Dynamic Morphometric Changes in Degenerative Lumbar Spondylolisthesis: A Pilot Study of Standing Magnetic Resonance Imaging

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Degenerative Lumbar Spondylolisthesis (DLS) is a condition that causes a forward slippage of one vertebrae on another.

In the lumbar spine the level most commonly affected is L4 on L5.

Several studies have evaluated risk factors that may predict stability or instability in DLS including disc height, magnitude of slip, facet joint effusion, orientation of the facet and degenerative changes.

However, the literature is not able to examine the dynamic role of nerve root compression or spinal canal alignment/stenosis as only supine MRI and CT scans are currently used in clinical practice.

A fully-open MRI scanner (MROpen, Paramed, Italy) has been developed which has the advantage of being able to image patients in a number of potentially symptomatic dynamic positions.

The Centre for Hip Health and Mobility (CHHM) at Vancouver General Hospital has recently obtained one of these scanners and has begun to use it in a research capacity.

Will allow for a better appreciation of the clinically relevant features that indicate instability demonstrated by MRI and not upright radiographs.

Objective

The purpose of this study is to evaluate the utility of upright open MRI in DLS patients and assess the ability of this technique to identify changes when compared to supine MRI.

A secondary objective is to assess the ability of upright MRI to demonstrate areas of stenosis not identifiable with standard supine imaging techniques.
Methods

Patients with DLS recruited through spine surgery clinics

One MRI will be completed in the upright position and another will be done in the supine position

The upright MRI scans will be compared to supine MRI scans for:
- Cross-sectional area
- Disc height
- Degree of anterolisthesis
- Disc angle
- Foramen diameter

Degenerative Spondylolisthesis: Single Level, Grade I or II

Radiant DICOM Viewer
Analysis of defined measurements

Spine Referral Clinic - Blusson Spinal Cord Centre, Vancouver, BC, Canada
Mid-sagittal Slice:
Diameter of the thecal sac, Disc height, Disk angle, and Degree of anterolisthesis
Lateral Sagittal View:
Diameter of the Neural Foramen

Upright

Supine
Axial Slice:
Cross sectional area of the dural sac, facet effusion, facet angle
### Measured Parameters Upright vs. Standing

<table>
<thead>
<tr>
<th></th>
<th>Upright</th>
<th>Supine</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross Sectional Area</td>
<td>81.23 mm²</td>
<td>112.72 mm²</td>
<td>p&lt;0.001*</td>
</tr>
<tr>
<td>Foramen Diameter Right</td>
<td>6.13 mm</td>
<td>9.47 mm</td>
<td>p&lt;0.001*</td>
</tr>
<tr>
<td>Foramen Diameter Left</td>
<td>6.71 mm</td>
<td>9.05 mm</td>
<td>p&lt;0.001*</td>
</tr>
<tr>
<td>Disc Height</td>
<td>5.39 mm</td>
<td>7.28 mm</td>
<td>p&lt;0.05*</td>
</tr>
<tr>
<td>Anterolisthesis</td>
<td>7.50 mm</td>
<td>4.68 mm</td>
<td>P&lt;0.001*</td>
</tr>
<tr>
<td>Disc Angle</td>
<td>3.6°</td>
<td>4.3°</td>
<td>p&gt;0.05</td>
</tr>
</tbody>
</table>

- A total of 14 patients, mean age was 64.8 and majority were female.
- All participants had DLS at the L4/5 level.
- Differences were noted between upright and supine MRI for cross sectional area, foramen diameter, disc height, and degree of anterolisthesis (p<0.05).
Patients were divided into two groups, Grade I and II slip.

Comparisons were made based on absolute slippage differences and disc height change between supine and upright MRI.

Statistically significant changes in disc height (p<0.001) and percent change of anterolisthesis (p<0.001) were seen in only Grade II spondylolisthesis between supine and upright MRI images.

### Slippage based on Grade of Spondylolisthesis

<table>
<thead>
<tr>
<th>Degree of Anterolisthesis</th>
<th>Grade I</th>
<th>Grade II</th>
</tr>
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<tbody>
<tr>
<td>Upright</td>
<td>6.84 mm</td>
<td>8.38 mm</td>
</tr>
<tr>
<td>Supine</td>
<td>5.59 mm</td>
<td>6.09 mm</td>
</tr>
<tr>
<td>Percentage Change</td>
<td>3.93%</td>
<td>8.13%</td>
</tr>
<tr>
<td>p</td>
<td>&gt;0.05</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

### Disc Height based on Grade of Spondylolisthesis

<table>
<thead>
<tr>
<th>Disc Height Average</th>
<th>Grade I</th>
<th>Grade II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upright</td>
<td>5.56 mm</td>
<td>5.27 mm</td>
</tr>
<tr>
<td>Supine</td>
<td>6.95 mm</td>
<td>7.52 mm</td>
</tr>
<tr>
<td>p</td>
<td>&gt;0.05</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>
Conclusions and Future Directions

• Pilot study – upright MRI has the ability to detect change from upright to supine position
• Differences between supine and standing MRI was found predominantly in those with Grade 2 DLS
• It is hypothesized that upright MRI will be able to provide a much more detailed picture of the anatomical variations in DLS produced by upright posture dynamic
• In the future, evaluation of this technology in surgical planning and selection of appropriate patients for fusion vs. decompression alone
• Further recruitment of patients ongoing and application to other spine pathologies future possibility.

(Rampersaud et al., Can J Surg [Internet]. 2014, Watters et al., Spine J; 2009)
Disclosures

No authors have any potential conflict of interest for this project