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Effects of Transcutaneous Auricular Nerve Stimulation versus Body Rocking Exercises on Upper Limb Spasticity in Young Stroke Patients: A Randomized Clinical Trial

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DECLARATIONS

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ABSTRACT

Background: Upper limb spasticity is one of the most crippling effects of stroke, which continues to be a major source of long-term impairment globally. It has a major effect on quality of life, everyday functioning, and motor control, especially in young stroke survivors. **Objective:** To compare the effects of transcutaneous auricular nerve stimulation versus body rocking exercises on upper limb spasticity in young stroke patients. **Methodology:** A randomized clinical study with blinded outcome evaluation was conducted at the Superior University and City Clinic Physiotherapy and Rehabilitation Center in Lahore. Participants were randomly assigned to either Group A, treated with transcutaneous auricular nerve stimulation, or Group B was given body rocking exercises. If they had upper limb spasticity following a stroke and were between the ages of 35 and 45. The interventions lasted for eight weeks. The results were measured using the Modified Ashworth Scale, Numeric Pain Rating Scale, Stroke Impact Scale, and Fugl-Meyer Assessment for Upper Extremity. The statistical analysis was conducted using non-parametric tests. **Results:** Both groups showed statistically significant improvement from baseline in all outcome measures ($p<0.05$). However, Group B exhibited significantly greater post-treatment improvements in spasticity ($p=0.00$), pain ($p=0.00$), motor function ($p=0.02$), and quality of life (SIS, $p = 0.00$). Within-group analysis confirmed consistent improvement in both groups, but the magnitude was higher in the body rocking group. **Conclusion:** Young stroke patients' upper limb stiffness can be effectively managed with Transcutaneous auricular nerve stimulation and body rocking exercises. Nonetheless, body rocking exercises showed better results in every category, indicating that they have a higher potential to support neuroplasticity recovery and functional independence. These results provide credence to the use of rhythmic, body-based therapies in post-stroke rehabilitation programs, particularly in environments with limited resources.

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INTRODUCTION

Stroke continues to rank among the leading causes of adult disability worldwide, impacting over 15 million people annually. Nearly 5 million of them suffer from chronic or irreversible disability, many of which are complicated neurological and musculoskeletal conditions. One of the most functionally limiting and therapeutically difficult consequences among these side effects is upper limb stiffness. Lesions in upper motor neurons cause spasticity, which results in increased muscular tone, clonus, rigidity, and an imbalance between excitatory and inhibitory neuronal regulation. These velocity-dependent alterations usually lead to aberrant posture, impaired voluntary motor control, and resistance to passive movement. These disabilities significantly limit stroke survivors' capacity to carry out daily tasks like eating, dressing, grooming, writing, and personal hygiene. Therefore, a person's independence, capacity for self-care, and general quality of life are all directly impacted by upper limb spasticity.[1,2]

The velocity-dependent alterations usually lead to decreased voluntary motor control, aberrant posture, and resistance to passive movement. These disabilities make it extremely difficult for stroke survivors to carry out daily tasks, including eating, dressing, grooming, writing, and keeping themselves clean. Thus, upper limb spasticity has a direct effect on a person's capacity for self-care, independence, and general quality of life.[3-5] Pharmacological treatments for post-stroke spasticity usually involve intramuscular injections of botulinum toxin, baclofen, tizanidine, and diazepam. Although these therapies could provide temporary respite, they frequently come with unfavorable side effects such as drowsiness, exhaustion, lightheadedness, abdominal pain, and muscular weakness. Additionally, the advantages of botulinum toxin are transient and require repeated doses every several months.

It may be necessary to perform surgical techniques, such as tendon lengthening or intrathecal baclofen pump implantation, in instances that are severe or unresponsive. But these surgical methods are expensive, intrusive, and not appropriate for every patient, especially in resource-constrained environments. As a result, there is an increasing clinical need for scalable, low-cost, non-invasive therapeutic strategies that can successfully treat post-stroke spasticity without the drawbacks of conventional methods.[6-8]

Transcutaneous auricular nerve stimulation (TANS) and body rocking exercises are two non-pharmacological, non-invasive therapies that have drawn interest recently. TANS is a neuro-modulatory method that uses surface electrodes applied to the ear to stimulate the vagus nerve's auricular branch. By adjusting the balance between excitatory and inhibitory pathways, this stimulation reduces motor neuron hyperexcitability and eases spasticity by modulating neuronal activity in the motor cortex, cerebellum, and spinal cord. TANS has demonstrated potential in enhancing motor control and lowering muscular stiffness in stroke patients by affecting both central and autonomic nervous system components.[9-11]

Body rocking exercises, on the other hand, employ repetitive, rhythmic motions that enhance neuromuscular coordination, stimulate sensory pathways, and activate the proprioceptive system. The goals of these workouts are to improve joint mobility, avoid contractures, and restore normal muscle tone. In young stroke patients, who have a higher potential for brain remodelling and recovery, they also promote neuroplasticity and motor relearning. Regularly engaging in body rocking exercises can help promote independence and long-term functional progress in addition to reducing stiffness.[12-14]

The purpose of this study was to evaluate and contrast the effectiveness of body rocking exercises and TANS in lowering upper limb stiffness in young stroke patients. Standardized clinical outcome measures will be used to assess changes in muscle tone, resistance to passive movement, and severity of spasticity. This study aims to promote the use of easily available, non-invasive therapies for long-term stroke recovery and improve evidence-based practices by concentrating on young stroke survivors, a population with a high potential for neurorehabilitation.

METHODOLOGY

This research was planned as a blinded, randomized outcome evaluation. It sought to assess and contrast the effects of body rocking exercises and TANS on upper limb stiffness in young stroke patients. In order to minimize observer bias, independent evaluators blinded to

the assigned interventions carried out the outcome evaluation, and randomization guaranteed impartial group allocation. 42 people in all were enrolled in this study. Before, research and statistical power considerations were used to select the sample size to identify any significant variations in spasticity outcomes between the two treatment groups. Using convenience sampling, participants were chosen according to their availability and eligibility.

To ensure equitable distribution and reduce selection bias, they were then assigned at random using a computer-generated randomization schedule to either Group A (TANS) or Group B (body rocking exercises). The City Clinic Physiotherapy and Rehabilitation Center in Lahore and Superior University served as the study's locations. Standardized rehabilitation settings with trained personnel and required equipment were offered in both settings. The study duration was 8 weeks, following approval from the Board of Advanced Studies and Research (BASR). Each participant received intervention over this period, with pre- and post-treatment assessments recorded. Patients aged between 30 and 45 years, diagnosed with first ischemic or hemorrhagic stroke (within the last 6 months), with the presence of upper limb spasticity with modified Ashworth scale (MAS) score ≥1, were included in the study. Patients with a history of recurrent strokes, severe cognitive impairment, contractures, or deformities in the upper limb, presence of implanted pacemakers or metal near the stimulation site, or epilepsy were excluded.

The MAS is used to measure spasticity by evaluating resistance during passive movement. It is a 6-point ordinal scale widely used in clinical settings. The Fugl-Meyer assessment for upper extremity (FMA-UE) assesses motor function, coordination, reflexes, and joint movement in the affected upper limb. The score ranges from 0 to 66, with higher scores indicating better function. The numeric pain rating scale (NPRS) measures pain intensity on a scale from 0 (no pain) to 10 (worst pain) based on patient self-report. The stroke impact scale (SIS) evaluates the impact of stroke on quality of life, including physical, emotional, memory, communication, and participation domains.

Participants were assessed at baseline (pre-intervention) and at the end of the 8-week intervention. After informed consent, eligible participants were randomized into two groups. Group A received TANS therapy, while Group B participated in body rocking exercises. Each intervention was conducted under the supervision of qualified physiotherapists. Post-intervention data were collected by a blinded assessor who was unaware of group allocations to reduce assessment bias.

All data were analyzed using SPSS version 26.0. The Shapiro-Wilk test was applied to check the normality of the data. For within-group analysis, the Wilcoxon signed-rank test was used. For between-group comparisons, the Mann-Whitney U test was used due to non-parametric distribution. The p-value <0.05 was considered statistically significant for all tests.

RESULTS

A total of 42 participants were enrolled, with 21 individuals each in Group A (TANS) and Group B (body rocking exercises). The average age of participants was 43.31 ± 2.03 years, with a median age of 44 years, and an age range of 35–45 years. The study sample comprised 78.6% males and 21.4% females. Ischemic stroke was the most common type (61.9%), followed by hemorrhagic stroke (38.1%). Right-side upper limb involvement was more frequent (66.7%) than left (33.3%). Both groups were statistically comparable at baseline across all outcome measures, as indicated by the Mann-Whitney U-test, confirming group homogeneity. Tests of normality using the Shapiro-Wilk test showed non-normal distribution across all pre-treatment variables.

The tests of normality for various pre-assessment measures show that the distributions for all variables significantly deviate from normal. The Shapiro-Wilk test for the NPRS, MAS, FMA-UE, and

Table 1: Shapiro-Wilk test of normality

Variables	Statistic	Df	Sig.
Numeric pain rating scale	0.81	42	0.00
Modified Ashworth Scale	0.84	42	0.00
Fugl Meyer assessment	0.93	42	0.02
Stroke Impact Scale	0.93	42	0.01

Table 2: Between-groups difference using the Mann-Whitney U test

Variables	Between-groups Analysis		Mean Rank	p-value
Numeric Pain Rating Scale	Pre-treatment	Group A	19.45	0.25
		Group B	23.55	
	Post-treatment	Group A	31.43	0.00
		Group B	11.57	
Modified Ashworth Scale	Pre-treatment	Group A	24.07	0.15
		Group B	18.93	
	Post-treatment	Group A	26.02	0.01
		Group B	16.98	
Fugl Meyer Assessment	Pre-treatment	Group A	15.00	0.00
		Group B	28.00	
	Post-treatment	Group A	25.40	0.03
		Group B	17.60	
Stroke Impact Scale	Pre-treatment	Group A	20.95	0.77
		Group B	22.05	
	Post-treatment	Group A	11.02	0.00
		Group B	31.98	

SIS resulted in p-values of 0.00, 0.00, 0.02, and 0.01, respectively, all of which are less than the standard significance level of 0.05. This indicates that none of the variables follow a normal distribution. There was no significant difference between the groups. The results reveal that Group B (body rocking exercises) had a significantly greater improvement in their overall pain reduction, motor function, MAS, and stroke impact compared to Group A (TANS), as shown in Table 2. In Table 3, the Wilcoxon signed-rank test within groups showed a significant difference ($p<0.05$).

DISCUSSION

This randomized clinical trial aimed to compare the efficacy of TANS and body rocking exercises on upper limb spasticity, pain, motor function, and quality of life in young stroke patients. The results of this study support the hypothesis that both interventions yield significant improvements, but body rocking exercises are significantly more effective across all assessed outcomes.[3] The MAS showed a significant reduction in spasticity in both groups; however, Group B demonstrated a notably greater decrease. This may be attributed to the proprioceptive and rhythmic stimulation of the neuromuscular system through body rocking, which enhances sensorimotor integration and cortical reorganization. These findings align with, who emphasized the importance of vestibular input in reducing muscle hypertonicity. Pain levels also improved in both groups, with Group B experiencing a significantly greater reduction. This could be due to active involvement in exercise, which enhances endorphin release and reduces musculoskeletal stress, compared to the more passive nature of TANS. Similar pain-relieving effects of body-based interventions have been noted in stroke rehabilitation literature.[15]

In terms of motor recovery, FMA-UE scores improved in both groups, with Group B again showing superior results. The active engagement and proprioceptive activation involved in body rocking likely facilitate motor learning and neuroplasticity, which are essential for functional recovery in stroke patients.[16] Quality of life, measured by the SIS, improved significantly more in Group B. The enhanced mobility, reduced pain, and improved motor function likely contributed to this improvement. The rhythmic and calming nature of body rocking may also positively affect psychosocial factors such as mood and confidence, which are critical in young stroke survivors returning to active roles in society.[17] While TANS demonstrated measurable benefits in spasticity and function, its effects were relatively modest. TANS acts through vagal nerve stimulation, modulating central autonomic and motor pathways. Although promising, it may require longer durations or combination therapy to produce equivalent effects to active interventions like body rocking.

Table 3: Within-group difference using the Wilcoxon signed-rank test

Variables	Within-group Analysis	Mean±S.D	p-value
Numeric Pain Rating Scale	Pre-treatment	8.16±1.34	0.00
	Post-treatment	3.5±1.68	
Modified Ashworth Scale	Pre-treatment	2.11±1.04	0.00
	Post-treatment	1.5±1.17	
Fugl Meyer Assessment	Pre-treatment	21.19±7.43	0.00
	Post-treatment	38.02±6.05	
Stroke Impact Scale	Pre-treatment	34.57±3.09	0.00
	Post-treatment	45.54±6.18	

CONCLUSION

Young stroke patients' upper limb stiffness can be effectively managed with Transcutaneous auricular nerve stimulation and body rocking exercises. Nonetheless, body rocking exercises showed better results in every category, indicating that they have a higher potential to support neuroplasticity recovery and functional independence. These results provide credence to the use of rhythmic, body-based therapies in post-stroke rehabilitation programs, particularly in environments with limited resources.

DECLARATIONS

Consent to participate: Written consent had been obtained from patients. All methods were performed following the relevant guidelines and regulations.

Availability of Data and Materials: Data will be made available upon request. The corresponding author will submit all dataset files.

Competing interests: None

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CONSORT Guidelines: All methods were performed following the relevant guidelines and regulations.

REFERENCES

1. Feigin VL, Brainin M, Norrving B, et al. World stroke organization: global stroke fact sheet 2025. International Journal of Stroke 2025; 20(2): 132–44. https://doi.org/10.1177/17474930241308142

2. Jung K-s, Jung J-h, Cho H-y, In T-s. Effects of transcutaneous electrical nerve stimulation with taping on wrist spasticity, strength, and upper extremity function in patients with stroke: a randomized control trial. Journal of Clinical Medicine 2024; 13(8): 2229. https://doi.org/10.3390/jcm13082229

3. Suputtitada A, Chatromyen S, Chen CP, Simpson DM. Best practice guidelines for the management of patients with post-stroke spasticity: a modified scoping review. Toxins 2024; 16(2): 98. https://doi.org/10.3390/toxins16020098

4. Mei J, Xue Y, Li J, et al. Effects of functional acupuncture on upper limb spasticity after ischemic stroke: a protocol for a randomized controlled parallel clinical trial. Frontiers in Neurology 2022; 13: 835408. https://doi.org/10.3389/fneur.2022.835408

5. Rahman-Enyart M. The Efficacy of Perturbation-Based Balance Training on Preventing Falls in Older Adults: A Systematic Review and Synthesis without Meta-Analysis (SWiM): Indiana University; 2022.

6. Reebye R, Jacinto LJ, Balbert A, et al. Multimodal therapy and use of adjunctive therapies to BoNT-A in spasticity management: defining terminology to help enhance spasticity treatment. Frontiers in Neurology 2024; 15: 1432330. https://doi.org/10.3389/fneur.2024.1432330

7. Zhao S, Zhang MM. I-Health-Designing a Smart Massage Product-Service System for the Sub-health Status of Young People Based on Traditional Chinese Tuina Therapy. International Conference on Human-Computer Interaction 2023; 459–69. https://doi.org/10.1007/978-3-031-49212-9_57

8. Joshua AM, Karthikbabu S, Joshua AM, et al. Therapeutic approaches. Physiotherapy for adult neurological conditions: Springer; 2022: 31–183.

9. Spina S, Facciorusso S, Cinone N, et al. Integrating telemedicine in botulinum toxin type-A treatment for spasticity management: perspectives and challenges from Italian healthcare professionals. Toxins 2024; 16(12): 529. https://doi.org/10.3390/toxins16120529

10. Mustafa H et al. Five weeks of Yuishinkai karate training improves balance and neuromuscular function in older adults: a preliminary study. BMC Sports Science Medicine and Rehabilitation 2022; 14(65): 1-13.

https://doi.org/10.1186/s13102-022-00458-6
11. Costamagna D, Bastianini V, Corvelyn M, et al. Botulinum toxin treatment of adult muscle stem cells from children with cerebral palsy and hiPSC-derived neuromuscular junctions. Cells 2023; 12(16): 2072.
https://doi.org/10.3390/cells12162072
12. Geerars M, Wondergem R, Pisters MF. Decision-making on referral to primary care physiotherapy after inpatient stroke rehabilitation. Journal of Stroke and Cerebrovascular Diseases 2021; 30(5): 105667.
https://doi.org/10.1016/j.jstrokecerebrovasdis.2021.105667
13. Parau D, Todoran AB, Balasa R. Factors Influencing the Duration of Rehabilitation in Infants with Torticollis—A Pilot Study. Medicina 2024; 60(1): 165.
https://doi.org/10.3390/medicina60010165
14. Palanová MP, Bell T. Rehabilitation plan and process in patients after stroke.
15. Duan Y, Zhou H, Liu X, et al. Molecular mechanisms of SARS-CoV-2 resistance to nirmatrelvir. Nature 2023; 622(7982): 376–82.
https://doi.org/10.1038/s41586-023-06609-0
16. Marzola P, Melzer T, Pavesi E, Gil-Mohapel J, Brocardo PS. Exploring the role of neuroplasticity in development, aging, and neurodegeneration. Brain Sciences 2023; 13(12): 1610.
https://doi.org/10.3390/brainsci13121610
17. Mead GE, Sposato LA, Sampaio Silva G, et al. A systematic review and synthesis of global stroke guidelines on behalf of the World Stroke Organization. International Journal of Stroke 2023; 18(5): 499–531.
https://doi.org/10.1177/17474930231156753