

# Application of Neural Rehabilitation Manipulator Training in Upper Limb Rehabilitation of Stroke Patients with Hemiplegia

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**Abstract:** *Objective:* To analyze the application of neural rehabilitation manipulator training in upper limb rehabilitation of stroke patients with hemiplegia. *Methods:* 94 patients with hemiplegia after stroke were selected from January 2021 to January 2023. The patients were randomly divided into a control group and an observation group, with 47 cases in each group. The control group received routine rehabilitation training while the observation group received neural rehabilitation manipulator training. The upper limb and nerve function, daily task performance ability, quality of life, and rehabilitation training satisfaction were compared between the two groups. *Results:* There was no significant difference in upper limb and nerve function between the two groups before training,  $P > 0.05$ . After training, the observation group had  $51.45 \pm 8.75$  points in ARAT and  $52.59 \pm 8.48$  points in FMA-UE, which were higher than those in the control group with  $43.81 \pm 6.67$  points and  $45.51 \pm 7.31$  points respectively,  $P < 0.05$ . The observation group had  $5.71 \pm 1.53$  points in NIHSS, which was lower than those in the control group with  $8.04 \pm 2.39$  points,  $P < 0.05$ . In terms of daily task performance ability and quality of life, there was no significant difference between the two groups before training,  $P > 0.05$ . After training, the observation group had  $78.54 \pm 10.63$  scores in MBI and  $171.93 \pm 19.12$  scores in SS-QOL, which were higher than those in the control group with  $70.51 \pm 9.25$  scores and  $160.13 \pm 18.42$  scores respectively,  $P < 0.05$ . In terms of satisfaction, the total satisfaction rate of the observation group was 93.62%, which was higher than that of the control group with 74.47%,  $P < 0.05$ . *Conclusion:* The application of neural rehabilitation manipulator training in the upper limb rehabilitation of stroke patients with hemiplegia can significantly improve the upper limb function of patients, relieve nerve defects, improve daily task performance ability and quality of life, and increase patient satisfaction with rehabilitation training.

**Keywords:** Neural rehabilitation manipulator training; Hemiplegia after stroke; Upper limb rehabilitation; Application effect

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## 1. Introduction

Stroke is a cerebrovascular disease with the highest incidence rate in China. Stroke causes disability and

mortality, which greatly impact the quality of life of patients. Most stroke patients have symptoms of hemiplegia that result in limb impairment and partial or complete loss of the ability to perform daily tasks<sup>[1]</sup>. Rehabilitation exercises in the past mostly focused on lower limb function and neglected upper limb function rehabilitation due to its difficulty, so this hindered the overall rehabilitation of patients. With the improvement of rehabilitation technology in recent years, various advanced equipment and means have been gradually developed for the upper limb rehabilitation of stroke patients with hemiplegia<sup>[2]</sup>. For example, the neural rehabilitation manipulator is a kind of instrument specially used for limb rehabilitation. The use of advanced technology to help patients carry out training is conducive to improving the rehabilitation effect<sup>[3]</sup>. Based on this, 94 patients with stroke hemiplegia from January 2021 to January 2023 were selected in this paper, and the application of neural rehabilitation manipulator training in upper limb rehabilitation of these stroke hemiplegia patients was analyzed.

## **2. Data and methods**

### **2.1. General information**

A total of 94 stroke patients with hemiplegia were selected from January 2021 to January 2023. The patients were randomly divided into the control group and the observation group, with 47 cases in each group. There were 25 male and 22 female patients in the control group, with an average age of  $68.12 \pm 3.43$  years, ranging between 52–81 years old. There were 27 male and 20 female patients in the observation group, with an average age of  $68.20 \pm 3.35$  years, ranging between 53–82 years old. There was no significant difference in the above indexes between the two groups ( $P > 0.05$ ). The study was approved by a medical ethics committee<sup>[4]</sup>.

Inclusion criteria: All patients met the diagnostic criteria for stroke hemiplegia, and all had obvious manifestations of upper limb dysfunction. Patients and their families were informed of the study content and agreed to participate.

Exclusion criteria: Patients with audio-visual impairment, unconsciousness, coma, etc., patients with upper limb dysfunction due to peripheral nerve injury and other reasons.

### **2.2. Methods**

#### **2.2.1. Control group**

The control group received routine rehabilitation training. Specific methods were used to induce the loosening of the finger joints of the limbs and effective passive activities of the patients. The muscle strength training of the wrist extensor muscle group and the stretching training of the wrist flexor finger muscle group were gradually increased for the patients. At the same time, the patients were guided to perform trunk control exercises, active and passive limb movements, gravity adjustment training, and the training of daily activities. The training lasted for one month<sup>[5,6]</sup>.

#### **2.2.2. Observation group**

The observation group received neural rehabilitation manipulator training by using the upper limb intelligent rehabilitation training system manufactured by Yikang Medical Equipment Company, Guangzhou. The electrodes were attached to the flexor and extensor muscles of the forearm of the patient with the active and passive training modes set. In the active training mode, the rehabilitation doctor guides the patients to complete specific actions by themselves while adjusting the threshold according to the EMG signal to complete the subsequent training content. When the EMG signal is higher than the threshold level, the manipulator can be driven to complete the corresponding specific training action. In the passive training mode, the robot guides

the finger on the affected side of the patient to complete the corresponding training action. This training is conducted for one hour per day, five times per week with two resting days. Regular rehabilitation training is conducted during the two resting days. This training lasted for one month [7–9].

### 2.3. Evaluation index

The upper limb and nerve function, daily task performance ability, quality of life, and rehabilitation training satisfaction were compared between the two groups. The upper limb function was evaluated by the ARAT scale and FMA-UE scale respectively. The higher the score, the better the upper limb function was. Nerve function was evaluated by the NIHSS scale. The lower the score, the better the nerve function was. Daily task performance ability and quality of life quality were evaluated by the MBI scale and SS-QOL scale respectively. The higher the score, the better the daily task performance ability and quality of life. Satisfaction was evaluated by a self-made questionnaire. The total score of the questionnaire was 100, 80–100 points represented very satisfied, 60–79 points represented satisfied, and less than 60 points represented dissatisfied [10–12].

### 2.4. Statistical Processing

SPSS 20.0 software was used to process the data obtained from the study. The data was expressed in number or rate with  $\chi^2$  test. The measurement data were expressed by mean  $\pm$  standard deviation (SD) and *t*-test was used. If  $P < 0.05$ , there is a significant difference.

## 3. Results

### 3.1. Results of upper limb function and nerve function were compared between the two groups

In terms of upper limb and nerve function, there was no significant difference between the two groups before training as shown in **Table 1**,  $P > 0.05$ . After training, the observation group had  $51.45 \pm 8.75$  points in ARAT and  $52.59 \pm 8.48$  points in FMA-UE, which were higher than those in the control group with  $43.81 \pm 6.67$  points and  $45.51 \pm 7.31$  points respectively,  $P < 0.05$ . The observation group had  $5.71 \pm 1.53$  points in NIHSS, which was lower than those in the control group with  $8.04 \pm 2.39$  points, showing  $P < 0.05$ .

**Table 1.** Comparison of upper limb and nerve function between the two groups (mean  $\pm$  SD)

Group	Number of cases	ARAT (Points)		FMA-UE (Points)		NIHSS (Points)	
		Before training	After training	Before training	After training	Before training	After training
Observation group	47	36.44 $\pm$ 5.28	51.45 $\pm$ 8.75	36.13 $\pm$ 6.82	52.59 $\pm$ 8.48	13.03 $\pm$ 3.39	5.71 $\pm$ 1.53
Control group	47	37.17 $\pm$ 5.97	43.81 $\pm$ 6.67	35.37 $\pm$ 5.35	45.51 $\pm$ 7.31	13.26 $\pm$ 3.88	8.04 $\pm$ 2.39
<i>t</i>		0.628	4.761	0.601	4.335	0.306	5.629
<i>P</i>		0.532	0.000	0.549	0.000	0.760	0.000

### 3.2. Results of daily task performance ability and quality of life compared between the groups

In terms of daily task performance ability and quality of life, there was no significant difference between the two groups before training as shown in **Table 2**,  $P > 0.05$ . After training, the observation group had  $8.54 \pm 10.63$  scores in MBI and  $171.93 \pm 19.12$  scores in SS-QOL, which were higher than those in the control group

with  $70.51 \pm 9.25$  scores and  $160.13 \pm 18.42$  scores respectively,  $P < 0.05$ .

**Table 2.** Results comparing daily task performance ability and quality of life between the two groups (mean  $\pm$  SD)

Group	Number of cases	MBI (Score)		SS-QOL (Score)	
		Pre-training	Post-training	Pre-training	Post-training
Observation group	47	62.71 $\pm$ 9.87	78.54 $\pm$ 10.63	140.20 $\pm$ 15.42	171.93 $\pm$ 19.12
Control group	47	61.27 $\pm$ 8.38	70.51 $\pm$ 9.25	142.72 $\pm$ 16.31	160.13 $\pm$ 18.42
<i>t</i>		0.762	3.907	0.770	3.047
<i>P</i>		0.448	0.000	0.443	0.003

### 3.3. Comparison of satisfaction results between the two groups

In terms of satisfaction, the total satisfaction rate of the observation group was 93.62%, which is higher than that of the control group with 74.47% as shown in **Table 3**,  $P < 0.05$ .

**Table 3.** Results of comparing satisfaction between the two groups [*n* (%)]

Group	Number of cases	Very satisfied	Satisfied	Dissatisfied	Overall satisfaction rate
Observation group	47	20 (42.55)	24 (51.06)	3 (6.38)	44 (93.62)
Control group	47	15 (31.91)	20 (42.55)	12 (25.53)	35 (74.47)
$\chi^2$		0.728	0.385	5.077	5.077
<i>P</i>		0.393	0.535	0.024	0.024

## 4. Discussion

Stroke is a common cerebrovascular disease. Stroke patients generally show disability and neurological impairment due to its sudden onset and delayed treatment<sup>[13]</sup>. The patient still has a high probability of sequelae even if emergency care has been provided. Hemiplegia is one of the most prevalent complications of stroke, which is manifested as the impairment of limb function, the reduction of daily task performance ability, and the serious decline of quality of life. Although this dysfunction is irreversible, it can be alleviated through active rehabilitation training to improve the limb function of patients to a certain extent<sup>[14]</sup>. Effective rehabilitation training can stimulate the damaged areas of the brain tissue of patients, improve the excitability of the remaining cells, increase the efficiency of synapses, and promote the regeneration of synapses, thus achieving partial recovery of activity and function<sup>[15]</sup>.

Upper limb rehabilitation is an important part of rehabilitation exercise for stroke patients with hemiplegia. However, upper limb function impairment often lasts a long time with a slow and difficult recovery. However, this impairment can still be reduced through rehabilitation training<sup>[16]</sup>. Conventional rehabilitation techniques mainly include electromechanical biofeedback, acupuncture, massage, occupational therapy, exercise therapy, and so on, but the overall effect of these techniques is not optimal. The recent development of robotic rehabilitation technology has also played a positive role in the upper limb rehabilitation of stroke patients with hemiplegia. One of the technologies is the professional neural rehabilitation manipulator with active and passive motion function modes which can be used according to the rehabilitation procedure of the patient and has intelligent speech function<sup>[17]</sup>. The device can collect and analyze the EMG feedback of the patient and convert it into audiovisual signals that can be recognized by the patient. The device can provide strong support

for the upper limb function exercise of patients by adjusting the relevant threshold level. This method can increase the sensory input of patients, reshape the damaged tissues of the upper limb, and promote the axonal synaptic connection and the regeneration of nerve collateral with good repeatability and consistent results for the recovery of limb function of patients<sup>[18-20]</sup>.

In summary, the application of neural rehabilitation manipulator training in the upper limb rehabilitation of stroke patients with hemiplegia can significantly improve the upper limb function of patients, alleviate nerve defects, improve life task performance ability and quality of life, and increase patient satisfaction with rehabilitation training.

## Disclosure statement

The authors declare no conflict of interest.

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