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Original Article

Effect of Oral Function Training on Swallowing Function in Community-Dwelling Older Individuals

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Abstract

Background: Dry mouth, masticatory discomfort, and swallowing in older individuals are important factors affecting overall health. To improve their quality of life, efforts are required to improve their oral function. Therefore, this study implemented a training program evaluating oral function to confirm improvements in swallowing.

Methods: The study was conducted for approximately 4 months, from Jul to Oct 2023. Participants aged 65 yr or older were selected from welfare facilities in the metropolitan region, with 24 participants in both the intervention and control groups.

Results: As a result of a study conducted on oral function training program, the intervention group exhibited significant improvements in the simulated swallowing flow rate (P <0.05), bite force (P <0.001), and tongue pressure (P <0.001).

Conclusion: The oral function training program effectively improved simulated swallowing flow rate, bite force, and tongue pressure. Consequently, there is an opportunity to implement oral function training programs at accessible welfare centers for older individuals in the community.

Keywords: Older individuals; Oral function training program; Oral function exercise; Tongue stretching exercise

Introduction

South Korea is currently experiencing a considerable increase in the proportion of individuals aged 65 and older within the total population. Projections indicate that the country will become a post-aged society by 2025 (1). Consequently, the issue of the older population has emerged as a crucial social issue, with growing interest in health problems and quality of life affecting this demographic (2,3). Oral health problems arise from rapid loss of muscle strength around the oral due to natural aging, resulting in difficulties with oral functions such as mastication, swallowing, and articulation (4,5). Severe symptoms of swallowing hypofunction can lead to dysphagia, resulting in nutritional deficiency, dehydration, and aspiration pneumonia (6). Therefore, early

management of swallowing function in older individuals is essential, with oral function training playing a necessary role in improving swallowing function.

Oral function training improves oral health in the older population by stimulating salivary glands and facilitating swallowing movements via stretching and exercising the muscles around the oral (7,8). Oral function training programs improve bite force, repetitive saliva swallowing test (RSST) results, and salivary flow rate (9,10). This intervention helps restore, improve, and maintain oral function among older individuals experiencing swallowing difficulties, thereby preventing dysfunction in their daily activities (11). Tongue strength is closely related to the oropharyngeal swallowing function and is essential for safe swallowing (12,13). Decreased tongue strength can lead to insufficient food intake as the reduced pressure between the tongue and the palate makes normal mastication and bolus formation difficult (14,15). Therefore, because tongue strength training prevents and maintains strength loss and improves swallowing function, implementing a program to maintain and strength should be considered (16,17).

However, as we enter a super-aging society, oral function decline can occur even in healthy elderly people, but there is no standardized method to provide appropriate intervention to elderly people at risk of functional decline (18). These studies have primarily focused on disease groups, such as stroke, Parkinson's disease, or nursing home residents with preexisting dysphagia diagnoses. Moreover, training programs often require specialized equipment or professional care and rehabilitation interventions (12,19–21). Previous research has predominantly focused on stretching and exercise, with a lack of studies addressing training to increase tongue strength. Exercising alone may have practical limitations in improving function, and it is necessary to provide a routine oral exercise program that can maintain continuous participation rather than a short-term improvement in oral function. As swallowing hypofunction can occur in healthy older individuals, it is imperative to expand the focus to community-dwelling older individuals who may not be diagnosed with dysphagia or be aware of their dysphagia risk. Developing easily implemented interventions at home becomes crucial in addressing this need.

Therefore, this study has developed a program that integrates oral exercise and tongue strength exercise, offering an easily executable regimen for home use. The objective is to deliver an oral function training program to older individuals through welfare centers, aiming to enhance awareness of swallowing dysfunction challenges and investigate its efficacy in ameliorating swallowing difficulties.

Materials and Methods

Participants

The study was conducted for approximately 4 months, from Jul 5 to Oct 25, 2023, targeting individuals aged 65 yr or older who used welfare centers in regions E and H within the metropolitan region. Sixty individuals were recruited for this study. Participants from Welfare center users from Region E constituted the intervention group, whereas those from Region H formed the control group, each comprising 30 individuals. After introducing the oral function training program to the recruited participants, written informed consent was obtained from all individuals, signifying their voluntary participation in the study.

The participant selection criteria included independent mobility and communication, absence of cognitive function problems, and capability to engage in oral exercises. The intervention group included individuals who participated in the program schedule more than four times.

The final selection of participants excluded individuals unable to attend because of health issues during the program period, those diagnosed with coronavirus disease 2019, those who attended the program fewer than four times, and those who did not practice oral exercises or tongue strength exercises. This group included participants who did not submit a practice log. Moreover, 12 indi-

viduals, including six who discontinued midway, withdrew from the study. Therefore, this study included 48 participants, with 24 individuals in both the intervention and control groups (Fig. 1). The number of participants was calculated using G*Power 3.1.9, yielding a minimum sample size of 28 individuals, considering a medium effect size of 0.4, a power of 0.7, and a significance level of 0.05. Considering a 50% potential dropout rate, 42 participants were targeted.

To uphold ethical standards and ensure participant protection, this study was approved for review by the Eulji University Institutional Review Board (EUIRB2022-087).

Research process

A dental hygienist with more than 5 years of clinical experience in a dental clinic and a professor from the Department of Dental Hygiene conducted subjective and objective evaluations of the oral function training program. These assessments covered the introduction of the program and oral health education related to mastication and swallowing functions.

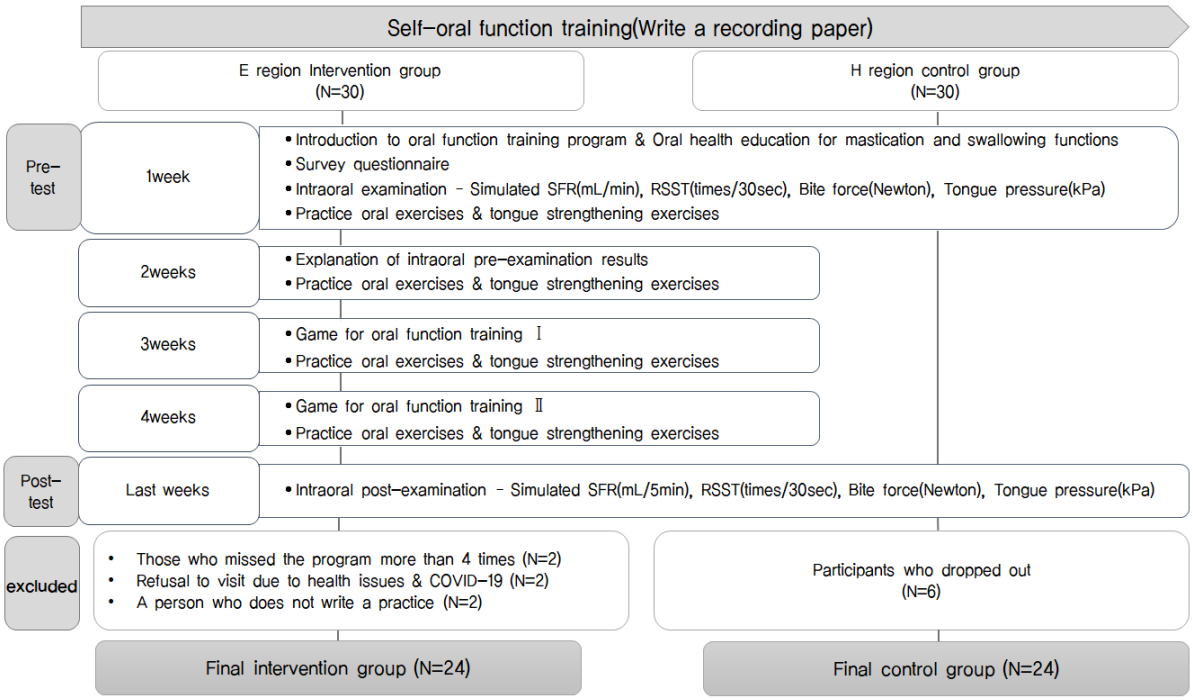

Fig. 1: Participants and the research process

The intervention group for the oral function training program underwent five educational sessions over 4 wk, once a week. On the first day of the visit, the oral function training program was introduced, and oral health education on mastication and swallowing disorders was provided to reduce the errors. The session also included instruction on oral exercises and how to use Peco-Panda (Peco-Panda®, JMS Co. Ltd., Tokyo, Japan), a tongue strength exercise tool. An intraoral pre-examination was conducted to evaluate the program's effectiveness. The intervention group was provided with a booklet outlining oral function training movements, guiding them to engage in self-practice of oral exercises once a day. For consistency and objectivity of the exercises, oral exercises and tongue strength exercises were recorded in the distributed practice log from beginning to end. The researcher maintained regular contact with the research group, making two weekly phone calls to provide encouragement for self-directed oral exercises. Additionally, partici-

pants were informed of the date and time of the next training session to prevent any missed sessions. On the last visit, a practice log was collected to confirm the daily performance of oral exercises and Peco-Panda. Additionally, an intraoral post-examination was conducted to assess the effectiveness of the program.

The control group was subjected to the circumstances of the H region welfare center, permitting only two visits. However, the participants were instructed to freely perform oral functional exercises and Peco-Panda at their own discretion, and intraoral pre- and post- examinations were conducted at the initial visit and 4 wk later (Fig. 1).

Measurements

Evaluation of subjective oral functions

General characteristics included four questions regarding sex, age, and educational level. Systemic disease and oral health behavior consisted of six questions, including systemic disease diagnosis, subjective oral health, daily brushing times, use of supplements, mastication discomfort, and pronunciation discomfort.

Subjective mastication ability was the key food intake ability (KFIA) questionnaire reported by Kim et al. (22), was used to evaluate the proficiency in chewing five major foods (peanuts, raw carrots, dried squid, caramel, and Kkakdugi) and assess the extent of ability. Higher scores indicated a greater subjective mastication ability. Subjective swallowing ability was investigated using 10 questions from the Korean version of the Eating Assessment Tool (EAT-10) (23). The lower the score, the higher the subjective swallowing ability.

Evaluation of objective oral functions

An oral examination was conducted to evaluate the oral condition of the participant. The number of remaining teeth was defined as the number of natural teeth, excluding third molars and teeth restored with tooth roots (excluding pontic and implant-supported). Whether dentures were worn were also recorded on the chart.

Bite force

Bite force was assessed using a bite sheet (Dental Prescale II - M and L size, GC Corporation, Tokyo, Japan). Participants were instructed to choose an appropriately sized sheet, insert it, and bite for approximately 3 seconds. Following the removal of the bite sheet from the oral cavity, the bite force was measured using the software and scanner of the bite force measuring device system (Bite force analyzer, GC Corporation, Tokyo, Japan).

Repetitive saliva swallowing test

This test involves counting the number of times swallowing can be repeated by palpating the participant's thyroid cartilage for 30 sec (24). The measurement value for swallowing power was the number of swallows in 30 sec, with a higher number indicating increased swallowing frequency (times/30 sec).

Simulated salivary flow rate

Saliva Check Buffer (Saliva Check Buffer, GC Corporation Tokyo, Japan) was used to test the saliva flow rate. The test began with chewing gum, an accessory to the product to stimulate salivary flow. The saliva produced in the first 30 sec was spat out or swallowed. Subsequently, the saliva flow while chewing the gum for 5 min was collected in a measuring tube (mL/5 min).

Tongue pressure

The JMS tongue pressure meter (Orarize® TPM-02, JMS Co., Ltd. Hiroshima, Japan) was connected to the digital tongue pressure meter body, a connecting tube, and a tongue probe (length, 25 mm; diameter, 15 mm). With the lips closed, the tongue probe is pressed against the hard palate with a maximum force for 7 sec (kPa). The highest value of the three measurements was defined as the maximum tongue pressure (25).

Oral exercise training

The oral exercises incorporated into the program (8) were modified and supplemented to suit the older population in Korea. Reference was made to exercises for improving oral function in old individuals at the Kochi Public Health Center in Japan (9). Participants were instructed to engage in these exercises for approximately 15 min once

a day.

Peco-Panda practice

Tongue strength exercises were performed using Peco-Panda as the tongue training tool in this study. The training portion of the Peco-Panda was positioned on the tongue, with the positioning part fixed to the upper and lower anterior teeth, and the training part was pushed up to the tip of the tongue. There are five types of Peco-Panda presented by the manufacturer, depending on hardness: blue (SS): 5 kPa, pink (S): 10 kPa, purple (MS): 15 kPa, green (M): 20 kPa, yellow (L): It is presented as 30kPa (26). In this study, referring to the product manual, we used the recommended pink (S): 10kPa at the start of training, considering the level of swallowing power required to improve the swallowing function of old individuals with reduced oral function. In this study, we followed the product manual-initiated training with a recommended pink (S) setting of 10 kPa. The training method was performed 3 d a week, three sets per day, 15 repetitions per set, totaling 45 repetitions daily.

Statistical analysis

Chi-squared and Wilcoxon rank-sum tests were used to detect differences in the distribution of questionnaire scores and mean differences in subjective oral function scores between the intervention and control groups. In addition, Wilcoxon's rank sum test was used to examine changes in several swallowing functions at baseline and 4 wk after training. All statistical analyses were performed using R (version 4.0.2, R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was set at $P<0.05$.

Ethical Considerations

This paper received an exemption from review by the Eulji University Institutional Review Board (EUIRB2022-087).

Results

Subject characteristics at baseline

The distribution of participant characteristics at baseline was compared between the intervention and control groups (Table 1). Regarding health characteristics, the majority of the intervention group (58.3%) and the control group (70.8%) were diagnosed with mostly one systemic disease. Subjective oral health was poor in 75.0% of the intervention group and 79.2% of the control group. Mastication discomfort was reported as more prevalent by 58.3% of the intervention group and 45.8% of the control group. However, pronunciation discomfort was reported as non-discomfort by 62.5% of the intervention group and 66.7% of the control group. The remaining teeth were 20 or more in 54.2% of the intervention group and 62.5% of the control group. The use of dentures by participants was 62.5% of the intervention group and 70.8% of the control group. Therefore, no significant differences were observed in the proportions of participant characteristics between the two groups. Thus, the homogeneity of participant characteristics was confirmed between the intervention and control groups (Table 1).

Self-evaluated oral function at baseline

The mean values of the self-evaluated oral function at baseline were compared between the intervention and control groups (Table 2). The KFIA score was 4.0 for the control group, marginally higher than the score of 3.5 for the intervention group; however, no significant differences were observed between the two groups ($P=.203$). In the intervention group, the self-evaluated EAT-10 score was almost zero, measuring 0.2, whereas in the control group, it was 0.5. Therefore, there were no significant differences between the two groups ($P=.104$). Thus, homogeneity in subjective oral function was confirmed between the groups (Table 2).

Changes after 4 wk (pre- and post-interventions)

The swallowing function scores in the intervention and control groups at baseline and after 4 wk are shown in Table 3. All swallowing functions, except RSST, namely simulated swallow flow rate (SFR), bite force, and tongue pressure, signifi-

cantly improved in the intervention group (P<0.05). In contrast, no significant difference in swallowing function was observed between baseline and after 4 wk in the control group (P<0.05).

Table 1: The distribution of participant characteristics in the intervention and control groups at baseline

Items		*Intervention group* n (%)	*Control group* n (%)	*P-value*
General characteristics				
Sex				
	Male	8 (33.3)	2 (8.3)	0.076
	Female	16 (66.7)	22(91.7)	
Age (years)				
	<80	9 (37.5)	8 (33.3)	1.000
	≥80	15 (62.5)	16 (66.7)	
Cohabitant				
	Alone	6 (25.0)	10 (41.7)	0.358
	with Someone	18 (75.0)	14 (58.3)	
Education				
	Uneducated	6 (25.0)	5 (20.8)	0.944
	Elementary school	10 (41.7)	12 (50.0)	
	Middle school	3 (12.5)	3 (12.5)	
	High school and above	5 (20.8)	4 (16.7)	
Systemic & Oral Health				
Systemic diseases diagnosed (n)[a]				
	No systemic disease	5 (20.8)	4 (16.7)	0.785
	Having one	14 (58.3)	17 (70.8)	
	Having two	4 (16.7)	2 (8.3)	
	Having three	1 (4.2)	1 (4.2)	
Subjective oral health				
	Bad	18 (75.0)	19 (79.2)	1.000
	Good	6 (25.0)	5 (20.8)	
Brushing times per day				
	One and below	3 (12.5)	1 (4.2)	0.602
	Twice and above	21 (87.5)	23 (95.8)	
Use of supplements				
	Un-use	4 (16.7)	10 (41.7)	0.112
	Use	20 (83.3)	14 (58.3)	
Mastication discomfort				
	Discomfort	14 (58.3)	11 (45.8)	0.485
	So-so	3 (12.5)	2 (8.3)	
	No discomfort	7 (29.2)	11 (45.8)	
Pronunciation discomfort				
	Discomfort	5 (20.8)	5 (20.8)	0.916
	So-so	4 (16.7)	3 (12.5)	
	No discomfort	15 (62.5)	16 (66.7)	
Remaining teeth				
	<20	11 (45.8)	9 (37.5)	0.770
	≥20	13 (54.2)	15 (62.5)	
Use of dentures				
	Use	9 (37.5)	7 (29.2)	0.759
	Non-use	15 (62.5)	17 (70.8)	

Chi-squared test, P<0.05; systemic diseases (hypertension, diabetes, heart disease, and depression)

Table 2: Self-evaluation of oral function in the intervention and control groups at baseline

Items	***Intervention group***	***Control group***	***P-value***
	M ± SD	*M ± SD*	
Self-evaluation of oral function (tool)			
Food Intake Ability (KFIA)	3.5 ± 1.5	4.0 ± 1.2	0.203
Eating Assessment (EAT-10)	0.2 ± 0.3	0.5 ± 1.0	0.104

The Wilcoxon rank-sum test, $P<0.05$

Table 3: Changes in swallowing function in the intervention and control groups between baseline and after 4 wk

Swallowing function	***Intervention group***		***P-value***	***Control group***		***P-value***
	Baseline	*After 4wk*		*Baseline*	*After 4wk*	
	M ± SD	*M ± SD*		*M ± SD*	*M ± SD*	
Simulated SFR (mL/min)	5.8 ± 2.0	7.1 ± 2.6	0.018*	5.7 ± 2.5	6.4 ± 3.0	0.064
RSST (times/30 s)	3.9 ± 2.7	4.3 ± 2.6	0.601	4.6 ± 6.9	4.8 ± 6.2	0.563
Bite force (Newton)	401.9 ± 339.4	596.4 ± 453.5	<0.001	302.5 ± 317.6	488.6 ± 551.8	0.207
Tongue pressure (kPa)	22.3 ± 9.8	26.6 ± 9.7	<0.001	22.2 ± 7.3	23.1 ± 5.9	0.199

Wilcoxon rank test, $P<0.05$

Discussion

Oral health in older individuals has a considerable impact on systemic health, and oral hypofunctions such as dry mouth, mastication, and swallowing are important contributors to systemic health (23). Efforts to improve oral function are necessary to maintain systemic health and improve the quality of life in the older population. Therefore, this study aimed to confirm the improvement in swallowing function via implementing an oral function training program and evaluating oral function in people aged 65 and older attending community welfare centers.

The oral function training program was conducted for 4 wk, and changes in various oral functions, including simulated SFR, RSST, bite force, and tongue pressure, were evaluated. The results showed significant improvements in the simulated SFR, bite force, and tongue pressure in the intervention group, whereas no significant improvement was observed in the control group.

Simulated SFR significantly increased with oral function training and tongue strength training, rising from 5.8 ± 2.0 at baseline to 7.1 ± 2.6 after 4 wk in the intervention group. Ibayasi et al. (8) and Jang and Hwang (26) showed a significant improvement in simulated SFR in the intervention group following the completion of an oral function training program, aligning with the findings of the present study. The oral muscle stretching and salivary gland massage included in the oral function training program increase blood flow and parasympathetic nerve activity in the salivary gland area, thereby affecting saliva secretion (28). Increased salivary secretion is effective in improving oral function in older individuals by facilitating swallowing (7,8), the active introduction of oral function training programs is recommended.

Bite force significantly improved in the intervention group, from 401.9 ± 339.4 at baseline to 596.4 ± 453.5 after 4 wk ($P<0.001$). Bite force and oral muscles improved after an oral function training program (22, 28). The bite force is closely related to masticatory function (29), and a decline in masticatory function can reduce cognitive

function and cause dementia (30). Training to maintain a stable bite is necessary to prevent brain diseases in the older population. Therefore, the oral health education and oral function training programs used in this study should persist in implementation, aiming to raise awareness among older individuals regarding the risks and preventive methods for oral hypofunction and to maintain oral function.

Tongue pressure results showed a significant difference in the intervention group, from 22.3 ± 9.8 at baseline to 26.6 ± 9.7 after 4 wk (P<0.001). Kim and Lee (31) combined a tongue strength training program and oral function exercises, similar to this study, demonstrating a greater improvement in tongue pressure than in a group solely performing oral exercise. Tongue strength exercises enhance the force exerted during swallowing, resulting in increased intraoral pressure. This facilitates the rapid and safe movement of food into the pharynx, potentially reducing food residue in the mouth and pharynx and the risk of airway aspiration (30,32).

As confirmed in this study, implementing an oral function training program is crucial for improving oral hypofunction and poor oral hygiene in older patients. Additionally, tongue strength exercises can also induce correct swallowing and improve nutritional function, ultimately improving the quality of life. Peco-Panda used in this study was verified as a simple, safe, and cost-effective tongue strength tool for addressing the early deterioration of swallowing function and improvement of tongue strength in the older population (18). Efforts to expand education and programs using this technology should be actively pursued.

A limitation of this study is that oral function and tongue strength exercises were self-trained for 4 wk, making it difficult for researchers to observe the practice of the intervention group directly. Additionally, the small number of participants hinders the generalizability of the study results to all older individuals. In future research, given the scarcity of studies combining oral function and tongue strength exercises, careful consideration should be given to sample size, and comprehensive investigations into objectively assessing improvements in oral function should be conducted. Although previous studies focused on oral or tongue strength exercises, this study included oral functional and tongue strength exercises, assessing them across simulated SFR, RSST, bite force, and tongue pressure. The study is significant as it conducted research to confirm the effectiveness of oral health education in preventing oral issues and improving oral function.

Conclusion

The oral function training program was effective in improving simulated SFR (P<0.05), bite force (P<0.001), and tongue pressure (P<0.001). Continuous use of a training program including oral exercise and tongue strength exercise for older individuals with weak oral and systemic health can help improve oral function. Therefore, it is necessary to introduce and actively expand the oral function training program as part of oral health promotion projects, enabling older individuals in the community to access and benefit from this program.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflicts of interest

The authors declare that there is no conflict of interest.

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