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The Effects of Multi-Sensory Stimulation on Swallowing Function in Stroke Patients with Dysphagia

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ABSTRACT

The purpose of this study was to investigate the effect of multi-sensory stimulation on swallowing function in stroke patient with dysphagia. Twenty stroke patients with dysphagia participated in this study. Among 20 stroke patients with dysphagia, the 10 patients who have multi-sensory stimulation at the same time were in a experimental group and the other 10 patients who have traditional dysphagia rehabilitation were in a control group. Both groups were randomly assigned. The experimental group received for 4 weeks, for multi-sensory stimulation, visual-auditory stimulation and BPO olfactory stimulation were supplied with traditional dysphagia rehabilitation. For the control group, only traditional dysphagia rehabilitation received. Before and after invention, Videofluoroscopic Swallowing (VFS) was conducted. After that, the data on the test of Functional Dysphagia Scale (FDS), penetration-aspiration scale (PAS), American Speech-Language-Hearing Association National Outcome Measurement System (ASHA NOMS), Olfactory Identification Test was collected. There were significant differences between the data of FDS, PAS, ASHA NOMS before and after invention in the experimental group ($p<.05$). For the control group, there were significant differences in FDS ($p<.05$). For change score comparisons between groups, there was greater significant differences in FDS of the experimental group than control group ($p<.05$). It is confirmed that multi-sensory stimulation has an positive effect on swallowing function in stroke patients with dysphagia.

KEYWORDS: Black Pepper oil, Dysphagia, Olfactory stimulation, Stroke, Visual-auditory stimulation

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1. Introduction

Stroke is one of the most common causes of dysphagia. Approximately 27%~64% of dysphagiapatients are caused by dysphagia [1, 2]. If stroke patients have dysphagia it will cause the complication such as respiratory system disease or malnutrition dehydration to patients, so it may give the patients economic loss with longer hospitalization period. Besides, functional recovery becomes low [3-5]. Therefore, it is very important to diagnose and treat dysphagia.

For dysphagiapatients, various possibilities with with sensory stimulation are being studied steadily. Ebiharaet al. [6] reported about the improvement of swallowing function by olfactory stimulation with BPO(Black Pepper Oil. The study showed that the latency of swallow becomes low and the activation of brain area related with brain mapping result swallowing. Later, Parket al. [7] reported on the improvement of general swallowing function for the dyshpgia patients by stroke.

In functional magnetic resonance imaging study, Kawai et al. [8] confirmed that the combination of auditory and visual stimulation changes the activation of cortex related to swallowing. Moreover, Ushioda et al. [9] reported about the activation of mirror neuron when swallowing after visual-auditory stimulation with MEG (Magnetoencephalography)

While there have been many studies about the positive effect of sensory stimulation on swallowing function no study for combining various sensory stimulations together. Therefore, the study about clinical effect for dysphagia patients is necessary. The purpose of this study was to investigate the effect of multi-sensory stimulation on swallowing function in stroke patient with dysphagia.

2. Methods

This study was conducted for the stroke patients with dysphagia in rehabilitation unit. About the standard of selection, more than 3 months from the onset, confirmed dysphagia by Videofluoroscopic Swallowing (VFS), confirmed having normal sensory function by Olfactory Identification Test. The general characteristics of the subjects in the study are shown in Table 1.

Table 1. General characteristics

		Experimental group (n=10)	Control group (n=10)
		N	N
Sex	Male	6	5
	Female	4	5
Age (years)		59.60±3.07	60.40±3.24
Lesion location	SupraT	9	9
	InfraT	1	1
Affected side	Right	0	1
	Left	10	9
Onset duration (months)	3-12	1	2
	13-24	4	1
	≥ 25	5	7
MMSE-K (score)		25±2.30	23±2.62

SupraT: Supratentorial; InfraT: Infratentoral; MMSE-K: Mini Mental State Examination-Korea.

The subjects were in two different groups of 10 subjects. For the experimental group, the subjects had dysphagia rehabilitation with multi-sensory stimulation. For the control group, the subjects only had traditional dysphagia rehabilitation. the subjects are divided in two groups randomly. Allocation was randomly assigned by tossing a coin. The invention proceeded for 4 weeks, 30 minutes once a day 5 times a week.

For olfactory stimulation, Absolute Aromas Black Pepper (Absolute Aromas Co., England) was used following the report of Ebihara et al. [6]. During treatment, put BPO on a cotton bud then swing it below 3~5 cm from patient's nose so that it helps the patient do nasal inhale [6]. BPO olfactory stimulation was given total two times during 30 minute treatment time before visual-auditory stimulation. Olfactory stimulation was performed at the point of 10 minutes and 25 minutes from the start of treatment for 1 minute each.

For visual-auditory stimulation, the content from the study of Ushioda et al. [9] was taken and modified then applied. Unlike previous studies, filmed the normal adults swallowing water then supplied it to the patients as visual auditory stimulation. About the material, the video shows and hears a person is swallowing water. After the blackout scene, the visual auditory stimulation's running time is 20 seconds. After 3.5 second- blackout scene, the scene of swallowing water is showed up from 3.6 second to 19.5 second, then the auditory stimulus of swallowing water starts at 16 second. Lastly, the blackout scene comes up during 0.5 second at the end.

During the 30 minute treatment, the visual-auditory stimulation was applied two times after olfactory stimulation. The visual auditory stimulation was applied for 4 minutes at the 11 minute and 26 minute out of whole treatment. And also, was screened 9 times during 4 minutes from the 26 minute, so total 18 times, the visual auditory stimulation was supplied repeatedly

For traditional dysphagia rehabilitation, the appropriate treatment method considering patients' symptom was applied. Chin tuck, head rotation, head tilt were applied as posture modified [10-12], and sensory input using an electric toothbrush and resistance exercise using tongue depressor were implemented [12]. As tongue depressor termal-tactile stimulation, stimulate anterior faucial arch with sour tasted ice stick and cotton swab [13]. And the direct swallowing therapy was applied supplying patients the yogurt which can be swallowed easy and safe [14].

Every intervention was applied in the indoor place which is quiet and independent. Total time for the treatment was 30 minutes, and the study for both experimental group and control group was implemented in the same circumstance. For experimental group, 10 minute-traditional dysphagia rehabilitation was supplied, and BPO olfactory stimulation was applied for 1 minute from the 10minute of the treatment. then from the 11 minute, the visual auditory stimulation was applied 9 times during 4 minutes, but after third time of the stimulation, let them swallow the yogurt. Yougurt was supplied to the patients by

the tea spoon, and the patients swallows the yogurt 3 times watching the visual auditory stimulation 9 times. From the 16 minute to 25 minute, the traditional dysphagia rehabilitation was reapplied for 10 minutes. From the 25 minute, 1 minute BPO olfactory stimulation was applied and 9 times visual auditory stimulation and 3 times yogurt was applied from 26 minute to 30 minute. For the control group, the traditional dysphagia rehabilitation considering patients' symptom was applied for 30 minutes [12].

To assess the effect on swallowing function, videofluoroscopic swallowing (VFS) was applied to both groups before and after intervention. functional dysphagia scale (FDS) [15] and (penetration-aspiration scale (PAS) [16] were implemented to evaluate swallowing function. To assess on diet level, American Speech-Language-Hearing Association National Outcome Measurement System (ASHA NOMS) were evaluated [17].

Statistical analyst were blinded for this study. For the collected data, SPSS version 21.0 was used. The descriptive statistic was implemented for subject's general characteristics, and the analysis on the comparison of change score of both groups was evaluated by Mann-Whitney U test. To check the treatment effects for both groups, Wilcoxon signed-rank test was used for the change before and after the treatment. To validate the significance, set the significance level α as .05.

3. Results

There was no significant difference between the two groups in general characteristics ($p>.05$)(Table 1). The change of swallowing on multi-sensory stimulation and traditional dysphagia rehabilitation is like to the Table 2. There were significant differences between the data of FDS, PAS, ASHA NOMS before and after invention in the experimental group ($p<.05$). For the control group, there were significant differences in FDS ($p<.05$).

Table 2. Comparison of experimental versus control group on swallowing function

	Experimental group (n=10)		Control group (n=10)		p (change score)
	Pre	Post	Pre	Post	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
FDS	51.30±8.67	36.40±9.50[a]	51.50±9.10	49.70±8.97[a]	.012[b]
PAS	5.30±2.00	4.10±1.52[a]	4.80±1.87	4.10±1.45	.907
ASHA NOMS	3.60±1.35	5.20±1.03[a]	3.90±1.10	4.30±1.06	.059

FDS: Functional Dysphagia Scale; PAS: Penetration-Aspiration Scale; ASHA NOMS: American Speech-language Hearing Association National Outcome Measurement System.

[a]$p<.05$, significant difference within groups

[b]$p<.05$, significant difference between the both groups

For change score comparisons between groups, there was greater significant differences in FDS of the experimental group than control group ($p<.05$).

4. Discussion

This study is to examined the effect of the multi-sensory stimulation including visual auditory stimulatioin and BPO olfactory stimulation on swallowing function in dysphagia patients by stroke. In this study, the olfactory stimulation method which was applied in Ebihara et al's study is used after modification [6]. In the previous study [6], BPO stimulation nasalinhale was applied for one minute before meal, but in this study, it is applied for a minute two times out of total 30 minute treatment.. For the visual auditory stimulation, modify the contents which was applied by Ushioda et al.[9] and others, and supply 20 second video 9 times, total 3 minutes two times out of total 30 minute treatment. Total 3 sets (1 set= Video 3 + Yogurt 1 spoon) were implemented. In this study, the sensory stimulation method which was applied in precedent study was applied considering real circumstance.

Among the experimental group applied with multi-sensory and the control group applied with traditional dysphagia rehabilitation for four consecutive weeks, there was a significant difference on FDS, PAS, ASHA NOMS before and after the intervention. However, the control group has only significant difference on FDS. In addition, there was a significant improvement on FDS in the difference between experimental group and control group in change score. This result shows that multi-sensory stimulation including olfactory and visual auditory stimulation should be more effective method than traditional dyspahgia rehabilitation for the swallowing function in stroke patients.

Ebihara et al. [6] reported that there was a significant reduce on swallowing reflex delayed time after being applied by olfactory stimulation with BPO and activation of brain cortex related with swallowing. Moreover, Park et al's study about BPO olfactory stimulation to dysphagia patients is equal to the result of the study about significant effect on FDS [7]. Munakata et al.'s study also proved that BPO olfactory stimulation had an effect on the improvement of child patients' swallowing function [18]. In previous studies, BPO olfactory stimulation has an positive effect on the improvement of swallowing function.

The studies of Kawai et al. and Ushioda et al. reported that visual auditory stimulation had an effect on the activation of brain area [8, 9]. Visual stimulation activates the mirror neuron of brain and it activates premotor area's neuron pretending activate itself [10]. Therefore, this study shows that visual auditory stimulation has an positive effect on swallowing function just like olfactory stimulation [19].

About the limitation of the study, the number of examines was not enough to certify the result and the comparison study could not be done with subjects' lesion location. Moreover, this study could not prove which stimulation has the best effect on swallowing function. Therefore, to

certify the study result, comparison study and more subjects are needed. Moreover, study should be implemented for longer time with follow-up.

5. Conclusions

It is confirmed that multi-sensory stimulation has an positive effect on swallowing function in stroke patients with dysphagia. multi-sensory stimulation should be applied actively to stroke patients for their recovery because of its positive effect. This study is about the multi stimulation including BPO olfactory stimulation and visual auditory stimulation for the dysphagia patients with stroke, and it is meaningful because its intervention considered clinical circumstance. Besides, BPO olfactory and visual auditory stimulation can be simply used to patient, and the cost is inexpensive.

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다감각 자극이 삼킴장애가 있는 뇌졸중 환자의 삼킴기능에 미치는 영향

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요 약

본 논문은 삼킴장애가 있는 뇌졸중 환자를 대상으로 다감각 자극이 삼킴장애에 미치는 영향을 규명하고자 한다. 본 연구에 20명의 삼킴장애를 동반한 뇌졸중 환자가 참여하였다. 모든 대상자는 10명씩 실험군과 대조군으로 무작위 할당되었다. 모든 대상자는 4주 동안 동일한 시간의 중재를 받았다. 실험군은 다감각 자극의 중재를 받았으며, 대조군은 전통적인 삼킴장애 재활을 받았다. 중재 전과 후로 비디오 투시조영 검사, 기능적 삼킴장애 척도, 침습-흡인 척도, 식이수준 검사(American Speech-Language-Hearing Association National Outcome Measurement System), 후각인지검사의 자료를 수집하였다. 실험군은 중재 전과 후로 비디오 투시조영 검사, 기능적 삼킴장애 척도, 침습-흡인 척도, 식이수준 검사에서 유의한 향상을 보였다 ($p<.05$). 대조군은 기능적 삼킴장애 척도에서 유의한 향상을 보였다. 두 군 간 변화량 비교에서, 실험군은 대조군보다 기능적 삼킴장애 척도에서 유의하게 더 큰 향상이 있었다. 다감각 자극은 뇌졸중으로 인한 삼킴장애 환자의 삼킴기능에 긍정적인 효과가 있음을 확인하였다.

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