Effects of Head Lift Exercise on Oropharyngeal Swallowing Function and Dropout Rate According to Reclining Angle in Patients with Dysphagia after Stroke: A Randomized Trial

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Objective: Although the effects of head lift exercise (HLE) in the reclining position have been reported, there is insufficient clinical evidence of the effects. This study compared the effects of HLE in the 0° supine position and 45° reclining position on the swallowing function and the compliance of patients with dysphagia after stroke after both exercises.

Methods: This was a randomized, assessor-blinded clinical trial. Thirty-five patients with stroke and dysphagia were assigned randomly to HLE in the 0° supine group (n=18) or HLE in the 45° reclining group (n=17). Patients in both groups performed HLE five days a week for four weeks and received the same conventional dysphagia therapy. The videofluoroscopic dysphagia scale (VDS) was used to evaluate the swallowing function. The dropout rate and subjective feedback related to compliance with the two exercises were monitored.

Results: No significant differences in the baseline characteristics were observed between the two groups. Patients in both groups showed significant improvement in the oral and pharyngeal phases of VDS (P < 0.05). After the intervention, no significant differences were observed between the groups (P > 0.05). Dropout rates of 22% and 6% owing to neck discomfort or fatigue were observed in the HLE in 0° supine group and the HLE in 45° reclining group, respectively.

Conclusion: HLE in the 45° reclining position has a similar effect on the swallowing function in patients with dysphagia after stroke to that of HLE in the 0° supine position and is associated with better exercise compliance. **(JKDS 2020:10:159-166)**

Keywords: Dysphagia, Head lift exercise, Compliance, Reclining position, Videofluoroscopic dysphagia scale

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INTRODUCTION

Head lift exercise (HLE), also called Shaker exercise, is a method of improving the opening of the pharyngo-esophageal segment by increasing the strength of the muscle groups involved in the opening of the upper esophageal sphincter. During swallowing, the suprahyoid muscles such as mylohyoid, geniohyoid, and anterior digastric muscles, help the anterior movement of the hyoid bone and induce the anterosuperior movement of the larynx. Improved strength and endurance of the weakened suprahyoid muscles facilitate the opening of the upper esophageal sphincter^{1,2}. This exercise is performed by sustaining three head lifts held (isometric) and repetitive head lifts of constant velocity without holding (isokinetic) while in the 0° supine position³.

However, despite these positive effects of HLE, it can be a physically demanding exercise. Easterling et al.³ reported a high dropout rate in patients performing the exercise because of muscle discomfort and compliance difficulty. Other studies reported neck soreness, fatigue, dizziness, and discontinuation in non-dysphagic elderly participants^{3,4}. Thus, completion of HLE may be a serious challenge, especially in patients with dysphagia along with chronic cough, pneumonia, and malnutrition⁵. Thus, it is clinically important to investigate an exercise method that is modified for the limitations of HLE and is easier to apply.

To compensate for the disadvantages of this conventional HLE, some studies tried HLE at a 30° - 45° reclining position. As a result, the reclining HLE was demonstrated to induce muscle activation of the suprahyoid muscles similar to when performing HLE in the 0° supine position^{4.6}. In addition, the reclining position helps to relieve neck pain and improves head and neck posture and range of motion in healthy adults and therefore is often used in clinical practice⁷. By using surface electromyography (sEMG), Koshi et al.⁶ reported that HLE is easier and more appropriate for reclining the backrest at the 30° than at the 0° position.

Thus, HLE in a reclining position (approximately $30^{\circ}-45^{\circ}$) is less strenuous than HLE with high physical demands and may be a new exercise that can be applied to patients with dysphagia. However, previous studies measured only muscle activation using sEMG^{4,6}. Therefore, the effects of HLE in a reclining position on the actual swallowing function are unknown. This study aimed to compare the effects of HLE at 0° supine position and that of HLE in a reclining position on swallowing function and the compliance of patients with stroke and dysphagia to these exercises, to identify the possibility of HLE in a reclining position as an alternative to HLE.

MATERIALS AND METHODS

1. Participants

We conducted a randomized, assessor-blinded clinical trial. In total, 35 patients with dysphagia after a stroke were recruited from a rehabilitation center (Seoul North Municipal Hospital) in the republic of Korea. Participants were randomly allocated to the 0° HLE group (n=18) or the 45° HLE group (n=17) by using a random allocation software program by a blinded occupational therapist. Block randomization with block size 4 was performed for 1:1 allocation.

Inclusion criteria were as follows: (1) oropharyngeal dysphagia after stroke confirmed by a videofluoroscopic swallowing study (VFSS), (2) observed aspiration or penetration in VFSS, (3) no significant cognitive deficits (Mini-Mental State Examination score >20), (4) above fair grade obtained on muscle testing of the neck, (5) symmetric posture of the neck, (6) able to perform HLE in a supine position, and (7) ability to swallow voluntarily. Exclusion criteria were as follows: (1) neck pain or discomfort, (2) poor general condition precluding further participation in the experiment, (3) communication problems (aphasia, apraxia), (4) unstable medical condition, (5) presence of a tracheostomy tube, and (6) cricopharyngeal dysfunction.

We explained the objectives and requirements of our study to all participants, and they voluntarily signed the informed consent form. The institutional review board of Seoul Medical Center approved the study (SEOUL 2017-03-016-002, approval notice date: 10/5/2017).

2. Sample size estimation

The G-Power 3.1 software (University of Dusseldorf, Dusseldorf, Germany) was used to calculate the sample size. A power of 0.80 was adopted considering a level of significance of 0.05 and an effect size of 0.88. According to a previous analysis, each group required at least 18 participants.

3. Procedures and intervention

The 0° HLE group performed HLE in a lying position on a flat surface. Conversely, the 45° HLE group performed HLE in the lying position while maintaining a 45° reclining position.(Fig. 1) The angle was controlled by a goniometer. Both groups performed HLE with the same frequency and type of exercise.

Exercise was performed with isotonic and isometric contractions. Participants sustained three head lifts held for 1 min without movement in the supine position, and a 60-s rest was allowed between the lifts. Then, the participants performed 30 repetitive head lifts without holding in the same supine position. The participants lifted their head high enough to observe their toes without raising their shoulders. HLE was performed three times per day, 5 days a week, for 4 weeks.

Both the groups received additional conventional dysphagia treatment (CDT). CDT was performed for 4 weeks, 5 times a week, for 30 minutes per day, which included thermal tactile stimulation, orofacial

muscle exercise, and various compensatory maneuvers. An occupational therapist with 7 years of clinical experience in treating dysphagia performed CDT in all the participants.

4. Outcome measurement

The primary outcome of this study was to measure the swallowing function using videofluoroscopic dysphagia scale (VDS) based on the VFSS before and 4 weeks after the intervention. The VDS is a functional evaluation scale that reflects overall swallowing function in stroke survivors based on VFSS findings. The VDS is divided into an oral stage (lip closure, bolus formation, tongue-to-palate contact, mastication, apraxia, premature bolus loss, and oral transit time) and pharyngeal stage (pharyngeal triggering, vallecular residues, pyriform sinus residues, laryngeal elevation, pharyngeal wall coating, pharyngeal transit time, and aspiration)⁸. The VDS findings were evaluated and interpreted by a physician specialized in rehabilitation medicine.

The secondary outcome of this study was to measure dropout rate and subjective feedback to compare patient compliance of the HLE at the 0° supine position and at the 45° reclining position. The dropout rate due to discomfort, pain, and fatigue in the neck and abdomen was monitored until the end of the intervention; dropout rate was not monitored for reasons such as discharge or transfer to another hospital. After the intervention was completed, the patients were briefly interviewed about their subjective feedback, such as difficulty and discomfort while performing the exercises.



Fig. 1. Performing the HLE according to reclining angle $(0^{\circ} \text{ and } 45^{\circ})$.

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5. Statistical analysis

Participant characteristics were analyzed using a statistical software program (SPSS Statistics 20), and descriptive statistics are presented as mean \pm SD. Shapiro-Wilk test was used to check normality of the outcome variables. To evaluate the intervention effects, Wilcoxon signed-rank test was used to compare pre- and post-intervention measures in each group. Mann-Whitney *U* test was used to compare intergroup changes in outcome measures. Significance level was set at P<0.05.

RESULTS

1. Patient characteristics and baseline information

Thirty-five participants were included in this study. Ten participants dropped out before the follow-up because of transferring to another hospital (0° HLE group [n=2] and 45° HLE group [n=3]) and giving up due to neck muscle discomfort, pain, and fatigue (0° HLE group [n=4] and 45° HLE group [n=1]).(Fig. 2) A summary of the baseline information features of the

participants (n=25) is shown in Table 1. The homogeneity test of each measurement item (VDS) showed no significant differences in baseline characteristics between the groups (oral and pharyngeal phase in liquid type of VDS evaluation; P=0.153 and 0.145, oral and pharyngeal phase in semisolid type of VDS evaluation; P=0.934 and 0.125).

2. Swallowing function

In this study, the swallowing function of the participants in the reclining position is compared with those in the supine position. The 0° HLE group show-

Table 1. Baseline characteristics of participants.

Characteristics	0° HLE group (n=12)	45° HLE group (n=13)
Age (year), mean±SD	63.00±10.55	63.40±6.65
Gender (male/female)	6/6	7/6
Type of stroke	7/5	7/6
(Hemorrhage/Infarction)		
Stroke lesion	8/4/0	9/4/0
(Cortical/Subcortical/Brain stem)		
Side of stroke (Right/Left)	4/8	8/5
Time since onset of stroke	3.00 ± 1.18	3.90±1.28
months, mean±SD		

SD: standard deviation.



Fig. 2. CONSORT diagram of participant recruitment.

ed significant improvement in the oral and pharyngeal phase of VDS (liquid type; P=0.011 and 0.003, semisolid type; P=0.005 and 0.002). The 45° HLE group also showed significant improvement in the oral and pharyngeal phase of VDS (liquid type; P=0.003 and 0.002, semisolid type; P=0.001 and 0.001). A comparison of both the groups after the intervention showed no significant differences (all, P>0.05).(Table 2)

3. Dropout-rate related compliance

Four out of 18 patients in the 0° HLE group dropped out, indicating a dropout rate of 22%. In the 45° HLE group, 1 out of 17 patients dropped out, indicating a dropout rate of 6%. The reasons for the dropouts were temporary pain in the neck, muscle weakness, and lack of endurance. There were no side effects such as prolonged muscle pain, discomfort, and severe fatigue after the intervention.

4. Subjective feedback of participants based on brief interview

Eight patients included in the 0° HLE group reported difficulty in performing the exercise because it was very challenging and bothersome to the neck and required significant abdominal effort. Two patients in the 45° HLE group reported abdominal and neck discomfort. All the other patients admitted that the neck and abdominal exercises required some effort, but the effort did not preclude performance of the exercise. Table 3 shows the subjective feedback related to HLE performance of 10 patients who reported relative difficulty in performance after the intervention.

Table 2. Comparison of swallowing function within and between two groups.

	0° HLE group (n=12)		45° HLE group (n=13)				Between		
	Before treatment	After treatment	Mean difference	P-value	Before treatment	After treatment	Mean difference	P-value	groups P-values
Liquid type									
Oral phase	11.79 (2.12)	10.62 (2.36)	-1.16 (0.98)	.011*	10.53 (1.52)	9.57 (1.32)	-0.96 (0.66)	.003*	.348
Pharyngeal phase	41.08 (3.23)	33.04 (5.34)	-8.04 (3.00)	.003*	39.11 (1.79)	31.42 (3.09)	-7.69 (3.30)	.002*	.440
Semisolid type									
Oral phase	13.91 (3.20)	10.95 (2.02)	-2.95 (1.87)	.005*	13.96 (2.84)	11.38 (2.36)	-2.57 (1.65)	.001*	.742
Pharyngeal phase	31.41 (2.54)	26.87 (3.31)	-4.54 (2.30)	.002*	29.76 (1.88)	25.34 (1.91)	-4.42 (1.30)	.001*	.196

The values are mean±standard deviation.

HLE: head lift exercise, VDS: videofluoroscopy dysphagia scale.

*P<0.05 by Wilcoxon signed-rank test.

Table 3. Subjective feedback of participants on performing two exercises.

0° HLE group	
Participant 1	It seems to be a burden on the neck muscles. Appropriate preparation such as sufficient stretching before exercise
	15 necessary
Participant 2	Some pain occurred in the neck, but it was fine soon. Overall, it was a tough exercise
Participant 3	A lot of effort of the abdominal muscles was required, and it was not easy to perform the exercise
Participant 4	It was a very difficult exercise, especially when I had to keep my head lifted up
Participant 5	Temporary muscle pain was experienced in the abdominal muscles, but it was relieved after a few days
Participant 6	Neck and abdominal pain was intense, and required a lot of effort. Hence, I did not want to do this exercise
Participant 7	It felt like a burden on the neck and shoulders. After the exercise, the shoulders and neck were stiff
Participant 8	I think it was an extremely tedious schedule, as the exercise had to be performed for four weeks. It is a physically
	difficult exercise, especially for the neck and shoulders
45° HLE group	
Participant 1	The neck feels uncomfortable
Participant 2	The neck and abdominal muscles required considerable effort and were difficult to perform

DISCUSSION

Both exercises led to significant improvements in the swallowing function; however, there was no significant difference between the two groups. This suggested that HLE in a reclining position and regular HLE have similar effects on stroke patients with dysphagia. In addition, HLE in a reclining position had better exercise compliance, as evident from the lower dropout rates and subjective feedback.

The present study confirmed the effectiveness of the two exercise methods in the improvement of the oral phase of VDS in patients with dysphagia after stroke. Oral phase items of VDS are mainly related to tongue function (e.g., bolus formation, tongue to palate contact). Both Exercises are head-raising workouts against gravity from head lifting to the 45° reclining and 0° supine positions that requires tongue stability⁴. Previous studies have also shown that HLE positively affects functional movement of the tongue in the oral phase and induces extensive activation of extrinsic muscles such as the hyoglossus^{9,10}. Mishra et al.⁴ reported that the HLE in a reclining position as well as in a supine position showed an increase in tongue strength. These previous studies support the results of this study.

The present study showed improvement of the pharyngeal phase of VDS in both groups. There was no difference between the two groups after intervention. HLE has been proven in many research studies to induce the activation of the suprahyoid muscles, and recent research has shown that both the exercise methods induce similar high levels of muscle activation^{4,6}. This supports the results of the present study. Sufficient muscle activation means considerable recruitment of motor units and can be expected to improve muscle strength when repeatedly performed. The improvement of muscular strength of the suprahyoid muscles suggests that it may contribute to normal swallowing mechanisms in the pharyngeal phase such as airway protection (reduced aspiration) and UES opening by inducing sufficient anterior-superior movement of the hyoid bone¹¹⁻¹³.

This study confirmed that both exercises have similar effects on the oropharyngeal swallowing. Nevertheless, the efficiency aspect is also important for the effective use of exercise, and efficient aspects of treatment are directly related to patient compliance. Several studies have reported a large number of dropouts among participants during HLE^{2,3}. Twentyfive percent of the HLE group in our study did not perform to completion (75% of patients performed to completion), whereas only 7% of the patients who performed HLE in the reclining position refused and 93% completed the treatment. The dropouts refused to perform the exercise because of neck pain, muscle fatigue, lack of endurance, and discomfort. Sluijs et al.¹⁴ reported that discomfort is an important factor in a patient's attitude toward exercising; pain and fatigue due to exercise are correlated with compliance to exercise and physical therapy. In their study, some participants reported that the exercise was difficult, painful, or tiring.

Compliance is an important factor in rehabilitative approaches in dysphagia treatment, and HLE in a reclining position has the potential to increase compliance in patients who experience inconvenience or discomfort when performing head lifts in a supine position. Previous sEMG studies have reported neck muscle (such as the sternocleidomastoid muscles) fatigue during HLE¹⁵⁻¹⁷, which results in noncompliance and ultimately makes it difficult to reach therapeutic goals. Thus, HLE in a reclining position is relatively easy to perform because sternocleidomastoid fatigue can be reduced with decreased loading during head lifting.

Chin tuck against resistance (CTAR) exercise^{5,16}, jaw-opening exercise^{18,19}, and jaw-opening-againstresistance (JOAR) exercise²⁰ have been introduced as therapeutic exercise methods that complement the limitations of HLE. A comparative study on HLE reported the effectiveness of swallowing function and compliance; however, no study has yet compared the effectiveness of swallowing function with 45° HLE and the above mentioned exercises. Further research in this regard is needed. CTAR, JOE, and JOAR are applicable to patients who can understand and perform the correct exercise to achieve therapeutic effects, and are limited to patients with severe cognitive decline or those unable to maintain a sitting position²¹. Therefore, 45° HLE can be a clinically useful method in that it is less stringent with regard to the subject criteria and can strengthen the suprahyoid muscles while alleviating neck pain and limitation of the range of motion.

This study demonstrated that the effect of reclining HLE is as effective as HLE on swallowing function in patients with dysphagic stroke. Thus, reclining HLE can be provided for patients with dysphagia as an alternative and less strenuous exercise. Further, HLE in a reclining position can be an alternative method for patients who cannot perform HLE in a supine position because of problems of posture and pain, or complain of muscle fatigue during HLE.

There are some limitations of our study. The sample size was small, and the findings are difficult to generalize. Activation of the suprahyoid muscles by using EMG was not evaluated; thus, the association between hyoid movement and increasing strength of the suprahyoid muscles could not be confirmed. It was difficult to compare only the effects of two HLEs excluding CDT because the participants of this study were inpatients with dysphagia. Finally, this study was not objective, because the patients were followed through interviews only to investigate compliance to the HLE.

This study used a goniometer to control the reclining angle at the supine position; however, the angle of the head lift slightly differed among the participants because the angle of head lift from the bed was not strictly controlled. Nevertheless, a merit of this study is that an alternative to regular HLE was attempted to demonstrate exercise compliance and to evaluate the improvement in the swallowing function. Further studies with a larger sample size are needed to determine the long-term therapeutic benefits of the two exercises.

CONCLUSION

HLE in a reclining position not only has an effect similar to that of regular HLE on swallowing function in patients with dysphagia after stroke but also has better exercise compliance. Therefore, HLE in a reclining position can be recommended as an alternative to regular HLE.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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