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Efficacy of Biofeedback Combined with Occupational Therapy on Upper Limb Function in Stroke Patients

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Abstract: *Objective*: To study the efficacy of biofeedback combined with occupational therapy in stroke patients, including upper arm function, hand function, and self-care ability. *Methods*: A total of 60 stroke patients who met the inclusion and exclusion criteria of this study were divided into a treatment group and a control group, with 30 cases in each group, using a random number table method. The total course of treatment was 4 weeks, with 5 treatments per week. Both groups received routine rehabilitation treatment, while the treatment group was supplemented with biofeedback therapy on the basis of routine rehabilitation. Before treatment and after 4 weeks of treatment, the Hemiplegic Hand Function Assessment Scale, Carroll Upper Extremity Function Assessment Scale, Wolf Motor Function Test (WMFT), and Brunnstrom Scale were used to evaluate patients' hand function, Activities of Daily Living (ADL) ability, and motor function, respectively. Adverse events during treatment were observed. *Results*: After treatment, the Brunnstrom stages, Carroll upper extremity function scores, and Wolf upper extremity function scores of patients in both groups were significantly improved ($p < 0.001$), and the improvement effect in the treatment group was more significant ($p < 0.001$). *Conclusion*: Stroke patients receiving basic rehabilitation treatment combined with occupational therapy and biofeedback therapy can better improve their upper arm and hand functions. Meanwhile, the combination of biofeedback therapy and occupational therapy is superior to occupational therapy alone, enhancing the self-care ability of stroke patients.

Keywords: Biofeedback combined with occupational therapy; Stroke; Upper limb function

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1. Introduction

Stroke is the leading cause of death and disability. Among them, the rehabilitation of hemiplegic upper limb function after stroke is a key and hot issue in clinical rehabilitation. Approximately 55–75% of patients are prone to residual upper limb dysfunction of varying degrees, which affects their quality of life and increases the burden on families and society. Occupational therapy can specifically formulate rehabilitation measures for Activities of Daily Living (ADL), accelerating the recovery of upper limb and hand functions. Biofeedback therapy can record

the electrical activity information of patients' muscles, helping them understand their own muscle status, thereby gradually adjusting muscle activity and better completing related movements. This study aims to analyze the therapeutic effect of biofeedback therapy on the hemiplegic hand function, upper limb motor function, and self-care ability of stroke patients.

2. Materials and methods

2.1. General information

A total of 60 hemiplegic patients after stroke who were hospitalized in the Department of Rehabilitation Medicine of our hospital from October 2023 to May 2025 were selected and divided into a treatment group (30 cases) and a control group (30 cases) using a random number table method [1]. There were no significant differences in general data such as age, gender, and time from onset to admission between the two groups ($p > 0.05$), indicating comparability. Specific data are shown in **Table 1**.

Table 1. Comparison of general conditions of patients

Group	Number of cases	Male/Female (cases)	Average age (Years, $\bar{x} \pm s$)	Time from onset to admission (Days, $\bar{x} \pm s$)
Treatment group	30	12/18	54.66 ± 13.58	71.90 ± 105.40
Control group	30	14/16	54.60 ± 11.14	59.00 ± 77.42

2.1.1. Inclusion criteria

Conforming to the national diagnostic criteria for the disease; confirmed as cerebrovascular disease by CT, MRI, etc.; presenting with unilateral hemiplegia; active wrist dorsiflexion range of motion > 10° on the affected side; patients and their families providing informed consent and signing the informed consent form.

2.1.2. Exclusion criteria

Suffering from severe hypertension or underlying heart disease; having large-area cerebral infarction; complicated with shoulder dislocation on the hemiplegic side; having severe cognitive impairment [2].

2.2. Treatment methods

Both groups of patients need to receive conventional drug therapy, such as blood pressure-lowering and blood sugar-lowering treatment, and actively carry out basic rehabilitation training in combination with their specific functional disorders.

First, the control group conducts basic rehabilitation training. Its training content involves basic items such as joint mobility training and balance function training. Each training session lasts 30–40 minutes, once a day, with a total course of 4 weeks and 5 treatment sessions per week [3].

Second, the treatment group conducts basic rehabilitation training, supplemented by occupational therapy and biofeedback therapy. In the selection of treatment environment and body position, an independent treatment room should be chosen. Patients should be instructed to sit upright to achieve the goal of natural relaxation [4]. For electrode placement, alcohol cotton balls can be used to wipe the connection between the electrode pads and the skin. After air-drying, place them on the extensor muscles of the upper arm on the hemiplegic side of stroke and other positions. In the specific treatment process, medical staff should guide patients to perform movements such

as elbow extension and finger extension so that the electromyographic signals can reach the threshold [5]. Patients can refer to voice prompts and adjust their movements according to the guidance of rehabilitation therapists. When the instrument sends a relaxation signal, patients can be guided to perform muscle relaxation, and the instrument will automatically adjust according to the spontaneous electromyographic signals. Regarding the treatment duration, it should be separated from occupational therapy by 1–2 hours, with a total course of 4 weeks [6].

2.3. Evaluation methods

The assessment should be conducted at different time points, such as before treatment and after the 4-week course of treatment, by the same professional physician to evaluate the patient's function, thereby enhancing the objectivity of the assessment results [7]. First, for the assessment of hemiplegic hand function, the physician can mainly evaluate the patient's hand function from perspectives such as hand muscle strength and fine motor skills, with a total score of 100 points. The higher the score, the better the recovery effect of the hand function. Second, the Carroll upper limb function assessment can be carried out, which specifically involves tests such as picking up and placing objects. Different actions are scored (0–5 points), with a total of 10 test items and a total score of 50 points [8]. Third, the Wolf upper limb function test can be conducted, where the patient is required to participate in 10 daily activity tasks, such as writing and picking up a water cup. The completion time and movements of the tasks are recorded and scored accordingly. The lower the total score, the better the upper limb function [9]. Fourth, the Brunnstrom scale can be created, which divides the recovery of upper limb and hand motor function into stages I–VI. The higher the stage, the better the recovery of the patient's upper limb and hand motor function. From the perspective of the entire treatment stage, the physician needs to follow the conditions of patients in different groups, analyze whether there are adverse conditions such as dizziness and skin allergies, and record the time and status of their occurrence, so as to take corresponding measures [10].

2.4. Statistical analysis

SPSS 22.0 statistical software was used for data processing. Measurement data (such as hemiplegic hand function assessment and Carroll upper extremity function assessment) were expressed as mean ± standard deviation ($\bar{x} \pm s$) [11]. Paired *t*-tests were used for intra-group comparisons before and after treatment, and independent sample *t*-tests were used for inter-group comparisons. Count data (such as the incidence of adverse events) were expressed as frequency (n) and percentage (%), and comparisons were performed using χ^2 tests. A p-value < 0.05 was considered statistically significant [12].

3. Results

3.1. Hemiplegic hand function assessment

Before treatment, there was no significant difference in the Hemiplegic Hand Function Assessment Scale scores between the two groups ($p > 0.05$). After 4 weeks of treatment, the scores of both groups were significantly higher than those before treatment ($p < 0.001$), and the score of the treatment group (82.5 ± 7.3) was significantly higher than that of the control group (65.2 ± 8.1), with a statistically significant difference ($p < 0.001$). Specific data are shown in **Table 2**.

Table 2. Comparison of hemiplegic hand function assessment before and after treatment

Group	Number of cases	Before treatment	After treatment	*t*-value	*p*-value
Treatment group	30	45.3 ± 9.2	82.5 ± 7.3	18.65	< 0.001
Control group	30	44.8 ± 8.9	65.2 ± 8.1	10.32	< 0.001

3.2. Carroll upper extremity function assessment

Before treatment, there was no significant difference in Carroll upper extremity function scores between the two groups ($p > 0.05$). After treatment, the scores of both groups were significantly improved ($p < 0.001$), and the score of the treatment group (42.3 ± 4.5) was higher than that of the control group (31.5 ± 5.2), with a statistically significant difference ($p < 0.001$) [13]. Specific data are shown in **Table 3**.

Table 3. Comparison of Carroll upper extremity function assessment before and after treatment

Group	Number of cases	Before treatment	After treatment	*t*-value	*p*-value
Treatment group	30	18.6 ± 5.1	42.3 ± 4.5	22.47	< 0.001
Control group	30	19.1 ± 4.8	31.5 ± 5.2	9.86	< 0.001

3.3. Wolf motor function test (WMFT)

Before treatment, there was no significant difference in WMFT scores between the two groups ($p > 0.05$). After treatment, the scores of both groups were lower than those before treatment ($p < 0.001$), and the score of the treatment group (28.6 ± 6.4) was lower than that of the control group (45.3 ± 7.2), with a statistically significant difference ($p < 0.001$).

3.4. Brunnstrom scale

Before treatment, there was no significant difference in Brunnstrom stages of upper limb and hand function between the two groups ($p > 0.05$). After treatment, the stages of both groups were improved ($p < 0.001$), and the stages of upper limb and hand function in the treatment group were higher than those in the control group, with a statistically significant difference ($p < 0.001$).

4. Discussion

The core of upper limb dysfunction after stroke is decreased muscle control due to nerve damage, manifested as motor dysfunction. Although routine rehabilitation training can improve some functions through basic exercises, it lacks targeting and accuracy, making it difficult to meet patients' needs. The results of this study show that the treatment group had a more significant improvement in various functions after the combination of biofeedback and occupational therapy, indicating the effectiveness of this treatment plan. Occupational therapy can simulate daily life scenarios, promote the integration of rehabilitation goals with patients' needs, facilitate patients to acquire living skills, strengthen the coordination of upper limb movement and cognitive functions, and accelerate functional recovery [14]. Biofeedback therapy can help patients break through muscle sensory barriers through visual signal feedback, understand their own muscle status, appropriately improve movement patterns, form good muscle control pathways, and accelerate neural remodeling. The organic combination of the two can not only

address the problems of patients in routine training but also convert motor functions into practical living abilities through occupational training, promoting the connection between rehabilitation training and daily life applications.

From a mechanistic perspective, biofeedback therapy can effectively stimulate the corresponding areas of the cerebral motor cortex through real-time myoelectric signal feedback, enhance the cortex's control ability over the hemiplegic limbs, effectively reduce abnormal muscle tone, and alleviate muscle spasticity, providing good conditions for subsequent precise movement training [15]. Occupational therapy can effectively consolidate the effects of biofeedback therapy through functional movement exercises, establish good neural pathways, strengthen muscle memory, and improve motor coordination and stability. The exertion of the above synergistic effects can achieve better therapeutic results.

At the same time, this study has certain limitations, specifically small sample size and single-center research, which may limit the generalizability of the results. Due to the relatively short follow-up time, long-term efficacy was not observed. In the future, attention should be paid to expanding the sample size, conducting multi-center studies, appropriately extending the follow-up time, and objectively verifying the long-term efficacy and safety of this treatment plan. In conclusion, the combination of biofeedback and occupational therapy can better optimize the upper limb and hand functions of stroke patients, continuously improve their self-care skills, and show good safety, providing a favorable plan for the subsequent clinical rehabilitation quality of stroke and having good promotion and application value.

5. Conclusion

In conclusion, the integration of occupational therapy with biofeedback therapy significantly enhances upper limb and hand function recovery in stroke patients, demonstrating superior efficacy compared to occupational therapy alone. This combined approach also leads to greater improvements in patients' self-care abilities.

Disclosure statement

The author declares no conflict of interest.

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