

Original Article

# Effects of neck exercises on swallowing function of patients with stroke

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**Abstract.** [Purpose] This study examined the effects of neck exercises using PNF on the swallowing function of stroke patients with dysphasia. [Subjects and Methods] A total of 26 study subjects were selected and randomly divided into an experimental group of 13 subjects, who received the PNF-based short neck flexion exercises, and a control group of 13 subjects, who received the Shaker exercise. [Results] The experimental group showed statistically significant improvements in premature bolus loss, residue in the valleculae, laryngeal elevation, epiglottic closure, residue in the pyriform sinuses, and coating of the pharyngeal wall after swallowing, and improvements in pharyngeal transit time, and aspiration on both the new VFSS scale and the ASHA NOMS scale. [Conclusion] PNF-based short neck flexion exercises appear to be effective at improving swallowing function of stroke patients with dysphagia.

**Key words:** Proprioceptive neuromuscular facilitation, Dysphagia, Stroke

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## INTRODUCTION

Approximately 33 to 73% of stroke patients are reported to experience dysphagia<sup>1)</sup>, a disorder that causes difficulty with chewing and swallowing food. The condition can cause very serious complications such as aspiration pneumonia, dehydration, and malnutrition, and may occasionally lead to death<sup>2)</sup>. Enabling dysphagia patients to eat by rehabilitating their swallowing function is important not just to ensure the medical safety and functional activities of those patients, but also to maintain their quality of life<sup>3)</sup>.

The treatment of dysphagia involves the suppression of parareflexia and the facilitation of the swallowing reflex, as well as sensory stimulation of the oral cavity and the face. Dysphagia can also be addressed with facial, oral, pharyngeal, and laryngeal muscle strengthening exercises<sup>4)</sup>, particularly tongue muscle strengthening exercises, vocal cord adduction, and the Shaker exercise, all of which are used extensively to treat the condition<sup>2)</sup>.

The Shaker exercise requires patients to keep their shoulders off the floor in a lying position and look at the ends of their feet by raising their heads. This forces the hyoid bone and the larynx to move forward and upward by contracting

the thyrohyoid, mylohyoid, geniohyoid, and the anterior belly of the diaphragm muscles. The Shaker exercise is effectively rehabilitates the swallowing function by helping to strengthen the suprahyoid and infrahyoid muscles and facilitating the opening action of the upper esophageal sphincter<sup>5)</sup>.

Proprioceptive neuromuscular facilitation (PNF) increases or facilitates the nerve-root mechanism's responses through proprioceptive stimulation. PNF exercises are used to enhance functional exercises by activating, strengthening, and relaxing muscle groups<sup>6)</sup>, and include short neck flexion exercises, which are known to effectively strengthen the suprahyoid, infrahyoid, longus capitis, and rectus capitis lateralis muscles<sup>7)</sup>. Therefore, the performance of neck exercises using PNF is considered an effective swallowing rehabilitation method.

While a number of studies have reported that the Shaker exercise is effective at treating swallowing disorders, no study has dealt with the effects of neck exercises using PNF on swallowing disorders. In light of this, the present study investigated PNF-based short neck flexion exercises in stroke patients with dysphagia to identify the effects of those exercises on swallowing disorders.

## SUBJECTS AND METHODS

The subjects of this study were stroke patients diagnosed with dysphagia, who visited F Hospital in Daegu between May and July, 2014. The selection criteria were as follows: symptoms of dysphagia for over six months prior to treatment; 24 points or higher on the Korean version of the mini-

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mental state examination (MMSE-K); at least fair grade in manual muscle testing of the neck flexors; and voluntary agreement to participation in this study. Patients with any kind of heart disease, internal disease, or musculoskeletal disease, who would have had difficulty performing our training, were excluded from the study. This study was conducted following an evaluation by the institutional review board of Daegu Fatima Hospital, and after receiving written consent from the selected patients and their guardians.

Twenty-six subjects were selected, using the above criteria. They were randomly divided into an experimental group comprising 13 subjects who received an intervention of PNF-based short neck flexion exercises, and a control group comprising 13 subjects who received an intervention of the Shaker exercise. Two experienced physical therapists conducted the exercise programs.

The experimental group performed PNF-based short neck flexion exercises three days a week for 30 minutes each time over a period of six weeks. The exercise method is described below.

Patients started by lying on a bed with their head and neck positioned off the bed. A tester was positioned on the left side behind the patient's head. The tester supported the patient's left laryngeal region with his right hand and placed his left fingertips below the patient's jaw. To complete the short neck flexion exercises properly, the tester told the patient to look at a target object in a direction 15° diagonally to the right-hand side. The tester then initiated the given exercises by moving the patient's neck in a diagonal direction opposite to the direction already specified. He then issued the verbal instruction "draw your jaw inward", and applied a proper level of resistance to the patient's jaw to fully activate the neck flexor below the jaw, which caused the patient to perform cervical flexion, in other words, external flexion on the right side or rotation to the right. When the patient found it difficult to continue the process due to the influence of gravity, the tester provided a minor level of support rather than resistance in order to help the patient complete the exercises. The same exercises were then performed in the opposite direction.

The control group performed both isometric and isotonic Shaker exercises three days a week for 30 minutes each time over a period of six weeks. The exercise method is described below.

For the isometric Shaker exercise, patients lay on the bed and raised their heads without moving their shoulders off the bed, looked at the ends of their feet for 60 seconds, and then lowered their heads back on the bed and rested for 60 seconds. When any patient had difficulty raising his or her head and keeping it off the bed for 60 seconds, the patient was instructed to perform the same exercise three times for as long as it could be maintained. The isotonic Shaker exercise had the patients raise their heads in the same posture and look at the ends of their feet 30 consecutive times. If a patient could not do 30 repetitions of the exercise, they were allowed to do fewer repetitions.

This study also included a videofluoroscopic swallowing study (VFSS), which is known to be the most accurate and effective test for evaluating the swallowing function of stroke patients objectively<sup>8</sup>. As the swallowing function is

**Table 1.** General characteristics of the subjects (Mean±SD)

	Experimental group (n=13)	Control group (n=13)
Age (years)	63.2±10.2	63.6±8.1
After onset (months)	15.6±2.9	16.15±3.1
Gender (M/F)	8/5	7/8
Side (R/L)	7/6	7/6

\*p<0.05

performed quickly within one to two seconds, the VFSS is essential for accurate measurement<sup>9</sup>. In addition, it is safe because it does not exceed the permitted radiation limits and actually has a lower radiation dose (mA) than computed tomography<sup>10</sup>. With a fluoroscopic machine erected, each patient was instructed to sit on the footrest of the machine's camera table facing to the side. The patient was then given an oral examination diet made up of a contrast medium, and its passage through the pharynx and larynx was observed and recorded via a monitor system<sup>11</sup>. This test was performed by a rehabilitation medicine specialist.

Based on the VFSS, the new VFSS scale and the American Speech-Language-Hearing Association National Outcomes Measurement System (ASHA NOMS) scale are currently used to analyze changes in the swallowing function and the degree of diet. The new VFSS scale is known as the most accurate and effective test of all swallowing function evaluation tests<sup>8</sup>. It consists of 14 items on a scale of 0 to 100 points, and a score on the high side indicates a high level of swallowing disorders. The scale has seven items for the oral stage and seven items for the pharyngeal stage. The ASHA NOMS scale is divided into seven stages ranging from one to seven. A score on the low side indicates a higher level of swallowing disorders<sup>12</sup>.

PASW 18.0 for Windows was used to analyze the study results. The Wilcoxon signed-rank test was performed to compare the new VFSS scale and the ASHA NOMS scale before and after the interventions. The Mann-Whitney U test was performed to compare the experimental and control groups at pre- and post- intervention.

## RESULTS

There were no significant differences between groups in the baseline characteristics (Table 1). The experimental group showed statistically significant improvements in premature bolus loss, residue in the valleculae, laryngeal elevation, epiglottic closure, residue in the pyriform sinuses, coating of the pharyngeal wall after swallowing, pharyngeal transit time, and aspiration on both the new VFSS scale and the ASHA NOMS scale (p<0.05). The control group showed statistically significant improvements in premature bolus loss, residue in the valleculae, laryngeal elevation, epiglottic closure, residue in the pyriform sinuses, pharyngeal transit time, and aspiration on both the new VFSS scale and the ASHA NOMS scale (p<0.05). No statistically significant differences between the groups were found in the ASHA NOMS scale and the new VFSS scale results (Table 2).

**Table 2.** Outcome measures (Mean±SD)

	Experimental group		Control group	
	Pre-test	Post-test	Pre-test	Post-test
ASHA NOMS	2.15±1.40	4.46±4.50*	2.00±0.91	4.84±1.40*
New VFSS (Oral phase)				
Lip closure	0.30±0.75	0.15±0.55	0.00±0.00	0.00±0.00
Bolus formation	0.46±1.12	0.00±0.00	1.15±1.51	0.69±1.31
Mastication	0.61±1.50	0.00±0.00	0.00±0.00	0.00±0.00
Apraxia	0.11±0.41	0.11±0.41	0.00±0.00	0.00±0.00
Tongue to plate contact	0.76±1.87	0.38±1.38	1.92±2.53	1.38±2.21
Premature bolus loss	1.26±1.60	0.46±0.72*	0.80±0.77	0.34±0.65*
Oral transit time	0.00±0.00	0.23±0.83	0.92±1.44	0.46±1.12
New VFSS (Pharyngeal phase)				
Residue in the valleculae	4.15±1.72	1.84±1.28*	3.07±1.32	1.53±1.19*
Reduced laryngeal elevation and epiglottic closure	9.00±0.00	3.46±4.55*	8.30±2.49	4.15±4.66*
Residue in the pyriform sinuses	8.30±2.49	4.50±2.59*	5.88±3.84	3.46±3.26*
Coating of pharyngeal wall after swallow	9.00±0.00	3.46±4.55*	8.30±2.49	6.92±3.94
Pharyngeal delay time	1.38±1.55	0.23±0.83*	1.38±1.55	0.00±0.00*
Pharyngeal transit time	0.46±1.66	0.00±0.00	0.46±1.66	0.00±0.00
Aspiration	6.92±4.13	1.84±4.50*	7.84±3.78	3.23±4.65*
VFSS TOTAL SCORE	42.53±8.56	17.15±15.43*	40.07±11.33	22.03±12.31*

\*p&lt;0.05

ASHA: American speech-language-hearing association national outcomes measurement system, New VFSS: new videofluoroscopic swallowing study scale

## DISCUSSION

Swallowing disorders following a stroke delay the patient's functional recovery and can lead to death through malnutrition or aspiration pneumonia<sup>13</sup>. Thus, the treatment of swallowing disorders is of paramount importance. Swallowing disorders exhibit various symptoms including leakage of food toward the front and rear of the oral cavity, reduction in the contraction of the pharyngeal muscles, residue in the valleculae and the pyriform sinus, reduced movement of the hyoid bone and the larynx, abnormal opening of the pharyngoesophageal sphincter, and delayed pharyngeal transit time<sup>12</sup>.

Shaker et al. reported that the performance of the Shaker exercise by stroke patients resulted in increased muscular strength in their suprahyoid and infrahyoid muscles, which was evident in the pharyngeal stage rather than in the oral stage<sup>14</sup>. Hong et al. reported that performance of the Shaker exercise by stroke patients with swallowing disorders resulted in statistically significant post-treatment improvements in residue in the valleculae, reduced laryngeal elevation and epiglottic closure, improvements in residue in the pyriform sinus, and pharyngeal transit time for the pharyngeal stage's lower-level items on the new VFSS scale. Performance of the Shaker exercise also resulted in improvement in dietary stages<sup>15</sup>.

These results are similar to the results of the present study. After the six-month interventions, both the experimental and control groups showed statistically significant differences in dietary stages and scores on the new VFSS scale. With regard to changes in lower-level items, both the

experimental and control groups exhibited statistically significant improvements in premature bolus loss, residue in the valleculae, laryngeal elevation, epiglottic closure, residue in the pyriform sinuses, pharyngeal transit time, and aspiration. Unlike the control group, the experimental group also showed a statistically significant improvement in coating of the pharyngeal wall after swallowing.

Easterling et al. conducted the Shaker exercise with 26 elderly people, but only 12 completed the intervention. Those who dropped out of the training complained of difficulties and discomfort when performing the exercise<sup>16</sup>. The present study had no dropouts, but many patients in the control group complained of difficulties with raising their heads and keeping that position for 60 seconds. Unlike the Shaker exercise, which can be performed only when the neck flexor has at least fair grade, PNF-based short neck flexion exercises can be performed regardless of the neck flexor's muscular strength. Therefore, it may be a more comfortable and less difficult exercise for patients.

This study confirmed that PNF-based short neck flexion exercises are a treatment method that can improve dietary stages and the swallowing function, and that they are as effective as the Shaker exercise. The study results suggest the effectiveness of PNF-based short neck flexion exercises as a treatment for swallowing disorders in stroke patients. Its limitation was the small number of subjects who complied with our selection criteria, making it problematic to generalize the study's results. Therefore, future studies should examine the effects of PNF-based short neck exercises on patients with swallowing disorders caused by various diseases.

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