TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION IN CONJUNCTION WITH TASK-ORIENTED TRAINING IN THE MANAGEMENT OF CHRONIC POST-STROKE SPASTICITY OF THE UPPER LIMB: A CASE REPORT

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ABSTRACT
Background: *Post-stroke spasticity is a major contributor to functional impairment and disability among stroke survivors as it negatively affects recovery and interferes with quality of life.*
Case presentation: *We present a 45-year-old man with a 6-year history of stroke affecting the right side of the body. He presented with chronic upper limb spasticity and hemiplegic gait. The patient received Transcutaneous Electrical Nerve Stimulation (TENS) to the belly of elbow flexors of the right upper limb using a frequency of 100HZ and pulse duration of 200μs for 60 minutes. Six sets of 100 repetitions of task-oriented training were also performed for 60 minutes. All treatments were administered twice weekly for 12 weeks. The patient's spasticity and motor function were assessed using Modified Ashworth Scale (MAS) and Brunnstrom Recovery Stages (BRS), respectively, before treatment and after 6 weeks and 12 weeks of treatment. There was significant reduction in spasticity post-treatment with more reduction recorded at 12 weeks. The patient's motor function also improved post-treatment but no difference was observed between the 6 weeks and 12 weeks of treatment.*
Conclusions: *This case report demonstrated the beneficial effects of TENS in conjunction with task-oriented training in reducing chronic post-stroke spasticity and improving motor function of the upper limb.*
Keywords: *Stroke, Spasticity, TENS, Task-oriented Training.*

INTRODUCTION

Stroke remains one of the most common non-communicable diseases among Nigerians with an estimated prevalence of 6.7 per 1000 persons, with men being more affected.[1] It is a leading cause of acquired disability in adults[2], hence, a major public health problem warranting effort from all stakeholders to devise effective prevention and treatment strategies.[1]

Post-stroke spasticity is a common motor impairment present in about 20% to 40% of stroke survivors.[3] It is a major contributor to

functional impairment and disability in stroke survivors as it negatively affects recovery and interferes with quality of life.[3,4] Thus, effective treatment approaches targeting spasticity and disability experienced by stroke survivors are warranted to improve their functional as well as physical and mental well-being.

One treatment approach reported to be beneficial for reducing spasticity among stroke survivors is the use of Transcutaneous Electrical Nerve Stimulation (TENS). The mechanisms through which TENS can modulate spasticity include increase presynaptic inhibition of the hyperactive stretch reflexes and decrease co-contraction of the spastic antagonist muscles (modulating reciprocal inhibition).[5] Importantly, evidence from recent systematic reviews and meta-analyses suggest that TENS is effective in reducing post-stroke spasticity among stroke survivors, especially when integrated with other physical interventions.[6,7] Because TENS is cost-effective, safe, and non-invasive treatment, it can also be used at home to manage spasticity, making it a promising alternative or adjunct to current standard treatments.[6]

Task-oriented training (TOT) is a component of current therapy approaches in stroke rehabilitation. It is typically used to enhance the functional recovery of post-stroke patients by providing goal-directed repetitive practice of motor tasks.[8] TOT uses principles of motor learning such as specificity, multiple repetitions, and intensified activity with aim of achieving true recovery of function.[9] There is evidence to suggest that TOT improves motor recovery among sufferers of stroke.[10]

The use of TENS in conjunction with TOT in the management of post-stroke patients is believed to minimize spasticity and enhance functional abilities.[11] While the application of these techniques is important for stroke patients, most studies focused on the lower limb with limited studies[11,12] conducted on the upper limb. Moreover, it appears that this strategy has not traditionally been a significant part of stroke rehabilitation in Nigeria as no published study could be found on the topic. We, therefore, aim to explore the effects of TENS in conjunction with TOT in the management of chronic post-stroke spasticity in a 45-year-old male stroke survivor.

Case Presentation

A 45-year-old businessman was referred to the Physiotherapy Department of Aminu Kano Teaching Hospital, Kano, Nigeria in February 2019 with complaints of difficulty to move the right arm and leg. The history dated 6 years back when he had stroke at 39 years of age. There was no prior history of meningism, dizziness, vomiting, fall, or trauma. The subject had no history of any medical or surgical condition. He was however diagnosed as being hypertensive during the stroke incident.

On general observation, the patient walked into the department unaided with a hemiplegic gait. He was conscious, alert, and oriented in time, place, and person without speech problem. He had a mesomorphic body

somatotype, weighed 64.0kg, and was 1.62m in height (body mass index = 24.4kg/m^2). Cranial examination, superficial and deep sensory assessments were intact. Reflex assessment revealed hyperreflexia (3$^+$) in the right biceps, triceps, and patella tendons. There was hypertonia in the right biceps brachii, brachialis, triceps, flexors of the wrist and phalanges, and pronators of the forearm. Somatosensory assessment revealed intact superficial and deep sensation. No radiological investigation was carried out.

Interventions

TENS was first administered before the TOT. The muscle groups treated were the right elbow flexors (biceps brachii and brachialis). Prior to the application, the nature of the perceived sensation of TENS was explained to the patient. The anterior aspect of the right forearm was dry-cleaned with a methylated spirit. The patient was made comfortable in supine position with the palms anteriorly placed. TENS electrodes (50x50) were then placed on the belly of biceps brachii and brachialis muscles (Figure 1). The TENS parameters used for the treatment were frequency of 100Hz, pulse duration of 200μs, and treatment time of 60 minutes. The treatment was administered twice weekly for 12 weeks (24 sessions). A two-channel TENS machine (EM-6300A, Taiwan) was used for the treatment.

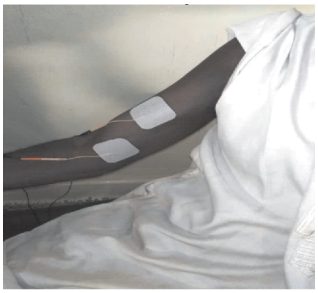

Figure 1: Electrode placement used to activate the elbow flexors (biceps brachii and brachialis)

Following the TENS treatment, TOT was performed with the affected upper limb. The patient was asked to perform a 60-minute goal-driven activity. This involves the movement of the involved arm from contralateral knee to ipsilateral ear with to achieve functional flexion and extension of the forearm. The patient performed 6 sets of 100 repetitions, twice weekly for 12 weeks (24 sessions).

Outcome Assessment

Because we intended to examine the spasticity of the upper limb, all outcome assessments were carried out for the right upper limb of the patient. Spasticity of the upper limb (i.e. elbow flexors) was assessed with Modified Ashworth Scale (MAS). It is a 6-point scale (0, 1, 2, 3, 4, 5), with a score of 0 representing no increase in muscle tone (no resistance) and 5 representing rigidity in flexion and extension. The MAS is commonly used to assess the perceived level of spasticity and proved to be a valid[13]and reliable[14] assessment tool for the upper extremity spasticity in stroke patients. To assess the motor recovery of the affected limb, Brunnstrom Recovery Stages (BRS) was used. The patient's level of motor function is rated on a 6-level Likert scale (1, 2, 3, 4, 5, 6), with a score of 1 indicating the stage of flaccid limb with no voluntary movement and 6 indicating the stage of near-normal and normal movement and coordination.[15]The BRS demonstrated adequate psychometric

properties for assessing motor recovery in stroke patients.[16,17]

All outcomes were assessed before treatment at 6 weeks (12 sessions) and 12 weeks (24 sessions) of treatment. The patient's data were entered manually into a Microsoft Excel spreadsheet. Changes in outcomes were calculated by subtracting post-treatment scores from pre-treatment scores.

Table 1 presents the pre- and post-treatment scores of the outcome parameters assessed. At 6weeks of treatment, MAS reduced from 3 to 2, and BRS improved from 3 to 4. At 12 weeks, MAS reduced from 3 to 0, and BRS improved from 3 to 4. The patient did not report any abnormal sensations with the TENS treatment.

Table 1: Pre- and post-intervention values for spasticity and motor recovery

Variables	Baseline	6-weeks	12-weeks
Modified Ashworth Scale (0-5)	3	2	0
Brunnstrom Recovery Stages (1-6)	3	4	4

DISCUSSION

The purpose of this case report was to describe the effects of TENS in conjunction with TOT in the management of chronic post-stroke spasticity of the upper limb. The results showed a marked reduction in the levels of spasticity and improvement in motor function after treatment. Thus, it could be said that combining TENS and TOT is effective in ameliorating chronic post-stroke spasticity and enhancing motor function of hemiplegic upper limb.

Post-stroke spasticity is a common complication resulting from hyper excitability of the stretch reflex mediated by type Ia afferent nerve fibers attributable to the failure of inhibition from the dorsal reticulospinal tract.[18] Along with other upper motor neuron syndromes such as agonist/antagonist co-contraction, weakness, and lack of coordination, spasticity poses significant motor impairment and disability.[19] In this report, the patient presented with a hypertonic upper limb with MAS score of 3 [more marked increase in muscle tone through most of the range of motion, but affected part(s) can easily be moved]. However, after 6 weeks of treatment, the patient's MAS score improved to 2, indicating a slight increase in muscle tone, manifested by a catch, followed by minimal resistance. The improvement was more apparent after 12 weeks of treatment evidenced by the MAS score of 0, which indicating no increase in muscle tone. The improvement in spasticity is believed to be enhanced by the high TENS applied in addition to the TOT training. The positive effect of stimulation with high TENS could be explained by the mechanisms reported by previous trials suggesting that TENS may enhance presynaptic inhibition of spastic muscles and facilitates sensorimotor integration.[11,12]

In line with our study, a previous trial conducted by Kim et al.[11] reported a significant reduction in upper limb spasticity following application of a high TENS (100Hz, 200μs, for 30 minutes) in conjunction with TOT in chronic stroke survivors. In contrast, Sonde et al.[20] found no significant effect of a low frequency TENS (1.7Hz, 14μs, for 60 minutes) in combination with physiotherapy

on upper limb spasticity even though the treatment led to significant improvement in motor function. It can be argued that the lack of significant effect of TENS on spasticity in the Sonde et al study could be attributed to the low frequency used despite the longer treatment duration. High frequency TENS (100HZ) is generally found to improve spasticity.[7] Moreover, longer duration of stimulation (> 30 minutes) seems to produce better effect.[6] Thus, clinicians may consider high frequency and longer stimulation duration to achieve maximal or clinically significant effects.

The patient's motor function also improved after the treatment evidenced by the BRS score of 4 (spasticity decreases but synergistic movement predominates) after 6 and 12 weeks of treatment compared to the BRS score of 3 (spasticity is marked, synergistic movement may be elicited voluntarily) at baseline. It can be hypothesized that the addition of TENS to TOT imparted positively on the spasticity and subsequently motor recovery. This is in agreement with a previous randomized controlled trial[12] suggesting that TENS can be an effective adjunct treatment in regaining motor function and improving ADL in hemiplegic patients.

The observations from this account cannot be generalized given that it is a case report. Second, spasticity was only assessed for the upper limb even though the patient had more significant impairment of the upper limb compared to the lower limb. Lastly, performance-based impairment using validated scales such as the Fugl-Meyer Assessment Scaleand Motor Activity Log was not assessed. Nevertheless, we hope to address these limitations in a future large randomized controlled trial with similar objectives.

Conclusion

This report demonstrated the beneficial effects of TENS in conjunction with TOT in reducing chronic post-stroke spasticity and improving motor function of the upper limb. Given the safety, low-cost, and non-invasive nature of TENS, this modality may be a valuable adjunct to the usual limb training in the rehabilitation of stroke patients, especially in low-resource settings.

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