
INTRODUCTION

Intramedullary stress distribution in the cervical spinal cord of the patient with cervical spondylotic myelopathy (CSM) was analyzed using a finite element method (FEM). The influence of the intramedullary stress on the pathogenesis of CSM was investigated.

MATERIALS and METHODS

Twenty cases of CSM in which a symptomatic disc level was any of C3-4, C4-5 and C5-6 were investigated. The symptomatic disc level was determined by neurological findings and intramedullary high signal area in T2 weighed magnetic resonance image (T2WI MRI) for each case.

FEM Analysis

Anterior and posterior margins of the spinal cord from C2 to C7 were extracted from preoperative midsagittal T2WI MRI and approximated by spline curves. A straight line model made by connecting cranial and caudal ends with straight lines was divided into triangular elements. Then the intramedullary stress distribution was analyzed by imposing fixed displacements obtained from the spinal cord shape on the straight line model (Fig.1). Initial modulus of elasticity and Poisson’s ratio of the spinal cord were applied as 5 kPa and 0.49, respectively. Average stresses were calculated in three disc levels of C3-4, C4-5 and C5-6 for each case.

Radiologic Assessment

Space available for the spinal cord (SAC), jaw diameter was measured in plane lateral radiographs, and the ratio of the anteroposterior diameter of the cord to the transverse diameter (anteroposterior compression ratio, APCR) was measured in axial T2WI MRI at the symptomatic disc level.

Statistical Analysis

A total of 60 disc levels were divided into two groups: 20 symptomatic disc levels (SDL group) and 40 non-symptomatic disc levels (Non-SDL group). 1. Comparison of Stress: Average stress was compared between two groups using unpaired t-test.

2. Multivariate Risk Factor Analysis

Multiple logistic regression analyses were used to identify the most critical risk factor for the symptomatic disc level. Average stress, SAC, jaw diameter, and APCR were analyzed as explanatory variables.

3. Receiver-operating characteristic (ROC) Analysis ROC analysis was performed to obtain the threshold of the average stress to be the symptomatic disc level.

RESULTS

The symptomatic disc level was at C3-4 in 4 cases, at C4-5 in 6 cases, and at C5-6 in 10 cases. The symptomatic disc level presented the highest stress among disc levels in each case.

1. Comparison of Stress

The mean stress of SDL group (1.49±0.46 kPa, mean±SD) was significantly higher than that of Non-SDL group (0.81±0.37 kPa) (P<0.001, Fig.2).

2. Multivariate Risk Factor Analysis

The average stress was the only factor significantly associated with the symptomatic disc level (odds ratio= 1.41 per 0.1 kPa, 95% confidence interval= 1.11, 1.77, Table 1).

Table 1 Risk factors for the symptomatic disc level

<table>
<thead>
<tr>
<th>Factor</th>
<th>p Value</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress Value</td>
<td>&lt;0.01</td>
<td>1.41</td>
</tr>
<tr>
<td>SAC</td>
<td>0.51</td>
<td>0.79</td>
</tr>
<tr>
<td>Jaw Diameter</td>
<td>0.55</td>
<td>0.83</td>
</tr>
<tr>
<td>APCR</td>
<td>0.67</td>
<td>0.09</td>
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</table>

3. ROC Analysis

The area under the ROC curve was 0.88. The cutoff point was 1.05 kPa with sensitivity of 85% and specificity of 80% (Fig.3).

DISCUSSION

Ozawa et al reported that pathologic changes in the spinal cord under the mechanical compression were correlated with the intramedullary stress distribution in a rabbit model. In the present study, the intramedullary stress distribution in the CSM was investigated. The intramedullary stress over 1.05 kPa had a crucial influence on the onset of CSM.

SIGNIFICANCE

In the patient with CSM, especially elderly patient, the cervical spinal cord was often compressed at multiple disc levels. The present analysis makes it possible to identify the symptomatic compression. It should be helpful to decide necessary and sufficient decompression levels in the surgery.

REFERENCE
