Diagnostic Brain Medicine

ORIGINAL RESEARCH

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Effect of Ultrasonic Pulse Electroconductivity Therapy Combined with Rehabilitation Training on Improving Limb Dysfunction in Patients with Acute Cerebral Infarction

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Keywords

Ultrasonic pulse electroconductivity therapy, Rehabilitation training, Acute cerebral infarction, Limb dysfunction

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Received: 14 May 2022, Revised:27 May 2022, Accepted:8 June 2022, Published:23 June 2022

Diagnostic Brain Medicine 2022; 3(2): 55-62

Abstract

Background Our study explores the improvement effect of ultrasonic pulse electroconductivity therapy combined with rehabilitation training on limb dysfunction in patients with acute cerebral infarction (ACI). **Methods** A total of 120 ACI patients admitted to our hospital from September 2018 to January 2019 were included and divided into control group and observation group according to random number table method, with 60 cases in each group. Patients in control group received rehabilitation training, and patients in observation group received ultrasonic pulse electroconductivity therapy on the basis of treatment in control group. The clinical efficacy, Fug-Meyer motor function score, National Institutes of Health Stroke Scale (NIHSS) score, adverse reactions, complications, and family satisfaction in the two groups were compared. **Results** 4 and 8 weeks after treatment, Fug-Meyer motor function score in two groups was significantly higher than that before treatment ($P<0.05$), and the score in the observation group was obviously higher than that in control group ($P<0.05$). 4 and 8 weeks after treatment, NIHSS score in both groups was visibly lower than before treatment ($P<0.05$), and the score in observation group was apparently lower than that in control group ($P<0.05$). After 8 weeks of treatment, no adverse reactions or complications occurred, and family satisfaction was good in both groups. **Conclusion** Ultrasonic pulse electroconductivity therapy combined with rehabilitation training can improve the motor function of limbs as well as the prognosis of patients with ACI and reduce the degree of nerve defect.

1 Introduction

Acute cerebral infarction (ACI) is a relatively common cerebrovascular disease, with high disability rate worldwide [1,2]. Wang et al. [3] reported that the disability rate of hospitalized patients with cerebral infarction within three months after the onset of the disease in China was 34.5% to 37.1% in the past 10 years, and the patients' subsequent quality of life was severely affected.

It has been confirmed by evidence-based medicine that early rehabilitation can effectively reduce the disability rate of ACI patients [4]. In clinical practice, bed rehabilitation training combined with physical therapy is often used as early rehabilitation treatment for ACI patients, so as to improve the muscle strength and function of the dysfunctional limbs of the patients. Ultrasonic pulse electroconductivity therapy (UPET) is a physical therapy modality that combines ultrasound and pulse current to continuously generate a specific electric current to electrically stimulate dysfunctional limbs with normal muscle activity intensity, thus achieving the therapeutic effects of strengthening muscle contraction and improving muscle mobility [5]. There are no studies on UPET combined with rehabilitation training to improve limb dysfunction in patients with ACI.

Collectively, this study aims to investigate the improvement effect of UPET combined with rehabilitation training on limb dysfunction in patients with ACI, with the aim of providing a reference for the treatment of clinical patients. Our findings were reported as follows.

2 Data and methods

2.1 General data

A total of 120 patients with ACI admitted to our hospital from September 2018 to January 2019 were included and divided into control group and observation group according to random number table method, with 60 cases in each group. The average age of the patients in observation group was 61.87 ± 3.22 years old, with 36 male cases and 24 female cases. The average age of patients in control group was 62.34 ± 2.41 years old, with 28 male cases and 32 female cases. There was no statistically significant difference between the two groups in terms of gender, age, types of ACI, and sites of hemiparesis (P>0.05). The relative data were shown in Table 1.

Table 1 Comparison of general data in two groups

Groups		Control group (n=60)	Observation group (n=60)	χ^2/t	*P*
Gender (cases)	Male	28	36	2.143	0.143
	Female	32	24		
Age (years old)		62.34±2.41	61.87±3.22	0.905	0.367
Types of ACI	Hemorrhagic	19	23	0.586	0.444
	Ischemic	41	37		
Sites of hemiparesis (cases)	Left hemiplegia	25	21	0.564	0.453
	Right hemiplegia	35	39		

2.2 Inclusion and exclusion criteria

2.2.1 Inclusion criteria

(1) Patients met the diagnostic criteria for patients with acute ischaemic stroke in the Diagnostic Points of Various Major Cerebrovascular Diseases in China 2019 [6] formulated by Chinese Society of Neurology. (2) Patients aged 50-80 years. (3) Patients who didn’t undergo thrombectomy surgery. (4) Patients underwent thrombolytic therapy within 6 hours of admission, and there was at least one limb dysfunction after thrombolytic therapy. (5) Patients had Fug-Meyer motor function score<50 and National Institutes of Health Stroke Scale (NIHSS) score>21 before treatment. (6) Patients with clear consciousness and good compliance to cooperate with physical examination score and treatment.

2.2.2 Exclusion criteria

(1) Patients with acute onset of the disease. (2) Patients with severe heart, lung, and kidney diseases. (3) Patients with blood pressure > 200/100 mmHg. (5) Patients with previous history of stroke. (6) Patients with limb dysfunction caused by nervous system diseases, such as epilepsy, cerebral hemorrhage, and brain tumor.

2.3 Methods

Patients in both groups received treatment to improve cerebral circulation, anticoagulation, hypertension, and hyperglycemia after admission.

2.3.1 Control group

Rehabilitation training was adopted in the control group, and the rehabilitation measures were formulated according to Guidelines for Early Rehabilitation Treatment of Stroke in China [4], including (1) good limb position: patients were instructed to use soft cushions to correctly position themselves on the bed, during which lateral decubitus position of the affected side and the healthy side were encouraged and semireclining position and supine position should be avoided as much as possible. Above positions were changed at least once every 2 h. (2) Bed position transfer: patients were instructed to move sideways on the bed or in the anterior-posterior direction, turn over and sit up for 30 min twice a day. (3) Bridging training: patients were instructed to take the lying position and cross the hands upward for 10 min of bridging training twice a day. Patients were urged to go up and down stairs and walk when their physical conditions permitted, and daily living ability training was interspersed with them for 14 days of continuous treatment.

2.3.2Observation Group

Based on the treatment in control group, patients in observation group were treated with UPET combined with rehabilitation training, using SLC-002 ultrasonic pulse electroconductivity therapeutic instrument from Henan Zhonghexin Medical Equipment Co., Ltd. Normal saline was used to clean the affected limbs of the patients, and then the electrode sheets were used to stick the tendon parts of the patients. The upper limbs were placed at the forearm tendon and the biceps tendon, and the lower limbs were placed at the quadriceps tendon and the gastrocnemius tendon. The electrode sheets were connected to the output electrodes of ultrasonic therapeutic instrument, and the current intensity was selected according to the patients’ tolerance. Abovementioned treatment was performed for 20 min twice a day, and the treatment duration was 14 days. The follow-up was conducted 4 and 8 weeks after treatment.

2.4 Observational indicators

2.4.1 Total effective rate of treatment

Indicators were evaluated 8 weeks after treatment. Basically cured: 10%~30% reduction in NIHSS score compared to before treatment. Improved: 31%~60% reduction in NIHSS score compared to before treatment. Significantly improved: >60% reduction in NIHSS score compared to before treatment. Invalid: <10% reduction in NIHSS score compared to before treatment. The total effective rate = number of (basically cured + improved + significantly improved) cases/total number of cases*100% [5].

2.4.2 Fug-Meyer motor assessment score

Fug-Meyer score was evaluated on both groups before treatment, and 4 or 8 weeks after treatment, with a total Fug-Meyer score of 100 points, <50 points being severe motor impairment, 50-84 points being marked motor impairment, 85-95 points being moderate motor impairment, and 96-99 points being mild motor impairment [7].

2.4.3 NIHSS score

NIHSS score was evaluated on both groups before treatment, and 4 or 8 weeks after treatment, with a total NIHSS score of 42 points, 0 point being no stroke, 1-4 points being mild stroke, 5-15 points being moderate stroke, 16-20 points being moderate to severe stroke, and 21-42 points being severe stroke [8].

2.4.4 Follow-up indicators (adverse reactions, complication rates, and family satisfaction)

After 8 weeks of treatment, the patients were followed up for 3 months. Telephone follow-up was taken to investigate the occurrence of adverse events and complications, such as deep vein thrombosis, pressure injury, and central pain, and to investigate the satisfaction of the patients' family members.

2.5 Statistical methods

Statistical analysis was performed using SPSS 20.0, count data were compared using the χ2 test, and measurement data were expressed as mean ± standard deviation (). Independent samples t-test was used for comparison between the two groups, LSD test was used for two-by-two comparisons between groups, and paired samples t-test was used for comparisons between different time points in the same group. Differences were considered to be statistically significant at $P<0.05$.

3 Results

3.1 Comparison of therapeutic effects between two groups

8 weeks after treatment, the total effective rate in observation group was significantly higher than that in control group ($P<0.05$). The results were shown in Table 2.

Table 2 Comparison of therapeutic effects between the two groups [cases (%)]

Groups	Cases	Basically cured	Significantly improved	Improved	Invalid	Total effective rate
Control group	60	10(16.67)	16(26.67)	12(20.00)	22(36.67)	38(63.33)
Observation group	60	14(23.33)	20(33.33)	17(28.33)	9(15.00)	51(85.00)
χ^2						7.350
P						0.007

3.2 Comparison of Fug-Meyer score between the two groups

Before treatment, there was no statistically significant difference in Fug-Meyer score between the two groups ($P>0.05$). 4 and 8 weeks after treatment, the functional score of upper and lower limbs in both groups was obviously higher than that before treatment ($P<0.05$), and that in observation group was visibly higher than that in control group ($P<0.05$). The results were seen in Table 3.

3.3 Comparison of NIHSS score between the two

groups

Before treatment, there was no statistically significant difference in NIHSS score between the two groups (*P*>0.05). 4 and 8 weeks after treatment, NIHSS score in observation group and control group was visibly lower than before treatment (*P*<0.05), and the score in observation group was apparently lower than that in control group (*P*<0.05). The results were seen in Table 4.

Table 3 Comparison of Fug-Meyer score between the two groups ($\bar{x}\pm s$, point)

Groups	Cases	Functional score of upper limbs			Functional score of lower limbs		
		Before treatment	4 weeks after treatment	8 weeks after treatment	Before treatment	4 weeks after treatment	8 weeks after treatment
Observation group	60	21.52±3.14	61.36±5.48*	87.91±6.33*	8.75±1.24	26.83±3.42*	40.21±5.74*
Control group	60	20.86±3.05	50.32±4.29*	68.32±5.40*	9.01±1.13	17.58±2.34*	29.44±3.28*
t		1.168	12.288	18.238	-1.200	17.290	12.619
P		0.245	0.000	0.000	0.232	0.000	0.000

Note: Comparison with before treatment: *$P<0.05$

Table 4 Comparison of NIHSS score between the two groups ($\bar{x}\pm s$, point)

Groups	Cases	NIHSS score		
		Before treatment	4 weeks after treatment	8 weeks after treatment
Observation group	60	28.45±1.72	14.27±1.33*	7.42±0.98*
Control group	60	28.16±1.80	19.61±1.20*	10.38±1.04*
t		0.902	-23.091	-16.045
P		0.369	0.000	0.000

Note: Comparison with before treatment: *$P<0.05$

3.4 Comparison of adverse reactions, complications, and satisfaction between the two groups

After 8 weeks of treatment and 3 months of follow-up, there were no adverse reactions and complications in both groups, such as deep vein thrombosis, pressure injury, and central pain, and family satisfaction was good.

4 Discussion

ACI is characterized by high incidence and recurrence rate, and is one of the diseases with high disability and mortality rate [3,9]. After the condition of ACI patients is stabilized, rehabilitation therapy can be performed as early as possible according to physical tolerance, which can safely and effectively promote the recovery of the function of the affected limbs [4]. Therefore, this study investigated the improvement effect of UPET combined with rehabilitation training on limb dysfunction in patients with ACI, and the results of our study uncovered that their combination was more effective.

ACI patients often suffer from corresponding neurological deficits due to ischaemia and hypoxic necrosis of local brain tissue. NIHSS score is commonly used in clinical practice to evaluate the degree of neurological deficits. The results of this study showed that 4 and 8 weeks after treatment, NIHSS score in observation group and control group was visibly lower than before treatment, and the score in observation group was apparently lower than that in control group. 8 weeks after treatment, the total effective rate in observation group was significantly higher than that in control group. These findings suggested that UPET combined with rehabilitation therapy improved neurological deficits, and combination of both was more effective. Rehabilitation therapy can maintain the normal range of motion of ACI patients' joints, thus achieving the therapeutic effects of preventing and treating muscle disuse atrophy and promoting the recovery of systemic functions. Schuhmann MK *et al.* have found that electrical stimulation therapy can reduce the synthesis and secretion of immune cells' interleukins and chemokines, thereby alleviating the inflammatory response of ACI [10]. Reducing the inflammatory response in the early stage of ACI can relieve the damage of patients' cerebral ischemic tissues [11]. In addition, electrical stimulation therapy can also decrease the degree of ischaemia and reperfusion injury in ACI, and play a protective role for the nerves in the early stage of ACI, thus alleviating neurological deficits [12].

Early limb dysfunction in ACI patients often manifests as low muscle strength and severely impaired motor function. In this study, Fug-Meyer score was used to assess the degree of limb motor dysfunction in ACI patients. According to the results, 4 and 8 weeks after treatment, the functional score of upper and lower limbs in both groups was obviously higher than that before treatment, and the score in observation group was visibly higher than that in control group. These findings hinted that UPET combined with rehabilitation therapy could improve patients' upper and lower limb motor function. The central nervous system of ACI patients still has a certain ability to remodel nerve cells in the early stage of injury [5]. Based on this, early rehabilitation therapy for ACI patients is feasible. UPET can enhance the response of central nerve synapses in ACI patients through repeated depolarization motion and sensory nerve axons by continuous electrical stimulation, which can enhance the synaptic response of the central nervous system in ACI patients to remodel the brain nerve cells of ACI patients, reconstruct the nerve conduction function, and enable the affected limbs to produce passive rhythmic contraction and diastole, thus simulating the normal state of muscle movement and enhancing the contraction ability of the muscles, and ultimately improving the motor function of the affected limbs of ACI patients [13]. In addition, our results revealed that no adverse events and complications occurred in UPET combined with rehabilitation therapy, and family satisfaction was good, indicating that UPET as a non-invasive electrical stimulation modality had a certain degree of safety, and was also more easily accepted by patients and their families. Overseas studies show that functional electrical stimulation combined with conventional rehabilitation can improve the limb mobility of ACI patients with dysfunction, and the therapeutic effect can be more significant by starting the treatment as early as possible [14-15].

In conclusion, UPET combined with rehabilitation training can improve the motor function of limbs as well as the prognosis of patients with ACI and reduce the degree of nerve defect.

Acknowledgements
Not applicable.

Conflict-of-Interest
The authors declare no conflicts of interest.

Authors' contributions
Conceptualization: C.R.J; Data curation:C.R.J; Formal analysis: C.R.J; Methodology: C.R.J; Writing – original draft:C.R.J; Writing – review and editing: C.R.J; All authors have read and agreed to the published version of manuscript

Ethics approval and consent to participate
This study was approved by Medical Ethics Committee, and patients were informed and agreed.

Funding
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Availability of Data and Materials
The analyzed data sets generated during the study are available from the corresponding author on reasonable request.

Supplementary Material
Not applicable

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