
Clinical Study on Post-stroke Dysfunction Using Transcranial Direct Current Combined with Rehabilitation Training

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Abstract: *Objective:* To explore the application effect of transcranial direct current combined with rehabilitation training in patients with post-stroke dysfunction. *Methods:* 60 patients with post-stroke dysfunction admitted to our hospital from January 2024 to December 2024 were selected and divided into a rehabilitation training group and a combined intervention group using the random number table method, with 30 cases in each group. The rehabilitation training group only implemented conventional rehabilitation training, while the combined intervention group added transcranial direct current therapy on the basis of conventional rehabilitation training. The intervention effects of the two groups were compared. *Results:* The joint intervention group's motor function scores and daily living activity ability scores were higher than those of the rehabilitation training group, and the incidence of complications was lower than that of the rehabilitation training group ($p < 0.05$). *Conclusion:* Transcranial direct current combined with rehabilitation training can significantly improve the motor function and daily living activities of patients with post-stroke dysfunction, reduce the risk of complications, and has clinical promotion value.

Keywords: Transcranial direct current; Rehabilitation training; stroke; Functional impairment; Clinical effect

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1. Introduction

As an acute cerebrovascular disease, the incidence rate of stroke continues to be high worldwide, and the incidence group is gradually showing a younger trend. After the onset, it can easily cause functional impairments in limb movement, daily life activities and other aspects, seriously affecting the quality of life of patients and placing a heavy burden on families and society^[1]. According to clinical statistics, more than 70% of stroke survivors will have varying degrees of functional impairment, among which problems such as limb hemiplegia and loss of self-care ability are the most common. This not only leads to an imbalance in the patient's own psychological state, but also significantly increases the pressure on family care and the consumption of medical resources. Rehabilitation training is currently a commonly used means to improve

functional impairment after stroke. Systematic limb activity training can delay muscle atrophy and promote motor function recovery to a certain extent. However, the effect of single rehabilitation training is often limited, especially for patients with severe neurological damage. The recovery process is slow and the effect is not ideal. Therefore, more effective combined treatment options need to be explored^[2,3]. As a new non-invasive neuromodulation technology, transcranial direct current has been increasingly used in the field of rehabilitation of neurological diseases in recent years. It can effectively regulate the activity of nerve cells by stimulating the cerebral cortex with mild electric current, and provide assistance for the remodeling of neural function. Based on this, this study combines transcranial direct current with rehabilitation training to observe its clinical effect on patients with post-stroke dysfunction and provide practical basis for clinical treatment.

2. Materials and methods

2.1. General information

60 patients with post-stroke dysfunction admitted to our hospital from January 2024 to December 2024 were selected and divided into a rehabilitation training group and a combined intervention group using the random number table method, with 30 cases in each group. There were 16 men and 14 men in the rehabilitation training group, aged 42 to 75 (58.62 ± 5.34) years old; including 21 cases of ischemic stroke and 9 cases of hemorrhagic stroke. The joint intervention group included 15 men and 15 men, aged 43 to 76 (59.15 ± 5.28) years old; including 20 cases of ischemic stroke and 10 cases of hemorrhagic stroke. There was no significant difference in basic information such as gender, age, and stroke type between the two groups of patients ($p > 0.05$), and they were comparable.

2.1.1. Inclusion criteria

- (1) Meet the diagnostic criteria for stroke and have clear functional impairment;
- (2) Onset time is 1 to 3 months;
- (3) Have clear consciousness and can cooperate with treatment.

2.1.2. Exclusion criteria

- (1) There are contraindications to transcranial direct current therapy;
- (2) Combined with severe heart, liver and kidney diseases;
- (3) Mental illness or cognitive impairment cannot cooperate.

2.2. Method

The rehabilitation training group implemented routine rehabilitation training. The training program was formulated by professional rehabilitation therapists based on the patient's individual functional assessment results, including core content such as limb function training and balance training. Each training session lasted 40 minutes, once a day, 6 days a week, and continued intervention for 8 weeks. In limb function training, patients with hemiplegic limbs first perform passive activities, with the therapist assisting them to complete joint flexion, extension, rotation and other movements for 15 minutes each time to maintain joint mobility and prevent muscle spasms. Then, active auxiliary training is carried out, with the help of rehabilitation equipment or therapists to guide the patient to carry out autonomous limb activities, 10 minutes each time, to gradually enhance muscle control ability. Finally, muscle strengthening training is performed to improve limb muscle strength through resistance exercises, weight-bearing training and other methods, 15 minutes each time. Balance training is carried out through balance boards, sitting balance exercises, standing against the wall, etc. The training intensity gradually increases from low to high. During the training process, a dedicated person is arranged to accompany the patient throughout the training. The principle of step-by-step is strictly followed and safety precautions are taken to prevent patients from falling and getting injured. At the same time, the patient's functional recovery is regularly evaluated during the training, and the training content and intensity are adjusted in a timely manner based on the evaluation results to

ensure the pertinence and effectiveness of the training.

The joint intervention group added transcranial direct current therapy to the rehabilitation training group, using a transcranial direct current stimulator produced by Shenzhen Yingzhi Technology Co., Ltd. Before treatment, the patient's head skin was cleaned and disinfected to remove grease and dirt to ensure the electrode conduction effect. The anode electrode is accurately placed in the primary motor cortex area on the opposite side of the lesion, and the cathode electrode is fixed on the non-active area of the ipsilateral shoulder. A special conductive paste is applied to the contact area between the electrode and the skin to ensure that the electrode and the skin are in close contact without bubbles. The current intensity was initially set to 0.5 mA, and then gradually increased to 1.5 mA. Each treatment lasted 20 minutes, once a day, and was separated by more than 2 hours from rehabilitation training to avoid mutual interference between the two treatment methods. The treatment lasted 6 days per week and continued the intervention for 8 weeks. During the treatment process, the patient's reaction is closely observed, and real-time communication is used to understand whether the patient has symptoms such as dizziness, headache, and skin tingling. At the same time, the skin condition of the electrode contact area is monitored. If skin redness, itching, etc. occur, the electrode position is promptly adjusted or the current intensity is reduced. Treatment is stopped if necessary. After the treatment, gently remove the electrodes and clean the patient's head skin. Record the specific parameters of each treatment and the patient's response to form a complete treatment file.

2.3. Observation indicators

The motor function score (assessed using the Fugl-Meyer scale, the total score is 100 points, the higher the score, the better the motor function), the daily living activity ability score (assessed using the Barthel index, the total score is 100 points, the higher the score, the stronger the self-care ability) and the incidence of complications (including pressure ulcers, pulmonary infection, deep vein thrombosis) between the two groups before and after the intervention.

2.4. Statistical methods

Data were analyzed using SPSS24.0. *t*-test for measurement data; χ^2 test for count data. $p < 0.05$ represents significant difference.

3. Results

3.1. Comparison of motor function scores between the two groups

After the intervention, the scores of the combined intervention group were higher than those of the rehabilitation training group ($p < 0.05$), **Table 1**.

Table 1. Comparison of motor function scores between the two groups ($\bar{x} \pm s$, points)

Group	Before intervention	After intervention
Rehabilitation training group (30)	45.36 ± 6.28	62.18 ± 7.35
Joint intervention group (30)	44.92 ± 6.34	75.64 ± 8.12
<i>t</i>	0.270	6.731
<i>p</i>	0.788	0.000

3.2. Comparison of daily living activity ability scores between the two groups

There was no significant difference in the daily living activity ability scores between the two groups before the intervention ($p > 0.05$). After the intervention, the scores of the combined intervention group were higher than those of the rehabilitation training group ($p < 0.05$), **Table 2**.

Table 2. Comparison of daily living activity ability scores between the two groups ($\bar{x} \pm s$, points)

Group	Before intervention	After intervention
Rehabilitation training group (30)	42.68 ± 5.92	58.34 ± 6.75
Joint intervention group (30)	43.12 ± 5.86	72.56 ± 7.42
<i>t</i>	0.289	7.765
<i>p</i>	0.773	0.000

3.3. Comparison of complication rates between the two groups

The incidence of complications in the combined intervention group was lower than that in the rehabilitation training group ($p < 0.05$), **Table 3**.

Table 3. Comparison of complication rates between the two groups [n (%)]

Group	Pressure ulcer	Lung infection	Deep vein thrombosis	Overall incidence rate [n (%)]
Rehabilitation training group (30)	3 (10.00)	3 (10.00)	2 (6.67)	8 (26.67)
Joint intervention group (30)	1 (3.33)	0 (0.00)	0 (0.00)	1 (3.33)
χ^2				4.706
<i>p</i>				0.030

4. Discussion

The occurrence of dysfunction after stroke is mainly related to the obstruction of nerve conduction pathways and the decrease in nerve cell activity caused by brain tissue damage. Restoring neurological function and improving limb movement ability are the core goals of clinical treatment [4]. As a traditional treatment method, rehabilitation training can promote local blood circulation, maintain muscle tension, and prevent joint stiffness through targeted limb activities and balance training. It can also stimulate the remodeling of nerve function. However, single rehabilitation training has a limited activation effect on nerve cells and can only indirectly affect the central nervous system through peripheral stimulation. It is difficult to quickly repair damaged neural pathways. Therefore, the functional recovery effect of some patients is not ideal [5].

Transcranial direct current therapy is a non-invasive neuromodulation technology that uses a weak constant current to act on the cerebral cortex, which can regulate the membrane potential of nerve cells and promote the release of neurotransmitters, thereby enhancing the excitability and plasticity of nerve cells. Relevant studies have confirmed that transcranial direct current can effectively increase the activity of nerve cells in the motor area of the cerebral cortex, promote the reconstruction of synaptic connections, and create favorable conditions for the recovery of neurological functions [6]. In this study, the combined intervention group added transcranial direct current therapy on the basis of rehabilitation training. After the intervention, the motor function scores and daily living activity ability scores were significantly higher than those of the rehabilitation training group. This result fully demonstrates that the combined application of transcranial direct current and rehabilitation training can produce a synergistic effect and more effectively promote the patient's functional recovery. From the perspective of the mechanism of action, rehabilitation training stimulates the reconstruction of neural pathways through peripheral limb activities, while transcranial direct current directly acts on the central nervous system to enhance neural activity in the motor areas of the cerebral cortex. The combination of the two can jointly promote neurological repair from both the central and peripheral levels, forming a two-way regulation

mechanism, thereby more significantly improving the patient's motor function ^[7].

The recovery of activities of daily living is an important basis for post-stroke patients to return to family and society. It is closely related to motor function but also involves more aspects of coordination. The post-intervention Barthel index score of the joint intervention group was significantly higher than that of the rehabilitation training group, indicating that transcranial direct current combined with rehabilitation training can not only improve the patient's limb movement ability, but also enhance their self-care ability. This is because while transcranial direct current activates the motor cortex, it can also regulate cognitive function areas related to daily life activities and enhance the patient's ability to coordinate and control movements. Coupled with targeted exercises in daily movements such as dressing, eating, and washing during rehabilitation training, patients can master life skills faster and gradually realize self-care ^[8]. In addition, the combined treatment plan can also effectively improve the patient's psychological state. With the improvement of self-care ability, the patient's self-confidence and self-identity are significantly enhanced, further promoting the overall recovery process.

The prevention of complications is very important in the treatment of patients with post-stroke dysfunction. Complications such as pressure ulcers, lung infections, and deep vein thrombosis will not only increase the patient's physical burden, but may also affect the recovery process and even threaten life safety ^[8]. In this study, the total incidence rate of complications in the combined intervention group was only 3.33%, which was much lower than the 26.67% in the rehabilitation training group. This difference was mainly due to two factors. On the one hand, transcranial direct current combined with rehabilitation training can more quickly improve the patient's limb movement function, allowing the patient to turn over, sit up, and even get out of bed on his own earlier, reducing local tissue compression, sputum accumulation and other problems caused by long-term bed rest, and fundamentally reducing the risk of pressure ulcers and lung infections. On the other hand, the improvement of neurological function improves the patient's body regulation ability and immunity, and significantly improves blood circulation status, effectively reducing the probability of deep vein thrombosis. At the same time, during the combined treatment process, medical staff observe patients more closely, can detect potential complication risks in a timely manner and take targeted preventive measures, further reducing the incidence of complications.

In clinical practice, it has been found that transcranial direct current therapy is highly safe. In this study, no serious adverse reactions occurred in the combined intervention group. Only one patient experienced slight skin redness. The symptoms were relieved after adjusting the electrode position. The operation is simple and non-invasive, requiring no complicated preoperative preparation and postoperative care. The patient has a high degree of acceptance and can better cooperate to complete the entire treatment process, which also provides guarantee for the smooth implementation of the combined treatment plan. Compared with other invasive neuromodulation technologies, transcranial direct current therapy is relatively low-cost and more suitable for promotion and application in primary hospitals, which can benefit more patients with post-stroke dysfunction.

The effect of rehabilitation training is often affected by the patient's cooperation and training intensity. Transcranial direct current therapy can improve the patient's neurological functional status to a certain extent, reduce numbness, weakness and other uncomfortable symptoms of the limbs, making it easier for patients to gain a sense of accomplishment during rehabilitation training, thus improving training enthusiasm and compliance. This virtuous cycle further promotes the improvement of treatment effects, making the overall recovery of the combined intervention group better than that of the single rehabilitation training group. In clinical practice, we have found that some patients have significant improvement in their limb mobility after 1 to 2 weeks of combined treatment. This rapid therapeutic effect greatly enhances patients' confidence in treatment, allowing them to participate more actively in rehabilitation training, forming a virtuous cycle of "effective treatment—active cooperation—better results". From the perspective of neuroplasticity theory, neural function remodeling after stroke has a certain time window, and 1 to 3 months after the onset is the critical period for functional recovery. The onset time of the patients selected in this study was all within this range. Through intensive treatment of transcranial direct current combined with rehabilitation training, neuroplasticity can be more fully utilized to promote the repair and compensation of damaged neural pathways, laying a good foundation for the long-term recovery of patients.

If this critical period is missed, the difficulty of neural function remodeling will be significantly increased, and the treatment effect will also be affected to a certain extent. Therefore, for patients with post-stroke dysfunction, standardized rehabilitation treatment and neuromodulation intervention should be carried out as early as possible.

In summary, transcranial direct current combined with rehabilitation training has significant application value in the treatment of patients with post-stroke dysfunction. It can effectively improve patients' motor functions and activities of daily living, reduce the incidence of complications, and is worthy of clinical promotion and application.

About the author

Huang Zhi (1987.10), female, Han nationality, native of Wuxi, Jiangsu Province, undergraduate, supervisor in charge of therapist, research direction: application of transcranial magnetic stimulation technology in stroke patients.

Disclosure statement

The author declares no conflict of interest.

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