Journal of Clinical and Nursing Research, 2026, Volume 10, Issue 6
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

Application Analysis of Tongue Muscle Training Combined with Respiratory Training Intervention for Dysphagia after Stroke

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Abstract: *Objective:* To explore the effects of tongue muscle training combined with respiratory training intervention on patients with dysphagia after stroke. *Methods:* A total of 70 patients with dysphagia after stroke admitted to our hospital from January 2025 to January 2026 were selected for the study and randomly divided into two groups. The control group (35 cases) underwent conventional rehabilitation training, while the observation group (35 cases) focused on tongue muscle training combined with respiratory training intervention. The intervention effects were compared between the two groups. *Results:* Before the intervention, there were no significant differences in swallowing function, respiratory function, and nutritional indicators between the two groups ($p > 0.05$). After the intervention, the observation group showed greater improvements in tongue muscle strength and swallowing laryngoscopy scores, as well as lower dysphagia scores and better respiratory function, with significant differences compared to the control group ($p < 0.05$). *Conclusion:* Tongue muscle training combined with respiratory training intervention can improve swallowing function and overall quality of life in patients with dysphagia after stroke, making it worthy of promotion.

Keywords: Tongue muscle training; Respiratory training; Stroke; Dysphagia

Online publication: Jun 30, 2026

1. Introduction

Stroke is a critical and life-threatening condition with a high incidence rate, high disability rate, and numerous complications, posing a significant threat to the physical health and quality of life of elderly individuals. Dysphagia is the most common complication after stroke, characterized by symptoms such as delayed tongue muscle movement, poor coordination of pharyngeal muscles, and impaired swallowing-breathing rhythm [1]. This complication not only leads to adverse reactions such as malnutrition, dehydration,

and aspiration pneumonia but also increases the risk of prolonged hospitalization and mortality, making it an important risk factor affecting the recovery of neurological and physical functions in patients. Swallowing is a delicate physiological activity involving the coordinated participation of tongue muscles, laryngeal muscles, and respiratory muscles, with precise coordination between elastic contraction and respiratory rhythm being crucial for normal swallowing [2]. According to the coordination mechanism of swallowing movement, respiratory training can adjust thoracoabdominal breathing patterns, correct swallowing-breathing difficulties, and reduce the risk of aspiration by enhancing tongue muscle strength, improving tongue flexibility, and enhancing the squeezing effect of swallowing [3]. This study aimed to explore the effects of tongue muscle training combined with respiratory training intervention on patients with dysphagia after stroke, with the analysis presented as follows.

2. General information and research methods

2.1. Data

Seventy patients with swallowing dysfunction after stroke admitted to our hospital from January 2025 to January 2026 were selected for the study and randomly divided into two groups. In the control group, there were 20 males and 15 females, aged between 59 and 78 years, with an average age of (68.45 ± 2.36) years. In the observation group, there were 19 males and 16 females, aged between 60 and 78 years, with an average age of (68.89 ± 2.45) years. No statistically significant differences were observed in the basic data between the two groups ($p > 0.05$). This study adhered to medical ethical guidelines and did not conflict with national laws and regulations.

2.1.1. Inclusion criteria

(1) Patients were clinically diagnosed with stroke and confirmed by head CT, MRI, or other imaging modalities;
(2) Patients had mild to moderate swallowing dysfunction as diagnosed by the Watian Drinking Water Test and imaging;
(3) Patients were conscious and able to cooperate with rehabilitation exercises.

2.1.2. Exclusion criteria

(1) Patients with concurrent oral diseases or esophageal cancer;
(2) Patients with dysfunction of vital organs;
(3) Patients with cognitive dysfunction unable to cooperate with training;
(4) Patients with severe hemiplegia.

2.2. Methods

2.2.1. The control group received conventional rehabilitation training

Daily swallowing function rehabilitation treatment was provided to the control group for 4 weeks, with continuous intervention for 6 days per week, once a day, and 30 minutes each time. First, basic oral and maxillofacial exercises were conducted, guiding patients to perform puffing and closing of the cheeks and relaxation exercises of the facial muscles to enhance the strength of the oral muscles. Second, pharyngeal stimulation exercises were performed using a cotton swab to stimulate the patient's soft palate, tongue, and

throat, utilizing sensory stimulation to restore the pharyngeal reflex. Third, basic swallowing exercises were conducted, instructing patients to swallow air while maintaining balance in the head and neck and using a standard swallowing force method. Fourth, dietary guidance was provided to adjust the patient's swallowing function, focusing on thin and thick liquid foods, and guiding patients to chew slowly and avoid aspiration caused by eating too quickly. This was combined with clinical standard neuromuscular electrical stimulation therapy. Parameter settings: pulse frequency 80 Hz, pulse width 700 μs, stimulation intensity adjusted to produce obvious contraction of the patient's local muscles without pain, single stimulation duration 20 minutes, once a day, and continuous intervention for 6 days per week.

2.2.2. The observation group focused on implementing tongue muscle training combined with respiratory training interventions

The exercises were conducted twice a day for 30 minutes each time, once in the morning and once in the afternoon, for a total of 4 weeks, 6 days per week. Specifically, it included:

(1) Specialized tongue muscle training

15 minutes each session, ① Tongue muscle strength training: Patients were instructed to maintain a sitting position with shoulders and neck relaxed, extend their tongue out of the mouth as far as possible, hold the extended position for five seconds, and then slowly retract it. Subsequently, they were instructed to perform actions such as lifting the tip of the tongue to press against the hard palate and pushing it down to press against the lower gingiva, with 15 repetitions per set, completing a total of 3 sets, with a 15-second rest between sets. For patients with weak tongue muscle strength who were unable to perform the extension independently, nurses could wrap the tongue with sterile gauze to assist in traction, gradually restoring normal tongue muscle activity. ② Tongue flexibility exercises: Patients were guided to perform 10 clockwise rotations and 10 counterclockwise rotations of the tongue inside the mouth; subsequently, the tip of the tongue was alternately pressed against the inner side of the left and right masseter muscles (holding for 1 second on each side). ③ Tongue resistance strength training: A sterilized tongue depressor (or spoon handle) was selected. The tongue depressor was placed flat on the patient's tongue surface, and the patient was instructed to exert upward force with the tongue to press against the tongue depressor, maintaining maximum contraction for 8 seconds and then relaxing for 2 seconds. The above was considered one set of actions, with a total of 4 sets completed. A 10-second rest was taken between sets. Each set consisted of 10 repetitions, completing a total of 3 sets, with a 10-second rest between sets. ④ Tongue-throat coordination training: Patients were guided to lift the tip of the tongue to press against the hard palate, causing the entire tongue surface to adhere to the hard palate (simulating the action of holding food), followed by a single dry swallowing motion. Each set consisted of 12 repetitions, completing 3 sets, with a 10-second rest between sets. All training should be conducted within the patient's physical capacity. If fatigue is felt, the number of repetitions can be appropriately reduced and gradually increased later.

(2) Specialized respiratory training

15 minutes each time, ① Warm-up phase: Calm breathing combined with shoulder and neck relaxation training for 1 minute. ② Abdominal breathing training: Patients were placed in a semi-reclining or sitting position with both hands placed on the abdomen. They were instructed to inhale through the nose (2 seconds) to cause the abdomen to bulge and exhale through pursed lips (4 seconds) to cause the abdomen to contract. Each set consisted of 10 repetitions, with a 20-second rest between sets and a total of 3 sets completed.

③ Pursed-lip breathing training: After inhaling through the nose for 2 seconds, patients were instructed to exhale slowly for 6 seconds with pursed lips as if blowing a whistle. Each set consisted of 8 repetitions, with a 30-second rest between sets and a total of 2 sets completed. ④ Resisted respiratory training: An inspiratory muscle trainer (initial resistance set at 30–50% of maximum inspiratory pressure) was used. Patients were instructed to inhale deeply and quickly as much as possible, hold their breath for 1 second, remove the mouthpiece, and exhale through pursed lips. After each inhalation, patients were instructed to breathe calmly for 2–3 times before proceeding to the next inhalation. Each set consisted of 6 repetitions, with a 30-second rest between sets and a total of 3 sets completed. If a decrease in blood oxygen saturation of ≥ 3%, an increase in heart rate of ≥ 20 beats per minute, significant dizziness, or signs of aspiration (coughing, wet voice, etc.) occur during training, training should be terminated immediately.

2.3. Observation indicators

(1) The swallowing function of patients in both groups was observed, including tongue muscle strength and standard swallowing function, which were recorded before and after intervention [4]. The standardized assessment of tongue muscle strength was used to quantitatively evaluate the muscle strength during tongue protrusion, retraction, elevation, and lateral movement, accurately assessing the recovery of tongue muscle motor function. The standard swallowing function assessment scale (SSA) was used to assess swallowing ability, with scores ranging from 18 to 46. A higher score indicated better swallowing ability. To improve the scientificity and accuracy of the evaluation, swallowing laryngoscopy was used as the "gold standard" to visually observe the oral and pharyngeal movements of patients, and the FEES (fibroendoscopic evaluation of swallowing) quantitative scoring standard (0–10 points, with higher scores indicating better swallowing function) was used [5].

(2) Respiratory function indicators of patients in both groups were observed, including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and peak expiratory flow rate (PEF).

2.4. Statistical analysis

Experimental data were properly processed using SPSS 24.0 software. Measurement data were presented as mean ± standard deviation ($\overline{x} \pm s$), and comparisons between groups were made using the *t*-test. Categorical data were presented as percentages (%) and analyzed using the chi-square test (χ^2 test). Significant differences were considered when $p < 0.05$.

3. Results

3.1. Comparison of swallowing function between the two groups of patients

Before intervention implementation, the performance of the two groups in terms of tongue muscle strength and swallowing function was similar, with no significant differences ($p > 0.05$). After intervention, the tongue muscle strength and swallowing laryngoscopy scores of patients in the observation group improved more significantly, while the swallowing dysfunction scores decreased more significantly, with significant differences compared to the control group ($p < 0.05$), as shown in **Table 1**.

Table 1. Comparison of swallowing function between the two groups of patients ($\overline{x} \pm s$, points)

Group	Number of cases	Tongue muscle strength		SSA		Swallowing endoscopy score	
		Before intervention	After intervention	Before intervention	After intervention	Before intervention	After intervention
Control group	35	4.21 ± 1.33	6.03 ± 1.25	28.64 ± 2.34	22.34 ± 2.55	4.26 ± 0.66	6.31 ± 0.55
Observation group	35	4.32 ± 1.26	8.31 ± 1.13	28.71 ± 2.25	19.61 ± 2.26	4.28 ± 0.59	7.65 ± 0.63
t		0.355	8.005	0.128	4.740	0.124	8.776
p		0.724	< 0.001	0.899	< 0.001	0.902	< 0.001

3.2. Comparison of respiratory function indicators between the two groups of patients

Before the intervention, there were no significant differences in respiratory function indicators between the two groups ($p > 0.05$). After the intervention, the indicators in the observation group were higher than those in the control group, with significant differences ($p < 0.05$), as shown in **Table 2**.

Table 2. Respiratory function indicators of the two groups of patients ($\overline{x} \pm s$)

Group	Number of cases	FVC(L)		FEV1(L)		PEF(L/min)	
		Before intervention	After intervention	Before intervention	After intervention	Before intervention	After intervention
Control group	35	1.82 ± 0.46	2.15 ± 0.59	1.50 ± 0.31	1.89 ± 0.23	325.64 ± 3.59	380.59 ± 3.12
Observation group	35	1.84 ± 0.39	2.86 ± 0.61	1.53 ± 0.26	2.17 ± 0.23	325.58 ± 3.26	386.54 ± 3.26
t		0.196	4.950	0.439	5.093	0.073	7.801
p		0.845	0.000	0.662	0.000	0.942	0.000

4. Discussion

Stroke patients often experience reduced tongue muscle strength, weakened tongue mobility, slowed pharyngeal reflexes, and slower breathing and swallowing rhythms. These issues prevent patients from swallowing normally, leading to difficulties in eating, choking, and a series of other manifestations. Without intervention, patients may not receive adequate nutrition and are prone to aspiration, resulting in a range of complications such as pneumonia and malnutrition. This not only delays the recovery process of neurological function but also affects the patient's quality of life [6–9].

Tongue muscle training targets various muscle groups of the tongue from multiple aspects, including muscle strength, flexibility, pressure, and coordination [10]. By activating tongue motor neurons, it accelerates the repair of damaged neural pathways, alleviates tongue muscle atrophy, and gradually improves muscle contractility and flexibility [11]. Standardized tongue muscle rehabilitation exercises can rebuild tongue surface movement patterns, correct unnatural phenomena such as tongue lateral displacement and uncoordinated movements, and enhance the tongue's ability to push, suck, and squeeze food [12]. Respiratory training, utilizing abdominal breathing and pursed-lip breathing exercises, can improve patients' thoracic breathing patterns, enhance the muscle strength of the diaphragm and intercostal muscles, improve pulmonary ventilation, stabilize resting breathing rhythms, and reduce ineffective breathing movements [13].

The results of this study show that compared to the control group, patients in the observation group

experienced greater improvements in tongue muscle strength and swallowing laryngoscopy scores, along with lower swallowing dysfunction scores and enhanced respiratory function indicators. The reason is that through coordinated practice of swallowing rhythms, patients can develop standardized breathing and swallowing sequences at different times, thereby avoiding aspiration caused by inhalation. Resistance breathing training can improve the endurance and control of respiratory muscles, enabling patients to accurately regulate their breathing frequency to meet their needs [14,15]. After intervention, the respiratory rate of the observation group gradually stabilized, and the consistency of their breathing rhythms significantly improved. Their motor coordination was also significantly better than that of the control group, suggesting that improving patients' respiratory regulation can restore them to a normal state.

5. Conclusion

In conclusion, the combined approach of tongue muscle training and respiratory training meets the rehabilitation needs of stroke patients with swallowing disorders. Specifically repairing the key functions of the tongue muscles and improving patients' pulmonary ventilation and respiratory muscle function can comprehensively enhance patients' swallowing ability, improve their dietary and nutritional status, and reduce the occurrence of complications.

Disclosure statement

The authors declare no conflict of interest.

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