

EFFICACY OF TENS WITH CONVENTIONAL OCCUPATIONAL THERAPY IN IMPROVING HAND FUNCTION OF STROKE SURVIVORS

ABSTRACT

BACKGROUND AND AIM

Stroke is currently the second leading cause of death and third main cause of disability throughout the world. Around 75% of stroke survivors suffered from upper limb dysfunction with limited functional activities whereas distal parts of upper extremity such as hand and forearm are mostly affected by stroke. Therefore, this study aims to determine the benefits of TENS along with conventional Occupational therapy in the rehabilitation of stroke patients to ascertain the optimal recovery of hand function.

METHODOLOGY

A Single-blind Randomized Controlled Trial was conducted on 76 individuals with acute phase or one-year history post-stroke. Group-A (n=38) received Low Frequency Transcutaneous Electrical Nerve Stimulation on elbow and wrist extensors (3 Hz, 400 μ s) along with conventional Occupational therapy while Group-B (n=38) received conventional Occupational therapy only. Both the groups received intervention for 5 days/week of duration 45 minutes till 3 weeks.

RESULTS

Group-A showed significant improvement in means scores of FMA-UE and ARAT ($p < 0.05$) in comparison to Group-B which showed moderate improvements in sensorimotor and activity capacity of hand function.

CONCLUSION

Conventional therapy along with TENS significantly improved the hand function in acute stroke patients as compared to the conventional therapy.

KEYWORDS Electrical stimulation, Transcutaneous Electric Nerve Stimulation, Conventional therapy, Stroke, Upper extremity, Activity limitations.

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INTRODUCTION

Globally 12.6 million people are permanently disabled due to stroke¹. Stroke is currently the second leading cause of death and third main cause of disability throughout the world². Among all risk factors, cardiac embolism is the cause of stroke in patients with age <40 years while in the individuals aged 41-50 years, atherosclerosis is reported to be the main cause leading towards the debilitating condition³. Around 75% of stroke survivors are suffered from the disability of upper limb with limited functional activities and upper extremity dysfunction⁴ whereas distal parts of upper extremity such as hand and forearm are mostly affected by stroke. Number of studies reported that approximately 70% limitation in fine motor activities of hand has shown after one week of stroke while 41% limitation has observed within third month post-stroke⁵. Moreover, the patient is unable to perform daily living activities due to upper extremity impairment. These basic activities are the survival living skills such as dressing, bathing, and toileting, transferring or feeding. Despite the adverse consequences of stroke, its rehabilitation is primary objective to improve the functional abilities of patients to minimize activity limitation and participation restriction. It has been observed that patients with post-stroke upper extremity impairments laid heavy burden on their families and caregivers⁶. Furthermore, >50% of patients with upper limb dysfunction remain frustrated with increased anxiety levels⁷ due to motor impairments of the upper extremity leading patient towards the poor perception regarding health related quality of life(HRQoL)⁸. However, depression in stroke patient is common because of slow recovery as 33% of stroke survivor showed the symptoms of depression at the acute stage while 34% showed symptoms at the later stage⁹ therefore, the core objective of stroke rehabilitation is to improve upper limb function in order to make patient independent in activities of daily living (ADLs). According to International Classification of functioning the activity involves participation which will ultimately increases social involvement and improves overall health status. Wakkal and colleagues concluded that 12% patients regained upper limb function at the sixth month of rehabilitation¹⁰ whereas quite a few patients experienced difficulty in fingers and hand coordination¹¹. Nevertheless, with the passage of time impairment in the motor activity of hand increases which results in the formation of deformity such as contractures, nerve compression therefore rehabilitation after stroke is very essential in order to prevent the development of deformity in the hand. Besides, occupational therapy is the core element of rehabilitation to improve hand function of the patient¹². Since upper extremity is involve in almost all functional activity, though a patient is trained for one hand skills too but bilateral involvement is required in many tasks. Secondly the disuse of affected arm will lead to not only disability and deformity but disfigurement and poor participation. Finally, the health and wellbeing of an individual get affected.

Subsequently due to reduced cortical representation in parietal cortex, sensory input to the brain is reduced which particularly affect hand functioning¹³. In order to improve sensory function in stroke patient application of somatosensory stimulation is common¹⁴. It helps in maintaining the cortical representation of the hand as well as it facilitates movement by motor system¹⁵. A systemic review revealed that somatosensory stimulation could provide effective outcome in improving motor function¹⁶. Many rehabilitative approaches are available for improving motor function of upper extremity such as muscle strengthening exercises, transcutaneous electrical stimulation (TENS), constraint induced movement therapy (CIMT), proprioceptive neuromuscular facilitation techniques etc. Though, a repetitive hand and finger exercise with varying loads is a new approach in stroke rehabilitation¹⁷. Therefore, occupational therapists must design treatment plan according to condition of the patient and the stage of the stroke to improve disabilities and impairments of upper extremity.

In rehabilitation, TENS is an effective device for electrical somatosensory stimulation operated by sending stimulating impulses across the skin surface and nerve stands to the brain which improves motor performance and corticospinal excitability¹⁸. TENS is effective, feasible and

easily applicable modality for the rehabilitation of stroke patient. According to Dos Santos-Fontes and colleagues, the application of somatosensory electrical stimulation (SES) through TENS could be an effective therapy for some stroke patients whereas 31–36% improvement as compared to baseline hand function was detected in the mean Action reach arm test ARAT score in stroke patients¹⁹. Moreover, the application of low-frequency TENS on upper limb showed improvements in motor kinematics and function due to changes in ipsilesional cortical oscillations²⁰ thereby induces cortical plasticity in the damaged region of the brain and enhances motor-function related activation²¹. Number of studies demonstrated that TENS also decreases resting-state low-frequency cortical oscillations which results in spontaneous recovery of hand function of the stroke patients²²⁻²³. Several studies showed that task related training with strengthening exercises and TENS is effective in decreasing spasticity and functional mobility of upper limb²⁴. Furthermore, it has been observed the effects of electrical stimulation assisted task specific upper extremity and hand exercises results in the improvement of the motor activity of hand along with the sensory improvement²⁵⁻²⁶. Another study compared the effects of electrical stimulation on the elbow and wrist extensor for twelve weeks and they found the significant improvement in hand and wrist motor activity²⁷ where it has been publicized that sufficient electrical stimulation is required for motor cortex's modulation of reorganization during performance motor activities which could provide beneficial results for improving motor function, especially in stroke rehabilitation²⁸. Thus, this study aims to determine the benefits of TENS along with conventional occupational therapy in the rehabilitation of stroke patients to ascertain the optimal recovery of hand function. Apart from Activities of daily living even Instrumental activities that need motor involvement of upper extremity also improve.

METHODOLOGY

Study Setting

The study was conducted at Occupational Therapy department of outpatient or day care at two of the tertiary care hospitals in Karachi.

Study Design

It is a quasi-experimental study, comparing the conventional occupational therapy effect to the combination of TENS with Conventional therapy at Stroke patients.

Target Population

Patients with acute phase or one-year post-stroke aged 20-80 years were enrolled.

Duration of Study

Six months.

Sampling Technique

Probability Sampling Technique-Simple random sampling was used.

Sample Size

A sample size of 76 was calculated using WHO software.

Inclusion Criteria

- Stroke survivors with acute phase to one-year post-stroke aged 20-80 years old were included.

Exclusion Criteria

Patients with severe cognitive impairment such as memory loss, aphasic and uncontrolled medical conditions were excluded.

Data Collection Procedure

A sample of 76 participants were randomly divided into experimental and control groups. Both the groups received intervention for 5 days/week for the duration of 45 minutes for total 3 weeks. The protocols of intervention are described as follows:

• Treatment Protocol for Group-A

Group-A (n=38) received Low Frequency Transcutaneous Electrical Nerve Stimulation (LF-TENS) on the extensors of elbow and wrist with frequency set at 3 Hz and pulse duration of 400 μ s for the duration of 20 minutes along with conventional therapy comprised of passive ROM, upper extremity stretchings and manual dexterity exercises through physio-ball and coin fine activities for 25 minutes.

• Treatment Protocol for Group-B

Group B (n=38) received conventional occupational therapy comprised of purposeful and functional therapeutic activities along with passive ROM, upper limb stretching, weight bearing, Bo bath technique and manual dexterity for 45 minutes.

Data Collection Tool

Data was collected at base line preliminary to the intervention and after the end of treatment on two outcome measures:

- Fugal- Meyer Assessment of Upper Extremity (FMA-UE) is a comprehensive, valid and reliable evaluation tool to assess post-stroke sensorimotor function. FMA-UE is a 3-point ordinal scale comprises of 33 items in which motor domain is widely used due to its primary value in monitoring functional recovery.
- Action reach arm test (ARAT) is a standardized tool to assess upper extremity activity capacity. ARAT is a 4-point ordinal scale comprises of 19 items to evaluate post-stroke coordination, dexterity and functional recovery.

Data Analysis

Data was entered and analyzed on SPSS (Statistical Package for Social Sciences) version 20. Demographic characteristics of the participants were determined through frequency, mean and standard deviations. While based on symmetrical normality assumption, paired t-test was applied for within the group analysis and independent t-test was run for the comparison of post mean values between the experimental and control groups whereas $p < 0.05$ was considered significant.

Ethical Considerations

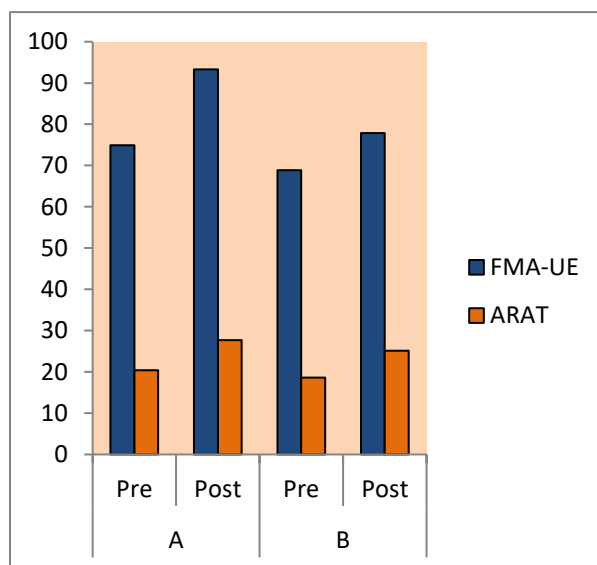
Participant's information was ensured to be kept confidential. Prior to the intervention, informed consent was taken by each participant that highlighted the possible risks, benefits, confidentiality and rights of withdrawal from the study at any time.

RESULTS

Total 76 participants with acute or one-year post-stroke history recruited in the study, 38 in each group respectively with mean age of 76.5 ± 9.7 in Group A have 19 male and 18 female subjects correspondingly whereas in Group B, 20 participants were male and 18 were females with mean age of 77.3 ± 9.3 . Participants were assessed at baseline and post 3-weeks intervention on FMA-UE and ARAT; moreover, no loss of follow-up was reported. Demographic characteristics of participants are shown in Table-1.

Table 1. Demographic Characteristics

	Group-A (n=38)	Group-B (n=38)
Age (years)	76.5±9.7	77.3±9.3
Gender	19 Males, 19 Females	20 Males, 18 Females
Stroke type		
Left Sided	18.0±6.7	18.0±6.2
Hemorrhagic	5±1.9	5±1.7
Ischemic	4.8±1.2	3.6±1.7
Stroke Duration	13.1 (8.5-25.6)	33.3 (26.0-39.0)

**Table 2. Paired T-test for Within the Group Pre-Post Mean Differences**

		FMA-UE Mean±S.D.	Mean Differen ce	ARAT Mean±S.D.	Mean Differen ce	P-value
Group-A	Pre	74.89 ±9.35	18.41	20.42 ±9.98	7.24	< 0.05
	Post	93.3 ±12.62		27.66 ±10.13		
Group-B	Pre	68.87 ±14.63	9.02	18.63±8.17	6.5	< 0.05
	Post	77.89 ±13.96		25.13 ± 8.05		

In within the group analysis, both the groups showed improvement in sensorimotor function on FMA-UE where Group-A scores significantly improved from 74.89 ±9.35 to 93.3 ±12.62 while Group-B showed improved scores as well from 68.87 ±14.63 to 77.89 ±13.96 post 3-weeks intervention ($p < 0.05$) respectively. Similarly, on ARAT, Group-A scores significantly improved from was 20.42 ±9.98 to 27.66 ±10.13 whereas Group-B showed moderate improvement in mean scores of hand function from 18.63±8.17 to 25.13 ± 8.05 ($p < 0.05$) post intervention as shown in Table2, Figure1.

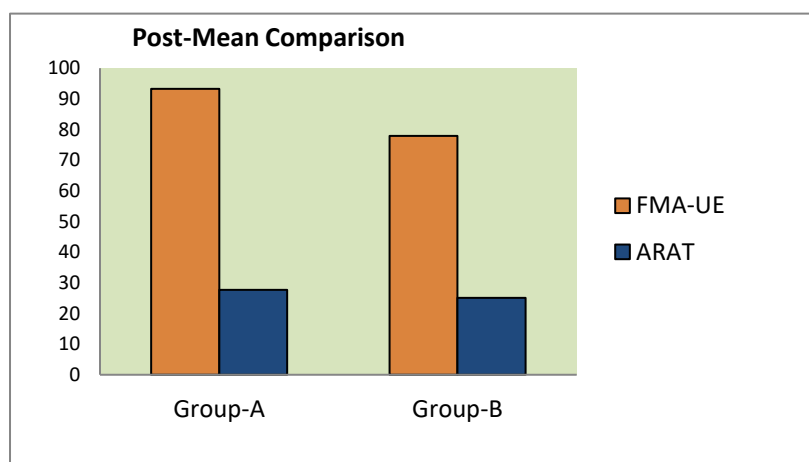
Figure-1 shows pre-post mean differences on FMA-UE and ARAT

The comparison of post-intervention means values on FMA and ARAT outcome measures revealed that Group-A mean scores significantly improved sensorimotor and activity capacity of hand function in post-stroke patients in comparison to Group-B which also showed moderate significant results. Moreover, strong positive correlation was determined between muscle activation and improvement of motor functioning of hand in patients who were treated with TENS. Therefore, it is as certain that TENS along with conventional therapy is effective in optimal recovery of hand function among stroke patients as illustrated in Table 3, Figure 2.

Table 3. Comparison of Post-mean Values between the groups

Parameters	Group-A	Group-B
FMA-UE	93.3 ±12.62	77.89 ±13.96
ARAT	27.66 ±10.13	25.13 ± 8.05

**Significant P-value for between the group differences at 3 weeks*

**Figure 2. Post-Mean Comparison of Group A and B****DISCUSSION**

The results of this study showed that the application of somato-sensory stimulation through TENS along with conventional manual therapy significantly improved the motor function of the hand. Therefore, it has been established that somatosensory electrical stimulation through TENS is the core part of stroke rehabilitation along with manual exercises. In contrast, Grant et al revealed that somatosensory stimulation through TENS was not effective in recovery of motor function of hand and motor system for movements in stroke patient²⁹. According to the study of Pollock and colleagues repetitive manual exercises did not proficiently recover the functions of hand and fingers in the patients with acquired brain injury⁸. However, our study showed better outcomes with respect to the motor function of hand by applying somatosensory

stimulation through TENS along with conventional Occupational therapy. On the other hand, findings of our study are consistent with the results of Laufer and Elboim-Gabyzont that showed sensory stimulation with TENS provide better outcome by leading the long lasting cortical plasticity³⁰. Moreover, Hatem and colleagues revealed that combination therapy of high-frequency TENS and rehabilitation treatment provide better results as compared to the rehabilitation treatment alone for stroke patients with upper extremity disabilities and impairments and they ascertained that low-frequency TENS has no effect on improving disabilities of upper extremity³¹. Whereas, our study provided a strong evidence that application of low frequency TENS leads to the improvement of motor function of hand and its kinematics due to change in the ipsilesional cortical oscillations¹⁴. Furthermore, Sonde et al showed that the application of low frequency TENS for 60 minutes results in increase of motor function of hand while our study demonstrated an effective application of TENS for the duration of 20 minutes to enhance motor function. Furthermore, Tu-Chan and colleagues evaluated the effects of repetitive application of somatosensory electrical stimulation through TENS that showed significant improvements in hand-finger movements on ARAT⁶, the findings are consistent with our study outcomes where both experimental and control group showed significant improvement on FMA-UE and ARAT with respect to treatment time. Besides, Kusoffsky, Wadell and Nilsson revealed that Low-frequency TENS optimizes motor control mechanism; however, it doesn't improve the sensory function of stroke-affected arm and hand³² whereas afferent stimulation with the help of low-frequency TENS uses plasticity and capacity of the brain for reorganization. In general, Low-frequency TENS therapy provides successful results in both early and later phase of stroke recovery.

CONCLUSION

It was concluded that conventional occupational therapy along with TENS significantly improved the hand function in acute stroke patients as compared to limiting to conservative occupational therapy. Thus combination of TENS with occupational therapy enhances motor activity of impaired muscles that leads to optimal functional recovery of stroke survivors.

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