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Original Article

Effect of neuromuscular electrical stimulation on lip strength and closure function in patients with dysphagia after stroke

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Abstract. [Purpose] This study aimed to investigate the effect of neuromuscular electrical stimulation (NMES) on lip strength and closure function of patients with dysphagia after stroke. [Subjects and Methods] Eight patients with dysphagia were recruited. NMES was applied to the orbicularis oris muscle. All the participants received NMES for 30 min/d, 5 d/wk, for 4 weeks. Lip strength was measured using the Iowa Oral Performance Instrument. To assess lip closure, the lip closure subitem of the videofluoroscopic dysphagia scale was used. [Results] Lip strength showed significant improvement and lip closure function showed a significant decrease. [Conclusion] This study demonstrates that NMES is useful for improving lip strength and closure function.

Key words: Dysphagia, Neuromuscular electrical stimulation, Orbicularis oris muscle

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INTRODUCTION

Neuromuscular electrical stimulation (NMES) is a typical remedial method that provides muscle contraction and sensory input through electrical stimulation to the neck front to treat dysphagia[1)]. NMES induces muscle contraction from depolarization of nerve fibers by transferring electrical stimulation to the muscle by using surface electrodes. The result is an effective method for strengthening muscles, preventing atrophy, and re-educating neuromuscular muscles[2)]. Several studies reported that NMES is effective for increasing muscle activation, and preventing aspiration[3, 4)]. However, only few previous studies have applied NMES to the oral phase, as most of the studies applied NMES to the pharyngeal phase. Therefore, the effect of NMES on lip muscle and function in the oral phase is unclear. Therefore, this study aimed to investigate the effect of NMES on lip strength and closure function.

SUBJECTS AND METHODS

In this study, 8 patients with dysphagia after stroke were included. The criteria for participation were as follows: 1) diagnosed as having dysphagia, 2) had difficulty closing lips, 3) no difficulty in communication, and 4) history of stroke within 6 months. The purpose of the study was explained to the participants before enrollment, and informed consent for participation was obtained in accordance with the principles of the Declaration of Helsinki.

This study applied NMES by using VitalStime (Chattanooga Group, Hixson, TN, USA). A pair of electrodes were attached to the orbicularis oris muscle to apply to the lip muscles. The electrical stimulation unit provided 1 channel of bipolar electrical stimulation at a fixed 80-Hz pulse rate and a biphasic pulse duration of 700 μs. The channel could be adjusted between

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0 and 25 mA of stimulation intensity. The intensity was increased until the patients felt a tolerable stimulation level (known as grabbing sensation) in their lip muscles. All the participants received NMES for 30 min/d, 5 d/wk, for 4 weeks. Evaluation was performed using the Iowa Oral Performance Instrument (IOPI Medical LLC, Carnation, WA, USA) to measure muscle strength during lip closure. The pressure bulb was inserted between two disposable tongue depressors, which were positioned between the centerline of the lips. At this time, the subjects gently closed their mouth and protruded their lips slightly. They were then instructed to press the tongue depressors with their lips as hard as possible[5]. Lip closure function was assessed using the lip closure item of the videofluoroscopic dysphagia scale. Lip closure was scored as 0, 2, and 4 to indicate intact, inadequate, and none[6].

The statistical analyses were performed using SPSS version 15.0 (IBM Corporation, Armonk, NY, USA). To evaluate the intervention effects, the Wilcoxon signed-rank test was used to compare measurement values before and after the intervention. The significance level was set at $p<0.05$.

RESULTS

In the post-intervention evaluation, a significant improvement in lip strength, from 15.9 ± 3.3 kPa to 20.5 ± 4.2 kPa ($p<0.05$), was observed. Lip closure function showed a significant decrease from 2.7 ± 0.9 to 1.2 ± 0.6 ($p<0.05$).

DISCUSSION

This study demonstrates that NMES is an effective intervention for improving lip strength and closure function in patients with dysphagia after stroke. Suiter et al.[4] showed that NMES activates the suprahyoid muscles in patients with dysphagia after stroke. High muscle activation is the recruitment of many motor units and has a potential to increase muscle strength if repeatedly applied[7]. This study also applied intensity at a tolerable stimulation level, this may lead to greater muscle contraction. The increase in lip muscle strength is related to lip closure function because proper lip closure of the orbicularis oris requires a strong contraction. Safi et al.[8] reported an increase in lip strength by applying NMES in healthy adults, which is consistent with our finding. Our study demonstrates that NMES is useful for improving lip strength and closure function. Therefore, we suggest the use of NMES as remedial treatment of dysphagia in the oral phase

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