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The Role of Electrophysiologic Evaluation in Dysphagia Diagnosis in Acute Stroke Patients

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Abstract

Background and Purpose: It was aimed at investigating the efficiency of electrophysiological evaluation procedure by compared to healthy controls in acute period stroke patients in this study. As a secondary aim, it was evaluated that whether the patient groups defined as “dysphagic” and “with normal swallowing” were different from each other or not, in respect to the stroke severity and disability.

Methods: Forty-two stroke patients and 15 healthy hospital personnel were included in this study. Demographic and disease characteristics of patients were recorded. The stroke severity and disability rate were evaluated. Electrophysiological evaluation was performed in all participants. Electro neuromyography recordings were received from submental electrodes and laringeal sensor. Swallowing interval times and dysphagia limit were recorded. Patient and control groups were compared in terms of electrophysiologic evaluation method. The patient group separated in itself as “normal swallowing” and “patients with dysphagia” according to the interval times and dysphagia limit and were compared in terms of stroke severity and disability rate.

Results: The all interval times in the patient group were found significantly longer than the control group. The stroke severity and the disability of the patients defined as “with dysphagia” were found significantly higher than the “normal swallowing” patients, in term of the pharyngeal phase time.

Conclusions: The electrophysiologic evaluation the swallowing phase times is a sensitive and objective method in acute period stroke patients that can drink liquid in normal quantities, especially.

Keywords: Acute stroke; Dysphagia; Deglutition; Deglutition disorders; Electro neuromyography

Introduction

Swallowing is a sensorimotor behavior controlled by numerous components that range from the central nervous system to bulbus and provides the passage of the food in the mouth to the stomach [1,2]. The term dsyphagia defines all the challenges that occur during the transport of the food from the mouth to the stomach [3].

Dysphagia is a serious cause of morbidity and mortality in stroke patients [4-6]. After stroke, when apparent dysphagia was determined in 37-47 % of the patients, especially in the first 2 weeks [5,7], swallowing abnormalities in the form of slight dysphagia was notified almost for every patients [8,9].

In dysphagia diagnosis, many diagnostic procedures such as bedside screen tests, video fluoroscopical and endoscopic evaluations and pharyngeal manometric pressure evaluations are used. However, right along with some advantages, these procedures also have some disadvantages. The bedside screening test has high incidence of wrong positiveness and negativeness rates depending upon the test content, due to it is a non-standard and subjective evaluation [10]. And the most important disadvantages of the other methods are due to them to provide an evaluation including the last structure attending to swallowing [11].

Electrophysiological evaluation method enables all neural paths to be evaluated including cortico bulbar motor tendons and bulbar swallowing center, which attend to the swallowing function. In the studies on various neurological diseases, it was shown that the usage of this method took shorter time, was easier, less invasive, cheaper and with higher patient tolerability, comparing to video fluoroscopy, endoscopy and manometric evaluations [9,12,13]. Whilst there are very few studies made in stroke patients [9,14,15], there is not any study made only on acute period stroke patients.

Therefore, in our study, it was aimed at investigating the efficiency of electrophysiological evaluation procedure with healthy controls in acute period stroke patients, in whom the dysphagia was seen intensely. Moreover, due to lack of studies in the literature that reveals the relationship of electrophysiological dysphagia evaluation with the severity of stroke and disability level; as a secondary aim, it was evaluated that whether the patient groups defined as “dysphagic” and “with normal swallowing” were different from each other or not, with respect to the stroke severity and disability.

Subjects and Methods

A total of 42 stroke patients, who were treated by being placed in the Neurology Clinic of our hospital in one month of period after stroke, and 15 healthy hospital personnel, with matching age and gender, were received to this prospective study.

To determine the patients with the possibility of swallowing disorder, for aspiration, a potential consequence fordy sphagia defined by Daniels [7], the patients who have at least two of the six clinical risk identifiers (dysphonia, dysarthria, abnormal gag reflex, abnormal deliberate cough, cough after swallowing, sound after swallowing) were included.

Patients and controls with a history of malignancy, head-neck surgery, stroke, respiration and swallowing problems, and smoking and alcohol consumption, as well as patients who did not cooperate, did not have head and sitting control, had dementia (<15 points in standardized mini mental test) or haemorrhagic stroke were excluded from the study. Besides, in the election of control group, the ones with hypertension, diabetes mellitus, systemic endocrine, which may affect the swallowing functions just as a known psychiatric disease, musculoskeletal system pathology, which may prevent them from obeying the instructions in the course of metabolic and/or electrophysiological evaluations, were also not included in the study.

Patients and their attendants (at least one person from their family/kinsmen) were informed about the study and their written consents were received. The approval of the hospital's local ethics committee was received before the study. The study was conducted in accordance with the Helsinki Declaration.

Ages, genders, hand dominances, concomitant co-morbid situations, elapsed time after ischemia and infarct localizations suiting the affected vein areas of the patients were noted.

The stroke severity used to be evaluated with National Institute of Health Stroke Scale (NIHSS) [16]. In this scale, patients are evaluated in 11 categories including consciousness, language, dysarthria, eye movements, visual field, negligence, facial paresis, proximal limb strength, extremity ataxia and feeling. Each category is scored between 0-2 or 0-4. The total score is between 0 and 42.

In defining disability rate, Modified Rankin Scale (MRS) was used [17]. In this scale the patients who receive 1 and 2 points are classified as independent with mild disability, and the ones who score 3 points and above are classified as functional dependent with medium and/or heavy disability rate.

Electrophysiologic evaluation

The electrophysiologic evaluation was conducted by a single physical medicine and rehabilitation specialist by using Medelec Synergy (Oxford, UK) 10 channels EMG device [18]. The patients were positioned as sitting and their heads are in neutral position. An active disc electrode was placed on the submental muscles, a reference disc electrode was placed on the jaw, a laryngeal (pizeoelectric) sensor was placed on the coniotomy section between cricoid and thyroid cartilage, fixed with elastic bandage. Signals were filtrated (band pass 0.01-20 Hz) and recorded with a channel. To objectively evaluate dysphagia, a limit of dysphagia was determined. Patients were subsequently provided with 1, 3, 5, 10, 15 and 20 ml water and they were asked to swallow with a single command. The study discontinued in the existence of any repetition and/or indications of aspiration during the swallowing within 8 seconds in any of these quantities. Three successive recordings were collected for each type of swallow, and the signals on single, superimposed, and averaged traces were examined and analyzed. According to dysphagia limit, stroke patients were separated into two groups as "dysphagic (patients with existence of any repetition and/or indications of aspiration during the swallowing within 8 seconds in any of each type of swallow) and "normal swallowing" (patients who drink 20 ml of water in one gulp).

Electro neuromyography (EMG) recordings were received from submental (SM) electrodes and laringeal sensor. The first of the 2 deflections obtained with piezoelectric sensor indicated the ascending of the larynx while second indicated the ending of pharyngeal reflex phase. The sharpest beginning of the initial deflection was numbered as '0', and the beginning of the second deflection was numbered as '2'. The 0-2 interval was the time elapsed during the rise, closing up and floating of larynx. In other words, the 0-2 interval was the total time of swallowing reflex (pharyngeal phase). Another measurement was the time between the point (A), which is the beginning of SM-EMG, and the point (0), which is the beginning of laryngeal deflection that represents the first point the swallowing reflex started. The measured 'A-0' time interval gave the oral phase time between the point that submental muscle complex started to strain voluntarily and the time that the swallowing reflex was triggered. The A-C time interval is recorded as total oropharyngeal swallowing duration, as the whole duration in which the SM muscle activity exists (Figure 1). EMG signals were filtrated (band pass 100 Hz-10k Hz), amplified, rectified and integrated.

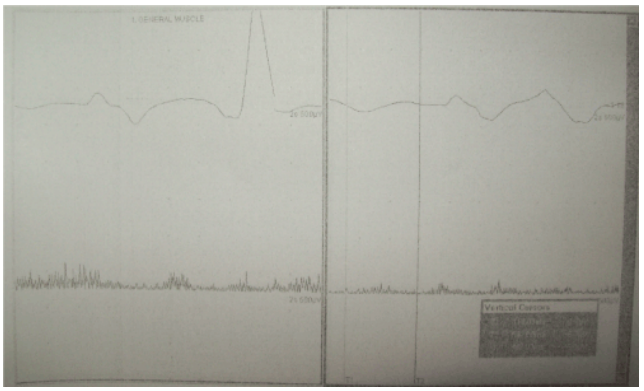

Figure 1: Laryngeal sensor signal and integrated submental muscle-EMG obtained from dysphagic patients.

Patients who had higher averages scores than the control group in the electrophysiologic evaluation in terms of A-0, 0-2 and A-C time intervals were considered as "patients with dysphagia".

Comparison

Patient and control groups were compared in terms of demographic characteristics and electrophysiologic evaluation methods. The patient group was sub-catagorised to "normal swallowing" and "patients with dysphagia" according to the times of intervals and dysphagia limit. These two sub-categories were compared in terms of stroke severity and disability rate.

Statistical analysis

The data analysis was conducted by using the SPSS 11.5 (SPSS Inc., USA) software. The descriptive statistics were displayed as mean ± standard deviation and median for the continuous variables by using chi-square tests and as % for the nominal variables. Sharpio-Wilk test was used to analyse the distribution of continuous variables. As the continuous variables were not normally distributed, Mann Whitney U was used to analyse the significance of the difference in terms of the variables between the groups.

Results

The average age of 57 cases included in the study was 66.0 years, of which 29 (50.9%) were women. All cases were right-hand dominant. When the accompanying co-morbid cases were examined, 24 of the cases (42.1%) cardiac heart disease, 33 (57.9%) had hypertension and 9 (15.8%) had diabetes mellitus. The distribution of demographic characteristics of patient and control groups and their comparisons are presented in Table 1.

	Patient Group (n=42) **Ave ± SD, n (%)**	**Control Group (n=15)** **Ave ± SD, n (%)**	**p**
Age (year)	67.26 ± 12.19	60.60 ± 11.94	0.077
Gender Female Male	22 (52.4) 20 (47.6)	7 (46.7) 8 (53.3)	0.844
Accompanying comorbidities Cardiac disease Hypertension Diabetes mellitus	24 (42.1) 33 (57.9) 9 (15.8)	0 0 0	0.001* 0.001* 0.001*

Table 1: The distribution and comparison of demographic characteristics of patient and control groups. Ave ± SD: average ± standard deviation. *The patient and control group comparisons were statistically different (p<0.05).

No statistical discrepancy was determined in terms of age and gender between the patient and control groups (p>0.05). The average stroke time of the patients was 5.00 (6.35 ± 5.50) days. An ischemic infarct in the irrigation area was detected on the medial cerebral artery (MCA) in 31 patients (73.8%), posterior cerebral artery (PCA) in 3 patients (7.1%), and posterior inferior cerebellar artery (PICA) in 8 patients (19.1%). The average stroke severity and disability scores of the patients were 4.0 and 3.5, respectively.

The distribution and comparison of electrophysiological evaluation results of the patients and control groups are shown in Table 2.

Electrophysiological evaluation	**Patient Group (n=42)** **Ave ± SD, n (%)**	**Control Group (n=15)** **Ave ± SD, n (%)**	**P**
A-0 time interval (msn)	380.30 ± 116.98	195.73 ± 59.98	0.001*
0-2 time interval (msn)	1030.97 ± 271.00	714.93 ± 151.19	0.001*
A-C time interval(msn)	1348.97 ± 231.19	978.13 ± 107.13	0.001*
Dysphagia limits The number of patient with dysphagia 1 cc 3 cc 5 cc 10 cc 15 cc 20 cc The number of patient with normal swallowing	24 (57.2) 0 4 (16.7) 3 (12.5) 7 (29.1) 4 (16.7) 6 (25.0) 18 (42.8)	0 0 0 0 0 0 0 15 (100)	0.001*

Table 2: The distribution and comparison of electrophysiological evaluation results of the patients and control groups. Ave ± SD: average ± standard deviation. *The patient and control group comparisons were statistically different (p<0.05).

The times of intervals in the patient group were significantly longer than the control group (p<0.05). The average values of interval times of control group were determined as 192.00 msn for A-0, 706.00 msn for 0-2 and 986 msn for A-C. Patients with lower values than these were categorised as "patients with normal swallowing", while those with higher values were considered as "patients with dysphagia".

The distribution of stroke severity and disability scores of the patients with "normal swallowing" and "dysphagia" are presented in Table 3.

Electrophysiological evaluation	**NIHSS score** **Ave ± SD**	**MRS score** **Ave ± SD**
A-0 time interval (msn) Patient with normal swallowing (n=0) Patient with dysphagia (n=42)	0 5.16 ± 3.04	0 3.42 ± 0.80
0-2 time interval (msn) Patient with normal swallowing (n=6) Patient with dysphagia (n=36)	2.83 ± 2.71 5.55 ± 2.95 *	1.66 0.81 3.65 ± 0.73 ¶
A-C time interval (msn) Patient with normal swallowing (n=0) Patient with dysphagia (n=42)	0 5.16 ± 3.04	0 3.42 ± 0.80

Table 3: The distribution of stroke severity and disability scores of the patients with "normal swallowing" and "dysphagia". ave ± SD: average ± standard deviation, NIHSS: National Institute of Health Stroke Scale, MRS: Modified Rankin Scale. * The patients with normal swallowing and patient with dysphagia comparisons were statistically different (p=0.041).¶ The patients with normal swallowing and patient with dysphagia comparisons were statistically different (p=0.010).

According to the 0-2 time interval, the stroke severity and the disability of the patients with "dysphagia" were significantly higher than those with "normal swallowing" (p<0.005). It was not possible to make any comparisons between groups according to the A-0 and A-C intervals as all patients were considered to have dysphagia according to these criteria. Analyses using dysphagia limits revealed that 18 patients (42.8%) tolerated drinking 20 ml water. Accordingly, the

patients were separated into two groups as "dysphagic" (n: 24, 57.2%) and "normal swallowing" (n=18, 42.8%). The distribution and comparison of the NIHSS and MRS according to the dysphagia limit are shown in Table 4.

Dysphagia limit	NIHSS score Ave ± SD	MRS score Ave ± SD
Patient with normal swallowing (n=18)	4.73 ± 2.81	3.14 ± 0.83
Patient with dysphagia (n=24)	5.68 ± 3.30*	3.32 ± 0.77¶

Table 4: The distribution and comparison of the NIHSS and MRS according to the dysphagia limit. Ave ± SD: average ± standard deviation, NIHSS: National Institute of Health Stroke Scale, MRS: Modified Rankin Scale. * There was no significant difference among the patients with normal swallowing and patient with dysphagia (p=0.331).¶ There was no significant difference among the patients with normal swallowing and patient with dysphagia (p=0.476).

No significant difference was determined in stroke severity and disability states among patients with "normal swallowing" and "dysphagia" according to the dysphagia limit evaluation (p=0.331 and p=0.476, respectively).

Discussion

In this study, the efficiency of electrophysiologic method in acute period stroke patients was analysed. This was done by comparing acute period stroke patients with healthy controls. Furthermore, the stroke severity and its associated disability of patients were compared in groups considered to have dysphagia and normal swallowing according to the electrophysiologic evaluations. Most importantly, stroke was found to be significantly associated with increased total swallowing durations, oral and pharyngeal phases. Moreover, stroke patients displayed a significant decrease in terms of dysphagia limit compared to the control group.

The electrophysiologic evaluation has emerged as a method in determining swallowing disorders in the last 15 years. This is an effective diagnostic method as swallowing is a muscular process [11-13]. Using this method, it is possible to evaluate both oropharyngeal swallowing durations (by using single gobbet analysis) and aspiration (by using dysphagia limits) [19,20]. Accordingly, in the present study electrophysiologic evaluation was used to evaluate oropharyngeal swallowing durations and dysphagia limits in stroke patients.

In a related study by Ertekin et al. [15], which included 34 patients with lacunar infarct for an average of 36 months, A-0, 0-2 and A-C interval durations of stroke patients were found to be significantly longer than the controls. In that study all patients but 1 had dysphagia limits of20 ml or under.

In another study conducted by Aydogdu et al. [14], the swallowing intervals and dysphagia limits were evaluated in one sided hemispheric infarct patients (2-75 days after stroke). The patient group had significantly longer A-0 and A-C intervals, while no difference was detected with respect to 0-2 intervals. Moreover, the study showed that 82% of patients had dysphagia limits of 20 ml or under.

In this group's previous study [9], dysphagia limits in patients with stroke (average time of 32 days, and most of who had MCA infarct) were evaluated. The dysphagia limit was found to be 20 ml or below in 75% of the patients.

In the present study, compared to the control group, statistically significant increases in all interval durations were detected in stroke patients. Despite the lack of a study in the literature that we can directly make a comparison to, the results of this study is in support with 2 reports previously published. The results of 0-2 interval durations of the present study contradict to that of Aydogdu et al. [14]. However, it is important to note that in that a for mentioned study only patients with MCA infarcts were included. Another possible reason for the difference is because patients PICA infarcts were included in the present study. Studies in the literature in which the anatomic structure of brain and oropharyngeal swallowing phases were evaluated; sensorimotor cortex in parietal and frontal lobe, the anterior insula, premotor cortical regions, cerebellum and subcortical regions were the regions that bilaterally related to the swallowing [21,22]. The oral phase is the swallowing phase that tongue and SM muscles play an active role, voluntary and under control of the cortical centers of brain. The pharyngeal phase is a swallowing phase that SM and pharyngo constructor muscles plays an active role, involuntary and under control of bulbar swallowing center [21,22]. The blood build up of bulbar swallowing center occurs through back system arteries. The reason for 0-2 interval time to be longer than the control group may be related to the response of the bulbar swallowing centres. The time of evaluation may also be an important factor in the extended 0-2 interval durations observed in stroke patients. Furthermore, the fact that electrophysiologic evaluations of all patients was made in the acute period may also be another reason for this difference.

The second analysis method used in the study, the dysphagia limit, decreased in stroke patients, in a similar fashion to the previous reports, but the rate of patients with dysphagia is higher than previous reports (42.8%). This could be due to patients preventing and compensating the aspiration with various compensation mechanisms, including some head and neck postures. In the literature, it is notified that there is a decrease in dysphagia and aspiration connected with posture in the studies including patients with dysphagia [23,24].

In this study, the relationship between electrophysiologic phases of swallowing and stroke severity and disability level was also analysed. As a secondary result, it was found that the stroke severity and disability level of the patients with longer pharyngeal phase time were higher than the patients with normal pharyngeal phase time. No significant difference was detected among the patients grouped according to dysphagia limit.

In the literature, similar to the recent study, the reports in which NIHSS and MRS were used in stroke patients with dysphagia, the rises of dysphagia levels (severity) were correlated to the increases of stroke severity and disability [9,25-27]. In the present study, due to A-0 and A-C intervals are longer in all patients comparing to the control group, a comparison between the stroke severity and disability level could not be done. However, it was found that the extension in pharyngeal phase time (0-2 interval) correlated to the stroke severity and disability level. This result is in support with the literature, however the results of dysphagia limit may be considered contradictive. Therefore, as indicated above, the dysphagia limit measurement alone could not reflect the actual swallowing disorder of the patient.

In the light of these results, one more important outcome may have emerged from the study. That is to say; as well as the extended

swallowing durations of acute phase stroke patients, nearly half of them can tolerate and drink 20 ml of water easily like healthy humans.

Study Limitations

The most important limitation of the study is the lack of video fluoroscopic or endoscopic evaluation on the patients, which is shown to be effective.

Conclusion

There is not a consensus diagnostic method in the evaluation of dysphagia in stroke patients. Along with the advantages, even if there are disadvantages of all the methods used for diagnosis; the electrophysiologic evaluation may be effective in dysphagia diagnosis especially in the patients that can swallow liquid in normal quantities. The analysis of swallowing phases and durations more sensitive method than the dysphagia limit. On the other hand, to show the efficiency of this method, the comparative studies are needed.

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