, MT was demonstrated to be a beneficial and risk-free intervention for improving walking velocity, balancing capacity, LEMF, PROM, step length, and reducing motor impairment in the lower limbs in post-stroke patients.

Author Contribution

1. S.B: Conceived and designed the analysis, data collection, wrote the paper

2. H.A.A: Conceived and designed the analysis, data collection, Contributed data or analysis tools

3. A.M.S: Conceived and designed the analysis, data collection, performed analysis, wrote the paper

4. A.A.M: Conceived and designed the analysis, wrote the paper

5. A.Y.A: Conceived and designed the analysis, data collection, wrote the paper

6. M.M.A: Conceived and designed the analysis, data collection, wrote the paper

7. S.I.M: Conceived and designed the analysis, data collection, performed analysis, wrote the paper

8. M.H.M: Conceived and designed the analysis, data collection, wrote the paper

9. A.H.M: Conceived and designed the analysis, wrote the paper

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