

아급성 뇌졸중 환자의 비디오 투시 연하 검사 소견과 뇌병변 부위 및 임상적 요인들의 연관성

동의료원 재활의학과, ¹고신대학교 의과대학 재활의학교실

전우현 · 박건웅 · 이재현¹ · 정호중¹ · 심영주¹

Association between Location of Brain Lesion and Clinical Factors and Findings of Videofluoroscopic Swallowing Study in Subacute Stroke Patients

Woo Hyun Jeon, M.D., Gun Woong Park, M.D., Jae Hyun Lee, M.D.¹, Ho Joong Jeong, M.D.¹ and Young Joo Sim, M.D.¹

Department of Rehabilitation Medicine, Dong-eui Medical Center, ¹Department of Physical Medicine and Rehabilitation, Kosin University College of Medicine

Objective: To investigate whether patterns of dysphagia were associated with the location of the brain lesion and clinical factors in subacute stroke patients.

Method: One hundred and seventy-eight first-ever subacute stroke patients who underwent videofluoroscopic swallowing study (VFSS) from January 2006 to April 2012 were enrolled in the present study. Swallowing-related parameters were assessed by VFSS. The location of brain lesions were classified into the cortical, subcortical, and brain stem. The degree of cognitive impairment and the independency of activities of daily living were assessed by the Korean version of mini-mental status examination and Korean version of modified Barthel index (K-MBI). Aphasia and hemineglect were assessed by Korean version of Western aphasia battery and line bisection test. These data were collected via retrospective chart review.

Results: A reduced laryngeal elevation and prolonged pharyngeal delay time were associated with brain stem lesion. Other swallowing parameters were not associated with lesion topology. Pyriform sinus residue was associated with the presence of aphasia and low K-MBI scores. Prolonged pharyngeal delay time was associated with the patient's age, type of stroke and brain stem lesion.

Conclusion: Pyriform sinus residue was associated with clinical factors such as aphasia and K-MBI scores rather than with the location of brain lesion. However, reduced laryngeal elevation and prolonged pharyngeal delay time were predominant in brain stem lesions. (**Brain & NeuroRehabilitation 2014; 7: 54-60**)

Key Words: brain stem, dysphagia, stroke

Introduction

Dysphagia is common in stroke patients and its incidence is various by report from 51% to 73%.^{1,2} According to a prior study, in a clinical dysphagia evaluation 6 months after stroke, 6~11% of the patients still suffered from symptoms of dysphagia,^{3,4} and when assessed with

a videofluoroscopic swallowing study (VFSS), 28~50% of the patients were confirmed to have dysphagia.⁴

Normal swallowing is a complex and sequential process in which oral phase, pharyngeal phase and esophageal phase are in harmony, and it is known that dysphagia occurs when there is a lesion in the brain stem where the nucleus of the swallowing reflex is located.⁵ In general, lateral fissure (insula) cortex is considered as the cerebral swallowing center.⁶ Cerebral cortical infarction can cause dysphagia but it is still controversial which of the two hemispheres plays a more important role in swallowing.⁷ Some previous studies reported that there were different patterns of dysphagia between right and left hemisphere lesion, however, others reported there were no different

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Correspondence to: Young Joo Sim, Department of Physical Medicine and Rehabilitation, Kosin University College of Medicine, 34, Amnam-dong, Seo-gu, Busan 602-702, Korea

Tel: 051-990-6261, Fax: 051-241-2019

E-mail: oggum@naver.com

patterns of dysphagia between the two.⁷⁻⁹ There are many conflicting studies on the association between the lesion location and the patterns of dysphagia, which has not been clearly identified yet.

While there were a lot of studies on the diagnosis and treatment of dysphagia in stroke patients, there were only limited studies published for to enlighten clinical factors associated with dysphagia.

Thus, we aimed to investigate the factors associated with dysphagia such as the brain lesion location, cognitive functions and the patient's characteristics (age, gender and type of stroke, etc.) via retrospective chart review.

Materials and Methods

1) Subjects

Subjects of this study were first-ever subacute stroke patients who had undergone a VFSS to screen or to evaluate for dysphagia in the Department of Rehabilitation Medicine at OO Medical Center from January 2006 to April 2012. Stroke was diagnosed only in case of cerebral infarction or hemorrhage had been verified on the basis of brain computed tomography (CT) or magnetic resonance imaging (MRI). The exclusion criteria were as follow; 1) Patients who had disease that might cause dysphagia. 2) Patients with bilateral stroke or a previous stroke history. 3) Patients without a CT or MRI results. 4) Patients whose lesion could not be classified like subarachnoid hemorrhage (SAH). 5) Patients who were unable to perform an appropriate VFSS due to their poor cooperation. 6) Cases in which the interval between the Korean version of mini-mental state examination (K-MMSE) and VFSS evaluations was longer than 2 weeks. A total of 178 patients met the inclusion criteria and were chosen for study, and their data were collected retrospectively from their medical records.

2) Methods

We reviewed the patients' medical records and test results retrospectively, and their demographic and clinical characteristics were recorded. First, as general properties, the patients' basic data on physical features such as age, gender, weight, height, body mass index (BMI), and the interval from onset of stroke to VFSS (number of days)

were checked. Clinical factors included factors such as the patients' independent performance of daily living activities assessed by the Korean version of the modified Barthel index (K-MBI)^{10,11} and their cognitive functions evaluated by the K-MMSE.¹²⁻¹⁴ The interval between K-MMSE and VFSS evaluation, the brain lesion laterality (left or right) and type of stroke (ischemic or hemorrhagic) were also investigated. The K-MMSE score performed most close to the date of VFSS was chosen and included in the study.

The VFSS was conducted by a physiatrist following modified protocol of Logemann.¹⁵ The test was conducted by making the subjects swallowing in the order of 2 ml and 5 ml water, yogurt, thick gruel, and wafers mixed with barium in the posture of sitting using fluoroscopy.

About the interpretation of the VFSS, new VFSS scale¹⁶ was used. Functions such as the lip closure, bolus formation, mastication, tongue to palate contact, premature bolus loss were assessed in the oral phase. Normal oral transit time was defined as less than 1.0 second for transition of the bolus in the oral phase. If transition of the bolus took longer than 1.0 second, we defined as an abnormal.

In the pharyngeal phase, findings such as laryngeal elevation and epiglottic movement, aspiration or penetration to the airway were evaluated. When the food entered the airway to any level but not pass into the true vocal folds, it was defined as penetration. When the food entered into the airway below the true vocal folds, it was defined as aspiration. After the swallowing, the amount of residue of the vallecular space and pyriform sinus was assessed as minimal (within 10%), moderate (10~50%), and large (more than 50%); a minimal amount was considered to be normal, moderate and large amount were considered to be abnormal. The pharyngeal delay time and the pharyngeal transit time of bolus in the pharyngeal phase were also measured. As for the pharyngeal delay time, defined as the time until the swallowing reflex appeared, a time of less than 0.5 seconds was considered normal. In case of the pharyngeal transit time, less than 1 second was considered normal. The abnormal oral phase was defined as at least one abnormality in lip closure, tongue movement, oral residues, premature bolus loss, or oral transit time, and the problematic pharyngeal phase was defined as more than one abnormality in laryngeal

elevation, pharyngeal delay time, vallecular space or pyriform sinus residue, penetration or aspiration.

About the classification of brain lesion location, the results of brain CT or MRIs were analyzed when the patients were hospitalized, and the lesions of the stroke were classified into 3 groups; the cerebral cortical lesions, subcortical lesions, and the brain stem lesions. The lesions were divided into the left and right hemispheric lesions. Cortical lesion with minimal involvement of white matter

considered as a cortical lesion, and the lesion of white matter around cerebral ventricle, thalamus, and basal ganglia was regarded as cerebral subcortical lesion.

3) Statistical analysis

We divided into 3 groups on the basis of lesion location, in order to assess whether demographic data (age, sex) and clinical characteristics (lesion laterality, stroke type, cognitive function, level of functional activity, BMI, presence of aphasia and neglect) associated with the pattern of dysphagia. The corresponding rates of each, 95% confidence interval and equivalent p-value were calculated by using multivariate logistic regression analysis method with each finding of VFSS as independent variables. When the p-value was less than 0.05, it was considered as statistically significant. For all statistical analyses, SPSS for windows 18.0 was used.

Table 1. Characteristics of Subjects

Patient characteristics	
Sex (female/male), number	77/101
Age, years, mean ± standard deviation	67.4 ± 11.7
Laterality, number	
Right hemispheric lesion	76
Left hemispheric lesion	102
Stroke type, number	
Ischemic stroke	121
Hemorrhagic stroke	57
Interval between onset of stroke and VFSS, days, median (minimum ~ maximum)	59 (31 ~ 175)
K-MMSE, median (minimum ~ maximum)	12.5 (0 ~ 30)
Neglect, number (%)	7 (3.9)

VFSS: videofluoroscopic swallowing study, K-MMSE: Korean version of mini-mental status examination.

Results

1) Characteristics of the target group

One hundred and seventy-eight subacute stroke patients were included. Their mean age was 67.4 ± 11.7 years. There were 76 patients with right hemispheric lesion and

Table 2. Characteristics of 3 Subgroups

Patient characteristics	Cortical lesion	Subcortical lesion	Brainstem lesion
Number	47	96	35
Age, years (Mean ± SD)	67.5 ± 13.7	66.7 ± 7.3	69.3 ± 10.0
Sex, number			
Male	31	50	20
Female	16	46	15
Laterality, number			
Right hemisphere lesion	17	43	16
Left hemisphere lesion	30	53	19
Stroke type, number			
Ischemic stroke	32	66	23
Hemorrhagic stroke	15	30	12
Interval between onset of stroke and VFSS, days, median (minimum ~ maximum)	61 (31 ~ 173)	55.5 (31 ~ 175)	61 (31 ~ 146)
K-MMSE, median (minimum ~ maximum)	13 (0 ~ 30)	13 (0 ~ 29)	11 (0 ~ 28)
K-MBI, median (minimum ~ maximum)	25 (0 ~ 90)	32.5 (0 ~ 90)	45 (0 ~ 85)
BMI, median (minimum ~ maximum)	22.9 (15.0 ~ 29.3)	22.1 (12.8 ~ 30.1)	22.7 (16.5 ~ 27.8)
Aspiration, number (%)	30 (63.8)	64 (66.7)	26 (74.3)
Aphasia, number (%)	15 (31.9)	24 (25)	11 (31.4)
Neglect, number (%)	3 (6.4)	2 (2.1)	2 (5.7)

VFSS: videofluoroscopic swallowing study, K-MMSE: Korean version of mini mental status examination, K-MBI: Korean version of modified Barthel index, BMI: body mass index.

Table 3. Abnormal Findings of VFSS in 3 Subgroups

Findings of VFSS	Cortical lesion	Subcortical lesion	Brainstem lesion
Lip closure, number	13	33	15
Bolus formation, number	13	35	15
Mastication, number	13	32	15
Tongue to palate contact, number	13	34	12
Premature bolus loss, number	13	30	13
Oral transit time, number	20	40	15
Residue in valleculum, number	26	60	19
Reduced laryngeal elevation, number	6	24	4
Residue in pyriform sinus, number	29	62	21
Coating of pharyngeal wall, number	36	78	28
Prolonged pharyngeal delay time, number	10	31	5
Pharyngeal transit time, number	10	30	10
Aspiration, number	30	64	26

VFSS: videofluoroscopic swallowing study.

102 patients with left. 121 patients had ischemic stroke and 57 patients had hemorrhagic stroke. The median interval from onset of stroke to VFSS was 59 days. The median score of K-MMSE was 12.5. Seven patients had hemispatial neglect (Table 1). Numbers of patient in cortical group was 47 (male 31, female 16; right hemispheric lesion 17, left hemispheric lesion 30), subcortical group was 96 (male 50, female 46; right hemispheric lesion 43, left hemispheric lesion 53) and brain stem group was 35 (male 20, female 15; right hemispheric lesion 16, left hemispheric lesion 19) (Table 2). Numbers of patients showed abnormal findings of VFSS in each group are presented in Table 3.

2) Factors affecting dysphagia depending on swallowing phase

The patients' age, gender, types of stroke, lesion location and laterality, BMI, presence of aphasia and hemineglect, scores of K-MBI and K-MMSE were not associated measured function in oral phase (lip closure, bolus formation, mastication, tongue to palate contact, premature bolus loss, oral transit time of bolus). From the results of VFSS, reduced laryngeal elevation in pharyngeal phase was significantly related to the brain stem lesion ($p = 0.045$). Pyriform sinus residue after swallowing was associated with aphasia and K-MBI score ($p = 0.018$). Prolonged pharyngeal delay time was related to brain stem lesion ($p = 0.023$), ischemic stroke ($p = 0.027$) and the age of the patient ($p = 0.011$) (Table 4).

In this study, any pattern of dysphagia was not associated with factors such as patients' gender, lesion laterality, BMI, hemineglect, K-MMSE score.

Discussion

Dysphagia usually occurs when the brain stem or bilateral cortices are injured.¹⁷ It is also observed in the patients with unilateral cerebral hemispheric lesion,¹⁸ however, the mechanism remained still illusive. According to a previous study, 37% of the patients with unilateral cerebral hemispheric lesion had dysphagia.¹⁹ It has been known that there is no correlation between dysphagia and lesion laterality,²⁰ which was in line with our results.

It has been argued that the location of the lesion is more important than the size or laterality of the lesion in predicting aspiration.²¹ However, most of previous studies showed a contradictory results regarding lesion location. Falsetti et al.²² reported that there was a high incidence of dysphagia in the cortical lesion of non-dominant hemisphere, but neither the subcortical lesion nor the brain stem lesion. Moreover, some other studies demonstrated that brain stem and cerebellar lesions had no statistical significant association with a high incidence of dysphagia.²²⁻²⁴ The evidence seems unclear so far, however, if one considers the fact that patients who had brain stem lesions showed abnormal findings not only in the oral phase especially prominent in pharyngeal phase including laryngeal elevation, cricopharyngeal achalasia and prolong-

Table 4. Factors Associated with Dysphagia

Parameters	OR	95% CI	p-value
Lip closure			
Aphasia	1.390	0.495 ~ 3.901	0.531
K-MBI	0.989	0.976 ~ 1.002	0.106
K-MMSE	0.952	0.824 ~ 1.099	0.500
Tongue to palate contact			
Laterality	0.658	0.350 ~ 1.236	0.193
Age	1.016	0.987 ~ 1.045	0.281
Premature bolus loss			
Aphasia	2.251	0.758 ~ 6.680	0.144
K-MBI	0.987	0.973 ~ 1.001	0.063
K-MMSE	1.004	0.867 ~ 1.163	0.958
Oral transit time			
Age	1.017	0.990 ~ 1.044	0.219
Residue in valleculum			
Aphasia	1.921	0.936 ~ 3.942	0.075
Hemineglect	3.169	0.362 ~ 27.752	0.298
Reduced laryngeal elevation			
Age	1.028	0.991 ~ 1.068	0.142
BMI	0.935	0.824 ~ 1.060	0.293
Brain stem	3.726	1.033 ~ 13.446	0.045*
Residue in pyriform sinus			
Aphasia	2.709	1.225 ~ 5.991	0.014*
K-MBI	1.014	1.002 ~ 1.026	0.018*
Hemineglect	3.209	0.361 ~ 28.538	0.296
Coating of pharyngeal wall			
BMI	0.948	0.829 ~ 1.084	0.436
Aphasia	1.006	0.223 ~ 4.537	0.993
K-MMSE	1.087	0.916 ~ 1.289	0.999
Prolonged pharyngeal delay time			
Age	1.048	1.011 ~ 1.087	0.011*
Ischemic stroke	2.482	1.111 ~ 5.545	0.027*
Brain stem	3.456	1.184 ~ 10.082	0.023*
Pharyngeal transit time			
Age	1.014	0.979 ~ 1.050	0.435
Aphasia	0.619	0.201 ~ 1.909	0.404
K-MBI	1.007	0.993 ~ 1.022	0.339
K-MMSE	0.977	0.925 ~ 1.031	0.400

K-MBI: Korean version of modified Barthel index, K-MMSE: Korean version of mini mental status examination, BMI: body mass index, OR: odds ratio, 95% CI: 95% confidence interval, * $p < 0.05$.

ed pharyngeal transit time⁵ as observed in this study, lesion location would be one important factor for risk of dysphagia. Therefore, our results suggests that the brain stem lesion plays a positively associated roles with dysphagia, especially in the pharyngeal phase, even though in the case of controlling the other confounding variables such as the patient's age, gender, associated disease and cognitive dysfunction. None of the other dysphagia variables could be predicted by brain lesion location.

Robbins et al.⁸ argued that aphasia and hemineglect may

also be related to dysphagia along with the lesion location. In addition, according to Schroeder et al.,²⁵ hemispatial neglect was related to initial dysphagia, but aphasia was unrelated to initial dysphagia. However, this study found that in the aphasia patients, the increase of residues of pyriform sinus after swallowing and the risk of dysphagia in the pharyngeal phase was increased by about 3 times, while that hemineglect did not have any relation to dysphagia in both oral phase and pharyngeal phase. According to our result, one need to pay special attention

to the patients with aphasia when assessing swallowing difficulty. However, in case of hemineglect, as the number included in this study was too small (7 patients, 4%), it need to be verified further.

It is commonly accepted that aging is one of the important factor leading dysphagia in elderly patients. In older patients, delays in the transfer of the bolus through the oropharynx, and problems in the opening of the upper esophageal sphincter have been reported to occur.²⁶ In our study, age itself was an independent variable in causing dysphagia in the pharyngeal phase.

In this study, K-MMSE score was not associated with any pattern of dysphagia. As it is a screening test for evaluation of cognitive function, it might have not sufficient sensitivity.

There are several limitations in this study. Firstly, the physicians who carried out VFSS were different time to time. Secondly the study design that we used in this study was a retrospective method, which would have problems of accuracy and completeness. Further prospective study in larger cohort of patients would be needed to find out the factors that affect the patterns of dysphagia.

Conclusions

In this study, particularly brain stem lesions showed patterns associated with pharyngeal dysphagia such as reduced laryngeal elevation and prolonged pharyngeal delay time. However, other brain lesions were not associated with any pattern of dysphagia, and no factors were associated with oral dysphagia.

In patients with aphasia and whose independent performance of daily living activities is severely compromised, and in older age groups and ischemic stroke patients, the incidence of pharyngeal dysphagia, such as large amount of pyriform sinus residue, prolonged pharyngeal delay time was increased.

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