Postural Control in Patients with Cervical Spondylotic Myelopathy after Surgery and Post-Surgery Exercise Training

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Disclosures:

Introduction: Cervical spondylotic myelopathy (CSM) is pathology of the cervical spinal cord and a common degenerative change of cervical spine. CSM patients are reported to suffer from impaired postural control so as to increase the risk of falling [1], while the effect of surgery and post-surgery exercise training on the postural control is still unknown. The purpose of this study was to clarify if the CMS patients benefit from the surgery as well as the follow-up exercise training in terms of improved postural control.

Methods:
Case Description
Fourteen CSM patients (9 males and 5 females, aged 54.3±12.0 years, ranged from 30 to 72 years old) prescribed to undergo the surgical treatment were recruited in this study. Subjects were excluded if they have spinal surgery previously, upper neuron disease, tumor, other disease influencing the balance, or are unable to stand more than one minute independently.

Outcome Measures
The subjects completed the subjective rating of the pain and functional level by the visual analog scale (VAS) and neck disability index (NDI) respectively, as well as the Timed up and go test in each examination of the three stages, i.e. the day before surgery, the third month after surgery, and the sixth month after surgery.

Postural control was examined using AMTI OR6-7 force plate (AMTI, Watertown, USA) and an ultrasound based 3D-motion analysis system (CMS20S, Zebris, Tubingen, Germany). The trajectory of the center of pressure (CoP) during the 40 seconds standing test was used to represent the overall postural control ability of the subject. The maximal displacements between the head and trunk (cervical motion), as well as between the trunk and lumbar (lumbar motion) were used to assess the regional control ability. The coherence was used to measure the level of synchronization between the cervical and lumbar motions in the frequency-domain [2].

Subjects were asked to stand barefoot on the force plate wearing the marker frames, and to perform four 40-second standing tasks including: the quiet standing with eye-open/eye-closed condition on the ground (EOG/ECG) as well as on the foam (EOF/ECF). Each standing task was examined twice from easy to hard condition for the first visit, and at random for the following examinations.

Intervention
The surgery was determined and conducted by the same surgeon. The patients were suggested to wear a collar after the surgery for three months. After the reassessment at 3-month post-surgery, the patients were referred to the physical therapist for exercise training. The exercise program included a series of deep neck muscle strengthening and health care, and lasted for six weeks.

Statistical Analysis
The Friedman’s ANOVA was used to evaluate the differences of the CoP among stages (since the CoP of the subjects were not normally distributed). The one-way repeated ANOVA was used to assess the parameters of the cervical/lumbar motion among stages. Significant difference was set at p < 0.05.

Results: Among the fourteen patients, eleven of them underwent the anterior cervical discectomy and fusion with PEEK cage (Polyaryletherketone cage), and others underwent the laminoplasty procedure. All subjects showed signs of improved clinical states after the surgery and exercise training except for declined function at the 6-month post-surgery stage (Table 1). The subjects showed the trend of decreased CoP trajectory at the 3-month and 6-month post-surgery stages than that at the pre-surgery stage, especially under the EOG condition (p=0.013). The maximal displacement of the cervical motion increased at the 3-month post-surgery and decreased at the 6-month post-surgery stage compared to that at the pre-surgery stage under the EOG and EOF conditions. On the contrary, the maximal displacement of the lumbar motion decreased at the 3-month post-surgery and then increased at the 6-month post-surgery stage, especially under the ECF condition (p=0.014). The coherence tended to be higher at the 6-month post-surgery than the other stages under the eye-open condition without significant difference (Figure 1).

Discussion: The major findings of this study were:
1) The overall postural control of CoP was improved after surgery, but there were no further improvements after the post-surgery training.
2) The cervical region tended to be unstable at the 3-month post-surgery stage and was stabilized after the exercise training, while the lumbar motion showed the opposite trend.
3) The coherence between the cervical and lumbar motions tended to be greater at the 6-month post-surgery stage than that at the pre-surgery and 3-month post-surgery stage.

This study showed that the overall postural control was improved after surgery since the spinal cord is compressed in the CSM patients and the surgery aims to directly release the compressed neurological structure. The neurological structure is not substantially changed with the exercise training such that no further improvements were observed at the 6-month stage. Wearing the collar for three months after the surgery, the cervical stability seems to be deteriorated, which may be due to the decreased muscle endurance. The post-surgery training seems to work on the improvement the cervical stability though the effect was not enough to overcome the influence of the visual occlusion on the regional control ability. In compensation for the changes of the cervical stability, the lumbar motion accordingly showed the opposite trend at the three stages.

The patient’s ability to regulate the regional motions tended to be ameliorated especially after the post-surgery training since the great coherence indicated that the cervical and lumbar motion frequency was synchronized which may help to maintain the standing balance.

Significance: The spinal surgery was evidenced to improve the overall postural control of the CSM patients. The post-surgery exercise training specifically ameliorates the cervical stability which could lead to the coordination between the cervical and lumbar motions to maintain the standing balance. The results could be the basis for the treatment procedures dealing with the posture control problem of the CSM patients.

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<th>Clinical states of the patients among the examination stages.</th>
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<tr>
<td></td>
<td>Neck pain (VAS)</td>
<td>Neck functional level (NDI)</td>
<td>Timed up and go test (seconds)</td>
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<tr>
<td>Pre-surgery</td>
<td>5.0±3.0</td>
<td>15.8±12.4</td>
<td>12.5±3.9</td>
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<tr>
<td>3-month post-surgery</td>
<td>2.8±2.2</td>
<td>8.2±14.2</td>
<td>12.2±4.6</td>
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<tr>
<td>6-month post-surgery</td>
<td>2.1±2.1</td>
<td>12.7±16.1</td>
<td>10.3±3.7</td>
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