



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

AbbVie Canada funded travel/accommodation expenses and for speaking at MRI workshop.

Objective

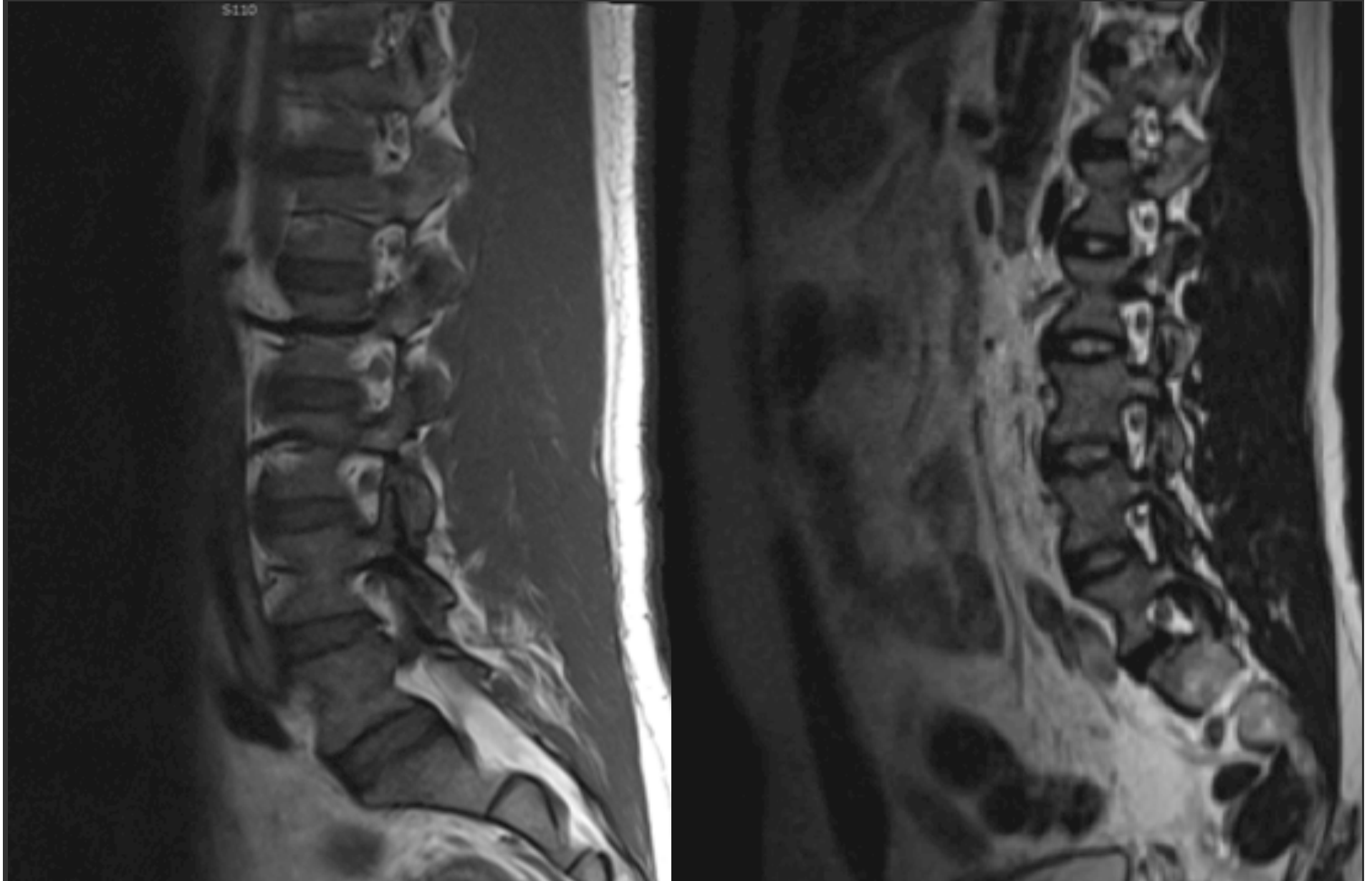
- Rapid screening MRI may be beneficial in a resource-constrained public healthcare system for mechanical low back pain assessment
- Hypothesis: **single T2 weighted 3D TSE-fs SPACE sequence is equivalent to multiple conventional 2D MRI sequences** in assessment of:
 - Lumbar neural foraminal stenosis (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)**

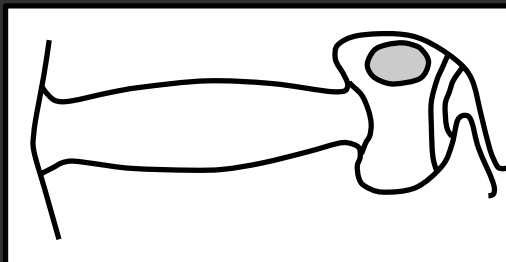
Grading Systems

- 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

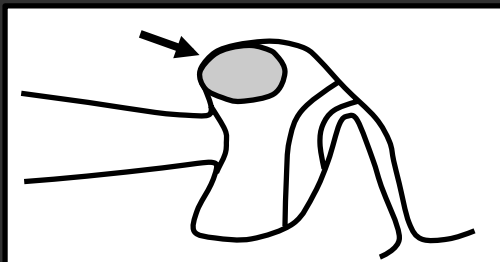
Lee et al. (2010) grading system for
Foraminal stenosis

Grade 0 (Normal) - 0, 1, or 2 sides of contact (L-shape)

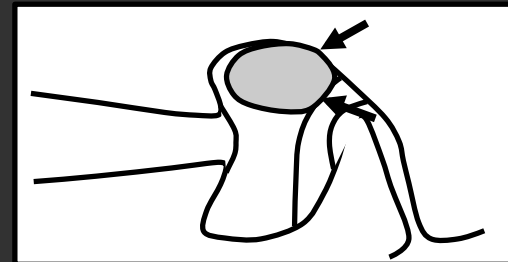
Schematic



0 sides of contact



1 side of contact

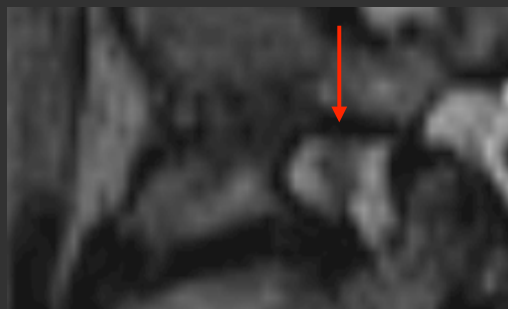


2 sides of contact ("L")

SPACE



Only 1 side of contact



Only 1 side of contact



L-shaped contact, 2 adjacent sides (superior-posterior)

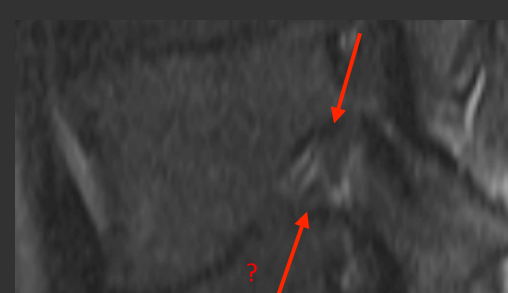
T1



Only 1 side of contact (superior interface is darker)



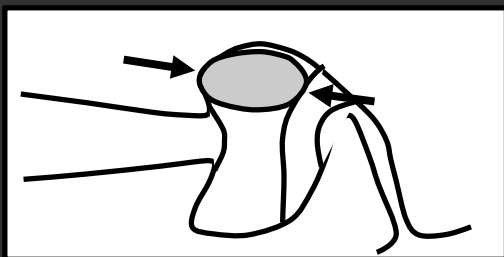
L-shaped contact, 2 adjacent sides (superior & anterior)



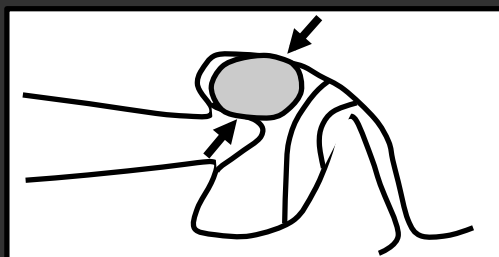
1 definite contact

Grade 1 (Encroachment) - 2 opposing sides or 3 sides

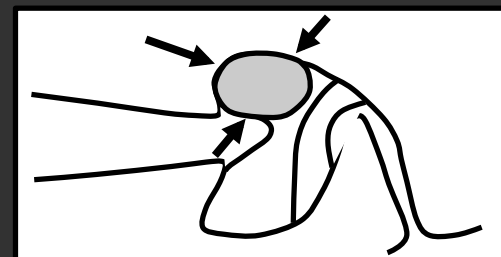
Schematic



2 opposing sides of contact

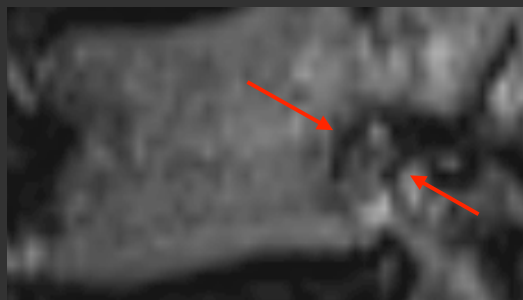


2 opposing sides of contact



3 sides of contact

SPACE



2 opposing sides of contact



2 opposing sides of contact

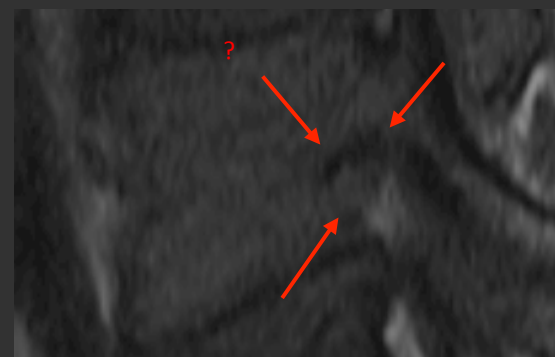


3 sides of contact

T1



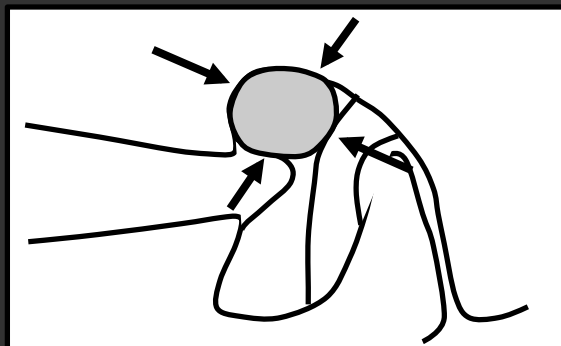
2 opposing sides of contact



3 sides of contact. Is there fat adjacent to the anterior surface? No influence on grade

Grade 2 (Stenosis) - 4 sides of contact

Schematic



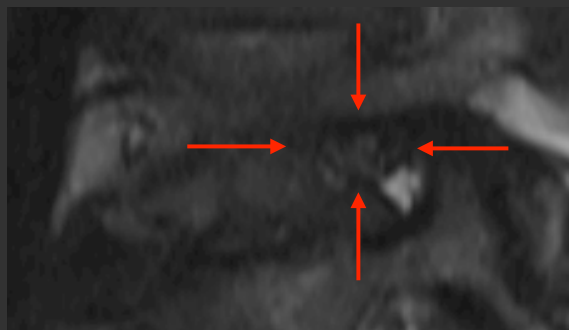
4 sides of contact

SPACE



4 sides of contact, no distortion

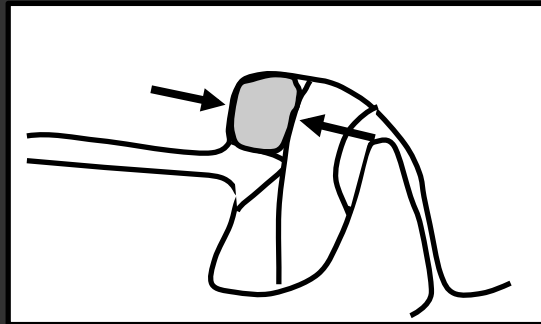
T1



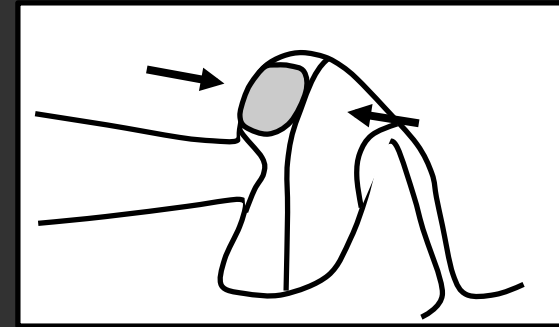
4 sides of contact, no distortion

Grade 3 (Severe Stenosis) – Deformity, flattening or distortion

Schematic



Deformed root with 4-sided contact



Deformed root with 2-sided contact

SPACE

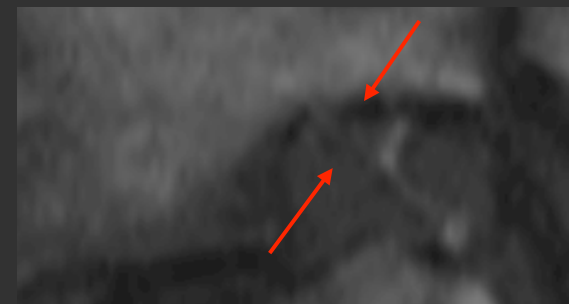


2-sided contact with distortion

T1



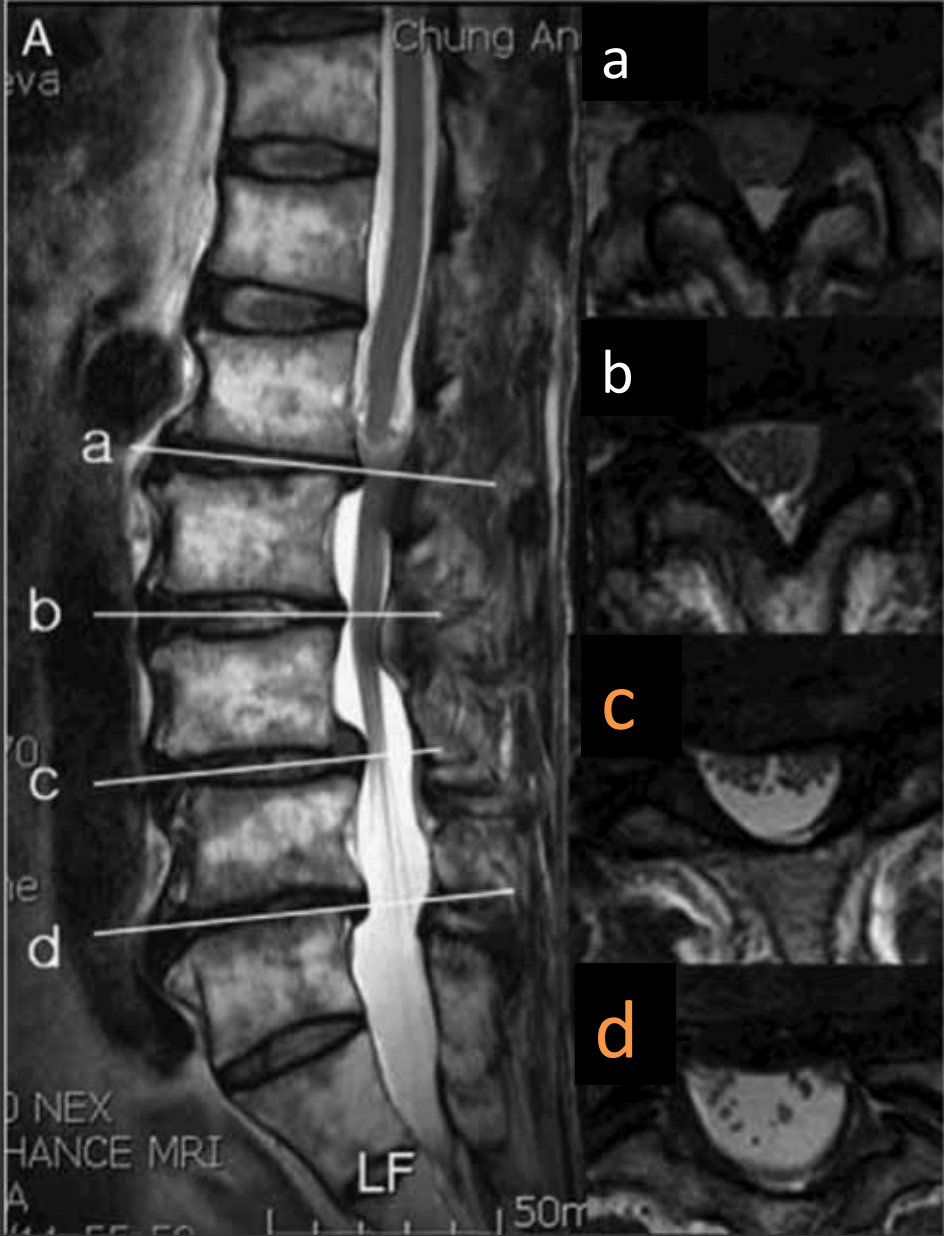
4-sided contact with compression/
distortion of nerve root



2-sided contact with compression/
distortion of nerve root

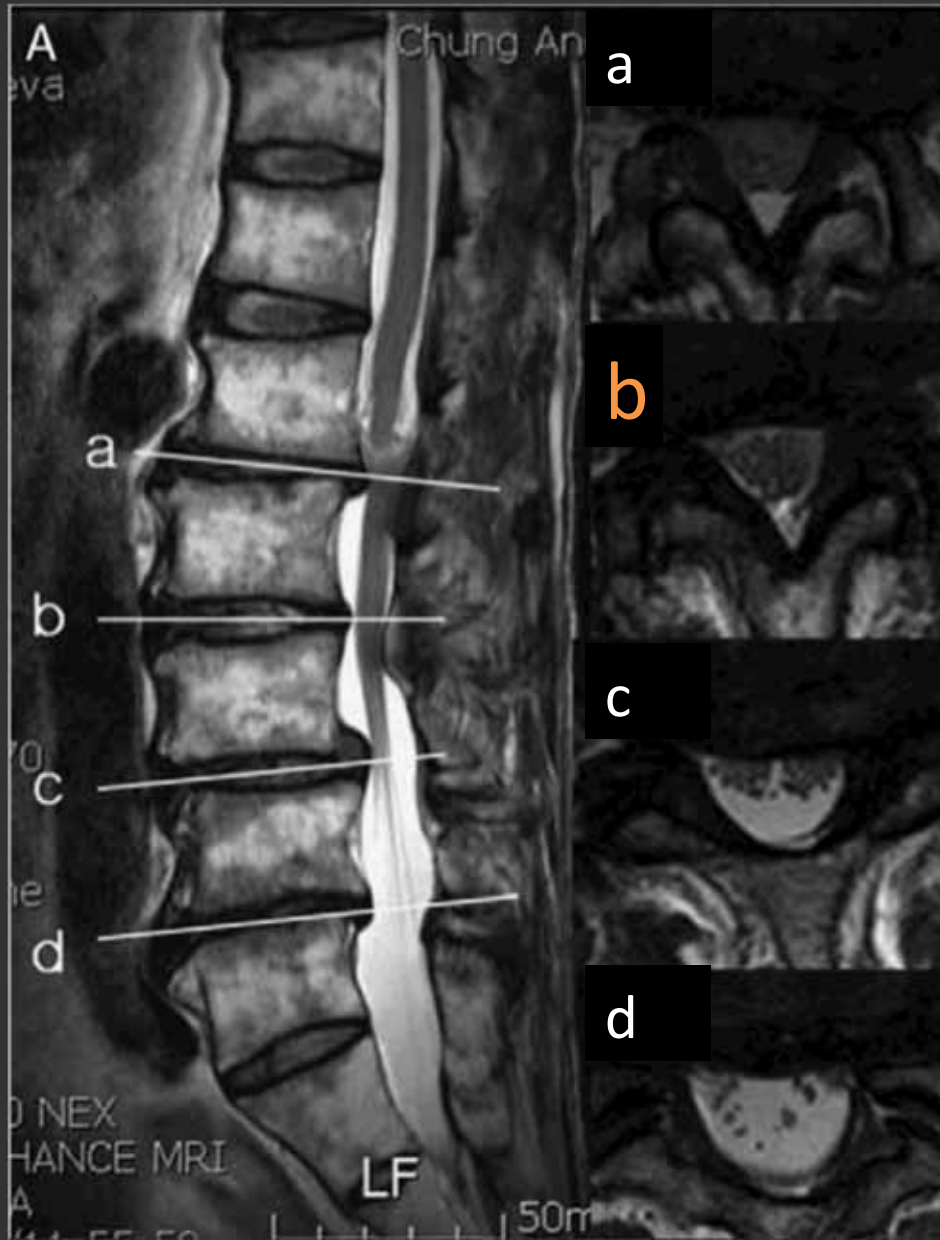
Song *et al.* (2008) grading system
for Central stenosis

Grade 1 (Mild)



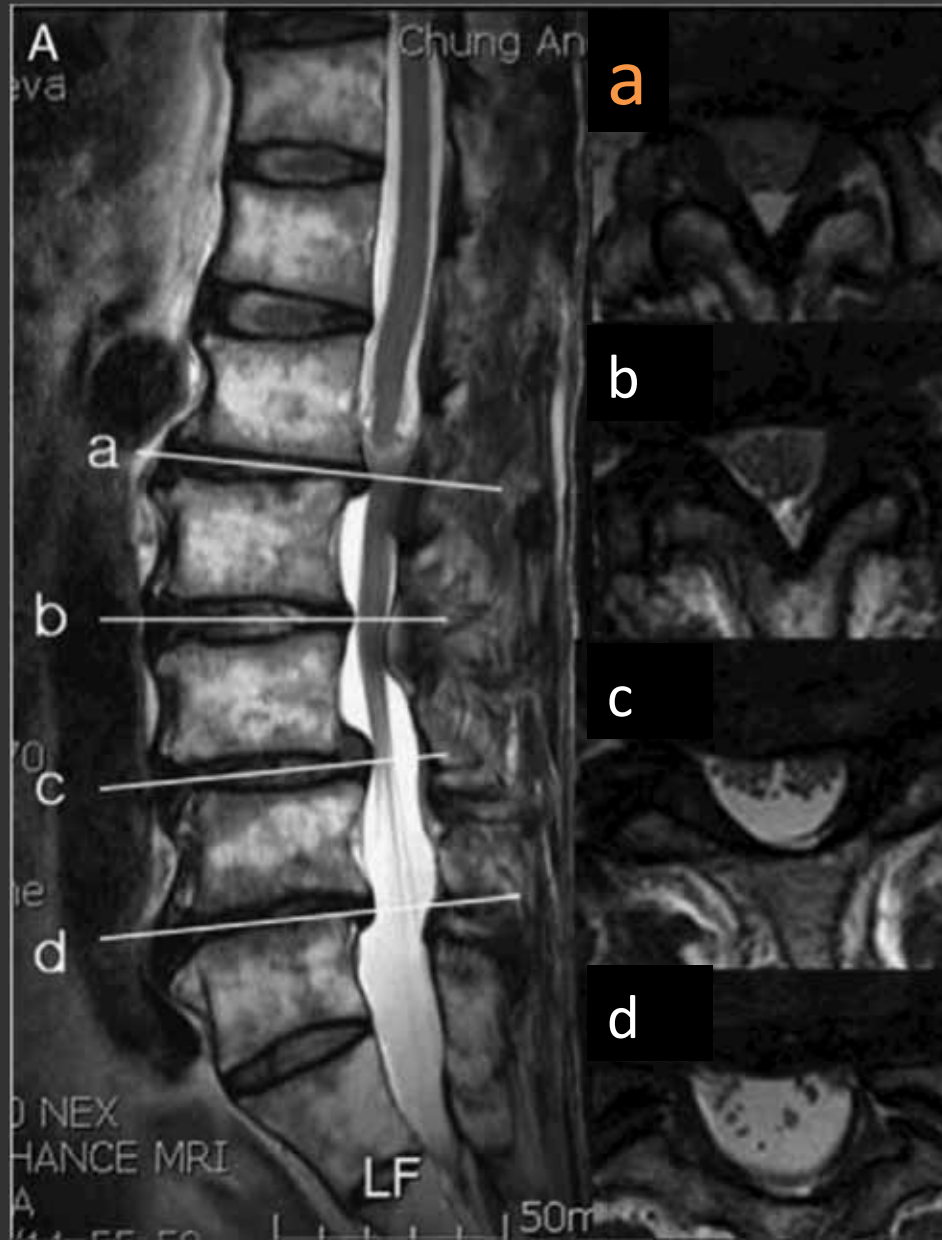
<50% of dural sac surface area occupied by nerve roots (c-d, regardless of presence or direction of compression)

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 1: Inter-Observer Agreement (Reader 1 vs Reader 2)

	Assessment Method	Statistic	3D-SPACE	2D-MRI
LCCS	<i>Song et al. Criteria</i>	kappa	0.71	0.69
	Global Clinical Assessment	kappa	0.85	0.78
LNFS	<i>Lee et al. Criteria</i>	kappa	0.54	0.37
	Global Clinical Assessment	kappa	0.23	0.28

Results Lumbar Central Canal Stenosis: Global Clinical Impression

Table 1: Inter-Observer Agreement (Reader 1 vs Reader 2)

	Assessment Method	Statistic	3D-SPACE	2D-MRI
LCCS	Song <i>et al.</i> Criteria	kappa	0.71	0.69
	Global Clinical Assessment	kappa	0.85	0.78
LNFS	Lee <i>et al.</i> Criteria	kappa	0.54	0.37
	Global Clinical Assessment	kappa	0.23	0.28

Results Lumbar Neural Foraminal Stenosis: Inter-Observer Agreement

Table 1: Inter-Observer Agreement (Reader 1 vs Reader 2)

	Assessment Method	Statistic	3D-SPACE	2D-MRI
LCCS	Song <i>et al.</i> Criteria	kappa	0.71	0.69
	Global Clinical Assessment	kappa	0.85	0.78
LNFS	Lee <i>et al.</i> Criteria	kappa	0.54	0.37
	Global Clinical Assessment	kappa	0.23	0.28

Results: Inter-Sequence

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

	Assessment Method	Statistic	3D-SPACE	2D-MRI
LCCS	Song <i>et al.</i> Criteria	kappa	0.75	0.54
	Global Clinical Assessment	kappa	0.78	0.85
LNFS	Lee <i>et al.</i> Criteria	kappa	0.51	0.41
	Global Clinical Assessment	kappa	0.63	0.66

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

- Markman JD, Gaud KG. Lumbar spinal stenosis in older adults: Current understanding and future directions. *Clin Geriatr Med.* 2008; 24:369-88.
- Chou R, Deyo RA, Jarvik JG. Appropriate use of lumbar imaging for evaluation of low back pain. *Radiol Clin North Am.* 2012; 50:569-85.
- Song KS, Jang EC, Jung HJ, et al. Observer variability in the evaluation of multiple lumbar stenosis by routine MR--myelography and MRI. *Journal of Spinal Disorders & Techniques.* 2008; 21:569-74.
- Sim J, Wright CC. The kappa statistic in reliability studies: Use, interpretation, and sample size requirements. *Phys Ther.* 2005; 85:257-68.
- Schizas C, Kulik G. Decision-making in lumbar spinal stenosis: A survey on the influence of the morphology of the dural sac. *J Bone Joint Surg Br.* 2012; 94:98-101.
- Lee S, Lee JW, Yeom JS et al . A Practical MRI Grading System for Lumbar Foraminal stenosis. *AJR.* 2010, 1095-98.