Effect of orofacial myofunctional exercise on the improvement of dysphagia patients’ orofacial muscle strength and diadochokinetic rate

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Abstract. [Purpose] Measurement of the diadochokinetic rate can provide useful information on swallowing rehabilitation in the oral phase by elucidating the speed and regularity of movement of muscles related to the lips, tongue, and chin. This study investigated the effect of a three-week period of orofacial myofunctional exercise on the improvement of cheek, tongue, and lip muscle strength and diadochokinetic rate in dysphagia patients. [Subjects and Methods] This study employed a pretest-posttest control group design. Both orofacial myofunctional exercise and the temperature-tactile stimulation technique were applied to the experimental group (n=23), while only the temperature-tactile stimulation technique was applied to the control group (n=25). [Results] Tongue elevation, tongue protrusion, cheek compression, lip compression, and alternating motion rate were more significantly improved in the experimental group than in the control group. [Conclusion] Orofacial myofunctional exercise is effective in the rehabilitation of swallowing function in the oral phase in dysphagia patients by improving orofacial muscle strength and response rate.

Key words: Orofacial exercise, Muscle strength, Alternating motion rate

INTRODUCTION

Stroke is a disease caused by central nervous system and peripheral nervous system damage from cerebral infarction and cerebral hemorrhage, and it is one of the major causes of death worldwide. In particular, the death rate of stroke is exceptionally high in South Korea (50.3 out of every 100,000 people as of 2013), showing the highest rate for a single disease1). Stroke not only has a high death rate but also has a high possibility of causing aftereffects, such as dysphagia, motor disorder, language disorder, cognitive disorder, and sensory disorder, in those who survive2). Among them, dysphagia, which is a problem in the process of passing food boluses from the oral cavity to the esophagus due to weakening or paralysis of the swallowing-related muscles3), occurs very frequently. If dysphagia is left untreated, it can lead to complications such as aspiration pneumonia and malnutrition and even death, which makes early detection and treatment critical4).

Swallowing involves four phases: the oral preparatory phase, oral phase, pharyngeal phase, and esophageal phase. Among these, patients with dysphagia from stroke frequently experience disruption in the oral preparatory phase, oral phase, and pharyngeal phase5). When the facial nerve or hypoglossal nerve is damaged by stroke, the muscles in the tongue, cheek, and lips, such as the orbicularis oris muscle, mentalis muscle, buccinator muscle, and palatoglossus muscle, weaken, causing problems in both the oral preparatory phase and oral phase5). The tongue triggers swallowing by stimulating fauces and oropharyngeal receptors and plays an important role in the oral phase by moving boluses to the anterior faucial arch6).

Although many studies have been conducted on the effect of orofacial myofunctional exercise in patients with dysphagia from brain damage, most of them have only focused on improving the strength of individual muscles, such as the tongue...
and cheek muscles\textsuperscript{7, 8}, and few studies have investigated the holistic improvement of orofacial muscle strength, speed, and functions. Measurement of the alternating motion rate can provide useful information on swallowing rehabilitation in the oral phase by elucidating the speed and regularity of movement of muscles related to the lips, tongue, and chin.

This study investigated the effect of a three-week period of orofacial myofunctional exercise on the improvement of dysphagia patients’ cheek, tongue, and lip muscle strength and alternating motion rate in dysphagia patients, and it suggests basic material for swallowing rehabilitation in the oral phase.

**SUBJECTS AND METHODS**

The subjects of this study were 48 stroke patients who were diagnosed with dysphagia by one of three medical institutions from January through April 2015 in Seoul and Incheon and who understood and agreed to participate in this study. This study conformed to the principles outlined in the Declaration of Helsinki and received clearance from an Institutional Review Board. All participants provided informed consent. As the minimum number of samples calculated based on power analysis using the t-distribution was 45 with a significance level (\( \alpha \)) of 0.05, effect size of 0.5, and power of test (1-\( \beta \)) of 0.95, the number of samples in this study was appropriate. The inclusion criteria for selection of the subjects were diagnosis within 6 months without aphasia, apraxia, depression, and cognitive disorder with a score of over 24 points on the Korean version of the Mini-Mental State Examination (K-MMSE).\textsuperscript{9} According to random assignment by table of random sampling numbers, participants were classified into the experimental group with the application of both orofacial myofunctional exercise and temperature-tactile stimulation technique, and the control group (n=25), which received application of temperature-tactile stimulation technique only.

For orofacial muscle strength, tongue elevation, tongue protrusion, cheek compression, and lip compression\textsuperscript{7} were measured by using the Iowa Oral Performance Instrument (IOPI), which is composed of a tongue bulb and a connecting tube. The measurement methods were as follows: For tongue elevation, the bulb was placed in the hard palate of the subject, who was instructed to compress the bulb with tongue as strongly as possible for 2–3 seconds. For tongue protrusion, the subject bit the bulb with his/her molars and compressed the bulb as strongly as possible. Cheek compression was measured with the bulb oriented toward the surface of cheek. Referring to the study of Clark et al.\textsuperscript{11}, lip compression was measured by having the subject bite and compress a tongue depressor with the lips, as the bulb cannot be fixed between the lips. All values presented are means of 3 measurements\textsuperscript{12}.

For alternating motion rate, the count-by-time was used; it represents the average number of times one syllable was repeated per second when /Pa/ and /Ta/ were repeated quickly, alternating between them, for 5 seconds. Praat version 5.1.3\textsuperscript{13} was used for the analysis of alternating motion rate, and means of 3-time measurements are presented.

Orofacial myofunctional exercise was composed of 9 items, which were cheek massage, neck massage, lip closing, cheek bloating, cheek sucking, lip protrusion, tongue protrusion, tongue elevation, and tongue lowering, conducted for 30 minutes daily, 5 times a week for 3 weeks. This program was selected based on information from the Team of Seirei Mikatahara General Hospital and Park et al.\textsuperscript{7}.

For the temperature-tactile stimulation technique, 30 minutes of stimulation was applied to the anterior faucial arch with an ice stick to facilitate pharyngeal swallowing per day, 5 days per week for 3 weeks.

For analysis, a preliminary homogeneity test was first conducted with the \( \chi^2 \) test or independent sample t-test, and then a pre-post efficiency test was conducted with the paired sample t-test. IBM SPSS Statistics version 23.0 (IBM Inc., Armonk, NY, USA) was used for analysis, and the significance level was 0.05.

**RESULTS**

According to the results of the independent t-test and \( \chi^2 \) test for age, gender, education level, time since dysphagia, and average K-MMSE score in the experimental and control groups, there were no significant differences in any of the variables (Table 1).

According to the results of the paired sample t-test comparing the change in pre-post orofacial muscle strength and

| Table 1. Baseline characteristics of the experimental and control patients with dysphagia |
|------------------------------------------------|
| **Variables** | **Experimental group (n=23)** | **Control group (n=25)** |
| Gender (male/female) | 8/15 | 6/19 |
| Age (years) | 62.5 ± 6.5 | 64.1 ± 7.1 |
| Years of education | 6.5 ± 3.0 | 6.1 ± 3.3 |
| Time since dysphagia (month) | 5.2 ± 1.0 | 4.9 ± 1.3 |
| K-MMSE | 23.8 ± 2.1 | 24.2 ± 1.9 |
| *p<0.05. Values are numbers or mean ± SD values.
**DISCUSSION**

Reinforcement of orofacial muscle strength and functions is the major goal of swallowing rehabilitation in the oral phase. According to the results of the investigation on the effect of orofacial myofunctional exercise on the improvement of orofacial muscle strength and alternating motion rate in dysphagia patients, tongue elevation, tongue protrusion, cheek compression, lip compression, and alternating motion rate were significantly improved. This corresponds with the results of preceding studies that indicated that orofacial muscle exercise improved swallowing functions of stroke patients by reinforcing orofacial muscle strength and formation of oral pressure7, 8).

The decline of orofacial muscle in the tongue, chin, and lips caused by stroke causes problems in the oral preparatory phase and oral phase of the swallowing process, such as problems with mastication and the formation of boluses, leading to the onset of dysphagia6). In normal swallowing, muscles in the cheeks and lips play an important role in oral containment by forming oral pressure14).

In particular, the strength of the tongue is crucial in the oral phase. When food boluses pass through the anterior faucial arch and reach the base of the tongue, pharyngeal swallowing is induced, and then the tongue is gradually elevated backward (a process called “rolling”), which requires the overall strength of the tongue5). Park et al.7) reported that orofacial exercise performed on patients with dysphagia from stroke improved the movement range and strength of the tongue, and in this study, orofacial myofunctional exercise also had a significant effect on the reinforcement of the tongue’s muscle strength. Furthermore, this study verified that orofacial myofunctional exercises, such as tongue protrusion, elevation, and lowering, not only increase muscle strength but also improve response rate and coordination between the tongue and chin. Future multilateral studies considering stroke severity are required to verify the effect of orofacial myofunctional exercise.

Regarding the limitations of the study, as all the subjects were subacute dysphagia patients, it is impossible to exclude the possibility of self-rehabilitation in the improvement of orofacial muscle strength. Moreover, it is difficult to determine the long-term effects, because the treatment period in this study was only three weeks.

The results of this study imply that orofacial myofunctional exercise is effective in the rehabilitation of swallowing function in the oral phase in dysphagia patients by improving orofacial muscle strength and response rate.

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