MRI scoring of lumbar central canal and neural foraminal stenosis: comparison of a novel 3D-SPACE at 1.5 Tesla with conventional 2D-MRI

Mihir Katlariwala
PGY-1 Diagnostic Radiology
University of Alberta

Co-Authors: Vimarsha Swami, Suki Dhillon, Zaid Jibri & Jacob Jaremko
Disclosure

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Objective

• Rapid screening MRI may be beneficial in a resource-constrained public healthcare system for mechanical low back pain assessment

• Hypothesis: single T2 weighted 3D TSE-fs SPACE sequence is equivalent to multiple conventional 2D MRI sequences in assessment of:
  • Lumbar neural foraminal stenosis (LNFS)
  • Lumbar central canal stenosis (LCCS)
Why SPACE?

Benefits of SPACE:
  • Shorter image acquisition time
  • Volumetric source data enables multiplanar reformatted images
  • Thin slices that reduce partial volume averaging
Foraminal Stenosis: Conventional vs SPACE
Methods

- **Prospectively** examined L3-L4, L4-L5 & L5-S1 levels in 20 patients (total N=60 for LCCS, N=120 for LNFS)

- **Two blinded readers** graded levels using:
  - morphologic grading systems
  - global impression on clinically significant stenosis

- Reliability statistics were calculated using **Cohen’s kappa (k)**
Grading Systems

1) Lee et al. (2010) suggest four grades (0-3) based on sagittal MRI for foraminal stenosis

2) Song et al. (2008) grade degree of central stenosis on axial T2 based on the % surface area of dural sac occupied by nerve root/tissue mid-disc slice

3) Global clinical assessment by radiologist
Lee et al. (2010) grading system for Foraminal stenosis
Grade 0 (Normal) - 0, 1, or 2 sides of contact (L-shape)

Schematic

0 sides of contact
1 side of contact
2 sides of contact ("L")

SPACE

Only 1 side of contact
Only 1 side of contact
L-shaped contact, 2 adjacent sides (superior-posterior)

T1

Only 1 side of contact (superior interface is darker)
L-shaped contact, 2 adjacent sides (superior & anterior)
1 definite contact
Grade 1 (Encroachment) - 2 opposing sides or 3 sides

Schematic

- 2 opposing sides of contact
- 2 opposing sides of contact
- 3 sides of contact

SPACE

- 2 opposing sides of contact
- 2 opposing sides of contact
- 3 sides of contact

T1

- 2 opposing sides of contact
- 3 sides of contact. Is there fat adjacent to the anterior surface? No influence on grade
Grade 2 (Stenosis) - 4 sides of contact

Schematic

4 sides of contact

SPACE

4 sides of contact, no distortion

T1

4 sides of contact, no distortion
Grade 3 (Severe Stenosis) – Deformity, flattening or distortion

Schematic

Deformed root with 4-sided contact

Deformed root with 2-sided contact

SPACE

4-sided contact with compression/distortion of nerve root

2-sided contact with compression/distortion of nerve root

T1
Song et al. (2008) grading system for Central stenosis
Grade 1 (Mild)

<50% of dural sac surface area occupied by nerve roots (c-d, regardless of presence or direction of compression)
Grade 2 (Moderate)

>50% of dural sac surface area occupied by nerve roots and no evidence of complete blockage (b)
Grade 3 (Severe)

Complete blockage (a)
## Results

**Lumbar Central Canal Stenosis: Inter-Observer Agreement**

<table>
<thead>
<tr>
<th>Table 1: Inter-Observer Agreement (Reader 1 vs Reader 2)</th>
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<tbody>
<tr>
<td>Assessment Method</td>
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## Results

Lumbar Central Canal Stenosis: Global Clinical Impression

<table>
<thead>
<tr>
<th>Assessment Method</th>
<th>Statistic</th>
<th>3D-SPACE</th>
<th>2D-MRI</th>
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<tr>
<td>LCCS Song et al. Criteria</td>
<td>kappa</td>
<td>0.71</td>
<td>0.69</td>
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<tr>
<td><strong>Global Clinical Assessment</strong></td>
<td>kappa</td>
<td>0.85</td>
<td>0.78</td>
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<tr>
<td>LNFS Lee et al. Criteria</td>
<td>kappa</td>
<td>0.54</td>
<td>0.37</td>
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<tr>
<td>Global Clinical Assessment</td>
<td>kappa</td>
<td>0.23</td>
<td>0.28</td>
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**Results** Lumbar Neural Foraminal Stenosis: Inter-Observer Agreement

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## Results: Inter-Sequence Agreement (3D-SPACE vs 2D-MRI)

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<th>2D-MRI</th>
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<td>LCCS Song <em>et al.</em> Criteria</td>
<td>kappa</td>
<td>0.75</td>
<td>0.54</td>
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<tr>
<td><strong>Global Clinical Assessment</strong></td>
<td>kappa</td>
<td><strong>0.78</strong></td>
<td><strong>0.85</strong></td>
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<tr>
<td>LNFS Lee <em>et al.</em> Criteria</td>
<td>kappa</td>
<td>0.51</td>
<td>0.41</td>
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<tr>
<td><strong>Global Clinical Assessment</strong></td>
<td>kappa</td>
<td><strong>0.63</strong></td>
<td><strong>0.66</strong></td>
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Conclusions

- High agreement 3D-SPACE and conventional MRI for stenosis assessment

- Inter-observer reliability was superior on SPACE than conventional MRI

- 3D-SPACE sequence can be reliably used to assess LNFS and LCCS
Future Directions

- Compare **diagnostic performance of SPACE vs conventional MRI** for other conditions:
  - Disc herniation
  - Spondylolysis
  - Facet arthropathy
  - Fractures

- Explore the role of 3D-SPACE as a **screening protocol** for suspected mechanical LBP
Key References

• Sim J, Wright CC. The kappa statistic in reliability studies: Use, interpretation, and sample size requirements. Phys Ther. 2005; 85:257-68.