Axial loading during MRI induce lumbar foraminal area changes and may be useful in diagnostics of nerve compromise

Brisby H\textsuperscript{1,4}, Rydberg N\textsuperscript{1,2}, Hutchins J\textsuperscript{1,4}, Lagerstrand K\textsuperscript{1,3}, Hebelka H\textsuperscript{1,2}

\textsuperscript{1} Institute of Clinical Sciences, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden

\textsuperscript{2} Dept. of Radiology, \textsuperscript{3} Dept. of Medical Physics and Techniques and \textsuperscript{4} Dept. of Orthopaedics, \textsuperscript{2-4} all at Sahlgrenska University Hospital, Gothenburg, Sweden
Introduction

• Lumbar foraminal stenosis is common with a prevalence of about 10% (1)
• Assessment is conventionally performed with MRI in supine position
• A few reports using upright MRI indicating a decrease of lumbar forminal area at standing, however no reliability measurements have been reported (1,2,3)
• How loading of the spine in a prone position, while also having the ability to get high quality MRI images, affect foraminal area has not previously been reported

Aim

To investigate if and how axial loading of the spine affects the lumbar intervertebral foramina evaluated on MRI
Methods

• Cohort of 89 LBP patients, mean age 43 years, range 27-66

• Lumbar MRI performed in relaxed supine position followed by axial loading in supine position using the Dynawell© compression device
Methods

• The area of the foramina L3-S1 (in total 534 foramina) was determined (T2W) using a free hand polygonal tool

• Qualitative grading of the foramina were performed (T1W and T2W) by using the Lee grading system (4), grading 0-3

Example of L4–5 foraminal area at unloaded MRI (left) and with axial loading (right)

Methods

- One radiologist performed measurements and quantitative grading of all foramina

- The sagittal image with the smallest foraminal area was used

- For 10 patients (60 foramina) repeated measurements as well as measurement by a second radiologist were performed - to evaluate intra- and inter-observer variations
Results – area measurement

• Intra class correlation coefficient for foraminal area measurement was 0.96 and 0.76 for intra-observer respective inter-observer agreement

• Overall, a mean reduction of 2.2%, unloaded-loaded MRI (mean 0.89 and 0.87 cm² respectively) (p = 0.002)

• A large variation in load-induced foraminal area change, range 58% increase to 42% decrease
Results – area measurement

- Stratified for lumbar level, a mean area reduction during loading was found for L3/L4 and L4/L5 foramina, but not for L5/S1

<table>
<thead>
<tr>
<th>Lumbar level</th>
<th>Mean change loaded/unloaded</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3/L4</td>
<td>↓ 0.03 cm²</td>
<td>0.036</td>
</tr>
<tr>
<td>L4/L5</td>
<td>↓ 0.03 cm²</td>
<td>0.004</td>
</tr>
<tr>
<td>L5/S1</td>
<td>0.00</td>
<td>ns</td>
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Results – qualitative assessment

• With qualitative foramina stenosis grading differences between unloaded/ loaded MRI was seen (p <0.001)

• In 25% of the foramina, a change of foraminal stenosis grade (higher or lower grade) occurred with loaded MRI, with a higher grading determined in 19% of all foramina (p <0.001)
Results – area measurement / qualitative assessment

- For 21% of the foramina, in which loading induced a decreased foraminal area, a concomitant higher qualitative grade was observed
Discussion

- Overall, a small reduction of mean foraminal area was induced with axial loading during MRI.

- However, the load-induced foraminal area change demonstrated a large dynamical range, in this group of LBP patients without radiculopathy.

- MRI with loading induced a higher foraminal stenos grade in about 1/5 of these patients, indicating that the applied load induce changes of a magnitude that might be of clinical relevance.

- This method have potential to improve diagnostics when conventional MRI findings do not match with clinical symptoms of lumbar radiculopathy.
Summary points

- Loading of the spine in a supine position during MRI affect lumbar foraminal area with large variations

- Effect of the loading on the foramina were more pronounced for L3/4 and L4/5 than for L5/S1

- Axial loading of the spine during MRI may unmask lumbar foraminal nerve root compromise not seen in conventional unloaded supine position
Disclosure

None of the authors has any potential conflict of interest