

# Analysis of the Effect of Transcutaneous Electrical Stimulation of Acupoints Combined with Rehabilitation Training in The Treatment of Upper Limb Dysfunction After Stroke

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**Abstract:** *Objective:* To analyze the effect of combining transcutaneous electrical acupoint stimulation (TEAS) with rehabilitation training in patients with upper limb dysfunction after stroke (ULDAS). *Methods:* A total of 130 ULDAS patients who were hospitalized and rehabilitated in Wuxi Xinwu District Rehabilitation Hospital from May 2021 to May 2023 were selected and randomly divided into Group A (65 cases, rehabilitation training) and Group B (65 cases, rehabilitation training + TEAS). The effects of the two groups were compared. *Results:* After treatment, the upper limb functional indexes of Group B were better than those of Group A ( $P < 0.05$ ). The rate of muscle tone grades 0–4 in Group B was higher than those of Group A ( $P < 0.05$ ). *Conclusion:* The function of upper limbs and muscle strength of ULDAS patients improved by combining TEAS with rehabilitation training.

**Keywords:** Transcutaneous electrical acupoint stimulation; Rehabilitation training; Stroke; Upper limb dysfunction; Muscle tone

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## 1. Introduction

The causative factors of stroke are mainly focused on the ischemic diseases of brain tissue (cerebral atherosclerosis, cerebral thrombosis, etc.). Affected individuals have a very high risk of both prevalence and mortality, and the condition develops to a life-threatening level in a short period<sup>[1]</sup>. After the onset of stroke, a variety of adverse manifestations occur rapidly, most often accompanied by sensory and limb dysfunction, causing serious adverse effects on the daily life of patients<sup>[2]</sup>. Clinical practice has confirmed that timely and effective interventions can inhibit the further development of stroke and improve the functionality of the upper limbs<sup>[3]</sup>. Since the human body, especially the hand needs to complete fine activities, returning to normal once damaged is difficult, and the overall recovery effect is not satisfactory with rehabilitation training alone<sup>[4]</sup>. Transcutaneous

electrical acupoint stimulation (TEAS) is the use of low-frequency pulsed direct current to electrically stimulate peripheral acupoints and their surrounding tissues to transmit information to the central nervous system, thereby playing a role in improving local neuromuscular function<sup>[5]</sup>. Combined rehabilitation training with TEAS can enhance the patient's muscle strength, and improve hand function, grip strength, and hand dexterity. This promotes the recovery of upper limb function and reduces pain, improves symptoms such as muscle spasms, and improves the patient's quality of life. Clinical practice has confirmed that the combined use of rehabilitation training and TEAS in patients with upper limb dysfunction after stroke (ULDAS) can improve the rehabilitation effect and significantly improve upper limb function<sup>[6]</sup>. Given this, this study analyzed the effect of combined TEAS based on rehabilitation training in ULDAS patients.

## 2. Information and methods

### 2.1. General information

A total of 130 cases of ULDAS patients who were hospitalized and rehabilitated in Wuxi Xinwu District Rehabilitation Hospital from May 2021 to May 2023 were selected and randomly grouped into Group A and Group B, with 65 cases each. Group A consisted of 35 males and 30 females aged 45–78 years old, with an average of  $52.64 \pm 5.81$  years. The patients weighed 45.38–87.76 kg, with an average of  $65.53 \pm 6.48$  kg. Group B consisted of 36 males and 29 females aged 43–79 years old, with an average of  $52.13 \pm 5.76$  years. The patients weighed 45.28–87.54 kg, with an average of  $65.76 \pm 6.25$  kg. General information between both groups was comparable ( $P > 0.05$ ). Inclusion criteria: (1) Patients with a confirmed diagnosis of ULDAS; (2) consented; (3) clinical data to meet the needs of the study; (4) able to cooperate; (5) condition of < 3 months. Exclusion criteria: (1) Patients with cognitive dysfunction; (2) craniocerebral trauma or brain tumor; (3) blood and immune system diseases; (4) schizophrenic patients.

### 2.2. Methods

#### 2.2.1. Group A

Group A received rehabilitation training. Compulsory exercise therapy was carried out. Splints were used to fix the healthy forearm and hand in the resting position during 90% of the waking time, and the two ends of the splints were fixed on the healthy side of the body using a sling. Every day, 7–8 shaping movements were completed, and 5 minutes of pulling and relaxation exercises were carried out before, during, and after shaping. This was carried out for 6h/d. After 5 days of training, patients were allowed to rest for 2 days and were then trained for another 5 days. Bilateral upper limb training was carried out where patients completed three small sections of horizontal abduction and adduction bilateral shoulder joint training with the assistance of the sling, with 100 movements/section. Patients rested for 3min after completing one small section and spent about 20min to complete three sections of the exercise. The abrasive plate was adjusted to a suitable angle for the patient, and the patient independently completed both sides of the flexion and extension of the shoulder and elbow movements at the same time, with 20 movements/section for 3min/section. They then rested for 3 minutes after completing a small section of training and spent about 20 minutes completing all three sections. The three sections of bilateral shoulder elevator training were completed by the same procedure as above. Three sections of holding the gymnastic bar with both hands were carried out, where the elbow joint was straightened to complete the shoulder forward flexion movement by the same procedure as above. Both forearms were placed on the treatment table, the elastic bar was held in hand, and the patient's forearms were rotated forward and backward on both sides at the same time by the same procedure as above. Both the affected and healthy sides of the wrist underwent dorsiflexion movement under the trigger of electromyography (EMG). After dorsiflexion of the wrist for

5 seconds, a proper pause was required for 10 seconds, alternately for 80 times, and approximately 20 minutes was spent to complete this. The Movement Imagination Technique was implemented. Patients were asked to lie on their backs on the bed with their eyes closed and relax their whole body for about 3 minutes. Patients were laid in a warm and relaxing place, and the muscles of the feet, legs, upper limbs, and hands were alternately tensed and relaxed. The patients were then prompted to carry out the intermittent “Movement Imagination” for 5–7 minutes and focused on imagining a certain movement that is conducive to the recovery of a certain function. Finally, the patients were guided to focus their attention on their bodies and the surrounding environment, where the patients were told that they had already returned to the ward, and were also encouraged to immerse in the body’s sensations and listen to the sounds around them.

### **2.2.2. Group B**

Group B received rehabilitation training combined with TEAS. TEAS treatment was performed on the hemiplegic side of the upper limb and the parameters were set according to the Brunnstrom staging. Stage I–II: the mode of the therapeutic instrument, the frequency, the pulse width, and the time were acupuncture, 2 Hz, 200  $\mu$ s, and 30 minutes, respectively; Stage III–IV: the frequency of the therapeutic instrument and the pulse width was 10 Hz and 400  $\mu$ s, and the stimulation was 5 seconds followed by a rest of 3 seconds. The total treatment time was 30 minutes, 5 times/week, for 6 weeks.

## **2.3. Indicator observation**

### **2.3.1. Upper limb function indicators**

The Fugl-Meyer scale (FMA score) was used to evaluate the function of the upper limb. The highest score was 66, which indicates normal function of the upper limb. The hand motor function state score, with the highest at 4 points, indicates normal hand function.

### **2.3.2. Grading of muscle tone**

The muscle tone grading was evaluated according to the Ashworth standard. Grade 0: muscle tone by systematic observation shows normal characteristics; Grade 1: normal muscle tone as a control, a slight increase by systematic observation, passive flexion joints by systematic observation, showing slight obstruction, also showing sudden tensing or relaxing; Grade 2: muscle tone by systematic observation shows a significant increase, and joint activities by systematic observation exhibits a prominent increase of muscle; Grade 3: after systematic observation of muscle tension, it is found that its increase is better than that of Grade 2, and at the same time, it is challenging to perform passive activities; Grade 4: stiffness, loss of mobility, stiffness upon passive flexion.

## **2.4. Statistical analysis**

The SPSS 25.0 software was used to process data. Measurement data were expressed as mean  $\pm$  standard deviation (mean  $\pm$  SD) and the count data were expressed as %. Measurement data were analyzed using a *t*-test, and count data were analyzed using a chi-squared ( $\chi^2$ ) test. Results were considered statistically significant at  $P < 0.05$ .

## **3. Results**

### **3.1. Comparison of upper limb function indexes**

As shown in **Table 1**, before treatment, there was no significant difference between the FMA scores and hand motor function scores of the two groups ( $P > 0.05$ ). After treatment, the FMA scores and hand motor function scores of Group B were higher than those of Group A ( $P < 0.05$ ).

**Table 1.** Comparison of upper limb functional indexes between the two groups (mean  $\pm$  SD)

Group	Cases, <i>n</i>	FMA score (points)		Hand motor function status score	
		Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Group B	65	25.86 $\pm$ 2.67	49.62 $\pm$ 5.13*	0.61 $\pm$ 0.12	2.64 $\pm$ 0.35*
Group A	65	25.15 $\pm$ 2.59	42.37 $\pm$ 4.54*	0.65 $\pm$ 0.14	2.18 $\pm$ 0.32*
<i>t</i>	-	1.538	8.532	1.748	7.820
<i>P</i>	-	0.126	0.000	0.082	0.000

Comparison with this group before treatment \* $P < 0.05$ .

### 3.2. Comparison of dystonia grading

As shown in **Table 2**, the rate of dystonia in Grades 0 and 1 in Group B was higher than that in Group A ( $P < 0.05$ ). The rate of dystonia in Grades 2, 3, and 4 in Group B was lower than that in Group A ( $P < 0.05$ ).

**Table 2.** Comparison of dystonia grading between the two groups [*n* (%)]

Group	Cases, <i>n</i>	Level 0	Level 1	Level 2	Level 3	Level 4
Group B	65	27 (41.54)	24 (36.92)	7 (10.77)	5 (7.69)	2 (3.08)
Group A	65	14 (21.54)	13 (20.00)	16 (24.62)	13 (20.00)	9 (13.85)
<i>t</i>	-	6.020	4.571	4.278	4.127	4.866
<i>P</i>	-	0.014	0.032	0.038	0.042	0.027

## 4. Discussion

The occurrence and development of stroke are directly affected by factors such as poor lifestyle and vascular diseases, and the vast majority of patients will have sequelae after the disease [7]. It causes serious damage to the local brain tissue and nerves of the patients and is very likely to cause upper limb dysfunction, decrease the patient's quality of life, and even lead to the loss of the patient's self-care ability [8].

The etiology of residual ULDAS is very complex, and once upper limb dysfunction occurs, multiple joints (trunk, upper limbs, and lower limbs) will be involved [9]. Limb movement conditions are affected by the balance between synergistic and antagonistic muscles, and some researchers have suggested that ULDAS is mainly due to localized damage to brain tissue, resulting in varying degrees of damage to motor cells and conduction pathways [10]. Stroke leads to limited or diminished function of the upper limbs, in which the anterior horn of the spinal cord reduces the number of motor neurons. The motor neurons with preserved function abnormally increase their excitability, leading to problems such as limited movement and muscle spasms of the upper limbs [11]. The muscles on the hemiplegic side of the upper limbs of patients with ULDAS reduce their contraction capacity and endurance, especially the muscle function and endurance on the extensor side, and ultimately, the upper limb trajectory and movement speed changes, resulting in upper limb dysfunction [12].

The study showed that after treatment, the upper limb function index and muscle tone index of Group B were better than that of Group A ( $P < 0.05$ ), confirming that combining TEAS with rehabilitation training for ULDAS patients can promote the effective recovery of upper limb function and muscle strength. Currently, the main clinical treatment of upper limb dysfunction is rehabilitation training, which utilizes targeted training to stimulate the functioning mechanism. Sensory organs have a conduction effect, which can transmit the relevant information to the cerebral nerves, so that they can respond in a relatively short period, prompting the improve-

ment of muscle and joint activities, and the early recovery of the organism's motor function and cerebral neural function. TEAS is a new method for the clinical treatment of stroke patients, which utilizes low-frequency pulsed direct current to effectively stimulate the corresponding acupoints, transmit somatosensory-motor signals to the corresponding parts of the brain, stimulate the electrical activity of the brain, stimulate the role of peri-cortical neurons to make the corresponding response promptly. This can help rebuild the function of the brain cells and promote the improvement of the patient's somatosensory-motor functions and their prognosis of recovery. TEAS effectively improves the systolic and diastolic movements and is conducive to the rapid restoration of the nerve conduction function, so that the muscle ability and upper limb function can be effectively improved. Through rehabilitation training, patients can remodel their neurons and promote the good recovery of wrist function. TEAS mimics the treatment of acupuncture on the corresponding acupoints, which stimulates the activity of muscle cells, restores the impaired function of the upper limb and active control ability as soon as possible, and effectively alleviates the spasticity symptom. Furthermore, it stimulates the relevant areas of the cerebral cortex and induces the response of the neurons of the upper limb, which is conducive to the improvement of muscle strength and hand coordination. The rehabilitation training combined with TEAS in ULDAS patients can achieve ideal results and improve the function of the upper limb, hand, and nerve.

In conclusion, the combination of TEAS with rehabilitation training in patients with ULDAS can better improve the function of the upper limb and muscle strength.

## Disclosure statement

The author declares no conflict of interest.

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