A Study of Functional Dysphagia Scale Improvements after Neuromuscular Electrical Stimulation

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Abstract. [Purpose] The main objective of this study was to provide basic data on the functional dysphagia scale after Neuromuscular Electrical Stimulation (NMES). [Subjects] Subjects were divided into normal persons aged over 70 (N=18) and normal persons younger than 30 (N=10). [Method] Each group underwent videofluoroscopy and the Functional Dysphagia Scale (FDS) was used to evaluate subjects’ swallowing characteristics. The aged group underwent a second videofluoroscopy and FDS evaluation after NMES. NMES was administered 60 minutes a day, 5 days a week for 2 weeks to the aged group’s suprahyoid and infrahyoid muscles using four electrodes. [Results] The average value of FDS after NMES of the aged group was significantly lower than before NMES. The average values of FDS before and after the NMES showed a significant statistical difference. [Conclusion] After NMES, the average value of FDS was very low in the older group, being only slightly lower than the average of the young group.

Key words: Dysphagia, Neuromuscular electrical stimulation

INTRODUCTION

A normal swallowing function is one of the most basic desires of a human being, since it satisfies the appetite and protects the respiratory tract. If any problem arises with the swallowing function, it can seriously impair quality of life, and even lead to death3). Dysphagia is a problem with transporting food from the mouth to the stomach, and recently, its meaning has been expanded to cover all swallowing-related behaviors and senses, as well as preliminary behaviors in preparation for swallowing2). Dysphagia mainly occurs in the case of progressive neurological disorders, stroke and cancers of the head and the neck, and in old persons. It is reported that dysphagia occurs in half of all persons who dwell in facilities for the elderly3). Studies of the swallowing function of normal elderly persons are few. Most studies of the characteristics of swallowing function of normal person-shave focused on the upward displacement or the anterior displacement of the hyoid bone, and few studies have investigated the velocity of swallowing or the delay time. Most preceding studies of swallowing function were conducted with young adults as subjects. The swallowing process is activated by complex combinations of several structures4, 5). It is accompanied by primary or secondary disorders in older persons and these have become public health issues because of the aging society. Thus, it is highly significant to conduct a comparative study of the characteristics of swallowing function and symptoms of the elderly. This study targeted normal persons aged over 70 and compared their characteristics of swallowing function and pharyngeal transit time (PTT) with those of a young adult group to identify the characteristics of dysphagia caused by natural aging in order to establish research data regarding prescription of diet types by internal and surgical prescription or dietary treatment, and to develop a program to enhance the swallowing function of older persons.

The purpose of this study was to investigate the characteristics of the swallowing function of normal older persons by comparing functional dysphagia criteria, after electrical stimulation of the neck. Videofluoroscopic examination of swallowing (VFS) a soft blended diet (SBD) was conducted, and the results of a group of normal old persons aged over 70 who had no record of swallowing function disorder were compared with those of a group of adults younger than 30. The goal of this study was to verify the characteristics of swallowing due to natural aging, and to provide basic data for a rehabilitation program promoting the swallowing function of elderly persons.
SUBJECTS AND METHODS

Subjects

Subjects were divided into normal persons aged over 70 and normal persons younger than 30. The aged group consisted of 8 men and 10 women, and the young group was comprised of 2 men and 8 women. Each group underwent videofluoroscopy and the Functional Dysphagia Scale (FDS) was evaluated for the swallowing characteristics. The aged group underwent a second videofluoroscopy and FDS evaluation after receiving neuromuscular electrical stimulation (NMES). NMES was administered for 60 minutes a day, 5 days a week for 2 weeks to the suprathyroid and infrathyroid muscles using four electrodes. We compared the data between the groups both before and after NMES.

None of the subjects had no dysphagia and we excluded those who had a medical history of disorders of the central nervous system, muscular diseases, head or neck cancer or esophageal disorders. Those with cardiac disorders, dermatologic diseases or seizures which might have been stimulated by NMES in the aged group were also excluded.

Methods

All subjects were given an explanation of the purpose of the study and the experimental process. An agreement to participation issued our the Institutional Review Board was read to the subjects, and all signed the agreement. The general characteristics of the research subjects are shown in Table 1. The selected normal aged persons group (n=18) and the young adult group (n=10) swallowed 10 mL of plain yoghurt mixed with barium, 3 times while VFS was recorded in the VFS room of the Department of Radiology of S hospital in C city. The examination was conducted by a rehabilitation specialist and a professional in the VFS room. Of the 11 items of FDS, only 6 items were accepted for values of p≤0.05.

The difference in the average FDS score before and after electrical stimulation of the neck muscles of the normal aged persons group. The average post-stimulation FDS score was 23.2 ± 11.82 for the aged group and 10.8 ± 10.1 for the young group. The FDS scores of the normal aged persons group before and after electrical stimulation are shown in Table 2.

RESULTS

Table 2 displays the results of FDS before and after electrical stimulation of the neck muscles of the normal aged persons group. The average post-stimulation FDS score was much lower than the average pre-stimulation FDS score. The difference in the average FDS score before and after electrical stimulation of the neck muscles was statistically significant (p<0.05).

Table 3 shows the results of FDS items before and after electrical stimulation of the neck muscles of the normal aged persons group. Of the 11 items of FDS, only 6 items were graded. The post-electric stimulation scores showed lower average values than the pre-electric stimulation average.
values for each of the 6 items of FDS. For the items of bolus formation, residue in the mouth, residue in the valleculae and residue in the pyriform sinuses statistically significant differences were found (p<0.05); however, no significant difference was found in delay of pharyngeal swallowing induction or in coating of the pharyngeal wall. The number of subjects who got awarded points in 6 articles decreased in post-electric stimulation value at the neck muscles than in pre-electric stimulation value. Especially, in the articles of the delay of pharyngeal swallowing induction, there was no subject who got points after electric stimulation. The most significant improvements in the post-electric stimulation swallowing of process of the neck muscles was improvement in bolus formation function, residue in the mouth, delay of pharyngeal swallowing induction, residues in the valleculae and the pyriform sinus, and coating of the pharyngeal wall in the problem of the oral step and the pharynx step. In the pharyngeal process step, residue in the valleculae was 27%, and residue in the pyriform sinus was 19%, and subjects with the problem of coating on the pharyngeal wall was 11%. In particular, the delay of pharyngeal swallowing reflection in the pharynx step was 5.6%, but no subject was found who was awarded points after electrical treatment. Functional improvement was shown to be better in all evaluated items compared to pre-stimulation.

In the FDS evaluation articles of the normal aged persons group after electrical stimulation t-values of residue in the mouth, and residue in the valleculae and the pyriform sinus after swallowing the pharyngeal process step were 2.977 (p=0.008) and 3.117 (p=0.006) respectively, showing statistically significant differences, and t-values of residues in the valleculae and the pyriform sinus after swallowing the pharyngeal process step were 2.699 (p=0.015) and 3.010 (p=0.008) respectively. Thus, 4 out of the 6 items evaluated showed statistically significant difference. However, for the delay of pharyngeal swallowing and coating of the pharyngeal wall after swallowing, no statistically significant difference found. The average FDS score (5.08 ± 6.8) of the normal old person group after electrical stimulation and the average value (5.3 ± 6.0) of FDS targeting the young adult group after electrical stimulation were similar. The F-value between the normal aged persons group after electrical stimulation and the young adult group was 0.424 (p=0.934), showing no statistically meaningful difference. It can be inferred that the swallowing function of the normal old person group after application of electrical stimulation to the neck muscles became similar to the function of the young adult group.

**DISCUSSION**

Neuromuscular electrical stimulation was applied for 60 minutes a day, 5 days a week for 2 weeks to the neck muscle of the normal aged persons group who showed weaker function in every evaluation items of FDS than the young adult group. The FDS was used to evaluate the change of swallowing function in the normal aged persons group, and the paired sample t-test was conducted on the pre and post-electrical stimulation average values. After 2 weeks of electrical stimulation of the neck muscles, the average FDS score of the normal aged persons group had greatly decreased, and the average t value regarding FDS of the normal old person group before and after electrical stimulation was 0.687 (p=0.001), showing a statistically significant difference. The effect of electrical stimulation has been proven by many previous studies7–9) of stroke patients, and we consider the electrical stimulation of the neck muscles reversed the functional decrease caused by natural aging of the normal elderly persons. Theory suggests that stimulation has a muscle retraining effect on the nerves of the muscles as well as a muscle strengthening effect10, 11). Among the evaluation items of FDS of the normal aged persons group, after electrical stimulation, the bolus formation function was 25% and residue in the mouth was 44% at the oral process step. In the pharyngeal process step, residue in the valleculae was 27%, and residue in the pyriform sinus was 19%, and subjects with the problem of coating on the pharyngeal wall was 11%. In particular, the delay of pharyngeal swallowing reflection in the pharynx step was 5.6%, but no subject was found who was awarded points after electrical treatment. Functional improvement was shown to be better in all evaluated items compared to pre-stimulation.

### Table 3. FDS item scores of the normal aged persons group before and after electrical stimulation

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre M ± SD</th>
<th>Post M ± SD</th>
</tr>
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<tbody>
<tr>
<td>BF</td>
<td>1.64 ± 1.26</td>
<td>0.75 ± 1.06*</td>
</tr>
<tr>
<td>ROC</td>
<td>1.44 ± 0.70</td>
<td>0.78 ± 0.94*</td>
</tr>
<tr>
<td>TPS</td>
<td>0.56 ± 2.36</td>
<td>0.27 ± 1.18</td>
</tr>
<tr>
<td>ROV</td>
<td>3.19 ± 3.89</td>
<td>1.11 ± 1.7*</td>
</tr>
<tr>
<td>RPS</td>
<td>2.00 ± 2.74</td>
<td>0.56 ± 1.34*</td>
</tr>
<tr>
<td>CPW</td>
<td>2.78 ± 4.61</td>
<td>1.67 ± 3.83</td>
</tr>
</tbody>
</table>

BF: Bolus formation, TPS: Triggering of pharyngeal swallowing, ROC: Residue in the pyriform sinuses, ROC: Residue in the oral cavity, ROV: Residue in the valleculae swallow, CPW: Coating of pharyngeal wall after swallow, * Significantly different (p<0.05)

### Table 4. Comparison of FDS scores of the normal aged persons group after electrical stimulation with those of the young group

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>the aged</td>
<td>18</td>
<td>5.08 ± 6.82</td>
</tr>
<tr>
<td>the young</td>
<td>10</td>
<td>5.30 ± 6.04</td>
</tr>
</tbody>
</table>

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REFERENCES