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Analysis of the Effect of Limb Rehabilitation Therapy Combined with Transcranial Magnetic Stimulation Therapy on Muscle Activity in Patients with Upper Limb Dysfunction After Cerebral Infarction

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Abstract: *Objective:* To analyze the effect of limb rehabilitation therapy combined with transcranial magnetic stimulation therapy on muscle activity in patients with upper limb dysfunction after cerebral infarction (CI). *Methods:* 320 patients with upper limb dysfunction after CI were selected, all of whom were treated in our hospital between June 2021 and June 2023. They were randomly grouped according to the lottery method into the control group (limb rehabilitation therapy, 160 cases) and the intervention group (transcranial magnetic stimulation therapy + limb rehabilitation therapy, 160 cases). The upper limb function scores, neuro-electrophysiological indicators, daily living ability scores, and quality of life scores of the two groups were compared. *Results:* Compared with the control group, upper limb function scores and daily living ability scores in the intervention group were higher after treatment, and the neuro-electrophysiological indicators of the intervention group were lower after treatment ($P < 0.05$). *Conclusion:* Transcranial magnetic stimulation therapy combined with limb rehabilitation therapy has significant effects in patients with upper limb dysfunction after CI and is worthy of promotion and application.

Keywords: Limb rehabilitation therapy; Transcranial magnetic stimulation therapy; Cerebral infarction; Upper limb dysfunction

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1. Introduction

Cerebral infarction (CI) is a disorder in the cerebral blood supply that causes ischemia and hypoxia in the brain tissue, resulting in softening or necrosis [1,2]. With the continuous improvement of modern medical standards, the mortality rate of CI shows a downward trend. However, many CI patients experience sequelae including upper limb dysfunction [3,4], which is inconducive to physical activity and recovery and affects their quality of life. Clinical measures should be taken, and effective treatment measures should be improved. Limb rehabilitation therapy is a rehabilitation therapy that improves limb spasticity through functional training and enhances limb movement ability. Transcranial magnetic stimulation therapy is a type of neurostimulation therapy that is safe, effective, non-invasive, and painless, often used in CI rehabilitation treatment [5,6]. This study aims to investigate the application value of transcranial magnetic stimulation therapy + limb rehabilitation therapy for upper limb dysfunction after CI.

2. Materials and methods

2.1. General information

The research subjects were 320 patients with upper limb dysfunction after CI who were admitted to our hospital from June 2021 to June 2023. The lottery method was used to randomly categorize the patients into the intervention group and the control group, each with 160 patients.

The control group consisted of 98 males and 62 females; age ranged from 52 to 75 years old, with an average age of 65.76 ± 5.24 years; the minimum body mass index was 19.25 kg/m^2, and the maximum body mass index was 28.96 kg/m^2, with an average of 24.78 ± 1.48 kg/m^2. The intervention group had 100 males and 60 females; the age range was 54–76 years old, with an average of 66.21 ± 5.33 years old; body mass index ranged from 19.18 kg/m^2 to 29.11 kg/m^2, with an average of 25.04 ± 1.56 kg/m^2. A comparison of the two sets of data showed no significant difference, $P > 0.05$.

Inclusion criteria: Patients diagnosed with CI after examination; patients with relatively complete medical records; patients with concurrent upper limb dysfunction; patients who are informed and agree to participate.

Exclusion criteria: Patients with mental illness; patients with severe cognitive impairment; patients with aphasia.

2.2. Methods

Both groups received conventional treatment, such as anticoagulation, nerve nutrition, and blood pressure control.

The control group adopted limb rehabilitation therapy. The first step was placing the healthy limb in two positions, usually lying on the healthy side and supine. The patients were instructed to take turns and change the two positions every 2 hours. Lying on the healthy side was required. The patient held the pillow in front of the chest of the affected side, bent the upper limb forward as much as possible, keeping the palm upward, put the affected side on the pillow, and flexed the lower limb as much as possible; in the supine position, a soft cushion was put under the scapula, and the height of the cushion was 2 cm. The upper limbs were spread slightly outward, keeping the palms upward, and stretched the fingers as much as possible. A 2 cm-high cushion was used to cushion the hip joints of the lower limbs to avoid hanging the hip joints. A 5 cm-high cushion was used to cushion the knee joints to prevent the lower limbs from stretching and muscle spasms. The second step was upper limb functional exercises, starting with some passive movements. The nursing staff assisted the patient in practicing passive activities of the elbow joint, fingers, and wrists. After 1–2 days of activity, the patient was instructed to use the unaffected hand to assist the passive activities of the joints on the affected side. The passive activity time of each joint was 5 minutes. After mastering passive activities, the patients could be guided to practice active activities, such as raising their upper limbs and crossing their hands. Each practice lasted for 10–15 minutes, three times a day. Later, the patients could slowly practice self-care activities like brushing their teeth, combing their hair, eating, etc.

The intervention group underwent transcranial magnetic stimulation therapy + limb rehabilitation therapy. The limb rehabilitation therapy was the same as that of the control group. The transcranial magnetic stimulator was used for transcranial magnetic stimulation therapy. The stimulation frequency was set to 10 Hz, the butterfly coil mode was selected, and the stimulation diameter was set to 12 cm. The stimulation target was the cortical motor area corresponding to upper limb dysfunction, the output was 120%, one sequence included 20 sets of stimulation, and the next stimulation sequence was performed after 1 minute. Each treatment was performed in 5 sequences, in the morning and evening. Transcranial magnetic stimulation therapy was continued for 20 days.

2.3. Observation indicators

(1) Upper limb function evaluation: The Fugl-Meyer Assessment (FMA) scale [7] was used to evaluate the motor function of the upper limbs, including hand dimensions, wrist dimensions, elbow dimensions, shoulder dimensions, reflex dimensions, etc. It had a total of 33 items, 0–66 points, the score was directly proportional to the upper limb motor function. Using the Functional Test of Hemiplegic Upper Extremity (Hong Kong version) (FTHUE-HK) [8], the score was directly proportional to the upper limb function. The upper limb mobility index (MI) [9] was used for evaluation, and the score was directly proportional to the upper limb mobility.

(2) Neuro-electrophysiological indicators: MEP (motor evoked potential) cortical latency and central motor conduction time.

(3) Evaluation of daily living ability: The Barthel Index (BI) [10] was used to evaluate the daily living ability, with a score of 0–100.

(4) Quality of life evaluation: The Generic Quality of Life Inventory-74 (GQOLI-74) [11] was used to evaluate the quality of life.

2.4. Statistical analysis

The statistical software used was SPSS22.0. Measurement data were expressed as mean ± standard deviation (SD), and *t*-test was used; count data were expressed as rates and χ^2 test was used. $P < 0.05$ indicated that the difference was statistically significant.

3. Results

3.1. Comparison of the upper limb function of the two groups

Before treatment, the difference of the FMA score, FTHUE-HK score, and MI score between the two groups was not significant ($P > 0.05$); after treatment, the FMA score, FTHUE-HK score, and MI score of the intervention group were higher than the control group, $P < 0.05$, as shown in **Table 1**.

Table 1. Upper limb function scores of the two groups (mean ± SD, points)

Group	Number of cases	FMA score		FTHUE-HK score		MI score	
		Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Control group	160	25.43 ± 6.57	34.35 ± 7.36*	2.91 ± 0.82	3.64 ± 0.74*	46.83 ± 10.27	62.64 ± 11.27*
Intervention group	160	25.12 ± 6.64	45.82 ± 8.49*	2.89 ± 0.84	4.42 ± 0.68*	45.78 ± 10.32	75.38 ± 10.92*
t	-	0.420	12.912	0.216	9.817	0.912	10.269
P	-	0.675	< 0.001	0.830	< 0.001	0.362	< 0.001

*$P < 0.05$ when compared with this group before treatment

3.2. Comparison of the neuro-electrophysiological indicators of the two groups

Before treatment, the difference of MEP cortical latency and central motor conduction time between the two groups was not significant ($P > 0.05$); after treatment, the MEP cortical latency and central motor conduction time in the intervention group were lower than the control group ($P < 0.05$), as presented in **Table 2**.

Table 2. Neuro-electrophysiological indicators of the two groups (mean ± SD, ms)

Group	Number of cases	MEP cortical latency		Central motor conduction time	
		Before treatment	After treatment	Before treatment	After treatment
Control group	160	25.41 ± 0.85	24.75 ± 0.67*	11.10 ± 0.51	10.58 ± 0.42*
Intervention group	160	25.45 ± 0.87	23.43 ± 0.52*	11.14 ± 0.53	9.16 ± 0.38*
t	-	0.416	19.687	0.688	31.713
P	-	0.678	< 0.001	0.492	< 0.001

*$P < 0.05$ when compared with this group before treatment

3.3. Comparison of the daily living ability of the two groups

Before treatment, the difference of BI scores between the two groups was not significant ($P > 0.05$); after treatment, BI scores of the intervention group were higher than the control group ($P < 0.05$), as displayed in **Table 3**.

Table 3. BI scores of the two groups (mean ± SD, points)

Group	Number of cases	Before treatment	After treatment	*t*	*P*
Control group	160	55.68 ± 8.24	74.31 ± 6.48	22.480	< 0.001
Intervention group	160	55.12 ± 8.75	85.37 ± 6.69	34.739	< 0.001
t	-	0.589	15.021	-	-
P	-	0.556	< 0.001	-	-

3.4. Comparison of the quality of life of the two groups

Before treatment, the GQOLI-74 scores of the two groups were compared, $P > 0.05$; after treatment, the GQOLI-74 scores of the intervention group were higher than the control group ($P < 0.05$), as shown in **Table 4**.

Table 4. GQOLI-74 scores of the two groups (mean ± SD, points)

Group	Number of cases	Physical functions		Psychological functions		Material life		Social functions	
		Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Control group	160	46.76 ± 6.22	53.74 ± 5.58*	45.87 ± 5.35	52.64 ± 5.44*	46.37 ± 5.02	53.18 ± 5.14*	46.16 ± 5.27	54.12 ± 5.08*
Intervention group	160	46.15 ± 6.35	62.13 ± 5.36*	45.28 ± 5.43	59.68 ± 5.37*	46.12 ± 5.03	62.45 ± 5.23*	45.81 ± 5.31	62.16 ± 5.15*
t	-	0.868	13.716	0.979	11.650	0.445	15.990	0.592	14.059
P	-	0.386	< 0.001	0.328	< 0.001	0.657	< 0.001	0.554	< 0.001

*$P < 0.05$ when compared with this group before treatment

4. Discussion

The incidence rate of CI is high, and the mortality rate has decreased due to the improvement of medical technology. However, the disability rate is still relatively high, and limb dysfunction has serious adverse effects on the lives of CI patients. Many patients with CI develop upper limb dysfunction, mostly due to the loss of high-level central control capabilities, resulting in abnormal movement patterns. Brain tissue cannot regenerate after damage, but the brain has plasticity. It can provide functional compensation through continuous repair of structure and function, such as synaptic sprouting, synaptic regeneration, and changes in synaptic thresholds, thus rehabilitation treatment is vital.

Limb rehabilitation therapy is a common method for functional rehabilitation of CI patients. It includes good limb positioning, upper limb functional exercise, self-care training, resistance training, etc. For example, good limb positioning can relieve limb spasms, while targeted training activities can strengthen and correct limb activities and help restore motor functions; at the same time, continuous training has a stimulating effect on the motor nervous system, which is beneficial to the remodeling of damaged nerves, improves nerve function, and enhances control ability. Transcranial magnetic therapy is a stimulation technology that uses magnetic fields to act on the cerebral cortex, thereby generating sensory currents and changing the action potentials of cortical nerve cells, affecting neural electrical activity and brain metabolism, which is beneficial to rebuilding regional cortical functions.

From the results obtained in this study, compared with the control group receiving physical rehabilitation therapy, the post-treatment FMA score, FTHUE-HK score, and MI score were higher in the intervention group adopting transcranial magnetic stimulation therapy + limb rehabilitation therapy, suggesting that transcranial magnetic stimulation therapy + limb rehabilitation therapy has a more obvious effect on improving upper limb dysfunction in CI patients. Moreover, the intervention group was superior when comparing neuro-electrophysiological indicators, indicating that transcranial magnetic stimulation therapy + limb rehabilitation therapy can optimize neuro-electrophysiological functions. The intervention group's BI score and GQOLI-74 score after treatment were higher than those of the control group, indicating that transcranial magnetic stimulation therapy + limb rehabilitation therapy can improve patients' living ability and quality of life.

5. Conclusion

All in all, the application of transcranial magnetic stimulation therapy + limb rehabilitation therapy for patients with upper limb dysfunction after CI can improve FMA scores, FTHUE-HK scores, and MI scores, reduce neuro-electrophysiological index levels, and improve BI scores and GQOLI-74 scores, which is worthy of widespread application.

Disclosure statement

The authors declare no conflict of interest.

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