Functional Electrical Stimulation for Patients with Reduced Laryngeal Elevation*

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Abstract—Larynx or hyoid bone movement was measured during swallowing reflex with and without electrical stimulation of the suprahyoid muscles. The power-assisted functional FES system was used to stimulate muscles only during swallowing reflex. This system may be useful for patients with reduced laryngeal elevation.

I. INTRODUCTION

Recently, laryngeal elevation by functional electrical stimulation (FES) has been reported for patients with reduced laryngeal elevation [1-4]. However, synchronizing the laryngeal elevation by swallowing reflex with that by electrical stimulation is difficult. The power-assisted functional FES system (PAS system®: OG Giken Co., Ltd, Japan) increases electrical stimulation with the increase in electromyography signal of the target muscles. Using this system, it is expected that electrical stimulation is given only when the laryngeal elevation muscles are activated by swallowing reflex. The aim of this study is to evaluate the movement of larynx or hyoid bone with and without FES in normal subjects and in patients with reduced laryngeal elevation.

II. METHODS

This study was approved by the Institutional Review Board and a written informed consent was obtained from all subjects. The surface electrodes were put on the suprahyoid muscles in 12 healthy subjects and 3 patients with pharyngeal dysphagia. All patients showed reduced laryngeal elevation by videofluoroscopic examination of swallowing (VF). Normal subjects swallowed 3 ml and 10 ml of water with and without the power-assisted FES. The colored marker was put on the surface of the thyroid cartilage and the laryngeal elevation was measured by using the 3-dimensional motion analysis system (KinemaTracer®: KISSEI COMTEC, Japan). The hyoid elevation with and without the power-assisted FES in patients were evaluated by VF.

III. RESULTS

The electrical stimulation increased in accordance with the increase in the movement of the larynx or hyoid bone during swallowing reflex. In normal subjects, the maximum laryngeal elevation in 10 ml of swallow with electrical stimulation was significantly larger than that of 3 ml and 10 ml of swallow without electrical stimulation (Table 1). The electrical stimulation also increased the laryngeal elevation during swallowing in patients.

<table>
<thead>
<tr>
<th>TABLE I. THE MAXIMUM LARYNGEAL ELEVATION IN NORMAL SUBJECTS (mm)</th>
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<tr>
<td>3ml of bolus</td>
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<td>With stimulation: 6.7 ± 3.0</td>
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<td>With stimulation: 8.8 ± 5.1</td>
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<tr>
<td>10 ml of bolus</td>
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<tr>
<td>With stimulation: 6.7 ± 3.3</td>
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<tr>
<td>With stimulation: 10.0 ± 4.1</td>
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IV. DISCUSSION

The power-assisted FES increased the movement of the larynx and hyoid bone during the swallowing reflex. The muscle fatigue can be avoided because electrical stimulation is given only during swallowing reflex. We suppose this system may be useful for patients with reduced laryngeal elevation.

REFERENCES

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