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The Influences of Halo-Vest Fixation and Cervical Hyperextension on Swallowing in Healthy Volunteers

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Study Design. Radiographic and electromyographic evaluation of swallowing functions was performed for different positions with a Halo-vest brace.

Objectives. The aim of this study was to clarify the mechanism of dysphagia of cervical hyperextension with a Halo-vest brace in neurologically normal adult volunteers.

Summary of Background Data. Garfin *et al* reported that 3 of 179 patients had dysphagia attributable to the Halo-vest brace after cervical spinal cord injury. Readjustment of the position of the head in the Halo-vest brace was required in those cases. They concluded that the head-extended position with a Halo-vest brace made it difficult to swallow. However, the details of this dysphagia were not known.

Methods. Six healthy adults volunteers between the ages of 24 and 33 participated in this study. Subjects were radiographically and electromyographically observed swallowing thin liquids at the neutral position without a Halo-vest brace (N-HV), the neutral position with a Halo-vest brace (N+HV) and at hyperextension with a Halo-vest brace (E+HV).

Results. In the durational measurements, there were significant changes between the N-HV and E+HV in pharyngeal transit time. The motion measurements showed that the initial hyoid position placed lower from the mandibular plane, and vertical hyoid movement was prolonged in the E+HV. In the electromyographic measurements, greater activity was observed from the suprahyoid muscles in the E+HV. One subject had laryngeal penetration already in the N-HV, and the same subject exhibited aspiration in the E+HV. Another two subjects exhibited penetration in the E+HV.

Conclusion. The result of this study demonstrated that cervical hyperextension with the Halo-vest brace caused mechanical changes in the swallowing of normal healthy adult volunteers.

Key words: Halo-vest brace, cervical hyperextension, videofluoroscopy, hyoid movement, suprahyoid muscles, electromyography. **Spine 2005;30:E179–E182**

The Halo-vest brace is a common mode for immobilization of the cervical spine.[1] Garfin *et al*[2] reported that hyperextension itself in the halo device increased dysphagia in 3 of 179 patients; repositioning of the neck reduced the degree of extension relieved dysphagia symptoms. We reported the influence of cervical hyperextension with a Halo-vest brace on the swallowing function in cervical myelopathy patients.[3] One of 4 patients exhibited aspiration of contrast medium in the trachea in the extension position with a Halo-vest brace. We concluded that excess extension of the neck position increased risk of dysphagia. However, the mechanism of dysphagia in Halo-vest brace use was still unknown. Here, the influence of cervical hyperextension on swallowing in 6 normal volunteers who were placed in a Halo-vest brace was studied. The aim of this study was to clarify the mechanism of dysphagia of cervical hyperextension with a Halo-vest brace in neurologically normal adult volunteers.

■ Materials and Methods

Factors contributing to dysphagia were evaluated in 6 healthy neurologically intact volunteers placed in a hyperextended position while being immobilized in a Halo–vest brace. Volunteers were between the ages of 24 to 33 and included 4 females and 2 males.

The head attachment of the Halo-vest brace (ACE Medical Co., Los Angeles, CA) was modified to cover the skull (Figure 1). The attachment had rubber inside the plastic cover, and we used a rubber cap with subjects.

Three positions were examined: the neutral position without Halo-vest brace (N-HV), the neutral position with a Halo-vest brace (N+HV), and hyperextension with a Halo-vest brace (E+HV).

Muscle activities were recorded from the suprahyoid muscles via Neropack Σ electromyography (Nihon Kohoden Inc., Japan). The electromyography signals were collected with a sampling frequency of 1 KHz (Maclab/8s, AD Instruments, Sydney, Australia). After reducing skin impedance, two recording electrodes were attached using Okitsu's method.[4] The raw electromyography signals were high-pass filtered at 20 Hz, low-pass filtered at 3 KHz, and full-wave rectified, and integral electromyography was calculated using Scope software (AD Instruments) for 1 second in each session.

The subjects were evaluated radiographically using videofluoroscopy.[5] The thin liquid barium consisted of 70% (w/v) barium sulfate. A 15-mL liquid bolus was placed in the mouth, and the subjects were instructed to hold the bolus over the tongue until given the command to swallow. The examination was recorded using a radiograph TV system (MA1000-A, Toshiba, Tokyo, Japan). Lateral-view videofluoroscopy was recorded on videotapes for later playback and analysis, at 30 frames per second. Displacement measurements were obtained by digitizing the videotaped studies on computer at 30 frames per second. We used NIH Image 1.63 software to analyze the fluoroscopic images frame-by-frame. Durational measurements were made after calibration of the digitized images. We

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