

# **A Comparitive Study Between High Frequency TENS Versus Low Frequency TENS For improving ROM & Functional Endurane Of Hand For Chronic Stroke Patient**

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## **ABSTRACT**

### **BACKGROUND**

Stroke is a major public health concern worldwide and places a huge burden on patients, families and wider society. Stroke is one of the leading causes of death and disability in India. There are three pathological types of stroke; ischaemic, primary intracerebral haemorrhage and subarachnoid haemorrhage. In the population-based stroke study 32% of patients were admitted with severe upper extremity paresis, and 37% with mild arm paresis. 50-75% of patients with initial upper limb impairment report persisting problems 6 months later. Transcutaneous electrical nerve stimulation (TENS) is a non-invasive modality widely used in pain management and rehabilitation. It involves the application of electrical currents through the skin to stimulate peripheral nerves, thereby modulating pain perception and promoting muscle contraction. TENS has demonstrated potential benefits in various patient populations, including stroke survivors.

### **AIMS AND OBJECTIVES**

To study the evaluate and compare the effects of high frequency tens versus low frequency tens to improve ROM and functional endurance on hand for chronic stoke patient

### **METHODOLOGY**

Thirty chronic stroke patients with upper limb involvement were randomly selected according to inclusion and exclusion criteria and were divided into two groups – Group A and Group B. Both the groups were assessed for the upper limb function status using fugal meyer assessment for upper limb and motor function using Motor assessment scale for upper limb. These parameters were assessed before the start of the program as pre-test values and at the end of 12 week as post-test values. Group A received high frequency tens and Group B low frequency tens.

### **RESULT**

The mean age of group A was 55.95 years and group B was 54.96 years. The statistical analysis correlates the study by proposing that groups taken for study either group A treated by high frequency tens and Group B treated by low frequency tens showed significant effect in improvement in upper limb functions of chronic stroke patients. The group A treated with high frequency tens had higher significance when compared to group B treated with low frequency tens. The mean improvement in upper limb function scores of FMA-UE was 22.20 in group A and 13.86 in group B. The mean improvement in motor function measured by MAS-UL was 12.87 in group A and 5.07 in group B. It was resulted that group A received high frequency tens had a superior effect over group B received low frequency tens.

## CONCLUSION:

This study concluded that high frequency tens had effective tool in upper limb motor functions in chronic stroke patients.

**KEY WORDS**High-frequency TENS, Low-frequency TENS

**Range of Motion (ROM):** The extent of movement that can be achieved in a joint or group of joints.

**Functional Endurance:** The ability to sustain and perform functional tasks over a prolonged period of time.

**Chronic Stroke Patients:** Individuals who have experienced a stroke and are in the chronic phase of their recovery.

## Introduction

Stroke is a leading cause of long-term disability worldwide, with a significant impact on individuals' quality of life and independence. Among the various impairments that can occur following a stroke, hand dysfunction is particularly prevalent and debilitating. Loss of hand function can severely limit an individual's ability to perform daily activities, negatively affecting their overall functional independence. Recovery of hand function after stroke is a complex process influenced by various factors, including neural plasticity, muscle strength, and range of motion (ROM). Traditional rehabilitation approaches such as physical therapy and occupational therapy play a crucial role in promoting functional recovery. However, there is a need for additional interventions that can enhance the rehabilitation outcomes and expedite the recovery process. Transcutaneous electrical nerve stimulation (TENS) is a non-invasive modality widely used in pain management and rehabilitation. It involves the application of electrical currents through the skin to stimulate peripheral nerves, thereby modulating pain perception and promoting muscle contraction. TENS based on its pain-modulating properties. High-frequency transcutaneous electrical nerve stimulation (TENS) is a therapeutic modality that has been explored in stroke rehabilitation to improve hand function. Highfrequency TENS typically involves the application of electrical currents with a frequency ranging from 80 to 150 Hz and a pulse duration of 50 to 200 microseconds. This type of TENS is primarily targeted towards motor nerves, aiming to enhance muscle activation, strength, and motor control. Low-frequency transcutaneous electrical nerve stimulation (TENS) is another therapeutic approach that has been investigated in stroke rehabilitation to improve hand function. Unlike high-frequency TENS, low-frequency TENS typically involves the application of electrical currents with a frequency ranging from 1 to 10 Hz and a longer pulse duration of 200 to 500 microseconds. This type of TENS is primarily targeted towards sensory nerves, aiming to modulate pain perception and promote muscle relaxation. <sup>3</sup> Therefore, this comparative study aims to address this research gap by directly comparing the effects of high-frequency TENS and low-frequency TENS on the range of motion (ROM) and functional endurance of the hand in chronic stroke patients. By examining the differential impact of these two TENS frequencies, this study seeks to provide evidencebased recommendations for optimizing TENS interventions in stroke rehabilitation. In the following chapters, the literature related to stroke and hand impairments,.. Muscle testing can be performed using manual strength testing, functional tests, and dynamometry. Manual muscle strength testing is one of the most commonly used form of muscle testing by practitioners. With MMT, the

patient is instructed to hold the corresponding limb or appropriate body part to be tested at a specific point in its available range of motion, working against gravity or while the practitioner provides opposing manual resistance to determine the grade to assign the muscle. MMT GRADES Grade 5 (Normal) : This grade means the patient is able to complete the full range of motion (movement) against gravity while the practitioner applies maximum resistance. Grade 4 (Good) : This grade means the patient is able to complete the full range of motion (movement) against gravity while the practitioner applies moderate resistance. Note: Don't forget to consider both sides to evaluate whether you are applying adequate force on the limb being tested. Grade 3 (Fair)

**METHODOLOGY:** It is a comparative study in which chronic stroke patients with of upper limb functional involvement were recruited for study. All these patients were voluntarily participated in this study after signing a consent form Group A: high frequency TENS with ROM exercises and Group B: Low frequency TENS with ROM exercises. **INCLUSION CRITERIA:** Patients with chronic stroke duration between 6 months to 2 years. Age group: 40-65years. Both genders. chronic stroke Patients with right or left upper limb hemiparesis / lower limb hemiparesis. Manual muscle testing grade 2 of upper limb muscles. Wrist drop due to stroke. 1.7.2 **EXCLUSION CRITERIA:** Post stroke hemiparesis patients with cognitive disturbances. Chronic spastic hemiplegic patients. Age above 65 years and below 40 years. Hemiplegia or hemiparesis due to head injury. 20 Any musculoskeletal condition of upper limb. Psychosomatic patients. Visual and hearing problem. Vestibular lesion. Subjects with neurological disorder other than stroke. Any surgical reconstruction of upper limb.

**PROCEDURE :** Thirty chronic stroke patients was randomly selected according to inclusion and exclusion criteria and divided into two groups –. Pre-test level of upper limb function was assessed through Fugl meyer scale – Upper extremity and Motor Assessment Scale – Upper Limb with observation checklist, among interventional group on first day of the study. High frequency TENS with Functional endurance & ROM was demonstrated to group A and Low frequency TENS with Functional endurance & ROM was demonstrated to group B. Participants of both the groups were practiced the techniques six days per week for twelve weeks. Post-test data was collected at the end of 12th week.

**Group A: High frequency TENS with Functional endurance & ROM**

The group A ie. Experimental group was treated with High frequency TENS for improving Functional endurance & ROM .

**Techniques:**

- i. High frequency tens in which patient in supine lying, Frequency of tens : 80 to 150 hz Mode is burst mode, The intensity of the electrical stimulation will be set at a comfortable level for each participant, below the sensory threshold for pain. Pulse girth:60 – 100 micro sec, The electrodes will be placed on the affected hand, targeting the muscles and nerves associated with hand function. Place both active & passive electrodes over the hand .passive electrode is place of roughly and tie a strap active electrode is place of roughly and tie a strap. Ensure both electrode have a minimum of 2 fingers space. Duration : 15 min / session

**Task or Activities**

- Try to Squeeze and release the fist
  - Try to Open and close the hand
  - Try to Tap the fingers on the table
  - Try to Touch each finger to the thumb one by one
  - With the hand closed, try to lift each finger and thumb
  - Handle objects using different types of grips, for example, make small balls of theraplast or modeling clay with the fingers, turn a cylindrical object in the hand (complex rotation), pick up beads or paper clips, put clothes pegs on the lip of a mug, insert pegs in a board, etc.
  - Grasp and release objects with different textures (balls, sponges, etc.)
  - Pick up and move various objects (balls, sticks, cubes, mug, glass, etc.) in different directions, for example, move an object following a sequence of movements forming a square or an 'X', put a ball in a glass and take it out, lift a glass, lift a rectangular object, place beads or pegs in a container with a small opening, insert pegs in holes in a piece of wood, transfer grains of rice from one pot to another, manipulate rings, etc.
  - Turn over playing cards
  - Color, connect the dots to make a drawing, copy shapes on a piece of paper
  - Handle utensils
  - Wipe, clean and dust the table with cloths with different textures (scouring pad, soft sponge, silk cloth, etc.)
  - Repeat 10 times
  - Do two sessions per day
- i. Range of motion exercises
- Flexion and extension of shoulder
  - Abduction and adduction of shoulder
  - External and internal rotation of shoulder
  - Flexion and extension of the elbow

- Supination and pronation of forearm
- Flexion and extension of the wrist
- Ulnar and radial deviation of the wrist
- Circumduction of the wrist
- Flexion and extension of thumb and fingers
- Abduction and adduction of thumb and fingers

#### Shoulder Flexion

- Start with patient lying face up.
- Support the patient's elbow with one hand and grasp the wrist with your other hand.
- Slowly lift the whole arm up to 90 degrees.
- Slowly lower the arm back to the patient's side.
- Repeat 10 times. Do two sessions per day

Shoulder Abduction • Support the patient elbow with one hand and grasp the wrist and hand with your other hand. • Keeping the elbow straight, move the arm out to the side away from the patient's body to a 90 degree angle with the hand no higher than the patient's shoulder. • Slowly return arm alongside the patient's torso. • Repeat 10 times. • Do two sessions per day.

group B Low frequency TENS over the hand

ie. Control group was treated with Low frequency TENS for improving Functional endurance & ROM .

- Low frequency tens and patient in supine lying, Frequency : 1 to 20 hz ,burst mode . The intensity of the electrical stimulation will be set at a comfortable level for each participant, below the sensory threshold for pain. Pulse girth:100-200 micro sec. The electrodes will be placed on the affected hand, targeting the muscles and nerves associated with hand function. Place both active & passive electrodes over the hand .2 passive electrode is place of roughly and tie a strap. 2 active electrode is place of roughly and tie a strap. Ensure both electrode have a minimum of 2 fingers space. Duration of tens : 15 min / session

**DATA COLLECTION AND ANALYSIS** The pre and Post test data was collected with regard to parameters under study were tabulated and statistically analyzed using paired and unpaired 't' test for interpretation of the results. The differences in the means was compared by Least Significant Differences (LSD) at 5 per cent level ( $P < 0.05$ ).

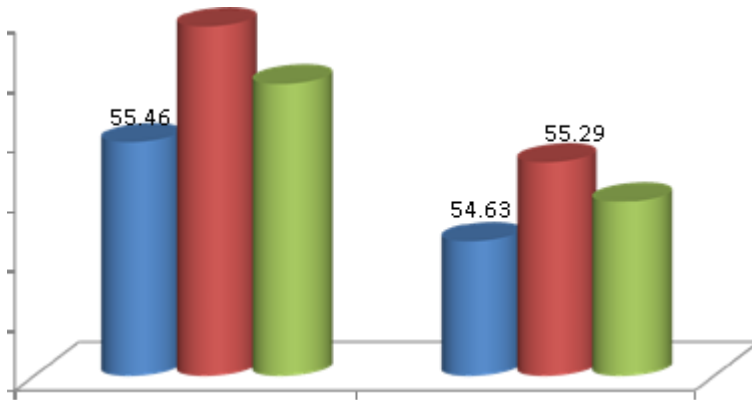
**DATA ANALYSIS** In present study, the two groups were compared for the significant difference to evaluate the effect high frequency TENS for improving Functional endurance & ROM and low frequency TENS for improving Functional endurance & ROM on upper limb functions in chronic stroke patients. The

statistical tools used for analysis were paired and unpaired “t” test. The differences between pre - test and post – test values were found. The data was collected at beginning and at the end of twelve weeks. The mean difference of Wolf motor function test and motor assessment scale – upper limb functions of group A were compared with group B and the actual pattern of variation were observed. With the ‘t’ value from the pre-test and post-test, the accurate level of significance was analyzed and interpreted. An alpha level of  $p < 0.05$  was the level of significance for the test. Paired ‘t’ test was performed to analyze the efficacy of treatment within the groups and unpaired ‘t’ test was performed to analyze the efficacy of treatment between both groups.

**DEMOGRAPHIC PRESENTATION OF DATA IN GROUPS:** Thirty chronic stroke patients of age group between 40 – 65 years were randomly selected according to inclusion and exclusion criteria and divided into two groups with 15 patients in each group. Group A had a mean age of 55.95 years and Group B had a mean age of 54.96 years. The mean age of male and female patients in group A was 55.46 and 56.43 years, respectively. The mean age of male and female patients in group B was 54.63 and 55.29 years, respectively. The demographic data has been presented in table and depicted in figure

**DEMOGRAPHIC PRESENTATION OF DATA IN GROUPS:**

GROUPS	SEX	NUMBER	MEAN ± SEM AGE	TOTAL NUMBER	AGE IN YEARS	
					MEAN± SEM	SD
Group A	Male	8	55.46±1.04	15	55.95±0.91	3.54
	Female	7	56.43±1.07			
Group B	Male	8	54.63±1.69	15	54.96±1.11	4.30
	Female	7	55.29±1.52			
Total		30	55.45±0.71	30	55.45±0.71	3.89



**5.1 ANALYSIS OF PRE-TEST AND POST-TEST VALUES OF FUGL MEYER ASSESSMENT – UPPER EXTREMITY (FMA-UE) WITHIN GROUP A:**

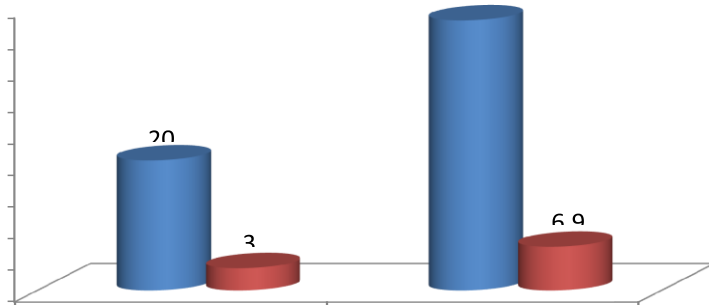
The Upper limb functions of each patient in Group A was assessed by using Fugl Meyer Assessment – Upper Extremity (FMA-UE) before the start of the treatment as pre-test values and at the end of 12<sup>th</sup> week as post-test values. The data has been presented in table 5.2 and depicted in figure 5.2.

**TABLE 5.2: ANALYSIS OF PRE-TEST AND POST-TEST VALUES OF FUGL MEYER ASSESSMENT – UPPER EXTREMITY (FMA-UE) FOR SIGNIFICANCE WITHIN GROUP A:**

	Mean	N	SD	Std. Error Mean	R	Mean Diff	T	P
Pre-test	20.60	15	3.50	0.90				
FMA-UE					0.8692	22.20	20.25	0.0001**
Post-test	42.80	15	6.92	1.78				

The above table shows the mean of pre-test and post – test values were 20.60 and 42.80, respectively. The mean improvement in Fugl Meyer Assessment – Upper Extremity (FMA- UE) of Group A was 22.20. The ‘t’ value 20.25 and ‘P’ value 0.0001 for upper limb motor function scores using FMA-UE within Group A analysis. When compared to table value, the above ‘P’ value is lesser at P<0.05, which is highly significant.

It indicates that Group A treated with high frequency tens had significant improvement in upper limb motor functions within Group A



PRE-TEST AND POST-TEST VALUES OF FUGL MEYER ASSESSMENT – UPPER EXTREMITY (FMA-UE) WITHIN GROUP A

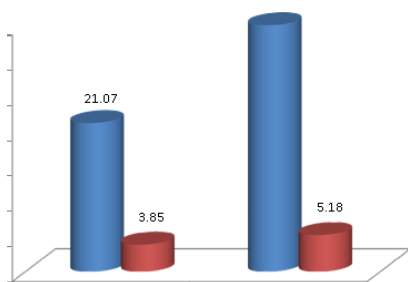
### 5.3 ANALYSIS OF PRE-TEST AND POST-TEST VALUES OF FUGL MEYER ASSESSMENT – UPPER EXTREMITY (FMA-UE) WITHIN GROUP B:

The upper limb motor function score of each patient in Group B was assessed by using Fugl Meyer Assessment – Upper Extremity (FMA-UE) before the start of the treatment as pre-test values and at the end of 12th week as post-test values. The data has been presented in table and depicted in figure

	Mean	N	SD	Std. Error Mean	R	Mean Diff	T	P
Pre-test	21.07	15	3.85	0.99				
FMA-UE				1.34	0.9085	13.86	13.091	0.0001***
Post-test	34.93	15	5.18					

The above table shows the mean of pre-test and post – test values were 21.07 and 34.93, respectively. The mean improvement in upper limb motor function score of Group B was 13.86. The ‘t’ value 13.091 and ‘P’ value 0.0001 for upper limb motor function scores using FMA-UE within Group B analysis. When compared to table value, the above ‘P’ value is lesser at  $P < 0.05$ , which is highly significant. It indicates that Group B treated with low frequency tens had highly significant improvement in upper limb motor function within Group B.



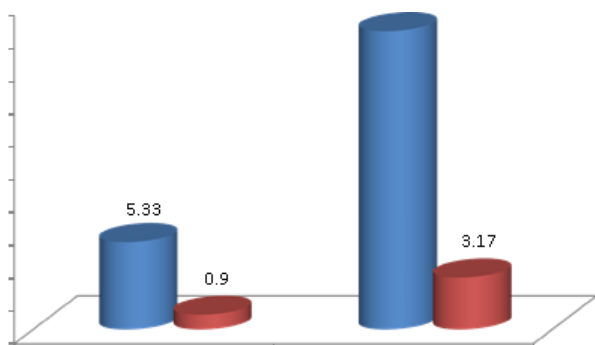


5.4 ANALYSIS OF PRE-TEST AND POST-TEST VALUES OF MOTOR ASSESSMENT SCALE – UPPER LIMB (MAS-UL) FOR SIGNIFICANCE WITHIN GROUP A:

The upper limb motor assessment score of each patient in Group A was assessed by using Motor Assessment Scale – Upper Limb (MAS-UL) before the start of the treatment as pre- test values and at the end of 12th week as post-test values. The data has been presented in table 5.4 and depicted in figure

	N	Mean	SD	Std. Error Mean	R	Mean Diff	T	P
Pre-test	15	5.33	0.90	0.23				
MAS-UL					0.4011	12.87	17.040	0.0001**
Post-test	15	18.20	3.17	0.82				

The above table shows the mean of pre-test and post – test values of upper limb function were 5.33 and 18.20, respectively. The mean improvement in functional assessment of Group A was 12.87. The ‘t’ value 17.040 and ‘P’ value 0.0001 for upper limb function scores using MAS-UL within Group A analysis. When compared to table value, the above ‘P’ value is lesser at  $P < 0.05$ , which is highly significant. It indicates that Group A treated with high frequency tens had significant improvement in upper limb function score within Group A



**ANALYSIS OF PRE-TEST AND POST-TEST VALUES OF MOTOR ASSESSMENT – UPPER LIMB SCORES USING MAS-UL FOR SIGNIFICANCE WITHIN GROUP B:**

The upper limb function score of each patient in Group B was assessed by using Motor assessment Scale (MAS-UL) before the start of the treatment as pre-test values and at the end of 12th week as post-test values. The data has been presented in table 5.5 and depicted in figure

	N	Mean	SD	Std. Error Mean	R	Mean Diff	T	P
Pre-test	15	5.13	0.74	0.19				
MAS-UL					0.6990	5.07	11.476	0.0019**
Post-test	15	10.20	2.15	0.55				

The above table shows the mean of pre-test and post – test values of upper limb motor function were 5.13 and 10.20, respectively. The mean improvement in functional assessment of Group B was 5.07. The ‘t’ value 11.476 and ‘P’ value 0.0019 for upper limb function scores using MAS-UL within Group B analysis. When compared to table value, the above ‘P’ value is lesser at  $P < 0.05$ , which is significant. It indicates that Group B treated with low frequency had significant improvement in upper limb function within Group B.

**DISCUSSION**

Stroke is a life changing event that affects not only the person who may be disabled, but their family and caregivers. Upper extremity motor deficits after stroke are more common. There is a strong relationship between upper extremity function and ability to perform activities of daily living; social and recreational activities have been found. In stroke rehabilitation TENS is an effective tool to improve upper limb functions by using different upper limb patterns. It contributes to the adaptation and reorganization of the CNS function. Correct and repeated stimulation through these approaches can lead to the non involved part of the brain functionally compensating for the affected area of the brain. Improvement in functional activity will improve quality of life and better neuroplasticity.

The purpose of the present study was to evaluate the effectiveness of high frequency tens and low frequency tens in improving upper limb functions of chronic stroke patients.

In present study, total 30 chronic stroke patients with impaired upper limb functions were selected randomly and divided into two groups - Group A and Group B (15 patients in each group), who received high frequency tens, respectively. The improvement in upper limb functions was assessed by using Fugl Meyer assessment – Upper Extremity and motor assessment scale – upper limb. Pre-test data were collected at the beginning of the study and post-test data were collected at the end of 12th week. The data were statistically analysed and comparing Group A and Group B, both the group showed significant improvement in upper limb functions, but Group A not only showed greater improvement but also recorded a high degree of consistency with ‘t’ values and as seen in graph showing mean improvement of both the parameters (figure 9), there is greater improvement in mean of upper limb functions in Group A.

In present study, Group A had a mean age of 55.95 years and Group B had a mean age of

54.96 years. Group A received high frequency tens showed improvement in upper limb functions in chronic stroke patients when comparing the pre and post test values proved by Fugl Meyer

Assessment – Upper Extremity (FMA-UE) and motor assessment scale – upper limb (MAS- UL). The mean improvement in FMA – UE and MAS – UL score was 22.20 and 13.86, respectively. This analysis found highly significant difference between pre and post test score within group A. The above scores have shown that high frequency tens are effective in improving upper limb functions of chronic stroke patients.

Group B received low frequency tens showed improvement in upper limb functions in chronic stroke patients when comparing the pre and post test values proved by Fugl Meyer Assessment – Upper Extremity (FMA-UE) and motor assessment scale – upper limb (MAS- UL). The mean improvement in FMA – UE and MAS – UL score was 12.82 and 8.00, respectively. This analysis found significant difference between pre and post test score within group B. The above scores have shown that low frequency tens is also effective in improving upper limb functions of chronic stroke patients.

The study was to comparing high frequency tens and low frequency tens improving upper limb functions of chronic stroke patients. The upper limb motor function score of each patient was assessed by using Fugl Meyer assessment – Upper Extremity before the start of the treatment as pre-test values and at the end of 12th week as post-test values. The mean of pre-test and post – test values were 20.60 and 42.80, respectively in group A and 21.07 and 34.93, respectively in group B. The mean improvement in upper limb motor function score of group A and group B was 22.20 and 13.86, respectively. The statistical analysis correlates the study by proposing that groups taken for study either Group A treated by high frequency tens or Group B treated by low frequency tens showed significant effect in improvement in upper limb motor

functions. The Group A treated with high frequency tens had superior effect in improvement in upper limb functions of chronic stroke patients when compared to Group B treated with low frequency tens

The study was to comparing the low frequency tens in improving upper limb functions by using motor assessment scale – upper limb of chronic stroke patients. The upper limb functional assessment score of each chronic stroke patient was assessed by using motor assessment scale – upper limb (MAS-UL) before the start of the treatment as pre-test values and at the end of 12th week as post-test values. The mean of pre-test and post – test values were 5.33 and 18.20, respectively in group A and 5.13 and 10.20, respectively in group B.

The mean improvement in upper limb functional assessment score of group A and group B was 12.87 and 8.00, respectively. The statistical analysis correlates the study by proposing that groups taken for study either Group A treated by high frequency tens or Group B treated by low frequency tens showed significant effect in improvement in upper limb motor functions. The Group A treated with high frequency tens had superior effect in improving upper limb functions when compared to Group B treated with low frequency tens

Thus, the above study resulted that high frequency tens had a superior effect over low frequency tens in upper limb functions of chronic stroke patients

## CONCLUSION

Based on the results, the present study states that both high frequency tens and low frequency tens are effective techniques to improve upper limb functions in chronic stroke patients but high frequency tens was better than low frequency tens on improvement in upper limb functions of chronic stroke patients. Thus, it can be concluded that high frequency tens is useful and an effective technique to treat upper limb functions in chronic stroke patients.

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