SIMULATION OF THE UPRIGHT CERVICAL SPINE USING A MRI-COMPATIBLE COMPRESSION DEVICE

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**Introduction:** Modern imaging procedures, such as computed tomography and magnetic resonance imaging (MRI), have delineated at high resolution the intervertebral disc, spinal ligaments and spinal cord, thereby facilitating the diagnosis of spinal diseases. However, these techniques are typically performed in a supine position rather than an upright position which patients predominantly manifest their symptoms.

**Methods:** Eight volunteers (5 men, 3 women) with a mean age of 42 (range 31-52) years old and body weight of 83 ± 7 kg (mean ± SEM) participated in this study. An institutional review board approved this study and informed consent was obtained from all participating subjects. The subjects had no previous history of spinal injuries or neck pain. Axial compression was applied between the head and the feet, in supine posture using a MRI-compatible compression device. This device consists of a footplate, inter-connecting straps, and a helmet. The compression force between the helmet and the footplate was determined with four calibrated scales, one on each of the inter-connecting straps.

**STUDY 1**

To determine how much axial compression force is required to simulate the upright cervical spine, the lordosis angle between C2 and C6 in a lateral plain radiograph in upright posture was compared to supine posture radiographs with axial loads of 0, 7, 10 and 13% of the subject’s body weight. **Discussion:** A previous cadaver study has demonstrated that the weight of the head plus neck is approximately 8.4% of body weight (2). Consistent with this study, our results indicated that 8.2% of body weight was necessary to simulate the upright cervical spine. In addition, the axial compression of the cervical spine resulted in posterior movement of the cervical spinal cord within the dural tube at C3/4 to C5/6. These results may support an idea that the posterior decompression is effective for patients with compression myelopathy.

**STUDY 2**

To study morphological changes of the cervical spinal cord and dural tube before and during axial compression, T2-weighted axial MR images were acquired using a 1.5T system (Magnetom Symphony, Siemens, Germany) with a cervical coil. The axial images were angled parallel with each disc level of C2/3 to C7/T1, perpendicular to the long axis of the spinal canal. Images were stored digitally and subsequently processed on a computer using NIH Image (v1.62). The following parameters were measured on both the spinal cord and dural tube: anterior posterior distance (A-P, mm), transverse distance (TD, mm), and cross sectional area (CSA, mm²). Additional measurements included: anterior subarachnoid distance from anterior dural membrane to anterior wall of the spinal cord (ASD, mm), and posterior subarachnoid distance from posterior wall of the spinal cord to posterior dural membrane (PSD, mm). MR images for one subject were eliminated because of poor image quality.

**Discussion:** The lordosis angle in supine posture with a load of 0, 7, 10 and 13% of the subject’s body weight were compared to those in the upright posture. There was a significant difference before and during compression regarding A-P of the dural tube at C5/6 (before: 10.4 ± 0.6; during: 10.0 ± 0.5mm, p < 0.05), ASD at C3/4 (before: 1.9 ± 0.4; during: 2.2 ± 0.5 mm, p < 0.02) and C5/6 (before: 1.3 ± 0.4; during: 1.7 ± 0.4 mm, p < 0.02). However, no significant difference in the spinal cord parameters and TD and CSA of the dural tube was found.

**References:**


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**Fig. 1**

Each parameter was measured twice and the mean values were evaluated. Data were expressed as mean ± standard error of the mean (SEM). Differences in all parameters before and during compression were evaluated with the Wilcoxon rank sum test. A p-value of less than 0.05 was considered statistically significant.