Mirror therapy and transcutaneous electrical nerve stimulation to improve upper limb function in patients with stroke: abridged secondary publication

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KEY MESSAGE

Mirror therapy combined with bilateral transcutaneous electrical nerve stimulation appears to be superior to sham mirror therapy plus nerve stimulation in improving upper limb motor function and community integration among people with subacute or chronic stroke. The effects were maintained at 4 weeks after treatment ended.

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Introduction

Approximately 70% to 80% of people with stroke have motor deficits in their upper extremities, and approximately 30% to 66% of them do not regain functional use of their paretic arm within 6 months after stroke.[1] Impairment of upper limb function hinders activities of daily living such as eating and personal care.

Bilateral transcutaneous electrical nerve stimulation (Bi-TENS) was applied to both the paretic and non-paretic limbs,[2,3] and mirror therapy (MT), in which patients view a reflection of the moving intact limb, can enhance recovery of motor function in paretic limbs after stroke.[4,5] Both TENS and MT can induce neuroplastic changes that enhance the motor system; they may act synergistically to support motor practice.

This study aimed to compare the effects of MT plus Bi-TENS versus sham MT plus Bi-TENS in promoting the recovery of upper limb motor function in people with stroke.

Methods

Older adults aged 55 to 85 years with first-ever stroke within 5 years who had residual upper limb impairment but retained minimal active movement and sufficient cognitive function were invited to participate. Participants were randomly allocated to receive either MT plus Bi-TENS or sham MT plus Bi-TENS, in addition to usual care. The intervention consisted of 16 sessions delivered twice weekly over 8 weeks. During MT, an adjustable-angle frame with a mirror box was positioned in front of participants. The paretic arm was positioned behind the mirror, and the intact arm was positioned facing the reflective surface. Concurrently, participants received TENS (100 Hz with 0.2 ms square pulses, at an intensity barely below the motor threshold) over the median and radial nerves of both intact and paretic arms while practising symmetrical bilateral upper limb exercises. Participants were reminded to focus on the illusion that the reflected arm was the paretic limb. Exercises included elbow flexion and extension, forearm supination and pronation, wrist flexion and extension, radial and ulnar deviation of the wrist, finger opposition, and gripping. During sham MT, the mirror surface was covered to remove the visual illusion.

Participants were assessed at baseline, 4 weeks (after 8 sessions), 8 weeks (after 16 sessions), and at a 4-week follow-up visit. Primary outcomes included motor impairment of the paretic upper limb, assessed using the Fugl-Meyer Assessment of Upper Extremity (FMA-UE) and upper limb motor function using the Wolf Motor Function Test (WMFT). Secondary outcomes assessed included proficiency in putting on and removing a long-sleeved jacket using the Jacket Test, frequency and quality of paretic arm use across 30 daily activities using the Motor Activity Log (MAL), perceived participation and the impact of stroke on daily life using the

Stroke Impact Scale 3.0, and level of community integration using the Community Integration Measure (CIM).

All statistical analyses were two-sided; the significance threshold was set at 5%. Data were analysed on an intention-to-treat basis. The two groups were compared using the independent *t* test for continuous variables and Chi-squared test for categorical variables. Mixed-effects models were used to examine group differences in changes in outcomes across assessment time points.

Results

In total, 30 participants with subacute stroke (3-11 weeks post-stroke) and 60 participants with chronic stroke (within 5 years post-stroke) were recruited. Participants with subacute stroke received 3 hours of standardised conventional physiotherapy and occupational therapy in addition to the intervention, whereas participants with chronic stroke received the intervention alone due to the COVID-19 pandemic. Consequently, participants with subacute and chronic stroke were analysed separately.

In the subacute stroke group, MT plus Bi-TENS was associated with greater motor recovery (FMA-UE), better upper limb motor function (WMFT), improved performance on a functional dressing task (Jacket Test), higher self-reported frequency and quality of paretic arm use in daily life (MAL), and higher levels of community integration (CIM). These improvements were maintained at the 4-week follow-up, suggesting lasting benefits.

In the chronic stroke group, MT plus Bi-TENS showed greater improvements in upper limb impairment (FMA-UE) and upper limb motor function (WMFT). The magnitude of change was typically smaller than that observed in the subacute stroke group.

Discussion

Among participants with subacute or chronic stroke, MT plus Bi-TENS had synergistic effects and resulted in significantly greater increases in FMA-UE and WMFT scores compared with sham MT plus Bi-TENS. Bi-TENS has been reported to improve motor function of the paretic upper and lower limbs, probably due to additional sensory input from the non-paretic side, which reduces paresis on the paretic side by rebalancing interhemispheric inhibition, activating homologous neural networks in the intact and lesioned hemispheres, and recruiting neural networks of the intact hemisphere.[2,3]

MT can improve upper extremity motor function and activities of daily living in people after stroke.[4] Its mechanisms are multifactorial. Visual input during MT may substitute for reduced proprioceptive input and increase spatial attention to the paretic limb, thereby improving motor function.[4,5] These improvements may be mediated by increased cortical activity in the lesioned hemisphere and activation of the mirror neuron system.[4,5]

The greatest improvements in post-stroke motor function occur 3 to 6 weeks after stroke onset,[1] although interventions can also improve motor function years after stroke onset.[2,3] Further studies are warranted to determine mechanisms of motor recovery across post-stroke phases, including differences in cortical reorganisation, kinematic changes, and other aspects of clinical improvement.

Conclusion

Compared with sham MT plus Bi-TENS, MT plus Bi-TENS achieved greater increases in FMA-UE, WMFT, Jacket Test, and CIM scores among participants with subacute or chronic stroke. The effects were maintained at 4 weeks after treatment ended.

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