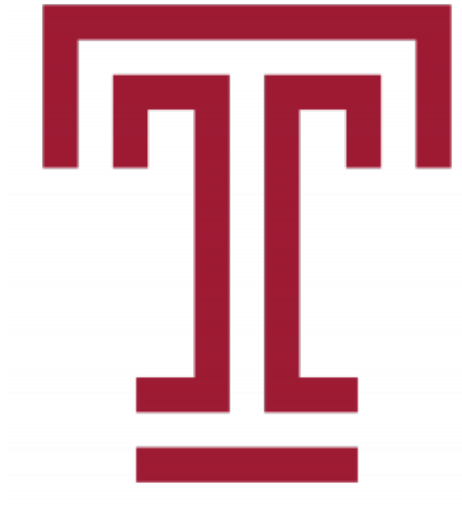


Effectiveness of Utilizing Supine MRI for Diagnosis of Lumbar Vertebral Instability in Spondylolisthesis

Ryan Hafner, MD
 Andrew Lowery, BS
 Akul Patel, MD
 Bridget Slattery, BS, MHS
 Frederick Ramsey, PhD
 Theresa Pazonis, MD
 Temple University Hospital
 Philadelphia, PA



Zeeshan Sardar, MD
 NY Presbyterian Hospital
 Columbia University
 New York, NY

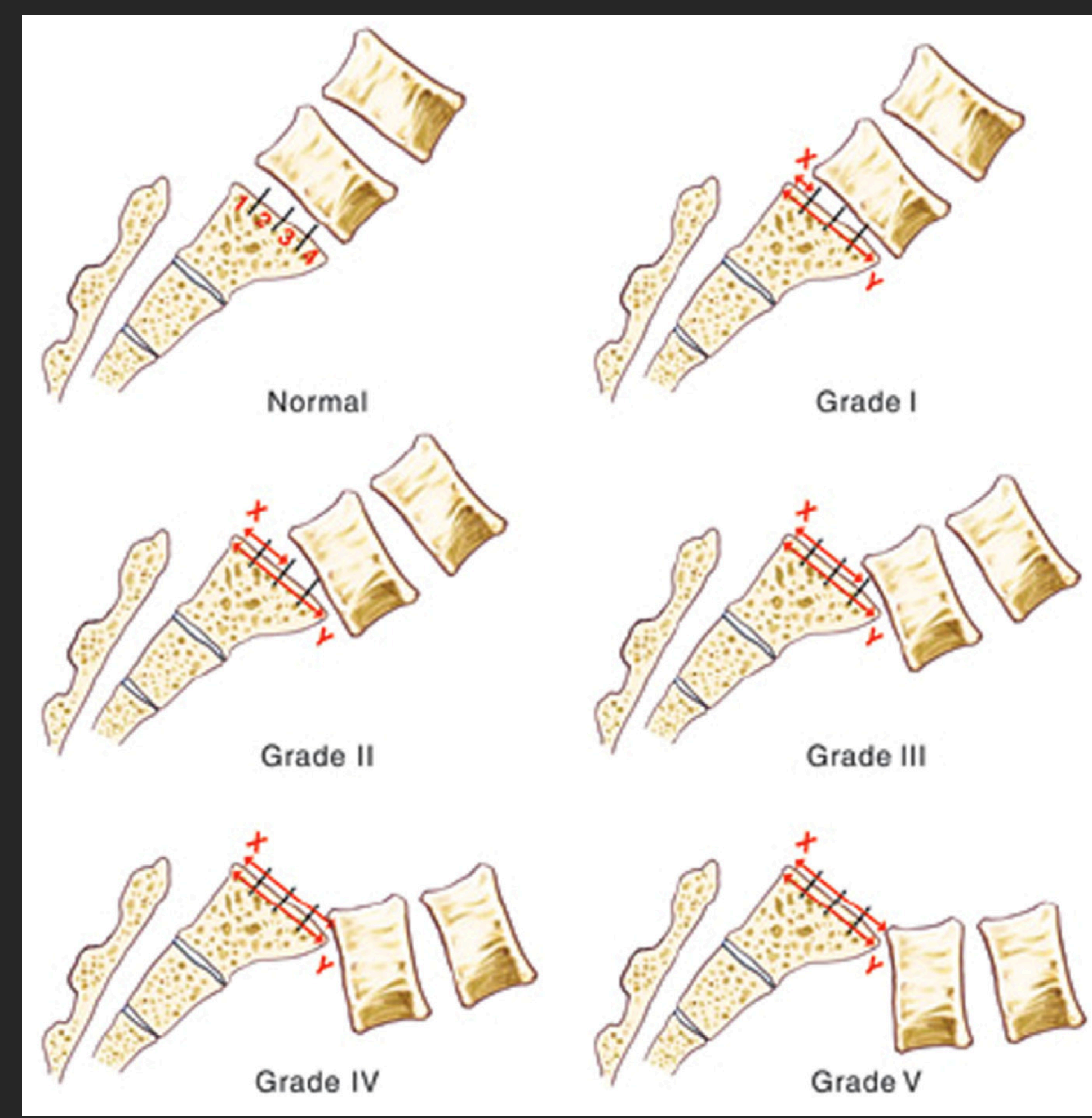


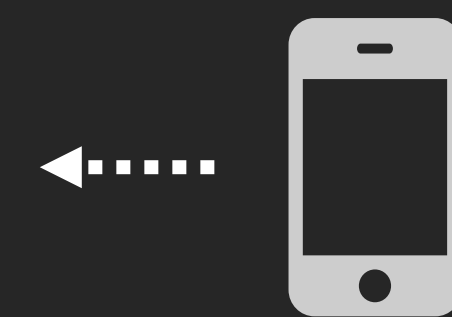
Figure 1. Meyerding grading (per Mai, et al)⁴

Location of Spondylolisthesis	Reviewer 1 Data			Reviewer 2 Data		
	MRI Superior	Neither Superior	Flex-Ex Superior	MRI Superior	Neither Superior	Flex-Ex Superior
L3-L4	3	2	0	3	2	0
L4-L5	26	13	2	25	15	4
L5-S1	4	0	0	5	0	0
Meyerding Grade						
Grade 1	25	2	13	24	4	16
Grade 2	8	0	2	9	0	1
Grade 3	0	0	0	0	0	0
Grade 4	0	0	0	0	0	0
Grade 5	0	0	0	0	0	0

Lumbar spondylolisthesis and its potential for vertebral instability can be more effectively analyzed using flexion-based radiographs in combination with supine MRI, which might be attributed to positional reduction while supine.

	Reviewer 1			p-value
	Group A	Group B	Group A and Group B difference	
Difference in Percentage Vertebral Translation (SD)	5.64 (3.56)	10.41 (5.74)	4.78 (5.62)	0.015
	Reviewer 2			p-value
	Group A	Group B	Group A and Group B difference	
Difference in Percentage Vertebral Translation (SD)	5.18 (3.15)	9.70 (5.45)	4.51 (5.54)	0.025

Superior Imaging Modality (%)	Reviewer 1		Neither Imaging Modality (%)
	Lateral Flexion and Extension Radiographs (%)	Lateral Flexion Radiograph and Supine MRI (%)	
2 (4)	33 (66)	15 (30)	
Superior Imaging Modality (%)	Reviewer 2		
	4 (7.41)	33 (61.11)	17 (31.48)



Take a picture to read more about spondylolisthesis on the American Academy of Orthopaedic Surgeons (AAOS) website.

INTRODUCTION

- Spondylolisthesis (is defined as the “slipping (-olisthesis) of a vertebra (spondylos) relative to an adjacent vertebra.”¹
- Symptoms can be difficult to distinguish from non-specific low back pain but patients can variably present with low back pain, radiculopathy, paresthesias, weakness, and most importantly, stenotic complications such as bowel and bladder dysfunction from cauda equina syndrome, which affect quality of life.²
- It can be classified based on underlying etiology: degenerative (most common), isthmic, traumatic, pathologic, and dysplastic.¹
- Severity of vertebral slippage and vertebral instability on imaging can be classified via the Meyerding technique, by measuring the movement of one vertebral body over the superior endplate of the inferior body.
- Treatment is typically conservative with rest and physical therapy but the degree of vertebral instability and severity of symptoms can warrant surgical correction.
- Current diagnostic gold standard includes using a combination of flexion and extension lateral lumbar radiographs to evaluate slippage.
- Our hypothesis** is that lateral flexion lumbar radiograph combined with supine lumbar magnetic resonance imaging (MRI) will be superior to the gold standard for detecting vertebral instability.

METHODS

- The study is a retrospective cross-sectional chart review analysis of patients who had ICD-10 coding of degenerative spondylolisthesis (M43.16) along with both flexion-extension lateral lumbar X-ray and supine MRI imaging within six months.
- Patients with prior spinal surgery, high-grade slippage (Meyerding grade V), and those without any apparent slippage or pertinent imaging were excluded.
- Two independent reviewers used Meyerding technique and analyzed the percent displacement in all images for inter-rater reliability; flexion-based X-ray vs. extension-based X-ray displacement (Group A) was compared with flexion-based X-ray vs. supine MRI displacement (Group B).
- Relative differences of displacement between the two groups were calculated; a 3% difference was considered significantly better to demonstrate vertebral instability.

RESULTS

- 107 patients were screened to have the appropriate ICD-10 coding for the study; 57 and 53 patients were excluded by each independent reviewer based on previous criteria.
- See Table 1 for complete data.
- For reviewer #1:
 - 33 out of 50 patients (66%) demonstrated greater instability (>3% relative difference) on flexion X-ray vs. supine MRI and 2 patients (4%) showed more instability on flexion vs. extension X-ray imaging.
- For reviewer #2:
 - 33 out of 54 patients (61%) showed greater instability with supine MRI and 4 patients (7%) showed more instability with extension X-ray imaging.
- Results between both reviewers were similar with Intraclass Correlation Coefficient = 0.73.
- When comparing the two groups, flexion lumbar X-ray in combination with supine MRI was superior at detecting vertebral instability in the setting of spondylolisthesis when compared to flexion X-ray in combination with extension lumbar X-ray imaging ($p < 0.05$ for both reviewers).

DISCUSSION

- Our results may suggest that the current gold standard of flexion and extension lumbar X-ray imaging to evaluate spondylolisthesis possibly underestimate the degree of vertebral instability in patients.
- The strong inter-rater reliability findings strengthen the findings of the study.
- The ability to detect and monitor vertebral instability in the setting of spondylolisthesis is critical to prevent worsening neurologic impairment and identify those patients who may benefit from surgical intervention, such as lumbar decompression with fusion.
- Limitations of the study include:
 - the technical and procedural differences between plain radiographic and magnetic resonance imaging, as patients may have positional reduction with MRI
 - limited sample size
 - inability to correlate increase in vertebral instability seen with supine MRI and clinical outcomes
 - the retrospective nature of the study

CONCLUSION

- The severity of spondylolisthesis, with its potential for dynamic changes, must be assessed accordingly in the best possible protocols that allow for dynamic change to occur.
- The gold standard of flexion vs. extension-based X-ray imaging may not be the optimal protocol to assess vertebral instability.
- As described above, the simple positional reduction allowed by MRI may have allowed better dynamic changes.
- Given the current cost of MRI usage, other studies are currently evaluating the effectiveness of using supine lateral radiographs in place of extension-based standing X-rays with promising results.³

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