EFFECT OF MICRODISCECTOMY ON LUMBAR FACET JOINT AND ENDPLATE KINEMATICS

Sheri I. Imsdahl¹, Jeffrey R. Campbell¹, Michael J. Lee², Randal P. Ching¹

¹Department of Mechanical Engineering, University of Washington, Seattle, WA USA, http://depts.washington.edu/uwabl/
²Department of Orthopaedics and Sports Medicine, University of Washington, Seattle, WA USA

INTRODUCTION

Lumbar disc herniation is a condition in which annular tears permit the nucleus pulposus to extrude through the disc, often resulting in pain due to compression of neural elements. Microdiscectomy is a common surgical treatment and can be performed in partial or subtotal fashion. In a partial microdiscectomy (PD), only the herniated fragment is removed. This contrasts with a subtotal microdiscectomy (SD), in which not only the herniated fragment is excised but the majority of the disc as well. Studies have shown a decreased reherniation rate after SD as compared to PD [1]. A disadvantage of SD is that the diminished shock absorptive function of the residual disc may lead to accelerated degeneration and subsequent back pain. Though the etiology of this pain is not well understood, it may be related to alterations in the motion patterns of the facet joints and endplate. Therefore, the purpose of this study was to examine the effects of PD and SD on facet and endplate kinematics.

METHODS

Six L2-L5 human lumbar specimens were used in this investigation. The specimens were dissected free of all non-ligamentous soft tissue, and the terminal ends were embedded in polymethylmethacrylate. Four non-metallic CT beads (The Suremark Co., Simi Valley, CA) were rigidly attached to each vertebra to serve as fiducial markers. Prior to testing, the specimens were CT scanned; and the data sets were segmented with SegVue (SegVue, Inc., Seattle, WA) to obtain a 3D reconstruction of each specimen. Specimens were tested in their intact condition and post- 1) unilateral laminotomy (UL), 2) UL + PD, and 3) UL + SD. Testing was done on a custom-designed spine simulator capable of applying a pure moment to the superior vertebra while allowing unrestricted motion of the specimen. The specimens were tested under continuous angular displacement control to maximum moments of: ±10Nm in flexion-extension (FE), lateral bending (LB), and axial rotation (AR); and a maximum resultant moment of ±7Nm in combined FE/LB. Throughout the motion tests, the 3D kinematics of the vertebrae were tracked with a four-camera VICON MX13 system (Vicon Motion Systems, Inc., Los Angeles, CA). The kinematic and geometric data were registered via the fiducial markers. Facet and endplate kinematics were examined at the index level (L3-L4) and the levels immediately adjacent to it. For each level, the centroids of the facet and endplate surfaces were expressed relative to the level below. To aid in establishing the normal motion corridors, the 3D positions of the centroids were plotted throughout the motion tests for each surgical condition. A volume was fit to the point cloud using Delaunay triangulation. The enclosed volume was computed, and a dimensional analysis was performed to describe its shape and orientation.

RESULTS

Sample data are shown in Figure 1. The plot shows 1) the collective 3D positions of the L3 inferior endplate centroid in the intact condition for all tests (FE, LB, AR, and combined loading) and 2) the "volume of motion" fit to the point cloud.

![体积变化](image.png)

Table 1 shows the change in centroid volume of motion according to surgical condition. The changes are represented as percent increases from the intact condition.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Left Facet</th>
<th>Right Facet</th>
<th>Endplate</th>
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<tbody>
<tr>
<td>UL</td>
<td>23 ± 18</td>
<td>17 ± 20</td>
<td>-1 ± 25</td>
</tr>
<tr>
<td>UL + PD</td>
<td>74 ± 54</td>
<td>48 ± 47</td>
<td>44 ± 47</td>
</tr>
<tr>
<td>UL + SD</td>
<td>106 ± 55</td>
<td>110 ± 63</td>
<td>103 ± 60</td>
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</table>

DISCUSSION & CONCLUSIONS

This study examined the effects of two increasingly invasive microdiscectomy procedures on the kinematics of the facets and endplate. The large increases in centroid volume of motion suggest that both procedures may have imparted non-physiologic strains to the facet capsules and discs. In vivo, this could result in accelerated facet and/or disc degeneration and may explain the pain experienced by some patients post-surgery.

REFERENCES


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