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Effects of NMES in combination with saliva or dry swallowing in stroke patients with dysphagia

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Abstract Objective
Dysphagia after stroke can cause various complications, especially aspiration pneumonia, which can be life-threatening. Therefore, rehabilitation Methods to reduce aspiration in patients with dysphagia are important. To investigate the effects of the NMES combined with saliva or dry swallowing on swallowing function in stroke patients with dysphagia.

Methods
Participants were assigned to the experimental group (n=9) or control group (n=8). The experimental group received the NMES combined with saliva or dry swallowing, whereas the control group received only the voluntary swallowing. NMES was applied using the VitalStim, a transcutaneous-type electrical stimulator. Two pairs of electrodes were placed on the anterior neck region. Two pairs of electrodes were also horizontally placed in the submental region and thyroid cartilage to target suprahyoid muscles and the thyrohyoid muscle, based on a previous study's Methods.(Figure 1) Both groups received training 5 days per week for 4 weeks. Oropharyngeal swallowing function was assessed using the videofluoroscopic dysphagia scale (VDS) and penetration-aspiration scale (PAS) based on a videofluoroscopic swallowing study.

Results
General characteristics of the participants are described in Table 1. There were no significant differences between groups based on general characteristics and the VDS and PAS scores. Three participants (experimental group, n = 1; control group, n = 2) dropped out before the post-test because oftransfer to another hospital. Therefore, 17participants were analyzed. 1.VDS assessment The experimental group showed more improvement in the pharyngeal phase of VDS than the control group. After the intervention, statistical analysis showed a significant difference in the pharyngeal phase of VDS between the groups (p=0.038)(Table 2).Effect sizes were observed for the oral phase (0.28), and pharyngeal phase of VDS (1.45). 2.PAS assessment The experimental group showed more improvement in the PAS score than the control group. After the intervention, statistical analysis showed a significant different in the PAS score between the groups (p=0.027)(Table 2).Effect sizes were observed for the PAS (0.83)

Conclusion
We confirmed that VSE during NMES had a positive effect on swallowing function in patients with stroke with dysphagia. In addition, saliva or dry swallowing conducted in

this study could be easily performed with only a small cue in stroke patients with lower cognitive function compared to other remedial or compensation approaches. It also has the advantage of high compliance. In addition, implementing NMES with VSE at the same time could reduce treatment time.

Table 1. Characteristics of participants.

Characteristics	Experimental group (n=9)	Control group (n=8)
Age (year), mean ± SD	60.67±6.85	60.00±10.92
Gender(n)		
Men	5	3
Women	4	5
Type of stroke (n)		
Hemorrhage	4	4
Infarction	5	4
Site of stroke lesion (n)		
Middle cerebral artery	6	5
Pontine	2	1
Basal ganglia	1	2
Paretic side (n)		
Right	4	2
Left	5	6
Time after stroke (months)	3.22±1.20	3.25±1.16
Feeding type (n)		
Oral feeding	3	3
Tube feeding		
NG tube	6	5
PEG tube	1	0
OE tube	0	0

SD: standard deviation. NG tube: nasogastric tube, PEG: percutaneous gastrostomy tube
OE tube: Oro-esophageal tube

Table 2. Comparison of Results between experimental group and control group

parameters	Experimental group			Control Group			Between groups
	Pre-test	Post-test	*p*-value	Pre-test	Post-test	*p*-value	*P*-values
VDS							
Oral phase	18.00±7.37	8.33±6.15	.008*	18.62±6.47	12.00±5.19	.018*	.321
Pharyngeal phase	36.33±13.87	20.50±8.65	.012*	35.31±6.25	29.06±5.38	.018*	.038†
PAS	4.44±1.87	2.44±1.50	.026*	5.25±1.98	4.50±1.77	.109	.027†

Values are expressed as Mean±SD
VDS: Videofluoroscopy Dysphagia Scale, PAS: Penetration-Aspiration Scale.
*p<0.05 , †p<0.05,*Wilcoxon signed-rank test, †Mann-Whitney *U*-test

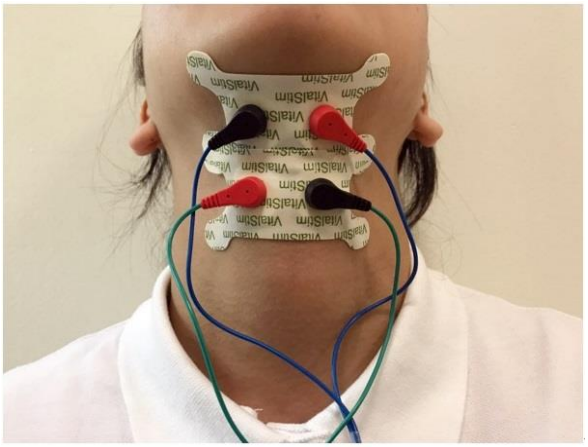

Figure 1. Electrode placement