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Effects of Orofacial Muscles Exercise Program on Swallowing Function and Satisfaction in Sub-Acute Stroke Patients with Dysphagia

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ABSTRACT

Background/Objectives: The aim of present study was to examine the effect of orofacial muscle exercise programs on swallowing function with smartphone video as well as satisfaction with outcome in sub-acute stroke patients with dysphagia.

Method/Statistical Analysis: We enrolledsub-acute phase of sixteen stroke patients with dysphagia. The participants were randomly assigned to the study group (orofacial muscle exercise program using smartphone video) orcontrol (paper-based orofacial muscles exercise program). All subjects completed their prescribed orofacial muscle exercise programs 20 min/day, 3 times per week, for 4 weeks. The outcome measures were the FDS(Functional Dysphagia Scale), PAS (Penetration-Aspiration Scale) and VASS(Visual Analog Satisfaction Scale).Main analysis was Mann-Whitney U test for comparison between groups.

Findings: After intervention, there were no significant differences in swallowing function between the two groups. Nevertheless, in study group satisfactionwas significantly higher than that of the control group.

Improvements/Applications: Authors suggest that orofacial muscle exercise programs using smartphone can have a more positive impact on satisfaction than can paper-based orofacial muscle exercise programs in sub-acute stroke patients with dysphagia.

Keywords: *Oral cavity, Stroke, Swallowing function, Dysphagia, Swallowing disorder*

Introduction

Stroke is a chronic disease that causes motor and sensory function disorder, speech disorder, dysphagia, etc. Dysphagia refers to problems that occur during the process of food moving from the oral cavity to the stomach. It has been reported that the occurrence of stroke with dysphagia varies from 25% to 63% [1]. The main symptoms of patients with oropharyngeal dysphagia after stroke are weakness and functional disorders in the tongue, pharynx, lips, cheeks, and masticatory muscles. These problems become the cause of death and are associated with decreased quality of life [2].

There are somemethods for the interventions of dysphagia. The interventions that have been introduced include head lift exercise [3], effortful swallow and Mendelsohn maneuver [4], lingual strength training [5], expiratory muscle strength training [6], oromotor exercises [7], etc. Oromotor exercises are methods that strengthen the muscles used in the oral phase as well as the pharyngeal muscles, are relatively easy for patient training compared to other interventions.

The muscles that make up the cheeks, lips and tongue are called the orofacial muscles, and greater muscular strength in the orofacial muscles translates

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to safer and more effective chewing and swallowing [8]. Orofacial muscle exercise improves muscular strength and movement in the muscles associated with tongue, lips, face, and chewing [9]; it can also be beneficial for patients with delayed oral and pharyngeal transit time [10]. Orofacial muscle exercise is also used in patients with decreased tongue movements, those with decreased sensation and coordination in the oropharyngeal muscles, or patients with reduced bolus control [7-10].

The number of people worldwide using the Internet with their smartphones went over 80% of the global population in 2015 [11]. As an IT powerhouse, South Korea is one of the countries that shows high rate of smartphone ownership and use [12]. One of the biggest advantages of smartphones is that they are easy to carry and can be used anytime and anywhere. Many studies have reported about rehabilitation intervention and assessment using smartphone [13,14], but little has been studied on the effectiveness of orofacial muscle exercise program using smartphone. Researches related to swallowing, in particular, are seriously lacking in studies on smartphone-based measurement and intervention [13,14]. Given the widespread use of smartphones equipped with video playback function among the general public in Korea, implementing orofacial muscle exercise while watching an instructional video instead of following the existing method of booklet-based implementation may yield higher effectiveness and satisfaction.

Therefore, this study aims to investigate whether an orofacial muscle exercise program using smartphone will have greater effects than the existing method of orofacial muscle exercise using the booklet on the swallowing function and intervention satisfaction in stroke patients with dysphagia.

Materials and Method

Subjects: Sixteen subacutepatients with stroke and dysphagia voluntarily participated in present study. The criteria used in the selection of participants were as follows: A patient 1) who has been diagnosed with stroke and is confirmed of dysphagia by a medical specialist, 2) who is in stable medical condition, 3) whose onset of stroke has been no less than a week but less than 3 months [15], and 4) who has scored 21 or higher in the Korean Mini-Mental State Examination and is capable of understanding the intervention program. Visual impairment was used as the exclusion criterion. After informed consent agreements, all subjects voluntarily participated in the study.

Measurements

Functional Dysphagia Scale (FDS): Functional Dysphagia Scale (FDS) is assessed through video fluoroscopy. The score ranges from a minimum of zero point to a maximum of 100 points. The higherscore, more severe the dysphagia. FDS is not intended simply to distinguish between penetration and aspiration but is a measure used for assessing the motor functions of the structures related to the swallowing function. This scale is useful for quantitative assessment of dysphagia. The inter-tester reliability of FDS is .59 [16].

Penetration-Aspiration Scale (PAS): Penetration-Aspiration Scale (PAS) assess the severity of penetration and aspiration through a video fluoroscopic swallowing study. The score ranges from level 1 to 8 depending on whether the bolus enters the airway and how the bolus is ejected once it is in the airway. Level 1 is normal swallowing, while level 8 is silent aspiration, which is the most severe stage of dysphagia. The test-retest reliability of PAS is .91 [17].

Visual Analog Satisfaction Scale (VASS): Visual Analog Satisfaction Scale (VASS) was used in this study to assess the satisfaction of both the experimental and the control group with respect to their respective interventions. In using this measurement instrument, the level of satisfaction was determined by using a 100 mm horizontal line drawn on a A4 paper with the left end marked as 0 and the right end as 10 and having the subject indicate on the line his/her level of satisfaction. A subject's score closer to 0 meant that he/she is less satisfied with the intervention. On the contrary, a subject's score closer to 10 suggests he/she has higher satisfaction with the intervention [18]. The VASS was administered after the completion of all interventions.

Procedures: Sixteen subjects who met the selection criteria were recruited in present study. All subjects were randomly assigned to experimental group or control group, 8 persons each. A pre-intervention assessment was conducted on all the subjects. Both groups received the same 30-minute-long traditional dysphagia therapy three days in a week for four weeks, twelve sessions in total. In addition, both groups performed orofacial muscle exercise under guardian supervision in a hospital room. The experimental group performed 20 minutes of orofacial muscle exercise by following an instructional video played back on a smartphone, and the control group performed 20 minutes of orofacial muscle exercise using the existing method of booklet guide.

The orofacial muscle exercise performed by both groups was composed of fifteen different movements in the following order; opening the mouth wide, moving the jaw from side to side with the mouth wide open, moving the jaw backward and forward with the mouth wide open, smiling, lifting the angle of the mouth to each side one after another, pouting the lips, sucking in the lips then bouncing them off, blowing from the mouth, sticking out the tongue, sticking out the tongue and moving it from side to side, making a candy inside the mouth with the tongue, swiping the gums with the tongue, inflating the cheeks, sucking in the cheeks and inflating one side of the check after another. The orofacial muscle exercise video was produced by having an occupational therapist model the movements. The total length of the video was seven minutes, and each movement was repeated five times. The experimental group was asked to perform the orofacial muscle exercise while watching the 7-minute video three times so as to repeat each movement fifteen times. Meanwhile, the control group was asked to perform the orofacial muscle exercise looking at a booklet with pictures of the fifteen movements. As in the experimental group and control group was asked to repeat each movement fifteen times. All subjects performed the orofacial muscle exercise for 20 minutes per session. Every session was monitored and guided by an occupational therapist for accurate performance of the exercise. All the subjects completed twelve sessions of intervention. Post-intervention assessment was conducted after completing the 4-week intervention.

Statistical Analysis

The collected data were analyzed using SPSS 22. The general characteristics and pre-intervention data between the groups were compared and analyzed using the Mann-Whitney U test and the Chi-square test. The Wilcoxon signed rank test was used to confirm the statistical difference between the two groups before and after intervention. The Mann-Whitney U test was used to compare and confirm the amount of variation in the both groups. The statistical significance level was set at .05.

Results and Discussion

There was no significant difference between the two groups of stroke patients with dysphagia in terms of general characteristics and swallowing function prior to the intervention ($p > 0.05$) [Table 1]. Two groups, however, showed significant improvement in swallowing function after the intervention ($p < 0.05$) [Table 2]. There was no significant difference between the groups in the amount of variation of swallowing function after the intervention ($p > 0.05$) [Table 3]. In satisfaction level, the experimental group was significantly higher than that of the control group after the intervention ($p < 0.05$) [Table 4].

Table 1: Comparison of general characteristics and swallowing function

	Study group (n = 8)	Control group (n = 8)	p
Age (year), mean ± SD	54.13 ± 5.41	55.38 ± 14.88	.224
Gender, n (%)			
Male	5(62.5)	4(50)	.614
Female	3(37.5)	4(50)	
Lesion side, n (%)			
Right side	4(50)	5(62.5)	.614
Left side	4(50)	3(37.5)	
Stroke type, n (%)			
Ischemic	7(87.5)	7(87.5)	1.000
Hemorrhagic	1(12.5)	1(12.5)	
Lesion location, n (%)			
Supratentorial	5(62.5)	4(50)	.614
Infratentorial	3(37.5)	4(50)	
Onset period (day), mean ± SD	22.75 ± 9.21	21.00 ± 9.02	.713
K-MMSE, mean ± SD	24.00 ± 3.38	24.25 ± 2.92	.813
FDS	27.75 ± 5.50	28.50 ± 3.96	.916
PAS	5.38 ± 1.51	5.50 ± 1.31	.911

Footnotes: K-MMSE = Korean Mini-Mental State Examination; FDS =Functional Dysphagia Scale; PAS =Penetration-Aspiration Scale.

Table 2: Comparison of swallowing function between pre and post-intervention within groups

	Study group (n = 8)			Control group (n =8)		
	Pre	Post	p	Pre	Post	p
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
FDS	27.75 ± 5.50	16.25 ± 5.28	.012*	28.50 ± 3.96	19.00 ± 4.41	.012*
PAS	5.38 ± 1.51	2.63 ± 1.19	.010*	5.50 ± 1.31	2.88 ± 0.64	.010*

Footnotes: *p<0.05, FDS =Functional Dysphagia Scale; PAS =Penetration-Aspiration Scale.

Table 3: Change score of swallowing function between two groups

	Study group (n = 8)	Control group (n = 8)	p
	Mean ± SD	Mean ± SD	
FDS	-11.50 ± 5.32	-9.50 ± 4.50	.368
PAS	-2.75 ± 0.71	-2.63 ± 0.92	.606

Footnotes: FDS =Functional Dysphagia Scale; PAS =Penetration-Aspiration Scale.

Table 4: Comparisons of satisfaction in the both groups after intervention

	Study group (n = 8)	Control group (n = 8)	p
	Mean ± SD	Mean ± SD	
VASS	8.90 ± 0.92	7.47 ± 0.82	.011*

Footnotes: *p<0.05, VASS =Visual Analog Satisfaction Scale.

The effectiveness of orofacial muscle exercise could not be ascertained until know due to serious lack in studies on the effects of orofacial muscle exercise training programs. Thus, this study investigated whether implementing a smartphone-based orofacial muscle exercise program instead of the existing booklet-based orofacial muscle exercise program will have a better effects on swallowing function and intervention satisfaction in subacute patients with stroke and dysphagia. The main three results are as follows:

First, both groups showed significant improvement in swallowing function after performing the orofacial muscle exercise. The orofacial muscle exercise program used in this study largely involved training the jaw, mouth, cheeks and tongue. Among these exercise for the jaw, mouth, cheeks and tongue, the jaw and the tongue exercises have been reported to be effective in strengthening the suprahyoid muscles (SH) [19-21]. According to previous studies, jaw opening exercise improves hyoid bone movement in patients with chronic dysphagia and is an effective training for improving muscular strength of the SH [19]. In this study, all of the jaw movements performed during the orofacial muscle exercise were tasks involving repeated forward and backward as well as side to side open-jaw movements. Therefore, the jaw movements are thought to have helped strengthen the SH. Muscle strengthening training in the SH improves the opening function of the upper esophageal sphincter by increasing the anterior and the upper movements of the hyoid bone [22]. Improvement of the upper esophageal sphincter opening reduces the residue of pyriform sinuses after swallowing [23] and protects the airway in a safer manner. Therefore, it appears that improved swallowing function resulted from the muscle training on the jaw, mouth, cheek and tongue through the orofacial muscle exercise.

It is surmised that the tongue movements performed in the orofacial muscle exercise program helped improve the upper esophageal sphincter opening from enhancing chewing movement and the strength of the SH [21-22]. The muscles that make up the mouth and the cheeks, such as the orbicularis oris muscle, buccinator muscle and superior pharyngeal constrictor, work with the tongue to provide adequate pressure to the food during chewing and swallowing and help ensure safe and effective swallowing [24]. Therefore, it appears that the mouth and the cheek movements performed during the orofacial muscle exercise program helped improve chewing movement and the strength of the SH, having a positive effect on improved swallowing function.

Second, although both groups showed improved swallowing function after the intervention, there was no significant difference in swallowing function between the groups. This can be explained as a combined outcome involving the neurological recovery after stroke and the

intervention effect from swallowing rehabilitation [25, 26]. Studies have demonstrated that a great deal of recovery happens in the early stage after the onset of stroke and that swallowing rehabilitation during this stage is effective [3-7]. This result also supports the recovery of dysphagia through neurophysiological repair and brain reorganization after two to three months from the onset of stroke, which is based on the theory of neuroplasticity [27]. Another possible explanation for the result showing no difference between the two groups is that the research period of four weeks was rather short and the sample size too small to yield significant intervention effect.

Third, after completing the intervention, the experimental group showed higher level of satisfaction for the intervention than the control group. This suggests that the intervention incorporating video watching can have a positive influence on the effectiveness in intervention for stroke patients with dysphagia. Higher satisfaction of rehabilitation leads to stronger motivation and more enthusiastic participation in rehabilitation [28, 29]. Thus, this result implies that the longer the intervention period is implemented, it is likely that the orofacial muscle exercise using video instructional guide will be perceived more positively by the patients compared to the orofacial muscle exercise using booklet guide.

This study is meaningful in that it presents an exercise intervention that can be performed in a hospital room using an easy-to-carry and easy-to-use smartphone. In order to improve the physiological functions and quality of life instroke patients with dysphagia and to overcome the limitations in the current rehabilitation system, it is necessary to develop, implement and evaluate interventions using a variety of device. Despite its merits, our study has the following limitations. The small sample size makes it hard to generalize the findings of present study to other stroke patients with dysphagia. And the research period of four weeks was rather short. Finally, long-term or sustained effects of the orofacial muscle exercise program could not be ascertained because a follow-up research was not conducted.

Conclusion

The purpose of present study was to examine whether an orofacial muscle exercise program using smartphone will have greater effects than the existing method of orofacial muscle exercise using the booklet on the swallowing function and intervention satisfaction in patients withdysphagia and stroke. There was no significant difference between the two groups in the amount of variation of swallowing function after the intervention, but in satisfaction level, the experimental group was significantly higher than that of the control group. These findings show that, compared to the orofacial muscle exercise program using a booklet, the orofacial muscle exercise program implemented while watching an instructional video using a smartphone does not result in better swallowing function but does lead to higher level of satisfaction for the intervention in stroke patients with dysphagia.

Ethical Clearance: Not required

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Conflict of Interest: Nil

REFERENCES

1. Gordon C, Hewer RL, Wade DT. Dysphagia in acute stroke, BMJ, 1987 Aug;295(6595):411-4.
2. Logemann JA, Veis S, Colangelo L. A screening procedure for oropharyngeal dysphagia. Dysphagia, 1999 Mar;14(1):44-51.
3. Antunes EB, Lunet N. Effects of the head lift exercise on the swallow function: a systematic review. Gerodontology, 2012 Dec;29(4):247-57.
4. Hoffman MR, Mielens JD, Ciucci MR, Jones CA, Jiang JJ, McCulloch TM. High-resolution manometry of pharyngeal swallow pressure events associated with effortful swallow and the Mendelsohn maneuver. Dysphagia, 2012 Sep;27(3):418-26.
5. Robbins J, Kays SA, Gangnon RE, Hind JA, Hewitt AL, Gentry LR, Taylor AJ. The effects of lingual exercise in stroke patients with dysphagia. Arch Phys Med Rehabil, 2007 Feb;88(2):150-8.
6. Pitts T, Bolser D, Rosenbek J, Troche M, Okun MS, Sapienza, C. Impact of expiratory muscle strength training on voluntary cough and swallow function in Parkinson disease. Chest, 2009 May;135(5):1301-8.
7. Carnaby GD, Harenberg L. What is “usual care” in dysphagia rehabilitation: a survey of USA dysphagia practice patterns. Dysphagia, 2013; Dec;28(4):567-74.

8. Clark HM, Solomon NP. Age and sex differences in orofacial strength. Dysphagia, 2012 Mar;27(1):2-9.

9. Ogura E, Matsuyama M, Goto TK, Nakamura Y, Koyano K. Brain activation during oral exercises used for dysphagia rehabilitation in healthy human subjects: a functional magnetic resonance imaging study. Dysphagia, 2012 Sep;27(3):353-60.

10. Clark HM, Henson PA, Barber WD, Stierwalt JA, Sherrill, M. Relationships among subjective and objective measures of tongue strength and oral phase swallowing impairments. Am J Speech Lang Pathol, 2003 Mar;12(1):40-50.

11. Mander J. 80% of internet users own a smartphone, 2015. http://www.globalwebindex.net (accessed 5 January 2015).

12. Kang S, Jung, J. Mobile communication for human needs: A comparison of smartphone use between the US and Korea. Comput Human Behav, 2014 Jun;35:376-87.

13. Milani P, Coccetta CA, Rabini A, Sciarra T, Massazza G, Ferriero G. Mobile smartphone applications for body position measurement in rehabilitation: a review of goniometric tools. PM R, 2014 Nov;6(11):1038-43.

14. Mosa ASM, Yoo I, Sheets L. A systematic review of healthcare applications for smartphones. BMC medical informatics and decision making, 2012 Jul;12(1): 67-97.

15. Moon JH, Hahm SC, Won YS, Cho HY. The effects of tongue pressure strength and accuracy training on tongue pressure strength, swallowing function, and quality of life in subacute stroke patients with dysphagia: a preliminary randomized clinical trial. Int J Rehabil Res, 2018 Mar;41(3):204-10.

16. Han TR, Paik NJ, Park JW. Quantifying swallowing function after stroke: a functional dysphagia scale based on videofluoroscopic studies. Arch Phys Med Rehabil, 2001 May;82(5):677-82.

17. Rosenbek JC, Robbins JA, Roecker EB, Coyle JL, Wood JL. A penetration-aspiration scale. Dysphagia, 1996 Jun;11(2):93-8.

18. Singer AJ, Jr HCT. Determination of the minimal clinically significant difference on a patient visual analog satisfaction scale. Acad Emerg Med, 1998 Oct;5(10):1007-11.

19. Wada S, Tohara H, Iida T, Inoue M, Sato M, Ueda K, Jaw-opening exercise for insufficient opening of upper esophageal sphincter. Arch Phys Med Rehabil, 2012 Nov;93(11):995-9.

20. Yoshida M, Groher ME, Crary MA, Mann GC, Akagawa Y. Comparison of surface electromyographic(sEMG) activity of submental muscles between the head lift and tongue press exercises as a therapeutic exercise for pharyngeal dysphagia, Gerodontology, 2007 Jun;24(2):111-6.

21. Vallejo J. Pre-and postsurgical evaluation of the position and stability over time of the base of tongue, hyoid bone and airway volume in skeletal class III patients submitted to orthognathic surgery. J Oral Maxillofac Surg Med Pathol, 2017 Mar;46:332.

22. Ishida R, Palmer JB, Hiiemae KM. Hyoid motion during swallowing: factors affecting forward and upward displacement. Dysphagia, 2002 Dec;17(4):262-72.

23. Cook IJ, Dodds WJ, Dantas RO, Massey B, Kern MK, Lang IM, Hogan WJ. Opening mechanisms of the human upper esophageal sphincter. Am J Physiol Gastrointest Liver Physiol, 1989 Nov; 257(5):748-59.

24. Podvinec S. The physiology and pathology of the soft palate, J Laryngol Otol, 1952 Sep;66(9):452-61.

25. Barer DH. The natural history and functional consequences of dysphagia after hemispheric stroke. J Neurol Neurosurg Psychiatry, 1989 Feb;52(2):236-41.

26. Hallett M. Plasticity of the human motor cortex and recovery from stroke. Brain Res Rev, 2001 Oct;36(2-3):169-74.

27. Dimyan MA, Cohen LG. Neuroplasticity in the context of motor rehabilitation after stroke. Nat Rev Neurol, 2001 Jan;7(2):76-85.

28. Eklund M, Hansson L. Ward atmosphere, client satisfaction, and client motivation in a psychiatric work rehabilitation unit. Can J Commun Ment Health, 2001 Apr;37(2):169-77.

29. Saltapidas H, Ponsford J. The influence of cultural background on motivation for and participation in rehabilitation and outcome following traumatic brain injury. J Head Trauma Rehabil, 2007 Apr;22(2):132-39.