

Effect of Breathing Exercises in Combination with Swallowing-Five-Acupoint Acupuncture on Dysphagia after Stroke

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Abstract

Objective: This study explored the effect of breathing exercises in combination with swallowing-five-acupoint acupuncture on post-stroke dysphagia. **Methods:** Fifty post-stroke dysphagia patients who attended our hospital and received the combined treatment of breathing exercises with swallowing-five-acupoint acupuncture, from June 2020 to February 2023, were included as the combination group. During the same time, 50 post-stroke dysphagia patients, who were treated with swallowing-five-acupoint acupuncture were selected as the control group. The clinical efficacy of the two groups was compared after 4 weeks of treatment, then the data of water swallow test (WST) grading, respiratory function indicator levels, and swallowing function scores were collected from the two groups. **Results:** The total clinical effective rate was higher in the combination group than in the control group ($p < 0.05$). After treatment, the WST grading, swallowing function scores and breathing frequency (BF) level in the two groups were reduced compared to that before treatment ($p < 0.05$), and these indicators in the combination group were lower than those in the control group ($p < 0.05$). After treatment, forced vital capacity (FVC) and maximum voluntary ventilation (MVV) levels in the two groups were increased compared to those before treatment ($p < 0.05$), and FVC and MVV levels in the combination group were higher than those in the control group ($p < 0.05$). **Conclusion:** The combination of breathing exercises with swallowing-five-acupoint acupuncture exerts a good therapeutic effect on post-stroke dysphagia, which not only alleviates the symptoms of dysphagia in patients but improves their respiration function.



1 Introduction

Stroke causes damage to the cerebral vagus, as well as the subnuclei or nuclei of the glossopharyngeal and hypoglossal nerves, and leads to pseudobulbar palsy and bulbar palsy, which can result in dysphagia due to abnormal muscle movement of the pharyngeal and tongue in patients [1,2]. Statistically, the incidence of dysphagia after stroke is as high as 80% [3]. This condition highly predisposes people to respiratory diseases such as aspiration pneumonia, seriously affecting the prognosis and quality of life of patients [4].

At present, the clinical treatment of stroke-associated dysphagia mainly based on neuromuscular electrical stimulation therapy and comprehensive rehabilitation training [5,6]. Moreover, acupuncture combined with swallowing training has a good effect on swallowing dysfunction after stroke [7]. Wang et al. have found that needling at five acupoints for swallowing function has precise efficacy in treating post-stroke in clinical practice [8]. Five acupoints for swallowing function are mainly composed of Fengchi acupoint (GB20), Tianzhu acupoint (BL10), Wangu acupoint (GB12), Yifeng acupoint (TE17), and Shexia acupoint (RN23) [9]. Needling at these five acupoints can ameliorate swallowing dysfunction of the patients by activating the brainstem reticular system and stimulating the central nervous system to restore and reestablish the swallowing reflex, however, this monotherapy has limitations in terms of its slow onset of effect and long course of treatment [10]. And previous study showed that acupuncture and acupuncture combined with rehabilitation were better than using rehabilitation alone in the treatment of poststroke dysphagia [11]. Furthermore, respiratory muscle training is effective in improving dysphagia by reducing penetration or aspiration during swallowing liquid bolus after stroke [12]. And a study has shown that breathing exercises can improve respiratory function in people with dysphagia after stroke [13]. Respiratory function

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training is a therapeutic method for alleviating dysphagia in stroke patients by enhancing their respiratory function, specifically, this training method focuses on improving the breath control of patients and promotes harmonization of the body's swallowing and respiration, thereby reducing the risk of dysphagia-induced aspiration pneumonia after stroke [14]. Previous study showed that Liyan acupuncture or pharynx three needles combined with breathing training can effectively promote the improvement of swallowing function, shorten the time of swallowing [15,16].

In order to explore the clinical application value of breathing exercises in combination with swallowing-five-acupoint acupuncture in post-stroke dysphagia, 100 patients with post-stroke dysphagia were divided into two groups in this study. Through the observation of patients' clinical outcomes, swallowing function, respiratory function and other related indicators, this study aims to provide a reference basis for the clinical treatment of post-stroke dysphagia.

2 Materials and methods

2.1 General information

The 50 post-stroke dysphagia patients who attended our hospital and received the combined treatment of breathing exercises with needling at five acupoints, from June 2020 to February 2023, were enrolled and set up as the combination group. During the same time, 50 post-stroke dysphagia patients, who were treated with needling at five acupoints for swallowing function were selected as the control group. There was no significant difference in the general data between the two groups ($p > 0.05$), which was comparable, as shown in Table 1. The present study was approved by the Ethics Committee of our hospital, and all the enrollees signed the written informed consent.

Table 1 Comparison of general data between the two groups.

Group	Cases	Gender (cases)		Age (years)	Disease course (years)	Type (cases)	
		male	female			Cerebral infarction	Cerebral hemorrhage
Combination group	50	24	26	64.50 ± 3.63	2.38 ± 1.24	38	12
Control group	50	27	23	64.82 ± 3.91	2.40 ± 1.12	35	15
			χ^2/t				
			p				

2.2 Inclusion criteria

(1) Stroke meets the diagnostic criteria in the Chinese Guidelines for the Diagnosis and Treatment of Acute Ischemic Stroke 2018 [17]. (2) Post-stroke dysphagia meets the diagnostic criteria in the Advances in Evidence-Based

Nursing Practice for the Recognition and Management of Dysphagia in Stroke [18]. (3) Confirmation by Computed Tomography (CT) or Magnetic Resonance Imaging (MRI). (4) First onset. (5) The grading of water swallow test (WST) \geq level II. (6) Patients have not received any systemic therapy for post-stroke dysphagia.

2.3 Exclusion criteria

(1) Dysphagia caused by other factors. (2) Patients had a massive cerebral infarction accompanied by impaired consciousness. (3) Exacerbation or recurrence of cerebrovascular disease during the course of the study. (4) Patients had aphasia, deafness, and psychiatric abnormalities, being unable to cooperate with the examination and treatment. (5) Patients were unable to tolerate the acupuncture used in this study. (6) Other neurological disorders. (7) Malignant tumors. (8) Pregnant or lactating women.

2.4 Therapeutic intervention

Patients in the control group were treated with swallowing-five-acupoint acupuncture. (1) Acupoints include Fengchi (bilateral), Tianzhu (bilateral), Wangu

(bilateral), Yifeng (bilateral), and Shexia (bilateral). (2) Acupuncture manipulation: the patient was asked to sit in a supine position and relax to eliminate nervous mood. After routine disinfection of the operator's fingers and the patient's acupoints (except for Shexia acupoint), disposable and sterilized acupuncture needles (0.30 mm \times 40 mm, Huatuo brand) were slowly inserted into Fengchi acupoint, Tianzhu acupoint, Wangu acupoint and Yifeng acupoint in the direction of the throat, and the depth of the needle is 25-40 mm. The inserted needles were manipulated with a small amplitude ($< 90^\circ$) and a high frequency (120-160 times/min) for 1 min till a tingling feeling appeared in the throat, and the needles were withdrawn after 30-min retaining without any manipulation. The patient was asked to open mouth and stick his tongue out. The operator held the patient's tongue body with the sterile gauze covered his fingers and tilted it up to expose the sublingual area. A disposable and sterilized acupuncture needle (0.30 mm \times 60 mm, Huatuo brand) was quickly inserted into the Shexia acupoint to a 40-60 mm depth at an angle of about 15° upwards, and quickly withdrawn without retaining the needle. Acupuncture was performed sequentially on both sides of the acupoint, once a day, 6 times a week. The course of treatment was 4 weeks, with 6 days of treatment and 1 day of rest.

Patients in the combination group were given breathing exercises on the basis of treatment in the

control group. (1) Deep breathing exercise: the patient was asked to be in a sitting or semi-reclining position. Next, the patient was asked to inhale deeply through the mouth and nose slowly to bulge the abdomen, and then start to gradually contract the abdomen and exhale slowly and evenly through the mouth. The inspiration and respiration were performed repeatedly and alternately, with each inspiration and respiration counted for one set. A total of 20 sets were performed once a day, with a 30-second interval between each two sets. (2) Pursed-lip breathing exercise: the patient was asked to be in a sitting or semi-reclining position. Next, the patient was asked to inhale through the nose and purse lips to exhale slowly, during which the patient was asked to exhale as long as possible. Each inspiration and respiration was counted for one set. A total of 20 sets were performed once a day, with a 30-second interval between each two sets. (3) Glottal functional training: the patients were asked to be in a sitting or semi-reclining position. They were required to slowly and deeply inhale through the mouth and nose. At the end of the inspiration, the patient was asked to make a "cough" movement or "P" sound with his glottis, each movement was preformed for 20 sets per day. There was a 30 s of interval between each two sets. (4) Thoracic breathing exercise: the patient was asked to be in a sitting position. The operator placed the palmar surfaces of both hands on the patient' s lower thorax and put some pressure on the uplifted thorax during inspiration of the patient to increase the resistance against thoracic movement. (5) Abdominal breathing exercise: the patient was asked to be in a supine position. The operator placed both hands at the patient' s abdomen and pressed on the abdomen as the patient slowly inhaled, allowing the patient to counteract abdominal resistance. The operator applied slight pressure to the abdomen as the patient exhaled for stretching the diaphragm. The training performed once a day for 30 min, with 5 times

per week. The course of treatment was 4 weeks, with 5 days of treatment and 2 days of rest.

2.5 Research indicators

In this study, we collected data comparing the indicators of neurological damage between the two groups before and after 4 weeks of treatment, as well as clinical data such as the patients' WST grading, respiratory function indicator levels, and swallowing function scores during the treatment period.

(1) Clinical efficacy: Comparison of clinical efficacy between the two groups after treatment. Cured: swallowing function became normal and WST was graded as level I. Significantly effective: swallowing dysfunction was relieved and WST was upgraded to 2-4 level. Effective: swallowing dysfunction was improved and WST was upgraded to 1 level. Ineffective: WST grading was not enhanced. Total effective rate= (number of cured cases + number of significantly effective cases + number of effective cases)/total number × 100% [19].

(2) Swallowing function: Comparison of WST grading and dysphagia assessment subscale in the neurological deficit scores between the two groups before and after 4 weeks of treatment. According to the instructions of WST grading, the patient was asked to sit upright and drink 30 mL warm water as usual. The nursing staff observed the time spent by the patient on drinking and choking condition during the drinking process. Level I: smoothly swallow the water once. Level II: swallow the water twice, without choking cough. Level III: swallow the water once, with choking cough. Level IV: swallow the water twice, with choking cough. Level V: difficulty in swallowing all the water, with frequent choking cough. The higher grading of the WST indicates more difficulty in swallowing [20]. According to the dysphagia assessment subscale in the neurological deficit scores, the patient had no abnormal swallowing and was counted as 0 point; the patient had difficulty

in swallowing, and drank and ate slowly, with multiple halts, which counted as 2 points; a score of 4 was counted as the patient was significantly slow to eat and some food needed to be avoided; a score of 5 was counted as the patient was only able to swallow special food; and a score of 6 was counted as the patient was unable to swallow food and had to be fed nasogastrically. The higher scores indicate worse swallowing function [21].

(3) Respiration function: Comparison of respiratory function indicators between the two groups before and after 4 weeks of treatment. A pulmonary function detector (PFT-B, Anhui Institute of Electronic Science) was used to measure forced vital capacity (FVC) level, maximum voluntary ventilation (MVV), and breathing frequency (BF) level.

2.6 Statistical analysis

The SPSS Statistics version 20.0 software was utilized to analyze the collected data. Enumeration data was

represented as %, and the χ^2 test was used for comparison of enumeration data. One-way ordinal categorical variables were analyzed using the rank sum test. Measurement data were shown as mean \pm standard deviation. Continuous variables were analyzed using the Kruskal-Wallis test and reported using mean \pm standard deviation for normally distributed data. Comparison between the two groups was analyzed by independent samples *t*-test, and comparison in the same group before and after treatment was analyzed by paired samples *t*-test. Differences were taken to be statistically significant if *P* values < 0.05.

3 Results

3.1 Comparison of clinical efficacy between the two groups

The total clinical effective rate in the Combination group was higher than that in the Control group (*p* = 0.005), as shown in Table 2

Table 2 Comparison of clinical efficacy between the two groups [cases (%)].

Group	Cases	Cured	Significantly effective	Effective	Ineffective	Total effective rate
Combination group	50	13 (26.00)	16 (32.00)	17 (34.00)	4 (8.00)	46 (92.00)
Control group	50	5 (10.00)	14 (28.00)	16 (32.00)	15 (30.00)	35 (70.00)
						χ^2 7.862
						<i>p</i> 0.005

3.2 Comparison of the WST grading between the two groups

Before treatment, there was no significant difference in the WST grading between the two groups (*p* >

0.05). After treatment, the WST grading in the two groups was reduced compared to that of before treatment (*p* < 0.001), and the WST grading in the Combination group was lower than that in the Control group (*p* = 0.001), as demonstrated in Table 3.

Table 3 Comparison of the WST grading between the two groups (cases).

Group	Cases	Time	The WST grading					χ^2	<i>p</i>
			Level I	Level II	Level III	Level IV	Level V		
Combination group	50	Before treatment	0	5	6	3	36	68.771	< 0.001
		After treatment	30	14	4	1	1		
Control group	50	Before treatment	0	6	2	8	34	52.680	< 0.001
		After treatment	10	22	11	4	3		

After treatment: Combination group vs. Control group, $\chi^2 = 17.844$, *p* = 0.001.

3.3 Comparison of swallowing function scores between the two groups

Before treatment, there was no significant difference in the swallowing function scores between the two groups ($p > 0.05$). After treatment, swallowing

function scores in the two groups were decreased compared to those before treatment ($p < 0.05$), and swallowing function scores in the Combination group were lower than those in the Control group ($p = 0.003$), as demonstrated in Table 4.

Table 4 Comparison of swallowing function scores between the two groups (mean ± standard deviation, scores).

Group	Cases	Swallowing function scores	
		Before treatment	After treatment
Combination group	50	4.46 ± 1.16	1.58 ± 0.54 *
Control group	50	4.34 ± 1.17	2.02 ± 0.87 *
<i>t</i>		0.515	3.038
<i>p</i>		0.608	0.003

Note: compared with the same group before treatment, * $p < 0.05$.

3.4 Comparison of respiratory function indicators between the two groups

Before treatment, there was no significant difference in FVC, MVV and BF levels between the two groups ($p > 0.05$). After treatment, FVC and MVV levels in the two groups were increased compared to those before

treatment ($p < 0.05$), and FVC and MVV levels in the Combination group was higher than those in the Control group ($p < 0.001$). After treatment, the level of BF in the two groups was decreased compared to that before treatment ($p < 0.05$), and the level of BF in the Combination group was lower than that in the Control group ($p = 0.009$), as presented in Table 5.

Table 5 Comparison of respiratory function indicators between the two groups (mean ± standard deviation).

Group	cases	FVC (%)		MVV (%)		BF (time/min)	
		Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Combination group	50	67.20 ± 3.72	82.17 ± 4.01*	67.46 ± 3.78	80.65 ± 4.77 *	20.06 ± 2.34	16.78 ± 2.57 *
Control group	50	66.71 ± 4.32	72.36 ± 4.90 *	66.51 ± 3.91	72.23 ± 4.57 *	20.00 ± 2.62	18.54 ± 2.43 *
<i>t</i>		0.608	10.960	10235	9.013	0.121	3.519
<i>p</i>		0.545	< 0.001	0.220	< 0.001	0.904	0.009

Note: compared with the same group before treatment, * $p < 0.05$.

4 Discussion

In order to find the effective approach for treating swallowing dysfunction after stroke, this study enrolled 50 post-stroke dysphagia patients undergoing the combination treatment of breathing exercises and swallowing-five-acupoint acupuncture, as well as 50 post-stroke dysphagia patients only undergoing the treatment of swallowing-five-acupoint acupuncture during the same time. Through

comparison of clinical treatment outcomes between the two groups, we found that swallowing-five-acupoint acupuncture in combination with breathing exercises treatment may have a relatively good effect in the treatment of patients with dysphagia after stroke.

The occurrence of ischemic or hemorrhagic lesions in part of the blood vessels within the skull of patients with stroke can damage the cortical swallowing center,

brainstem swallowing center and peripheral afferent nerves, leading to abnormal alterations of the swallowing process in patients [22]. The results of this study demonstrated that combination of breathing exercises with swallowing-five-acupoint acupuncture exerted a significantly therapeutic effect on post-stroke dysphagia patients and ameliorated swallowing dysfunction. Swallowing-five-acupoint acupuncture is performed by needling at acupoints including Fengchi and Shexia. Among them, the posterior branch of the third cervical nerve and the branch of the minor occipital nerve are distributed under the Fengchi acupoint. It has been shown that needling at this acupoint can establish contact with the facial nerve nucleus and accessory facial nerve nucleus, stimulate the laryngeal reflex and promote the upward lifting of the hyoid bone, thus effectively improving the swallowing dysfunction of stroke patients [23]. Needling at Shexia acupoint can stimulate the nucleus of the glossopharyngeal, vagus and hypoglossal nerves to unlock the relevant collaterals of the tongue and facilitate neurotransmission. The excitation of the tongue nerves is beneficial to the reconstruction and restoration of the swallowing reflex, as well as to improve muscle coordination, which plays a positive role in rehabilitation of the body's swallowing function [24]. Breathing exercises can improve the body's swallowing function by strengthening the myodynamia of respiratory muscle groups, preventing respiratory muscle atrophy, increasing laryngeal elevation height, enhancing oropharyngeal cavity pressure, and balancing the coordination of respiratory and swallowing muscles [13]. In light of this, it is suggested that the clinical efficacy of breathing exercises in combination with swallowing-five-acupoint acupuncture in the treatment of post-stroke dysphagia is excellent. This combination therapy is effective in improving the symptoms of dysphagia in patients and achieves better therapeutic effects compared to the single treatment with swallowing-five-acupoint acupuncture.

When ischemic or hemorrhagic lesions occur in part of the intracranial blood vessels in stroke patients, they can cause damage to the cortical nuclei bundles of the body, leading to the accidental entry of water into the upper respiratory tract, which should enter the stomach through the mouth, thus disturbing the respiratory function of patients [25]. In this study, the results showed that combination of breathing exercises with swallowing-five-acupoint acupuncture effectively improved the respiratory function of patients with swallowing dysfunction after stroke. In the five acupoints for swallowing function, Tianzhu acupoint belongs to foot greater yang bladder meridian, whose sinews accumulate in the tongue through its connection with the brain. Needling at this acupoint can stimulate the pharyngeal muscle groups and strengthen the swallowing reflex, which improve the patient's respiratory muscle weakness and ventilation disorders, and thus enhance the respiratory function of the body [26]. Breathing exercises include deep breathing exercise, pursed-lip breathing exercise, glottal functional training, thoracic breathing exercise and abdominal breathing exercise, among them, deep breathing exercise, pursed-lip breathing exercise and glottal functional training can enhance the strength of respiratory muscles, prevent muscle atrophy, effectively regulate alveolar ventilation, improve the ratio of ventilation to blood flow, and thereby improve respiratory function [27]. Thoracic breathing exercise increases the flexibility of the spine and thoracic mobility, which contributes to the enhancement of lung compliance, increases the expiratory rhythm, and effectively improves the coordination of respiratory function when the patient swallows [27]. Abdominal breathing exercise increases the strength and mobility of the diaphragm and slows down the respiratory rate, which improve the coordination of the patient's respiratory and swallowing activities [28]. Therefore, combination of breathing exercises with swallowing-five-acupoint acupuncture can effectively enhance the patient's respiration function in the

treatment of post-stroke dysphagia. This combination therapy can obtain a better therapeutic effect compared to the single treatment with swallowing-five-acupoint acupuncture.

In summary, combination of breathing exercises with swallowing-five-acupoint acupuncture exerts a good therapeutic effect on post-stroke dysphagia by not only alleviating the symptoms of dysphagia in patients but improving their respiration function. Nevertheless, there were some limitations in this study, such as a small sample size, a short follow-up period, and failure to exclude the influencing factors like lesion location in our results. In the future, we will expand the scale of the study to assess the effect of breathing exercises in combination with swallowing-five-acupoint acupuncture on the long-term prognosis of patients, and analyze the in-depth mechanism of this treatment for stroke, in order to provide high-level evidence to support combination of breathing exercises with swallowing-five-acupoint acupuncture used in the treatment of stroke.

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Conflicts of Interest

The authors declare no conflicts of interest.

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Author Contributions

Conceptualization: Chenfeng Hu; Data curation: WenXiao Yu; Formal analysis: Chenfeng Hu; Methodology: WenXiao Yu; Writing – original draft: Chenfeng Hu; Writing – review and editing: WenXiao Yu; 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.

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Availability of Data and Materials

The analyzed data sets generated during the study are available from the corresponding author on reasonable request.

Supplementary Materials

Not applicable.

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