Brain Neurorehabil. 2018 Sep;11(2):e19
https://doi.org/10.12786/bn.2018.11.e19
pISSN 1976-8753·eISSN 2383-9910

Brain & NeuroRehabilitation

Original Article

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Selection of Head Turn Side on Pharyngeal Dysphagia in Hemiplegic Stroke Patients: a Preliminary Study

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OPEN ACCESS

Received: Jun 28, 2018
Accepted: Sep 28, 2018

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HIGHLIGHTS

- The head turning as a compensatory strategy has no clinical basis for the improvement of dysphagia in hemiplegic stroke patients.
- A head postural compensatory strategy should be carefully re-considered in hemiplegic stroke patients with pharyngeal dysphagia.

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Funding
This study was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIP) (NRF-2016R1A2B4012054).

ABSTRACT

The objective of this preliminary study is to investigate the effects of various head turn in hemiplegic stroke patients with pharyngeal dysphagia. Twenty hemiplegic stroke patients with dysphagia participated in this study. A patient with dysphagia from an upper esophageal sphincter disorder was excluded. All participants underwent a videofluoroscopic swallow study (VFSS) with a 3 mL liquid diet, and their heads were randomly turned to a neutral position, toward the weaker side, toward the stronger side, or to a chin tuck posture. To assess patient swallowing function with VFSS, the videofluoroscopic dysphagia scale (VDS) and penetration-aspiration scale (PAS) were conducted by a physiatrist blinded to the participant's characteristics. No significant improvements in the VDS and PAS were observed in patients with heads rotated toward the weaker or stronger side when compared with heads in the neutral position. However, there was a significant improvement in the VDS for heads in the chin tuck position when compared with those in the neutral position ($p < 0.05$). These preliminary results revealed that the head turn practice without VFSS, as a compensatory strategy, could not improve dysphagia in hemiplegic stroke patients. Therefore, compensatory postures might be re-considered with in hemiplegic stroke patients with pharyngeal dysphagia.

Keywords: Dysphagia; Deglutition; Postural Modification; Stroke; VFSS

INTRODUCTION

Dysphagia after a stroke is a common disorder and occurs in 50% to 75% of stroke patients [1,2]. Patients with dysphagia have a poor quality of life and are at risk of aspiration pneumonia, which is associated with increased mortality in early stroke patients [3,4]. As a consequence, early detection of dysphagia should be considered in cases of acute stroke [5-8]. and standardized swallowing tests are recommended in clinical practice guidelines for all acute stroke patients for stroke rehabilitation [9].

Rehabilitation of dysphagia involves exercise training, compensatory strategies, surgical management, and pharmacologic management [10,11]. In particular, postural compensatory

Conflict of Interest
The authors have no potential conflicts of interest to disclose.

strategies are commonly recommended to reduce the risk of aspiration because they can be immediately applied to the patients with dysphagia [12]. In 1989, Logemann et al. [13] postulated that turning the head towards the paralyzed side directs the dietary flow into the unaffected pharyngeal wall, and a videofluoroscopic swallow study (VFSS) results of 5 patients with brainstem strokes proved this hypothesis. Based on this study, posturing the head towards the weaker side is one of the most commonly recommended compensatory strategies, and is generally used in the clinical setting for hemiplegic stroke patients with pharyngeal dysphagia. However, there is a lack of clinical evidence for the therapeutic efficacy of head turn in hemiplegic stroke patients with dysphagia [12,14]. In spite of insufficient evidence, head turn without explicit verification by individual VFSS is still a recommended practice in the published literature to date [10,12].

Therefore, it is necessary to investigate head turn and to test its effect as a compensatory technique in hemiplegic stroke patients with pharyngeal dysphagia. The objectives of the present study were to investigate the proper direction of head turn and to demonstrate its efficacy by comparing the improvement of dysphagia according to each type of head positions, including the chin tuck maneuver.

MATERIALS AND METHODS

Participants

Twenty hemiplegic stroke patients with dysphagia were recruited for this study. Inclusion criteria for the study were unilateral stroke patients with dysphagia. Dysphagia was assessed by the American Speech-Language-Hearing Association National Outcome Measurement System Swallowing Scale (ASHA-NOMS), and patients identified between levels 1 to 5 were enrolled. The exclusion criteria were: 1) a history of other disease which could directly affect the swallowing ability, such as dementia, Parkinson's disease and motor neuron disease; 2) severe cognitive or language dysfunction that prevented patients from following instructions; 3) severe impairment of balance that prevented patients from sitting with the directed posture in the chairs with armrests and backrests; or 4) obvious limitation of neck motion due to orthopedic problems. In addition, participants who showed cricopharyngeal muscle dysfunction [15] on VFSS were excluded, because this study focused on the effects of head postural modification on dysphagia in hemiplegic stroke patients with dysphagia due to pharyngo-laryngeal weakness.

Ethical approval was obtained from the Samsung Medical Center Institutional Review Board (SMC 2016-02-063-001). Written informed consent was obtained from all individual participants included in this study.

Experimental design

All patients underwent VFSS as described by Logemann et al. [13] with some modifications. Patients were seated upright and administrated 3 mL liquid diet with four random positions: neutral, maximal head turn to the weaker side or stronger side, and the chin tuck posture. Images of the swallowing process were taken from the lateral view, including the oral cavity, pharynx and upper esophagus using fluoroscopic equipment (Sonialvision ZS-100I; Shimadzu, Kyoto, Japan), and recorded by a TS-H653N DVD recorder (Toshiba Samsung Storage Technology, Tokyo, Japan). To assess swallowing function with a VFSS, the videofluoroscopic dysphagia scale (VDS) [16] and penetration-aspiration scale (PAS) [17] were applied by a physiatrist blinded to the participant's characteristics. Penetration was defined as the passage of the contrast material above the true vocal cord, but not below it. Aspiration was defined as the passage of the contrast material into the trachea through the true vocal cord.

In addition, affected mylohyoid electromyographic responses were detected by opposite cortical magnetic stimulation in all participants.

VDS

VDS is used as an objective predictor of the prognosis of dysphagia after stroke [16]. It is well known that dysphagia has a strong correlation with the occurrence of aspiration up to 6 months after onset of the swallowing disorder [18]. VDS is composed of 14 criteria, which can be subdivided into oral and pharyngeal functions: the former includes lip closure, bolus formation, mastication, apraxia, tongue-to-palate contact, premature bolus loss, and oral transit time, while the latter includes triggering of pharyngeal swallow, vallecular residue, laryngeal elevation, pyriform sinus residue, coating of pharyngeal wall, pharyngeal transit time, and aspiration. Since these criteria can be easily determined, a patient's status of dysphagia can be understood in detail. Comparisons to previous patient examinations can also be made to determine the therapeutic effects of swallow treatments.

PAS

This 8-point scale is a multidimensional tool for evaluating penetration or aspiration behaviors. The first dimension is the depth of bolus invasion into the airway, and the second dimension is the patient's response during swallowing [17]. The first dimension is considered to be more important regarding the severity of swallowing function than the second. In penetration, cases with residue that remained above the vocal folds are scored either a 2 or 3, and cases with residue that reach the vocal cord are scored a 4 or 5. Aspiration is scored a 6, 7, or 8. Patients with a score of 8 who have aspiration without an effort to cough or expel the material, and those that clinically correspond with a silent aspiration, are regarded as those with the most severe stage of dysphagia.

Mylohyoid transcranial magnetic stimulation (TMS)-induced motor evoked potentials (MEP)

Single-pulse TMS was applied to each patient to determine the functional integration from the motor cortex to the mylohyoid muscle [19]. The patients were seated on a reclining armchair. Electromyography (EMG) data were recorded from the contralateral submental mylohyoid muscle via surface electrodes. EMG activity was amplified using the Medelec Synergy EMG/EP system (Medelec, Oxford, UK), and the data were band-pass filtered at 10–2,000 kHz. We used a Magstim BiStim^2 Stimulator TMS System (Magstim Company Ltd., Wales, UK) and a 70-mm figure 8 coil. The coil was then positioned 2–4 cm anteriorly and 4–6 cm laterally, and moved around within the area to obtain the maximal MEP responses to locate the mylohyoid hot spot area in the contralesional hemisphere. We defined MEP as absent if no response was obtained from the stimulation site on the affected hemisphere after 3 successive discharges with maximum output [19].

Patients were classified into the response group and the no-response group according to the affected mylohyoid TMS-induced MEPs.

Statistical analysis

A statistical analysis was performed using SPSS for Windows version 20.0 statistical software (SPSS, Inc., Chicago, IL, USA). The differences of basic characteristics between the groups according to responses of the TMS-induced MEPs were assessed using the Mann-Whitney U test. In addition, the Wilcoxon signed rank test with Bonferroni's correction was used for identifying the differences in swallowing functions at each posture. Differences were regarded as significant when p values were < 0.05.

RESULTS

All participants successfully completed the experimental procedures. Of the 20 patients, one patient with cricopharyngeal muscle dysfunction on VFSS was excluded. VFSS results of the remaining 19 hemiplegic stroke patients (aged 68.5 ± 8.9 years, 13 males) were analyzed. General characteristics of 19 patients are described in Table 1.

Total participants

The VDS scores showed no significant improvements when patient heads were postured to the weaker or to the stronger side as opposed to the neutral posture. In addition, any parameter in the VDS had no significant difference in the head turn posture between the weaker or stronger side over the neutral posture. However, the total VDS scores in the chin tuck posture were significantly lower than those in the neutral posture ($p < 0.05$). In particular, the pharyngeal phase score of VDS and the laryngeal elevation parameter showed significant improvements in the chin tuck posture over the neutral posture ($p < 0.05$, Table 2).

In the PAS, there were no significant improvements between the head turn posture to the weaker or the stronger side over the neutral posture. The PAS in the chin tuck posture was 1.8, which tended to be lower than that of the neutral posture, which was 2.1, and was statistically insignificant (Table 2).

Comparison between each group according to TMS-induced MEPs

Ipsilateral mylohyoid TMS-induced MEPs were absent in 10 patients. There was no significant difference in the general characteristics, except in the sex between the response group and the no response group (Table 1). Fig. 1 shows that the pharyngeal stage score of the VDS was significantly improved in the chin tuck posture over the neural posture in the response group ($p < 0.05$). There was no significant difference according to postural modification in the no-response group (Fig. 1).

Table 1. General characteristics of participants

Characteristic	Total participants (n = 19)	Response group (n = 9)	No-response group (n = 10)
Age (yr)	68.5 ± 8.9	69.7 ± 9.0	67.4 ± 9.2
Sex (male:female)	13:6	9:0	4:6
Stroke type (infarction:hemorrhage)	15:4	7:2	8:2
Lesion side (right:left)	11:8	6:3	5:5
Lesion location (supratentorial:infratentorial)	16:3	7:2	9:1
Duration of stroke (day)	19.9 ± 17.2	17.3 ± 14.6	22.6 ± 19.9
ASHA-NOMS (1:2:3:4:5)	5:1:0:6:7	3:1:0:2:3	2:0:0:4:4
TMS-induced MEPs (response:no response)	9:10	-	-

Values are presented as mean ± standard deviation or ratio.
ASHA-NOMS, American Speech-Language-Hearing Association National Outcome Measurement System Swallowing Scale; TMS, transcranial magnetic stimulation; MEP, motor evoked potentials.

https://doi.org/10.12786/bn.2018.11.e19

Table 2. Swallowing function assessments by compensatory posture in total participants (n = 19)

Values	Posture			
	Neutral	Head turn to weaker side	Head turn to stronger side	Chin tuck
VDS				
Total score	31.2 ± 12.3	30.5 ± 10.5	29.6 ± 12.9	26.9 ± 11.8*
Oral phase	6.5 ± 3.8	6.5 ± 3.8	6.4 ± 3.9	6.3 ± 4.0
Lip closure	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Bolus formation	1.4 ± 1.5	1.4 ± 1.5	1.4 ± 1.5	1.4 ± 1.5
Mastication	0.6 ± 1.7	0.8 ± 1.7	0.8 ± 1.7	0.8 ± 1.7
Apraxia	0.2 ± 1.0	0.2 ± 1.0	0.2 ± 1.0	0.2 ± 1.0
Tongue to palate contact	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Premature bolus loss	2.8 ± 1.6	2.8 ± 1.6	2.8 ± 1.6	2.7 ± 1.7
Oral transit time	1.3 ± 1.5	1.3 ± 1.5	1.1 ± 1.5	1.1 ± 1.5
Pharyngeal phase	24.6 ± 11.3	23.9 ± 10.2	23.2 ± 12.0	20.6 ± 11.0*
Triggering of pharyngeal swallowing	2.8 ± 2.2	2.8 ± 2.2	2.6 ± 2.3	2.6 ± 2.3
Vallecular residue	2.8 ± 1.4	2.6 ± 1.2	2.6 ± 1.5	2.5 ± 1.5
Laryngeal elevation	5.7 ± 4.5	5.7 ± 4.5	5.7 ± 4.5	3.8 ± 4.6*
Pyriform sinus residue	5.2 ± 3.8	4.7 ± 3.8	4.3 ± 3.8	4.3 ± 3.8
Coating on the pharyngeal wall	4.3 ± 4.6	4.3 ± 4.6	4.3 ± 4.6	4.3 ± 4.6
Pharyngeal transit time	2.8 ± 3.1	3.2 ± 3.1	2.8 ± 3.1	2.5 ± 3.0
Aspiration	0.9 ± 2.2	0.6 ± 1.9	0.9 ± 2.2	0.6 ± 1.9
PAS	2.1 ± 1.4	2.0 ± 1.4	2.1 ± 1.6	1.8 ± 1.1

VDS, videofluoroscopic dysphagia scale; PAS, penetration-aspiration scale.
*p < 0.05, compared with neutral posture.

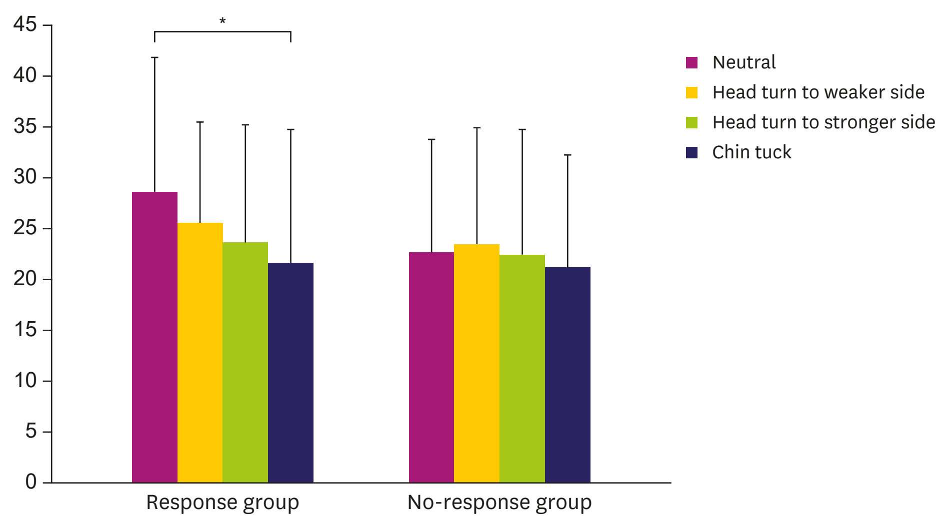

Fig. 1. Pharyngeal phase score of videofluoroscopic dysphagia scale according to the head posture in each group.
*p < 0.05, compared with the neutral posture.

DISCUSSION

This study investigated the effects of head turn to improve dysphagia in hemiplegic stroke patients. Head turn is one of the most commonly used compensatory maneuvers for swallowing disorders in hemiplegic patients after stroke. The high-resolution manometry was used for identifying the effects of postural compensation by direct measurement of intra-esophageal pressure changes during swallowing. Takasaki et al. [20] reported that the maximum and mean values of the resting upper esophageal sphincter (UES) were statistically lower and the length of the zone of the UES was statistically shorter when turning the head in the opposite direction of the side with manometry as opposed to the neutral position in

https://doi.org/10.12786/bn.2018.11.e19

healthy subjects. Also, Kim et al. [21] demonstrated that the maximum pressures of UES and the lower pharynx during deglutition at the counter-manometry head rotation posture were lower than those at the neutral posture. Based on previous studies, it was assumed that head turn made deglutition smoother by lowering the UES pressure. In addition, only a few studies focused on the efficacy of head turn in hemiplegic stroke patients, except for the study of five patients with lateral medullary syndrome [22]. Therefore, the postural modification with head rotation could have some evidence to improve dysphagia by lowering the UES opening in stroke patients. However, there is a lack of evidence to support using postural modification with head rotation to improve dysphagia in hemiplegic stroke patients.

In strokes, oropharyngeal dysphagia is best defined as the disruption of bolus flow through the mouth and pharynx [23]. VFSS is considered the standard swallowing test for determining dysphagia. VFSS is commonly available and can assess all stages of swallowing. In addition, it allows the assessment of therapeutic maneuvers including compensatory postures. Turning the head towards the paralyzed side is believed to increase bolus flow to the unaffected pharyngeal wall, which is more sensate and stronger [22] and facilitates the opening of the UES by providing external pulling to the sphincter [24] or lowering the resting pressure and shortening its length [20]. As a result, it has been recommended to the unilateral hemiplegic stroke patients in the clinical setting as a compensatory strategy of dysphagia. However, the weaker or stronger side of pharyngeal wall could not match the location of stroke lesion, because the important cranial nerves (CNs) for swallowing function such as vagus (CN V) and glossopharyngeal nerves (CN IX) is innervated bilaterally [13]. In the present study, the head turn had no clinical benefits for improving dysphagia in hemiplegic stroke patients. Instead, our results revealed that the chin tuck posture was an effective compensatory posture for hemiplegic stroke patients with pharyngeal dysphagia. Although it has been suggested that the chin tuck method, in which the chin is lowered toward the chest before swallowing, can induce airway protection by posterior shifting of the tongue base and the epiglottis [25], there is some doubt as to the effectiveness and usefulness of this maneuver in preventing aspiration in the patients with neurologically induced dysphagia [26,27]. This study demonstrated that laryngeal elevation improved during swallowing in the chin tuck posture. It has been proposed that laryngeal elevation is the single most important factor for a successful pharyngeal swallowing sequence [28]. The results obtained in our study indicated that the chin tuck posture was an effective compensatory strategy for pharyngeal dysphagia in the clinical practice.

However, the chin tuck posture did not improve swallowing function in all participants in this study. In particular, the preservation of TMS-induced MEPs of the mylohyoid muscle could predict the effects of postural modification with chin tucking in hemiplegic stroke patients with dysphagia. The initiation of the oropharyngeal stage of swallowing starts with the contraction of the mylohyoid muscle, which is the first muscle to become active in swallowing [29]. In previous study, the EMG activity of the submental muscle complex, like the mylohyoid, geniohyoid and anterior digastrics muscles, was closely related to that of laryngeal elevator muscles. It fires concurrently with other submental muscles to initiate a swallowing, and functions as the laryngeal elevators pulling the laryngeal upward [30]. Alteration in TMS-induced MEPs to assess the cortical pathways of the mylohyoid muscle may predict which patients have a higher than average risk for progression to chronic dysphagia after stroke [31]. The response of TMS-induced MEPs in this study might be interpreted as the severity the damage to the integrity of the corticobulbar tract to the mylohyoid muscle [32]. In this study, the improvement of the swallowing function after postural modifications

https://doi.org/10.12786/bn.2018.11.e19

did not occur in the patients without a mylohyoid TMS-induced MEPs response. These different effects of postural modification with the chin tuck could be related to the severity of the corticobulbar tract integrity after the stroke. The postural modification with the chin tuck might be effective in only stroke patients with the preservation of the corticobulbar tract. Therefore, the recommendation of postural modification with the chin tuck method might be considered with the response of mylohyoid TMS-induced MEPs. However, further study with a larger group of participants is needed to verify our results. In addition, the method of postural modification will be more precisely recommended by VFSS results.

This study had some limitations. First, VDS and PAS were used to assess the swallowing function measured with lateral view without A-P view during VFSS. Without the A-P view, lateral view of VFSS alone is not enough to determine the weakness of the pharyngeal wall in stroke patients. Therefore, the results of this study could not reveal that the head turn is not inappropriate for all stroke patients with dysphagia. The further study with A-P view of VFSS will be needed. These assessment tools were semi-quantitative measurements, and we could not use more sensitive assessment tools such as a quantitative analysis of VFSS and high-resolution manometry. In addition, only 3 mL liquid diet was used to investigate the effects of four different postures because of the radiation hazard with longer VFSS times. Therefore, this study could not demonstrate the effects of different postural modification for dysphagia with different food materials. We could not show the change of UES pressure by postural modification. It was another limitation in this study. Only this preliminary study could not demonstrate a definite conclusion for the optimal postural modification strategy in stroke patients with stroke, because of small number of participants and heterogeneity of stroke characteristics. To clarify this, the further study with large participants will be needed. In spite of these limitations, this study revealed that the postural modification without VFSS might not be recommended in hemiplegic stroke patients with pharyngeal dysphagia.

In Conclusion, these results revealed that the head turn without VFSS as a compensatory strategy could be no clinical basis for the improvement of dysphagia in hemiplegic stroke patients. Therefore, a head postural compensatory strategy should be carefully re-considered in hemiplegic stroke patients with pharyngeal dysphagia.

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