



Effect of Olfactory Stimulation Mixed Carbonated Water Swallow on Suprahyoid Muscle Activity in Healthy Subjects

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ABSTRACT

The aim of this study was to examine the effect of olfactory stimulation mixed carbonated water swallow on activation of the suprahyoid muscle in healthy adults. Twenty healthy adults measured the activation of the suprahyoid muscle using surface electromyography (sEMG) when swallowing. There are the four swallowing tasks for the subjects: (1) odorless olfactory stimulation with distilled water, (2) odorless olfactory stimulation with carbonated water, (3) Black Pepper Oil (BPO) olfactory stimulation with distilled water, (4) BPO olfactory stimulation with carbonated water swallowing. Counterbalancing was done to exclude order effect. Six times for each task, total 24 times swallowing was done. 5 minute break time was given between each task, one researcher proceeded the experiment for consistency. Fix the reference voluntary contraction as 5 ml water swallowing to standardize the size of sEMG signal. Standardized data were used in statistical analysis, and statistical analyst was blind to the experiment. Among the four tasks, tasks 2 and 4 showed significantly stronger the suprahyoid muscle activity than tasks 1 and 3 in the maximum value ($p < .05$). In conclusion, Carbonated water, as immediate effect, could promote the maximum activation of the suprahyoid muscle, the immediate effect could not be found with BPO olfactory stimulation.

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KEYWORDS: Olfactory stimulation, Carbonated water, Swallowing, Suprahyoid, Dysphagia

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1. Introduction

Dysphagia is the dysfunction in the process of bolus move from oral cavity to stomach[1]. One of the common symptoms of dysphagia is the aspiration[2]. Aspiration is a general symptom and it comes with, dehydration, malnutrition, aspiration pneumonia[3]. Therefore, there are many studies about intervention done to prevent aspiration of dysphagia and for the successful rehabilitation[4].

Among the studies, there was a study done, and it was about the carbonated water changing the chemical characteristic of bolus to reduce the risk of aspiration so that be swallowed safely[5, 6]. In the study about videofluoroscopy swallowing study (VFSS) with dysphagia patients, carbonated water had faster pharyngeal transmit time and less residue than its of thin liquid, and also showed up the significant reduce of aspiration [6].

In study of Ebihara et al.[7], Black Pepper Oil (BPO) olfactory stimulation reduced latency of swallow and improved reflexive swallowing movement activating insular and orbitofrontal cortex in brain imaging. Park[8] reported that BPO olfactory stimulation improved swallowing function. Carbonated water and BPO olfactory stimulation could be applied effectively for the treatment of dysphagia patients. However, the effect of combining both carbonated water and BPO olfactory stimulation is not enough.

Therefore, this study tries to find out the effect of combining carbonated water and BPO olfactory stimulation on suprahyoid muscle activity when normal healthy adults' swallowing.

2. Methods

This study was done with 20 healthy adults who agreed with their participation in subjects without problems of Olfactory Identification Test [7]. The general characteristics of the subjects are shown in Table 1.

Table 1. Characteristics of subjects

Sex	Subjects (n=20)	
	Male	Female
	10	10
Age (years)	26.4±1.90	
Height (cm)	169.5±9.7	
Weight (kg)	64.2±14.3	

The subjects were being tasked four swallowing tasks. Counterbalancing was done to exclude order effect. For the odorless olfactory stimulation, put the distilled water on a cotton swap, and Absolute Aromas Black Pepper (Absolute Aromas CO., England) was used for BPO olfactory stimulation putting on the point 3~5 cm below nose with a cotton swap and let them inhale[6].

After nasal inhale, following tasks were done: odorless olfactory stimulation with distilled water swallowing (task 1), odorless olfactory stimulation with carbonated water swallowing (task 2), BPO olfactory stimulation with distilled water swallowing (task 3), BPO olfactory stimulation with carbonated water swallowing (task 4). Six times for each task, total 24 times swallowing was done. 5 minute break time was given between each task, one researcher proceeded the experiment for consistency. As the solution of swallowing task, Chojung Sparkling water

(ILHWA CO., Korea) was used as carbonated water.

Attached surface electromyography (sEMG) electrode on suprahyoid muscle using Noraxon Telemetry DTS (NORAXON Inc., USA). Before attaching sEMG electrode, removed pubic hair on electrode attachment point using razor and sterilized it with alcohol to smooth the skin surface. Fix the Reference Voluntary Contraction (RVC) as 5 ml water swallowing to standardize the size of sEMG signal. Standardized data were used in statistical analysis, and statistical analyst was blind to the experiment.

SPSS 21.0 was used for analyzing data and descriptive statistic was used for the general characteristic. Repeated Measured ANOVA was used for the mean and maximum activation of suprahyoid muscle on the four tasks, post-hoc test was analyzed by Bonferroni's. We set the level of significant α as 0.05.

3. Results

The result of suprahyoid muscle activation

from sEMG is like the Table 2. There was no significant differences on the mean value ($p>.05$), and tasks 2 and 4 showed significantly stronger the suprahyoid muscle activity than tasks 1 and 3 in the maximum value ($p<.05$).

4. Discussion

This study is to know about the effect of combination of BPO olfactory stimulation and carbonated water on the activation of suprahyoid muscle of healthy adults using sEMG.

As a result, there was a significant difference in the maximum activation out of 4 tasks. This result shows that BPO olfactory stimulation and carbonated water had a strong effect on suprahyoid muscle activation when swallowing even though they did not have an effect on continuous mean muscle activation. The reason why there was no significant difference in mean activation value was that the subjects were young adult without dysphagia, so olfactory stimulation and carbonate stimulation could not have an effect on continuous mean muscle activation.

Table 2. Analysis of mean and maximum activation on 4 task

RVC values	Odorless olfactory stimulation		BPO olfactory stimulation		P
	Distilled water (Task 1)	Carbanated water (Task 2)	Distilled water (Task 3)	Carbanated water (Task 4)	
Mean (%)	11.06±2.40	10.75±3.66	10.60±3.34	10.94±3.56	.847
Maximum (%)	104.46±9.98	130.53±26.10 ^{a,b}	110.68±19.28	140.54±30.85 ^{a,b}	.000

RVC: Reference Voluntary Contraction; BPO: Black Pepper Oil.

^a $p<.05$, significant differences on task 1

^b $p<.05$, significant differences on task 3

In the study, there was no significant difference between task 1 and 2, and between task 3 and 4 according to post hoc test result. It seemed that only BPO olfactory stimulation cannot have a prompt effect on the contraction of suprahyoid muscle. In the study of Park, with dysphagia patients, separated two groups in the control group applied with odorless olfactory stimulation and the experimental group applied with BPO olfactory stimulation, and intermediated them for 6 weeks. As a result of the study, there were significant effects on delayed swallowing reflex, laryngeal elevation and epiglottis closure, vallecula residue, pharyngeal transmit time in the experimental group. Ebihara[7] suggested in his study, when applied BPO olfactory stimulation to dysphagia patient for 30 days, it improved brain activity with decrease of latency of swallow. Therefore, BPO olfactory stimulation has rather long term effect with neuroplasticity than immediate effect on swallowing.

Miura[9] reported that carbonated water facilitated swallowing of healthy subjects showing increase of power frequency content of suprahyoid muscle. In the study using VFSS, it said that carbonates water decrease the risk of aspiration more than noncarbonated water and activated swallowing function[5].

In this study, there were significant differences on the maximum activation value in task 2 and 4 applied with carbonated water compare to distilled water swallowing. When swallowing, suprahyoid muscle has an important role for airway protection making hyoid bone move toward anterior superior and helping laryngeal elevation

and epiglottis closure[10]. In addition, suprahyoid muscle is closely related to increase in pharyngeal contraction[11], upper esophageal opening[12], and reduction of pyriform sinuses residue[13].

Just like previous studies, it proves that carbonated water can help better and stronger swallowing. Patients with dysphagia experience aspiration more with thin liquid[14]. With the result, this study can be the essential for dysphagia rehabilitation promoting safe swallowing to the patients who suffer from the difficulty with liquid intake[15-20].

The limitation of the study, the number of subjects was not enough to certify the theory. And only short-term effect was proved in the study, so post study needs to deal with long term effect. In the analyzing sEMG, it is also needed to analyze the change of the swallowing speed with duration value and timing analysis, also needed to study about various muscle related with swallowing function.

In conclusion, this study was to investigate the effect of olfactory stimulation mixed carbonated water swallow on activation of suprahyoid muscle in healthy adults. In results, tasks 2 and 3 were significantly stronger in maximum value of suprahyoid muscle activity than tasks 1 and 3. Based on findings, carbonated water, as immediate effect, could promote the maximum activation of suprahyoid muscle, the immediate effect could not be found with BPO olfactory stimulation.

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후각자극과 탄산수 병행이 목뿔위근의 활성화에 미치는 효과

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요 약

본 연구는 건강한 성인을 대상으로 후각자극과 탄산수를 병행이 목뿔위근의 활성화에 미치는 효과에 대해 알아보려고 한다. 건강한 성인 20명은 표면근전도 검사를 통해 삼킴 과제 수행 시 목뿔위근의 활성화 측정되었다. 모든 대상자는 다음의 4가지 삼킴 과제 ((1) 무취 증류수 삼킴, (2) 무취 탄산수 삼킴, (3) 블랙페퍼오일 후각자극과 증류수 삼킴, (4) 블랙페퍼오일 후각자극과 탄산수 삼킴)를 수행하였다. 기준능동수축은 5ml의 물 삼킴을 통해 표면근전도 신호를 표준화하였다. 표준화된 값은 통계분석에 사용되었으며, 분석을 실시한 분석자는 실험내용을 알지 못했다. 4 가지 과제 사이에 목뿔위근의 최대활성 값에서 과제 1과 3에 비해 과제 2와 4는 유의하게 더 강한 활성을 보였다($p < .05$). 탄산수는 즉각적인 효과로서 목뿔위근의 최대 활성을 촉진할 수 있지만, 블랙페퍼오일 후각자극은 즉각적인 효과를 확인할 수 없었다.



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