Spinal Flexion Combined with Extension Produces More Diffuse Nucleus Pulposus Migration through the Annulus Compared to Flexion Alone

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INTRODUCTION

Repetitive flexion and extension of a spinal motion segment has been shown to produce intervertebral disc herniations[1]. Cyclic neutral to full flexion motions have also been shown to produce intervertebral disc herniations[2]. Research indicates though, that repeated extension motions have the ability to reverse herniations[2]. It is important therefore, to evaluate differences in the quantity of nucleus infiltration through the posterior annulus in spines exposed to repeated flexion and extension compared to those exposed to flexion alone.

METHODS

Thirty porcine spinal motion segments were utilized in this investigation, consisting of the C3 and C4 vertebral bodies and the intervening disc. Specimens were divided into two groups with one group being exposed to both repeated flexion and extension while the other was exposed to pure repeated flexion.

Specimens were placed under 1500N of axial compression using a dynamic servohydraulic testing system (model 8511, Instron Canada, Burlington, Ontario, Canada). Specimens were exposed to 10000 cycles of either flexion and extension or pure flexion. Prior to testing, a radiopaque dye was injected into the disc allowing for visual observation of nucleus migration.

Digitized transverse plane photographs of the dissected specimens were taken and the images analyzed using commercially available software (Adobe Systems Inc., San Jose CA, USA). The entire disc area was first traced; the endplate area was then traced and subtracted from the total disc area. The portion of the annulus with evidence of nucleus pulposus infiltration, indicated by the presence of dye, was traced and divided by the total annulus area. This gave a percentage of annulus with damage present. An independent samples t-test determined the statistical differences between the two groups.

RESULTS

The group exposed to flexion alone was found to have significantly less diffusion of nucleus through the annulus compared to the group exposed to flexion and extension (p=0.023). The flexion only group also had significantly less disc height loss compared to the flexion and extension group (p=0.00032). Differences in disc height loss and annular damage between the two groups is summarised in Table 1.

![Figure 1: Process of damage quantification; tracing the outlines of the entire disc, the endplate, and the area infiltrated by nucleus pulposus.]

DISCUSSION AND CONCLUSIONS

While flexion alone has the potential to cause nucleus to track through the posterior annulus, the effects are amplified when a cycle of flexion is followed by a subsequent cycle of extension. Stress concentrations in the posterior annulus of some spines during extension[3] may cause a more rapid degradation of the posterior annulus. This would facilitate a higher quantity of nucleus to be hydraulically pumped posteriorly during the subsequent cycle of flexion.

It would appear that motions requiring both flexion and extension have the potential to produce higher levels of damage in the posterior annulus compared to those requiring flexion alone.

REFERENCES


Table 1: Average Annular Damage and Axial Creep between Groups

<table>
<thead>
<tr>
<th></th>
<th>Average Damage (%)</th>
<th>Standard Deviation (%)</th>
<th>Axial Creep (mm)</th>
<th>Standard Deviation (mm)</th>
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<tbody>
<tr>
<td>Flexion</td>
<td>5.9</td>
<td>5.3</td>
<td>4.5</td>
<td>0.7</td>
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<td>Flexion/Extension</td>
<td>12.4</td>
<td>8.8</td>
<td>6.9</td>
<td>1.9</td>
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</tbody>
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