

# Back Pain and MRI: The Whens, Whats and Whys

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Shields Health Care Group

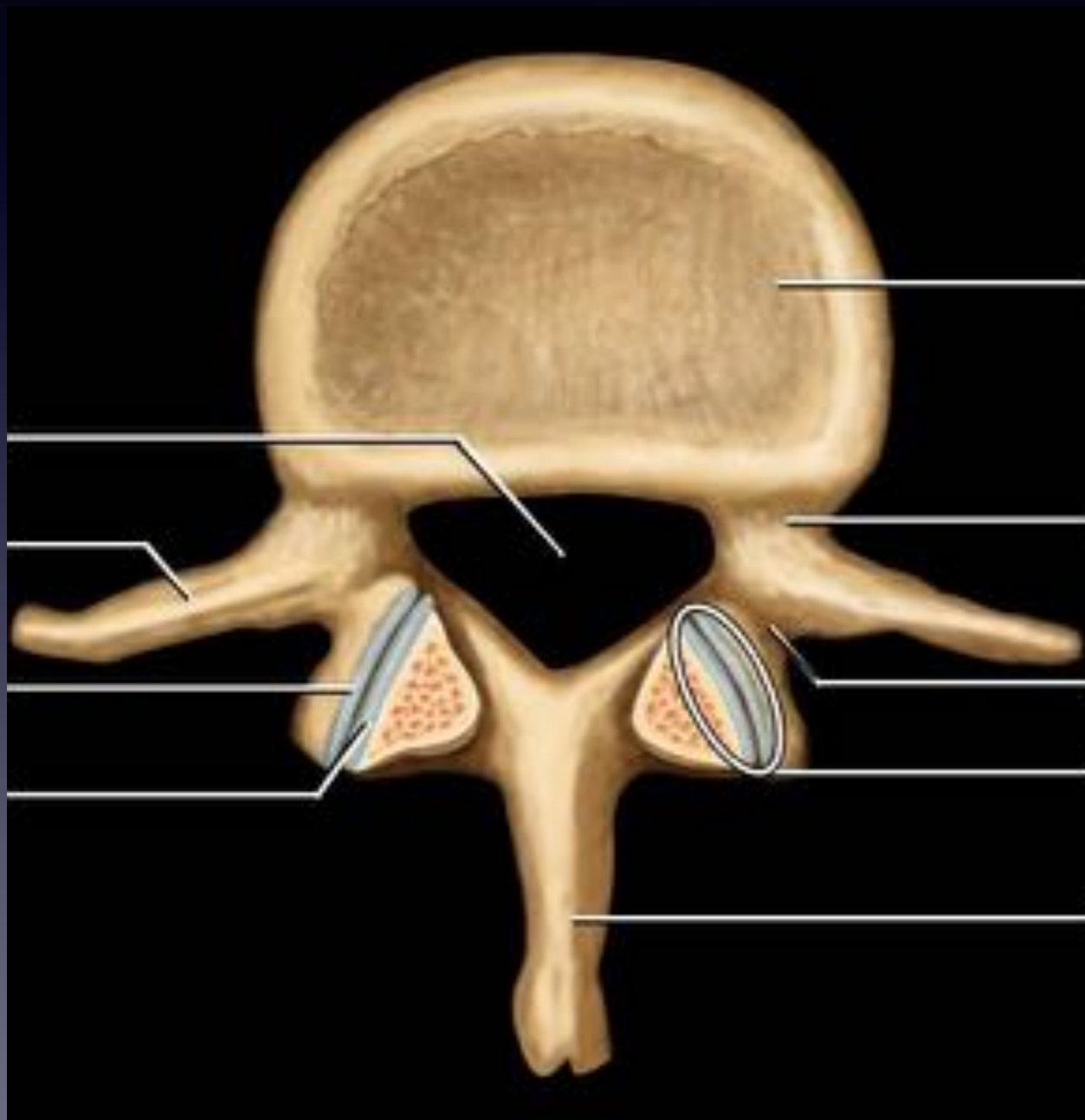


November 2018

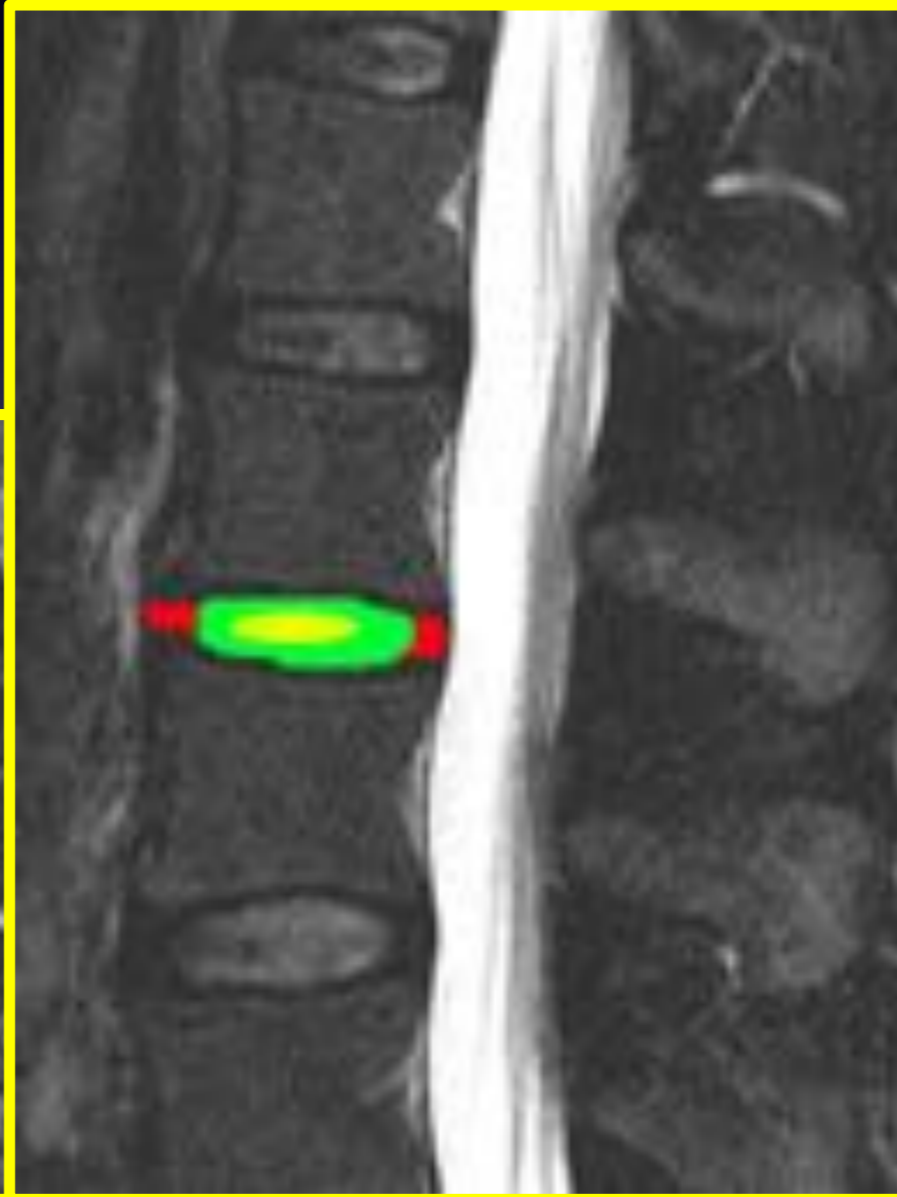
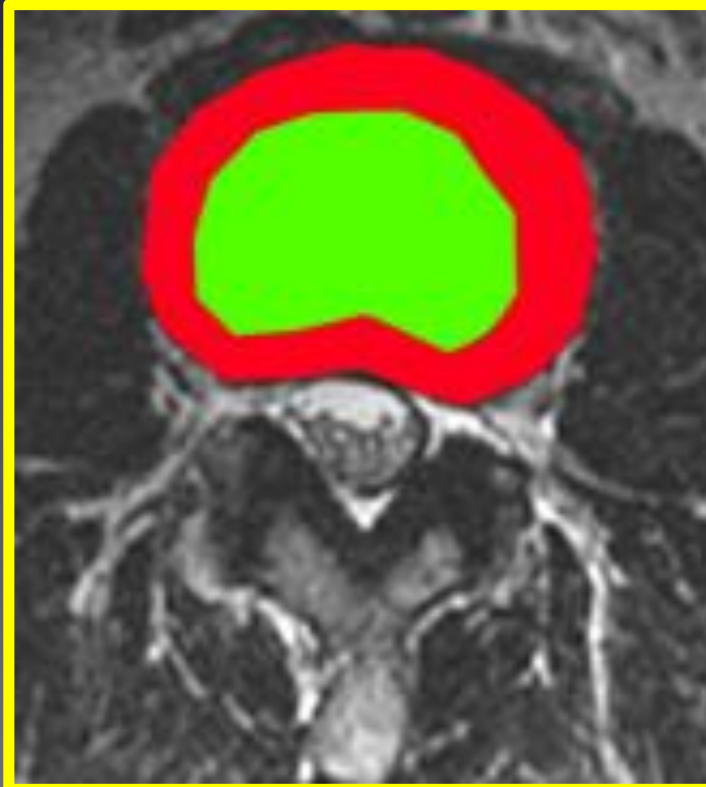
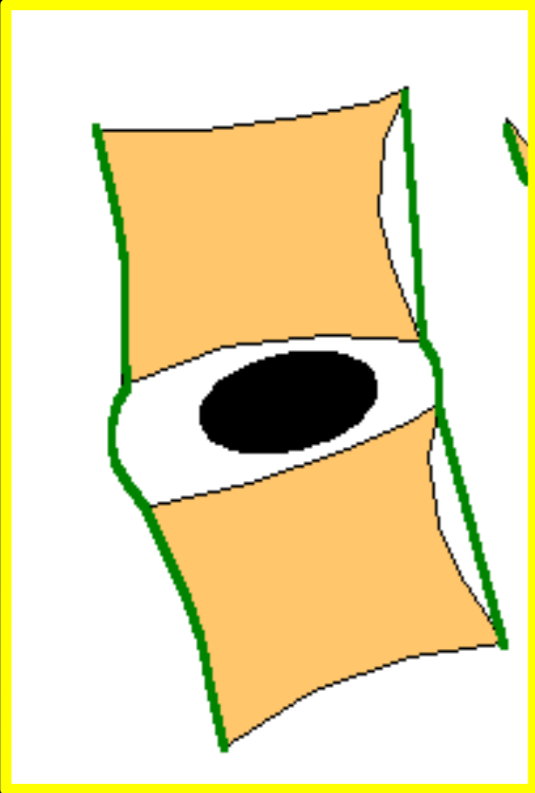
# Objectives

- Quick review of lumbar spine anatomy focusing on MRI
- Introduce American College of Radiology Appropriateness Criteria for Imaging of Low Back Pain
- **WHEN DO WE IMAGE, WHY A PARTICULAR MODALITY, WHAT ARE WE LOOKING FOR -**  
Case Based Approach to Spine Imaging

# Anatomy



# Normal Disc

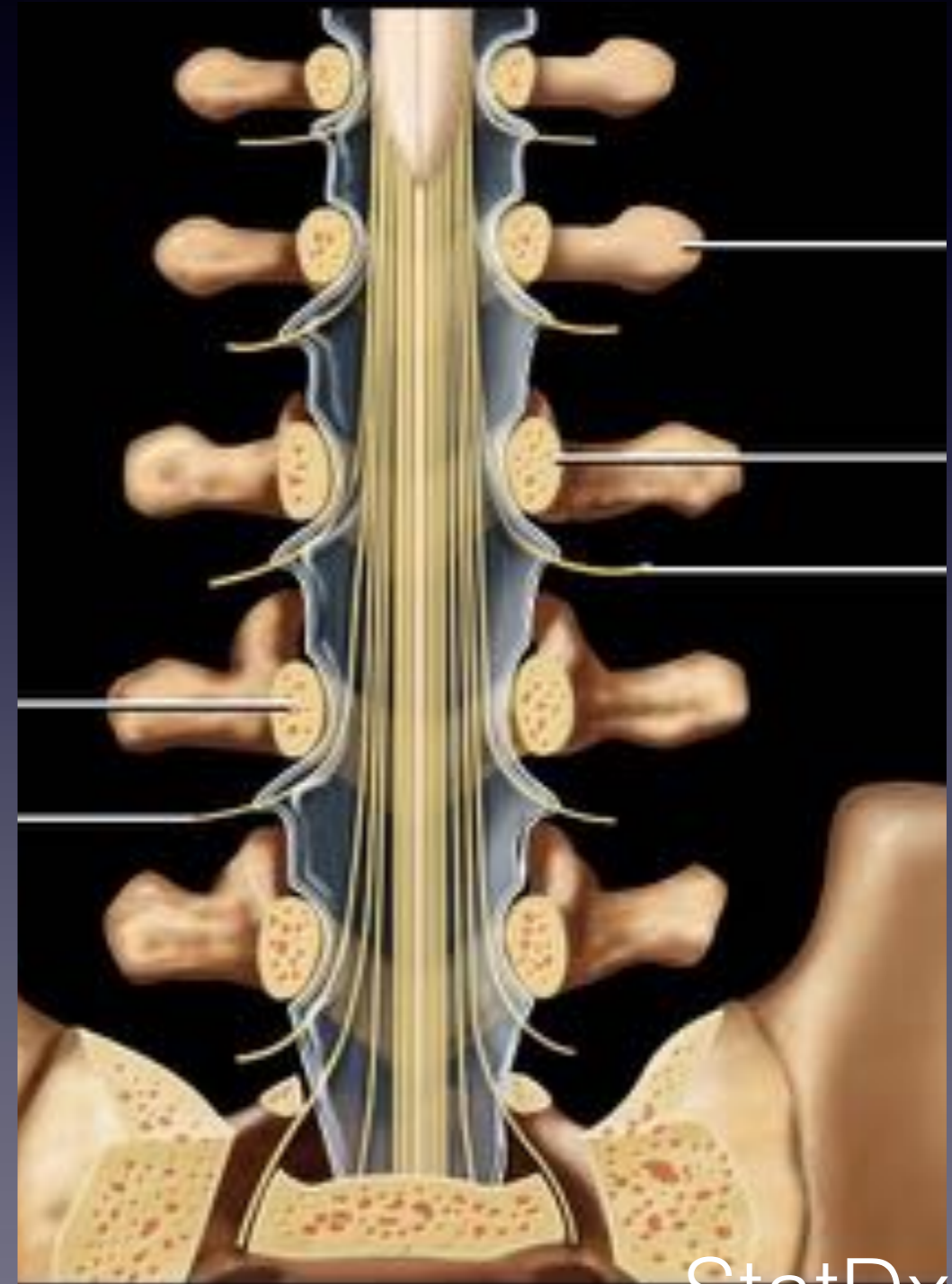
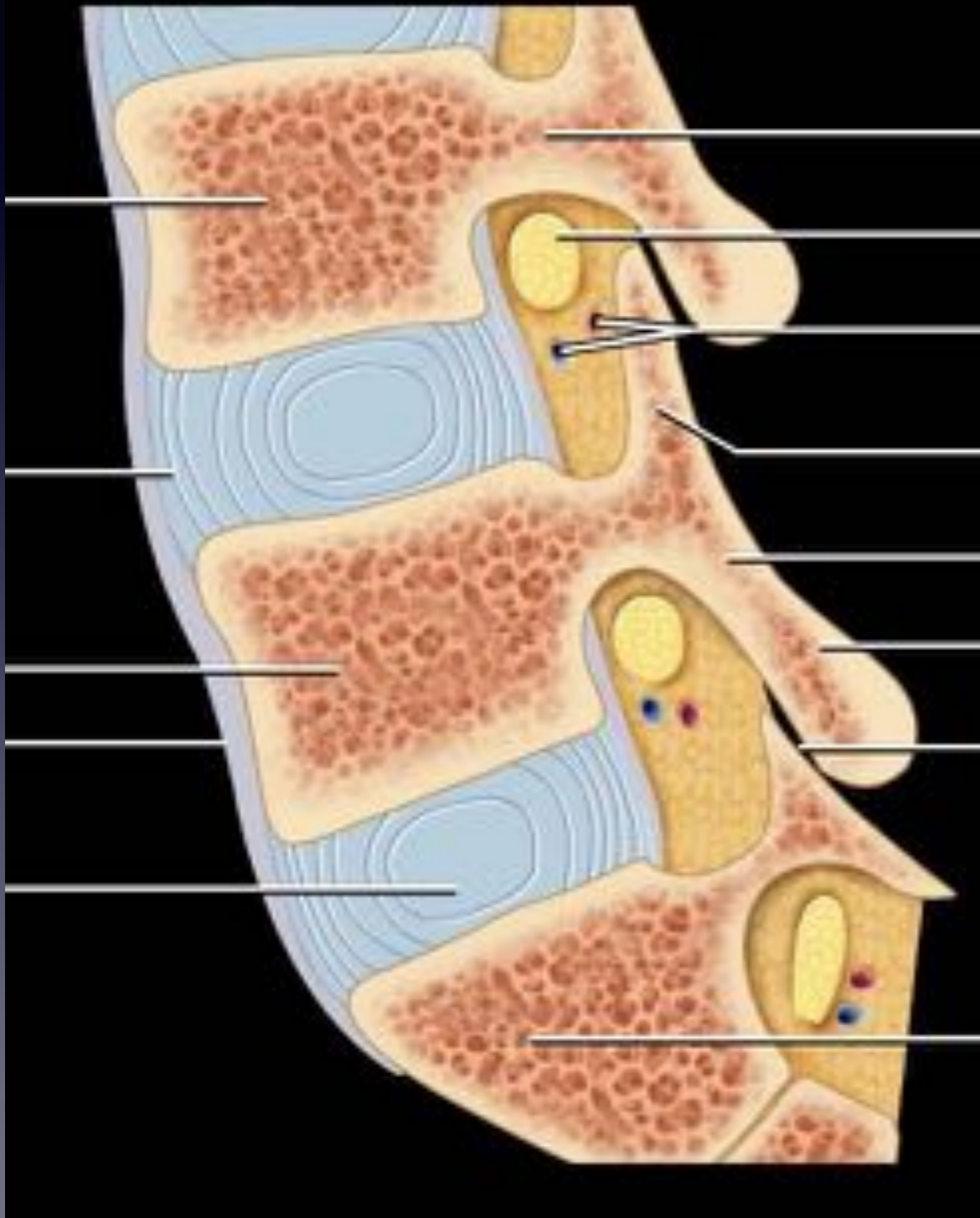




# Anatomy

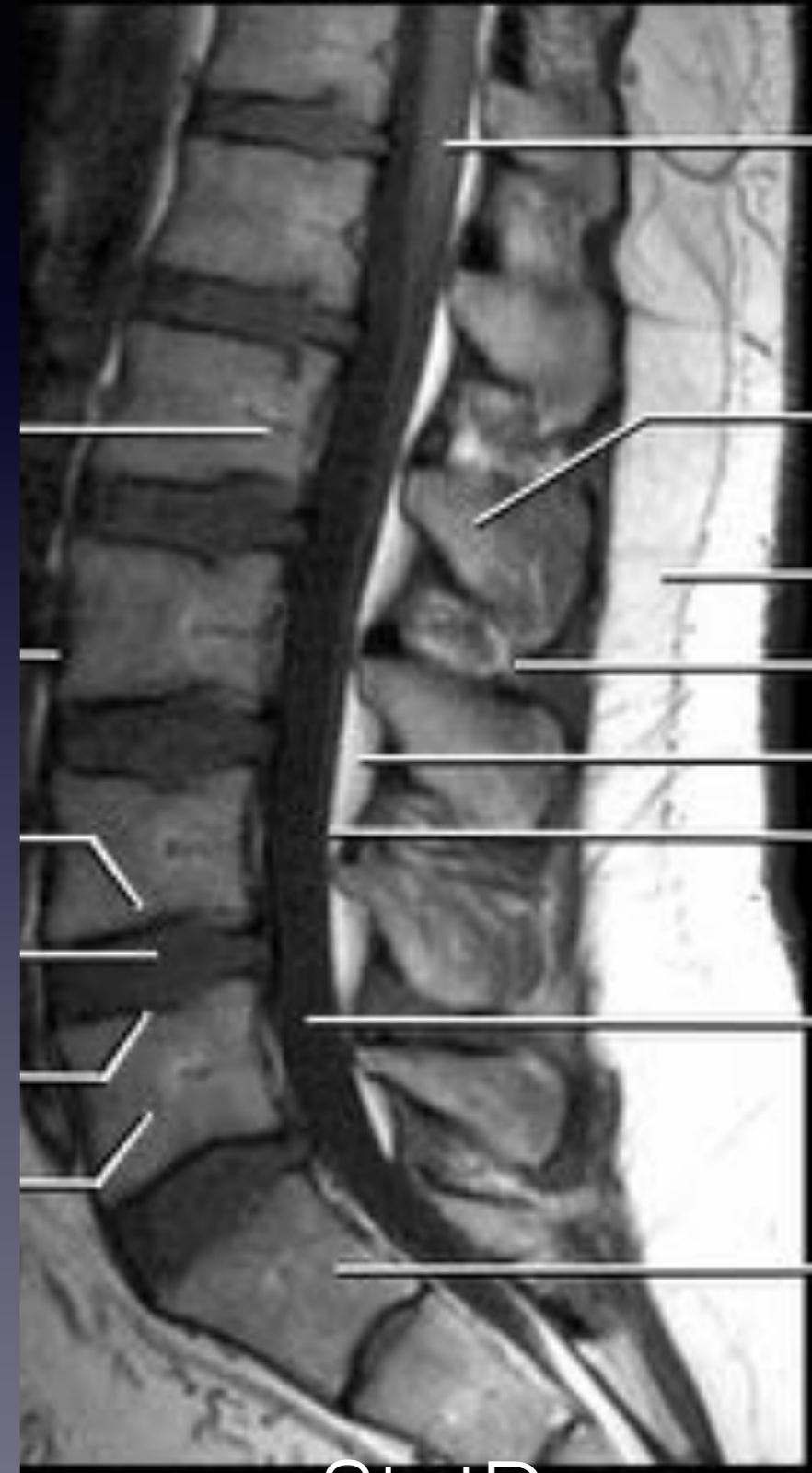
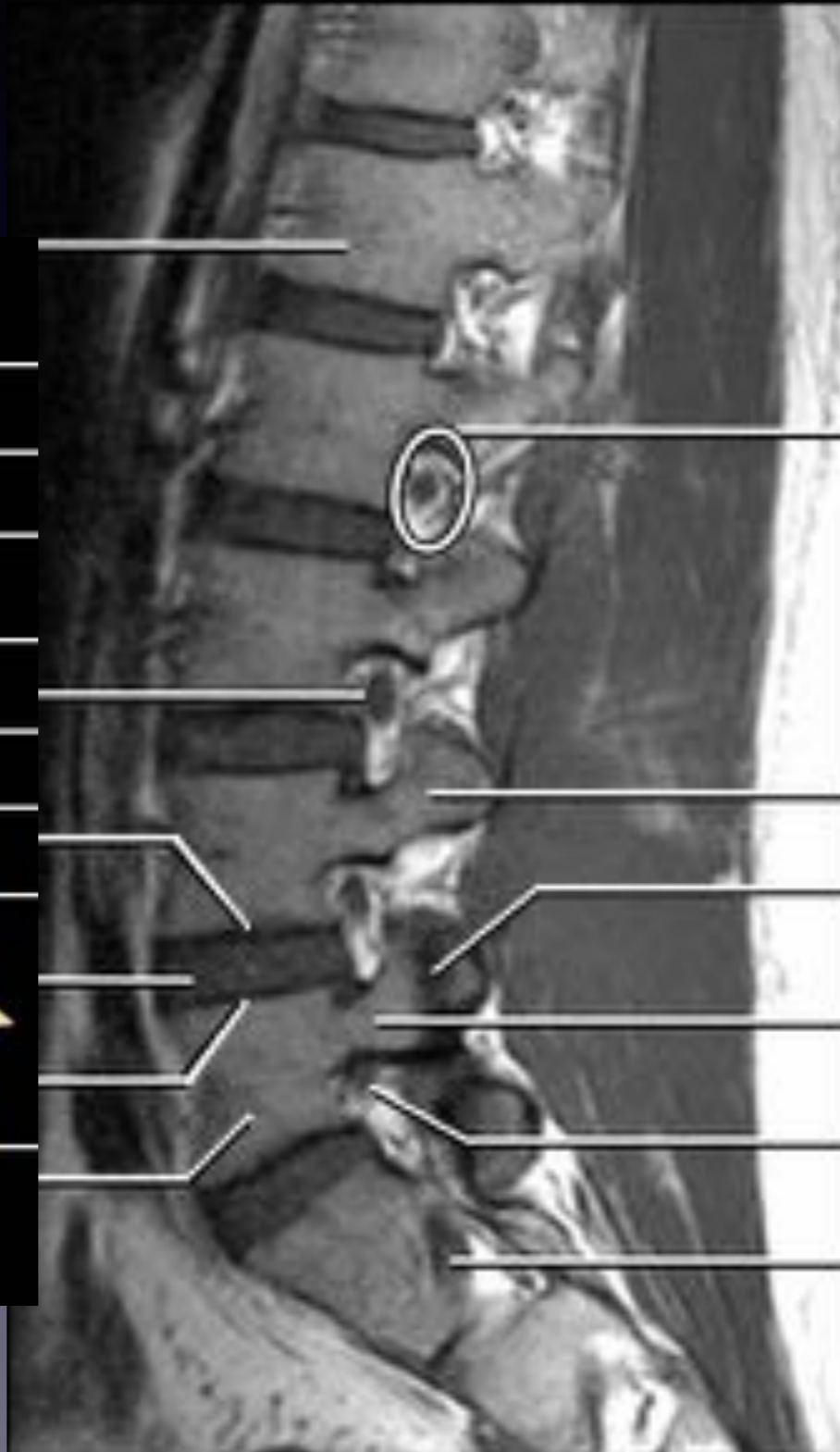
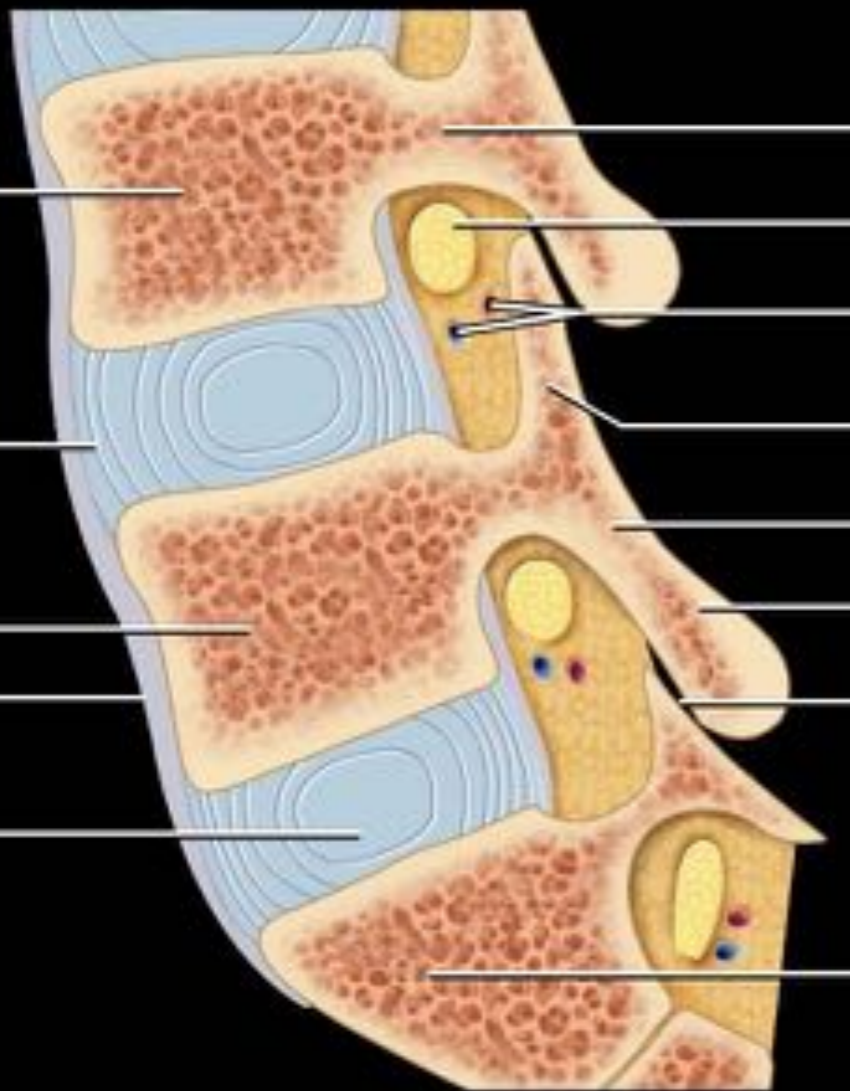


# Anatomy

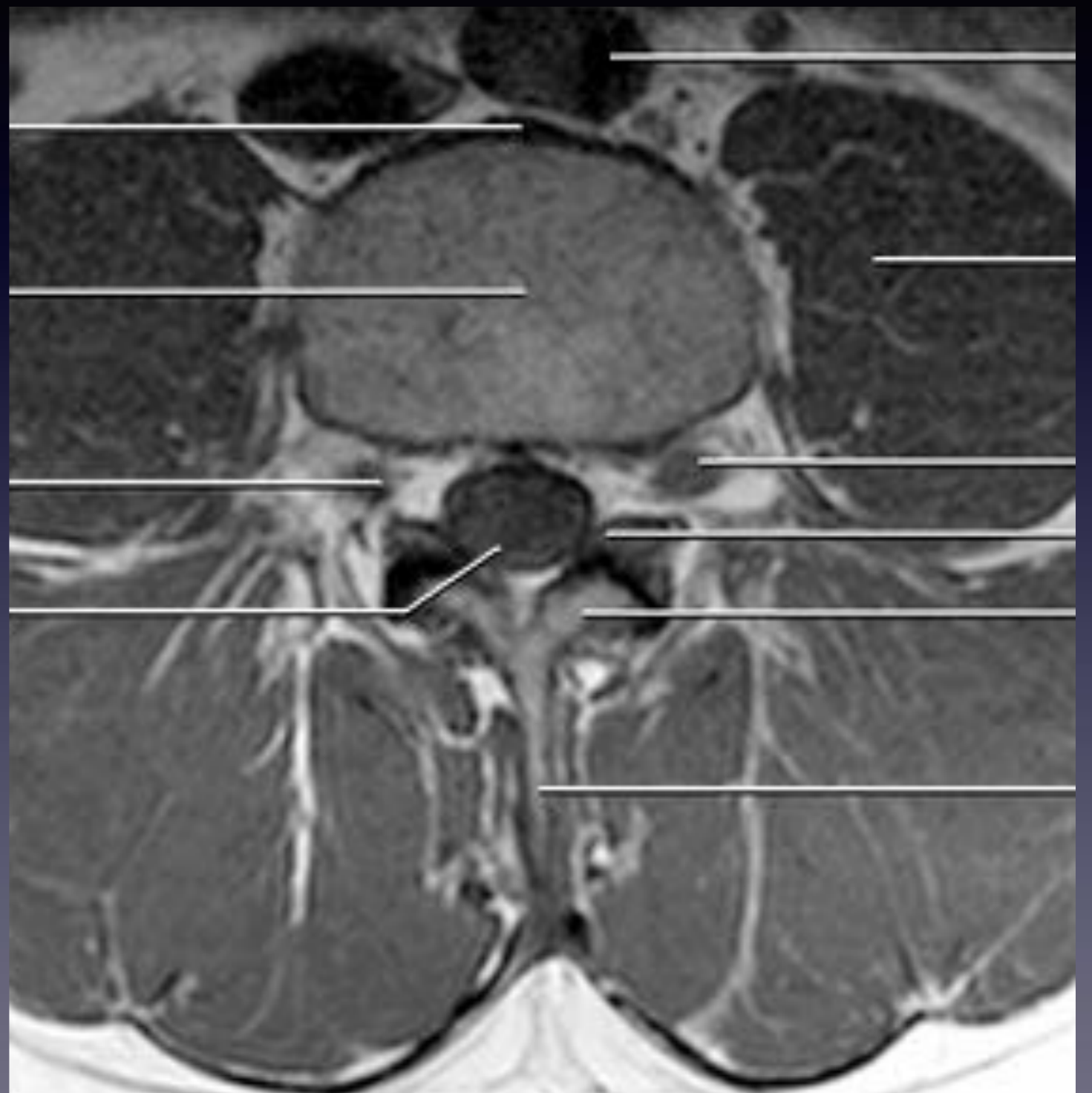
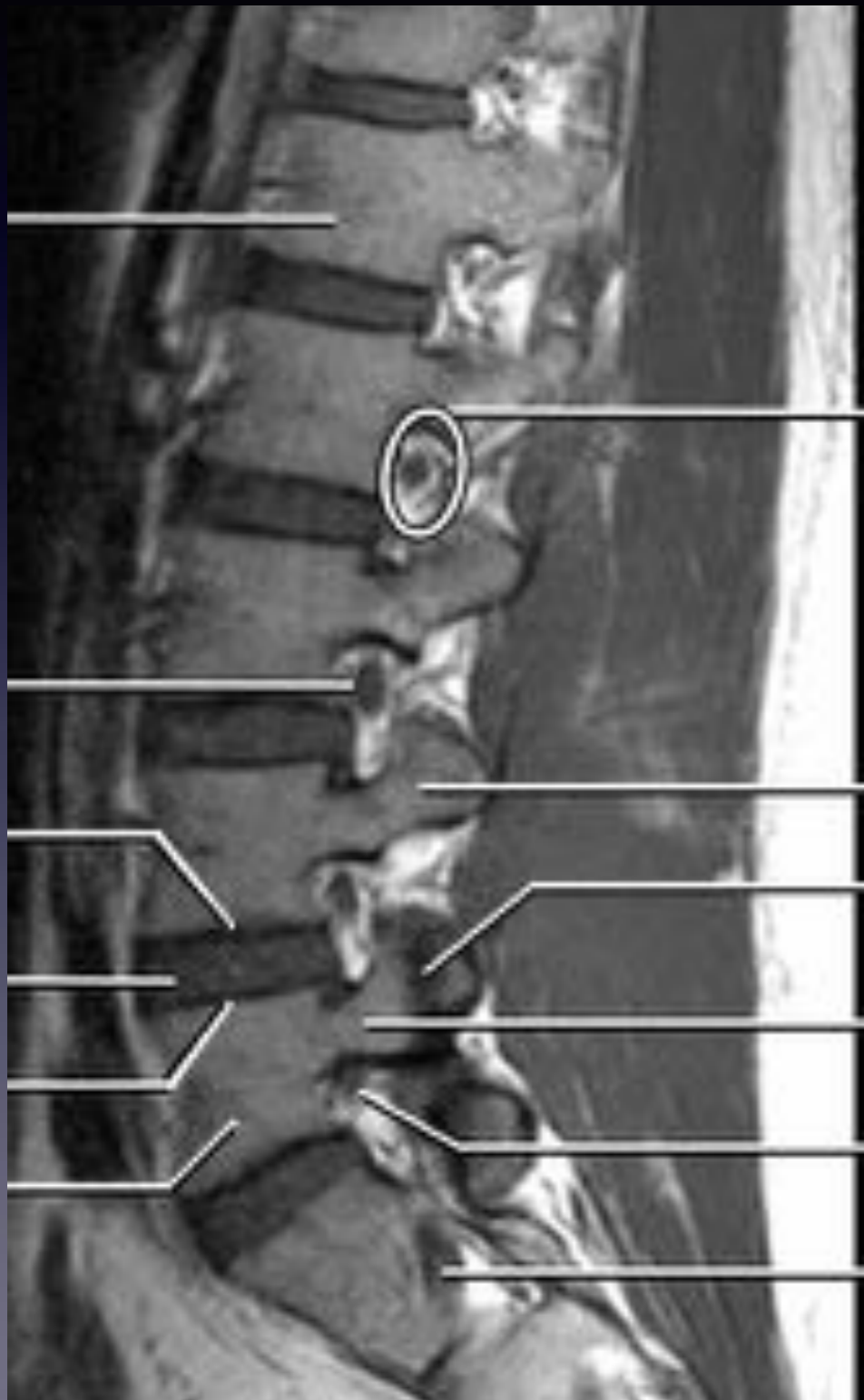




# Anatomy

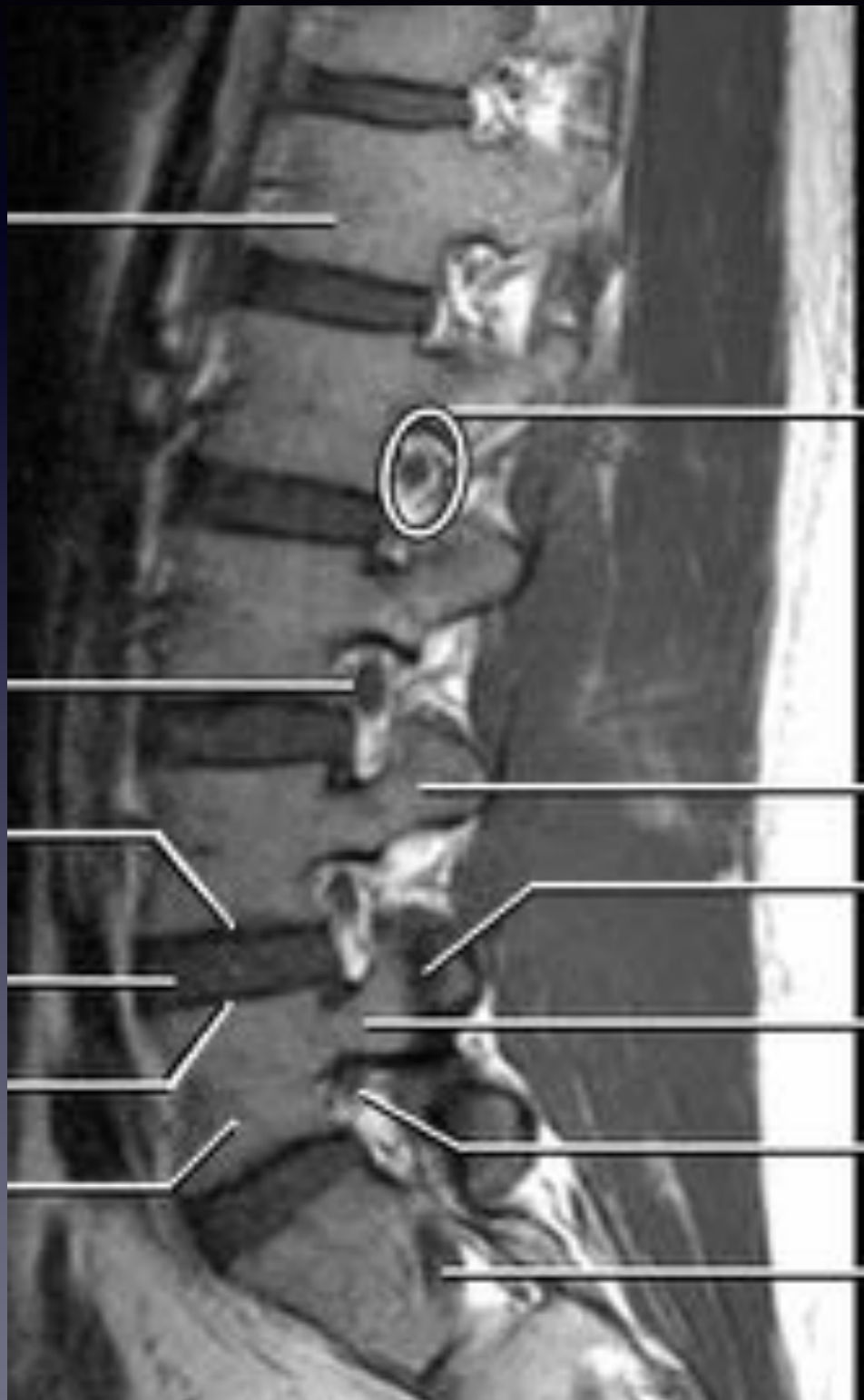


# Anatomy





# Anatomy



# American College of Radiology Appropriateness Criteria



[s://www.acr.org/Clinical-Resources/ACR-Appropriateness-Criteria](https://www.acr.org/Clinical-Resources/ACR-Appropriateness-Criteria)

# American College of Radiology Appropriateness Criteria

- The ACR Appropriateness Criteria® are evidence-based guidelines funded solely by the American College of Radiology to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition. By employing these guidelines, providers enhance quality of care and contribute to the most efficacious use of radiology.



# American College of Radiology Appropriateness Criteria

- In June 2016, the Centers for Medicare & Medicaid Services (CMS) named the American College of Radiology (ACR) a “qualified Provider-Led Entity” (qPLE) approved to provide appropriate use criteria (AUC) under the Medicare Appropriate Use Criteria program for advanced diagnostic imaging. This means that medical providers can consult ACR Appropriateness Criteria to fulfill impending Protecting Access to Medicare Act (PAMA) requirements that they consult AUC prior to ordering advanced diagnostic imaging for Medicare patients.

# Case 1

- 44 year old male with 2 week history of back pain following a sudden twisting at work. Pain extends to buttocks. What is most appropriate step regarding imaging?
  - Image with MRI immediately since there is radicular pain
  - Start with conservative treatment for 6-8 weeks
  - Check for “red flags” before making decision
  - Image with CT scan to look for fracture

# Disc bulges, protrusions, annular fissures (maybe normal aging spine)





# Check for Red Flags

**Table 1. Red Flags:** Indications of a more complicated status include back pain/radiculopathy in the following settings (adapted from [7]).

Red Flag	Potential Underlying Condition as Cause of LBP
<ul style="list-style-type: none"><li>• History of cancer</li><li>• Unexplained weight loss</li><li>• Immunosuppression</li><li>• Urinary infection</li><li>• Intravenous drug use</li><li>• Prolonged use of corticosteroids</li><li>• Back pain not improved with conservative management</li></ul>	<ul style="list-style-type: none"><li>• Cancer or infection</li></ul>
<ul style="list-style-type: none"><li>• History of significant trauma</li><li>• Minor fall or heavy lift in a potentially osteoporotic or elderly individual</li><li>• Prolonged use of steroids</li></ul>	<ul style="list-style-type: none"><li>• Spinal fracture</li></ul>
<ul style="list-style-type: none"><li>• Acute onset of urinary retention or overflow incontinence</li><li>• Loss of anal sphincter tone or fecal incontinence</li><li>• Saddle anesthesia</li><li>• Global or progressive motor weakness in the lower limbs</li></ul>	<ul style="list-style-type: none"><li>• Cauda equina syndrome or severe neurologic compromise</li></ul>

# Imaging Appropriate? No

Last review date: 2015

## American College of Radiology ACR Appropriateness Criteria®

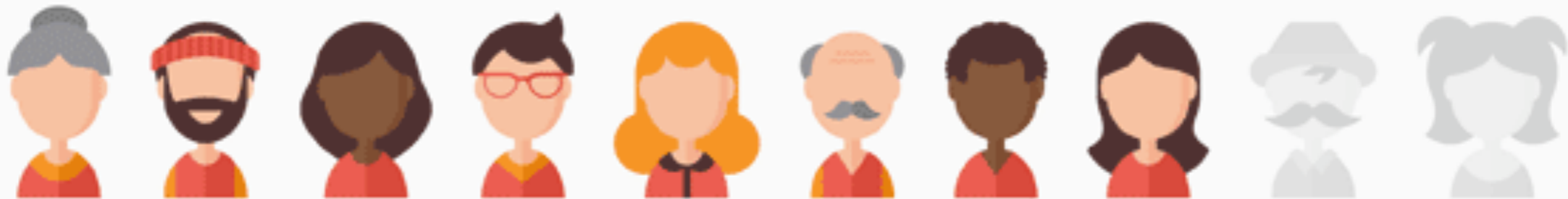
**Clinical Condition:** Low Back Pain

**Variant 1:** Acute, subacute, or chronic uncomplicated low back pain or radiculopathy. No red flags. No prior management.

Radiologic Procedure	Rating	Comments	RRL*
MRI lumbar spine without IV contrast	2		○
X-ray lumbar spine	2		☆☆☆
CT myelography lumbar spine	2		☆☆☆☆
Tc-99m bone scan with SPECT spine	2	If there is concern for spondylolysis in a young patient, SPECT/CT remains the gold standard.	☆☆☆
CT lumbar spine without IV contrast	2		☆☆☆
CT lumbar spine with IV contrast	2		☆☆☆
MRI lumbar spine without and with IV contrast	2		○
CT lumbar spine without and with IV contrast	1		☆☆☆☆
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

# What if we image everybody?

Approximately 8 out of Every 10 Americans Will Experience a Back Problem at Some Point During Their Lifetimes

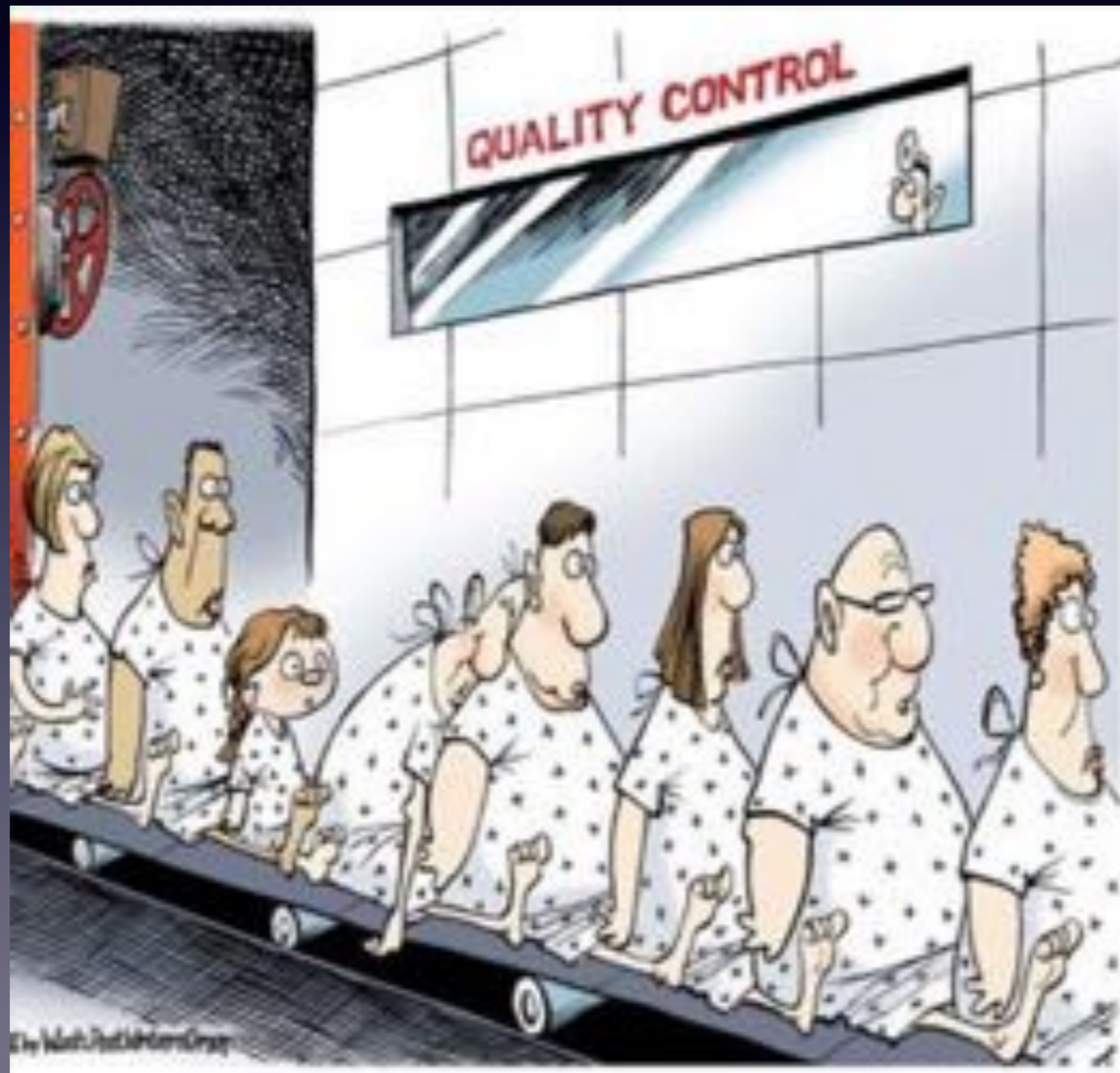


Source: <http://www.webmd.com/back-pain/america-asks-13/12-back-pain-tips>

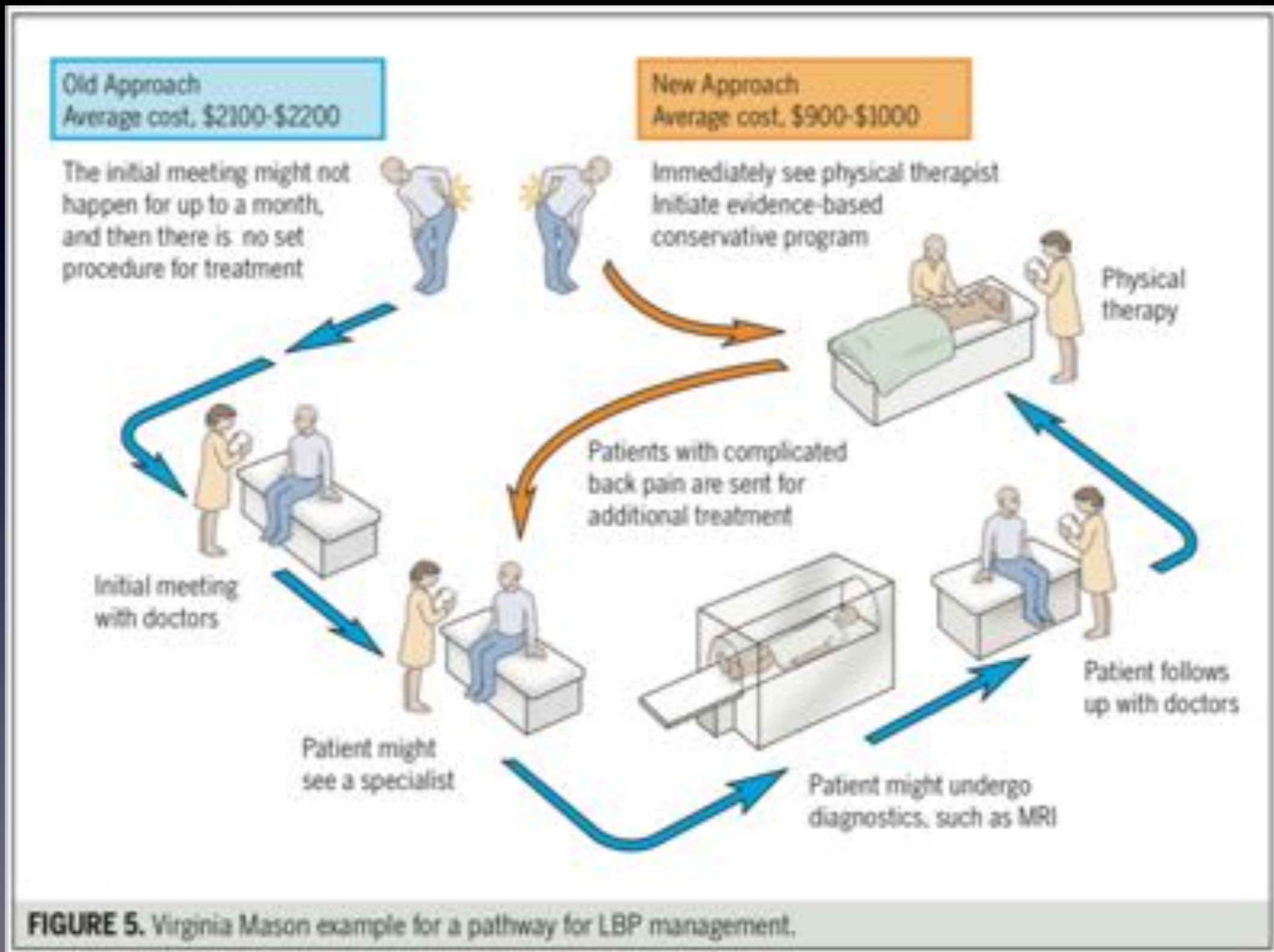
*Arch Intern Med.* 2009 February 9; 169(3): 251–258



What if we image everybody?



# Why not image everybody?





# Up to one half of spine imaging is 'inappropriate'

## Analysis of Appropriateness of Outpatient CT and MRI Referred From Primary Care Clinics at an Academic Medical Center: How Critical Is the Need for Improved Decision Support?

Bruce E. Lehnert, MD<sup>a</sup>, Robert L. Bree, MD, MHSA<sup>a,b</sup>

*J Am Coll Radiol* 2010;7:192-197. Copyright © 2010 American College of Radiology

**Table 2. Examination-specific inappropriate rates**

Examination	Number	
	Inappropriate/Total	% Inappropriate
CT head/brain	28/45	62
CT maxillofacial	5/14	36
CT spine	9/17	53
MR spine	19/55	35
MR shoulder	7/19	37
CT chest	8/67	12
CT chest/ abdomen/pelvis	3/10	30
CT abdomen/pelvis	18/102	18
Miscellaneous CT and CT angiography	6/29	21
MR brain and orbits	5/40	13
MR pelvis	1/5	20
MR knee	5/36	14
MR abdomen	1/14	7
Miscellaneous MR and MR angiography	3/6	50



# Inappropriate studies have decreased yield

**Table 3. Examples of inappropriate examination indications**

Examination	Indications
CT brain	<ul style="list-style-type: none"> <li>• Chronic headache without associated neurologic findings</li> <li>• Migraine variant</li> <li>• Family history of brain tumor</li> </ul>
CT maxillofacial	<ul style="list-style-type: none"> <li>• Simple sinusitis</li> </ul>
CT spine	<ul style="list-style-type: none"> <li>• Back pain</li> </ul>
MR spine	<ul style="list-style-type: none"> <li>• Low back pain with or without radiculopathy prior to 6 weeks of conservative therapy</li> </ul>
MR shoulder	<ul style="list-style-type: none"> <li>• Shoulder pain with no conservative therapy</li> <li>• Osteoarthritis in older patients</li> </ul>
CT chest	<ul style="list-style-type: none"> <li>• Very small lung nodules</li> <li>• Screening for cancer</li> <li>• Follow-up proven benign lesion</li> </ul>
CT abdomen/pelvis	<ul style="list-style-type: none"> <li>• One episode of microscopic hematuria during urinary tract infection</li> <li>• Follow-up of benign lesions</li> </ul>
MR knee	<ul style="list-style-type: none"> <li>• Osteoarthritis in older patients</li> </ul>

**Table 4. Outcomes of imaging for appropriate and inappropriate examinations**

Outcome	Appropriate (n = 341)	Inappropriate (n = 118)
Negative	68 (20%)	55 (47%)
Positive, unrelated	66 (19%)	28 (24%)
Positive, affected management	199 (58%)	15 (13%)
Positive, did not affect management	8 (2%)	20 (17%)

# Three-Year Incidence of Low Back Pain in an Initially Asymptomatic Cohort

## Clinical and Imaging Risk Factors

Jeffrey G. Jarvik, MD, MPH,\*†||\*\*†† William Hollingworth, PhD,\* \*\*  
Patrick J. Heagerty, PhD,§†† David R. Haynor, MD, PhD,\*||  
Edward J. Boyko, MD, MPH,‡¶||†† and Richard A. Deyo, MD, MPH†‡\*\*

**Table 3. Multivariate Cox Regression Hazard Ratios for Back Pain Prediction (n = 128, 72 events, 56 censored)**

	Hazard Ratio	95% CI
Age	1	0.99–1
Prior low back pain (>5 episodes)	1.4	0.6–2.9
Current smoker	0.6	0.3–1.3
Depression	2.3	1.2–4.4
BMI	1	1.0–1.1
Male gender	0.9	0.4–2
Baseline imaging results		
Disc extrusion	1.2	0.4–3.4
Disc protrusion	0.5	0.3–0.9
Nerve root contact	2.2	0.6–8
Central stenosis	1.9	0.8–4.8

Note. All variables included in model.

### ■ Key Points

- Depression is an important predictor of new low back pain.
- MRI findings are likely less important in predicting future back pain than psychological factors.
- New imaging findings have a low incidence.
- Disc extrusions and nerve root contact may be the most clinically important new imaging findings.
- We did not find an association between new low back pain and Type 1 endplate changes, disc degeneration, annular tears, or facet degeneration.

# Are there negatives to inappropriate imaging other than financial?

- Psychological - sense of well being is decreased in patients who have been imaged and are aware of results





# Case 2

- 45 year old female with back pain extending to left lower extremity returns after 2 month course of Physical Therapy. Back pain and extremity pain has not abated and patient thinks it has worsened. Next step?
- No imaging yet - should try a second course of P.T.
- X-ray
- MRI without contrast
- CT without contrast
- Discography and CT to see where pain is originating from

# Disc Herniation



# Imaging Appropriate?

## Yes

**Clinical Condition:**

Low Back Pain

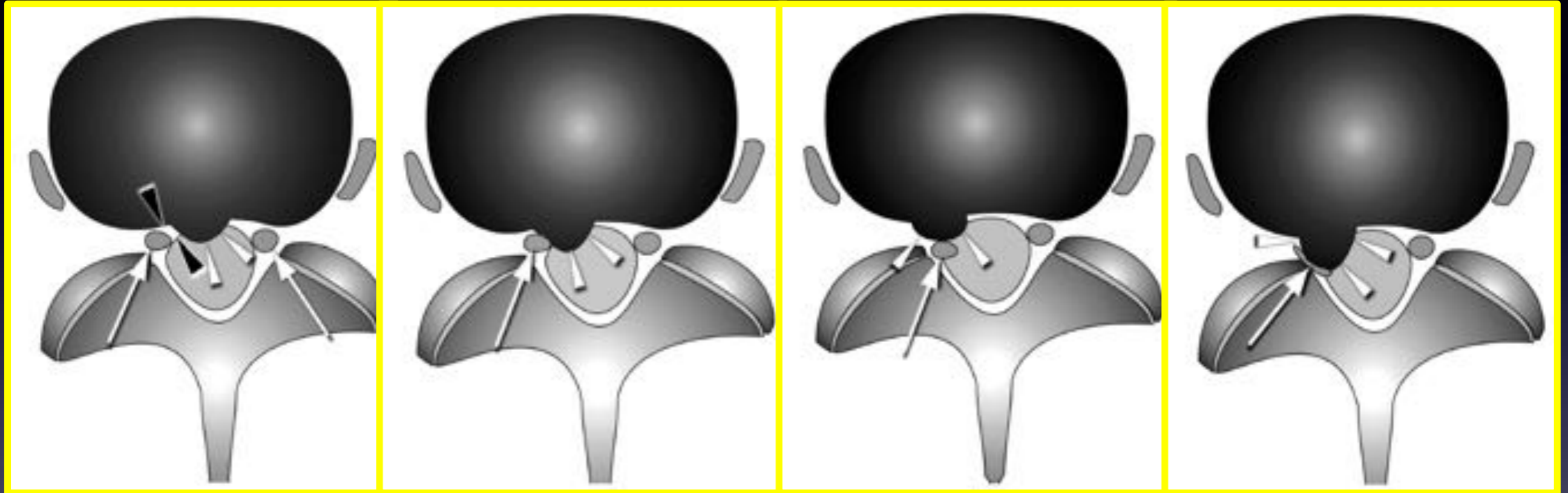
**Variant 4:**

Acute, subacute, or chronic low back pain or radiculopathy. Surgery or intervention candidate with persistent or progressive symptoms during or following 6 weeks of conservative management.

Radiologic Procedure	Rating	Comments	RRL*
MRI lumbar spine without IV contrast	8		○
CT lumbar spine with IV contrast	5	MRI is preferred. CT is useful if MRI is contraindicated or unavailable and/or for problem solving.	☻☻☻
CT lumbar spine without IV contrast	5	MRI is preferred. CT is useful if MRI is contraindicated or unavailable and/or for problem solving.	☻☻☻
MRI lumbar spine without and with IV contrast	5	This procedure is indicated if noncontrast MRI is nondiagnostic or indeterminate. Contrast is indicated if patient has history of prior lumbar surgery. See variant 5.	○
CT myelography lumbar spine	5	MRI is preferred. This procedure can be indicated if MRI is contraindicated or nondiagnostic.	☻☻☻☻
X-ray lumbar spine	4	This procedure is usually not sufficient for decision making without MR and/or CT imaging but can be helpful in surgical planning.	☻☻☻
Tc-99m bone scan with SPECT spine	4	This procedure can be particularly useful for facet arthropathy or stress fracture. SPECT/CT can be useful for anatomic localization and problem solving.	☻☻☻
Discography and post-discography CT lumbar spine	3	Although controversial, this can be useful in patients with >3 months of LBP (chronic LBP patients).	☻☻☻
CT lumbar spine without and with IV contrast	3		☻☻☻☻
<p><b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate</p>			<p>*Relative Radiation Level</p>



# Effect on Nerve Root



**No Compromise**

**Contact**

**Deviation**

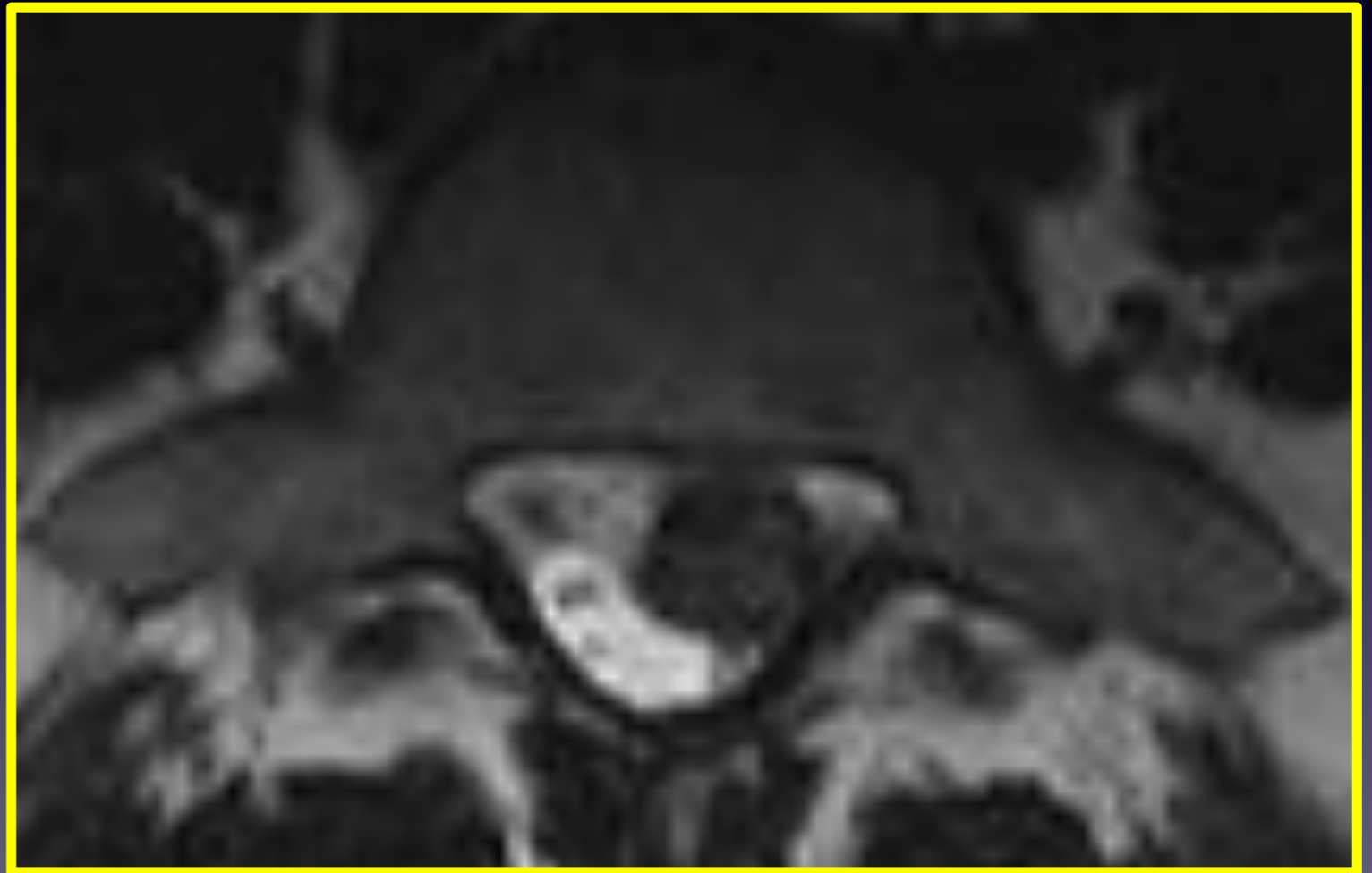
**Compression**

Pfirmann et al. MR Image–based Grading of Lumbar Nerve Root Compromise due to Disk Herniation: Reliability Study with Surgical Correlation, *Radiology* 2004; 230:583–588.

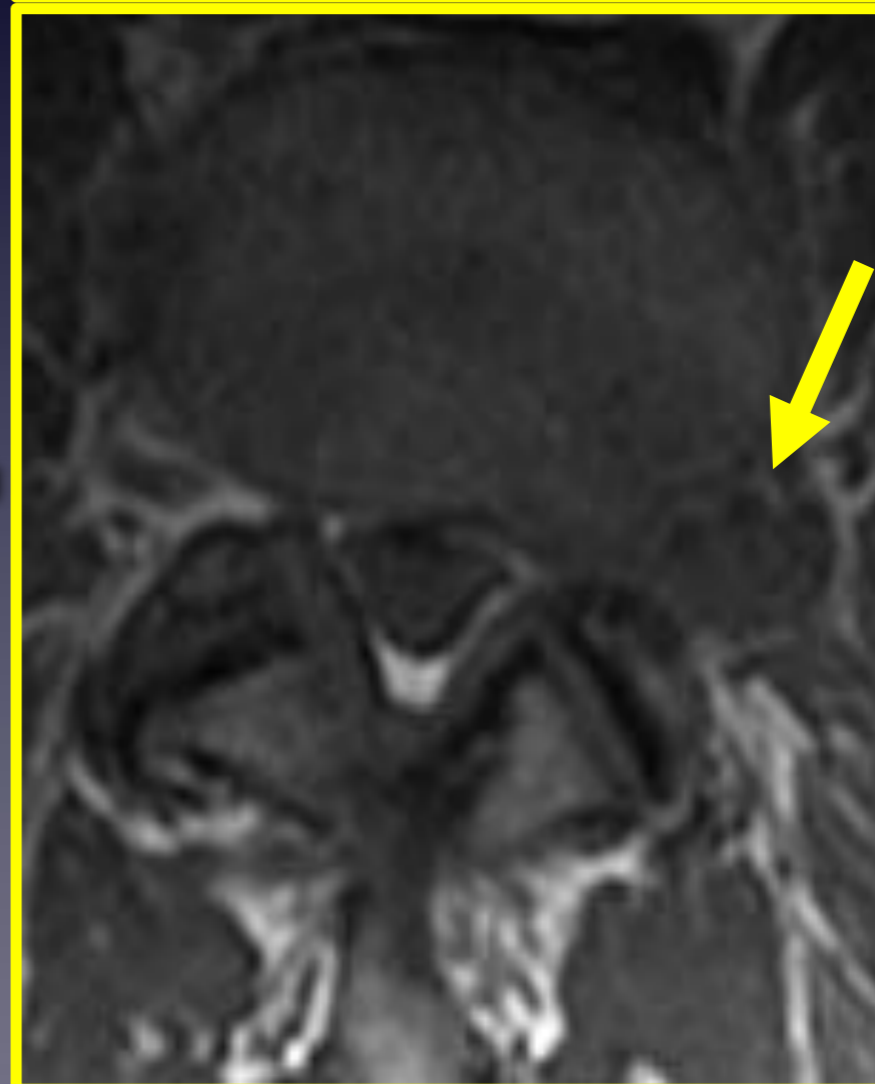
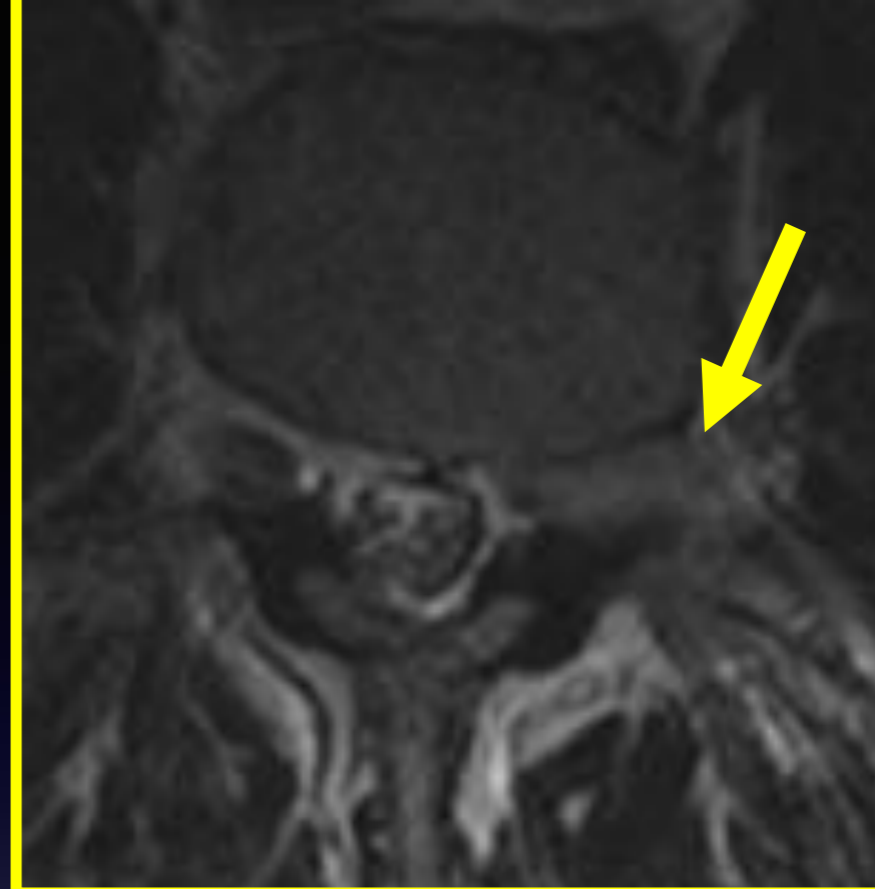
# Effect on Nerve Root



**Compression**

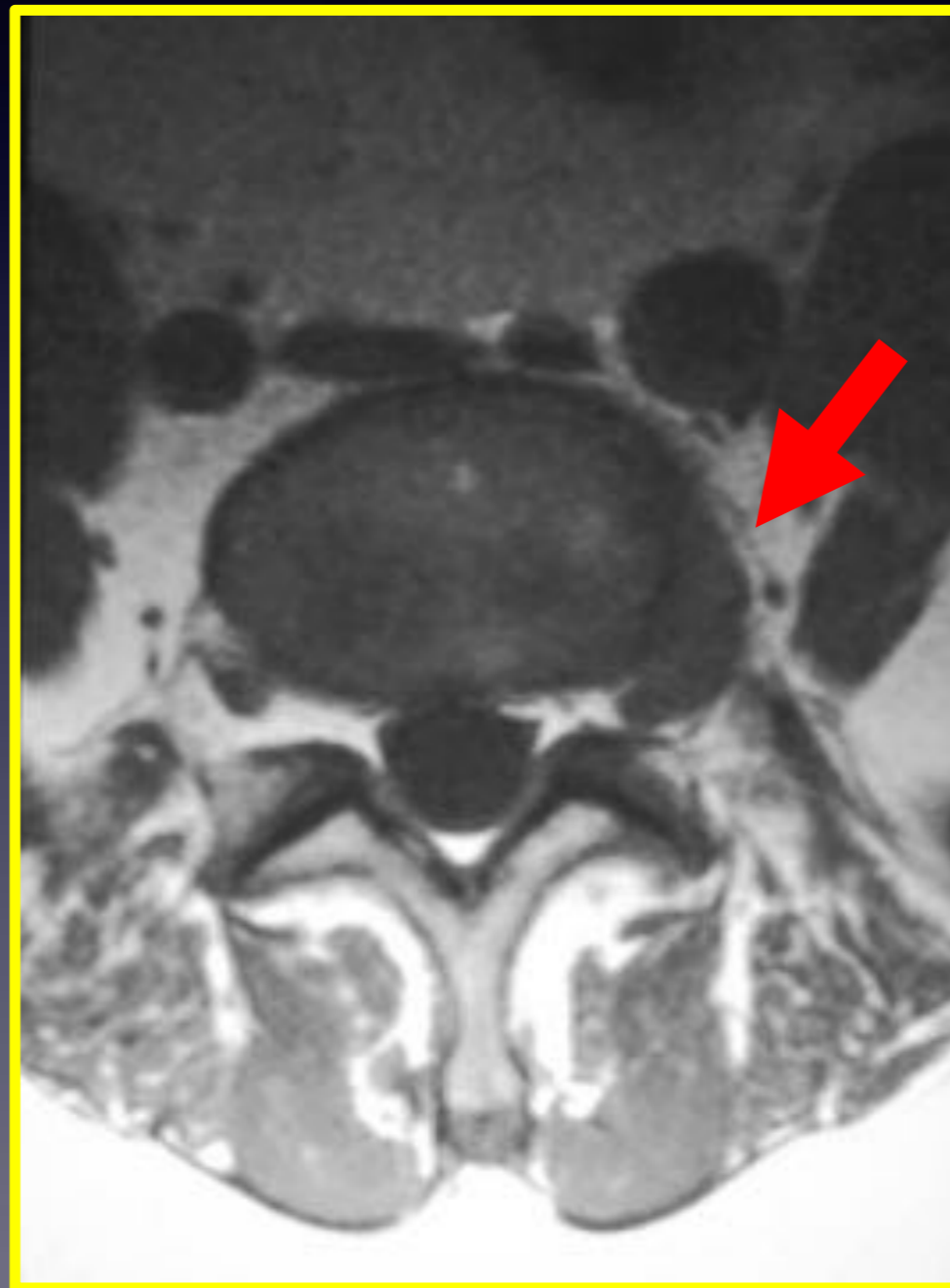


# Disc Extrusion: Foraminal

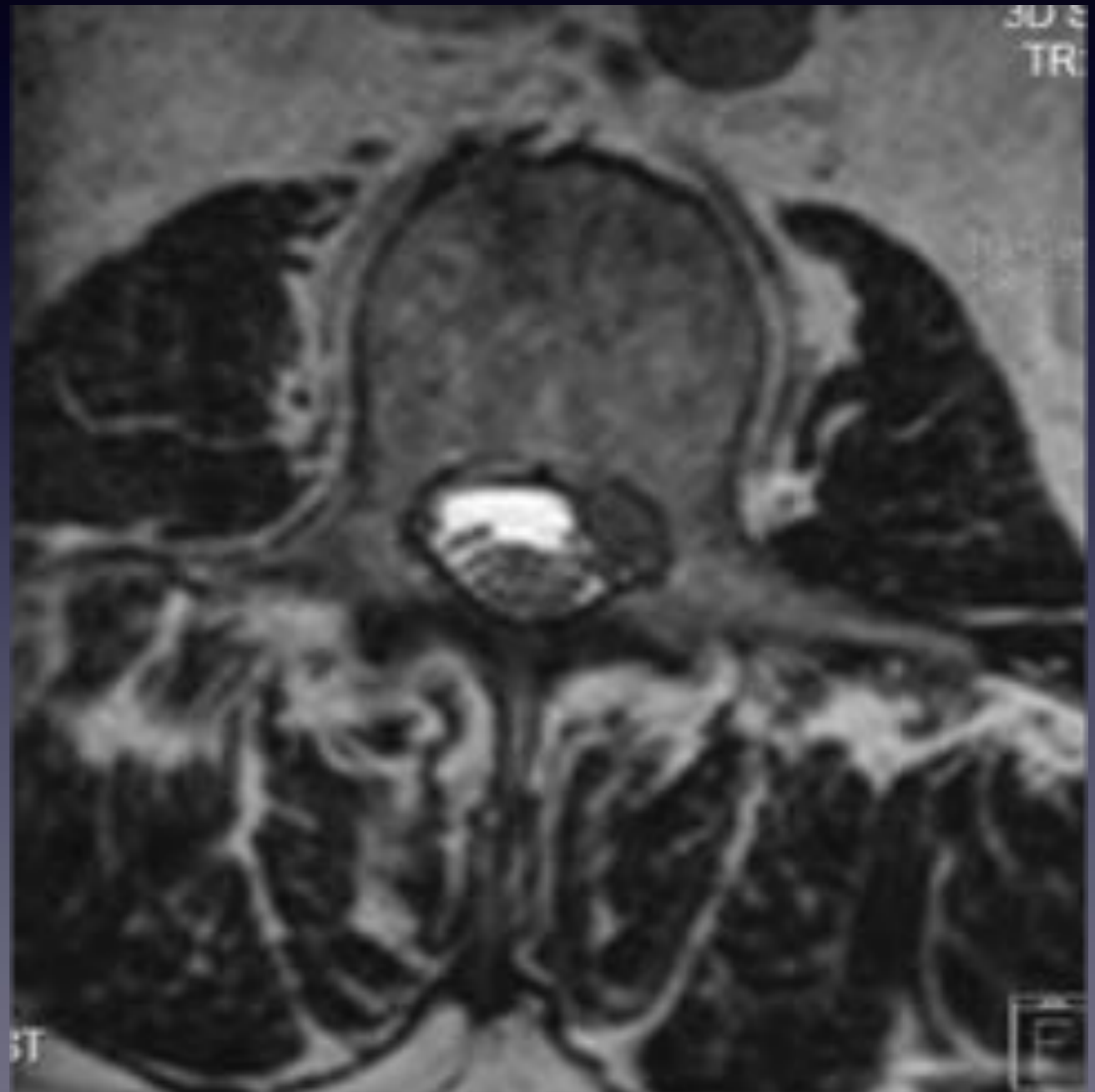




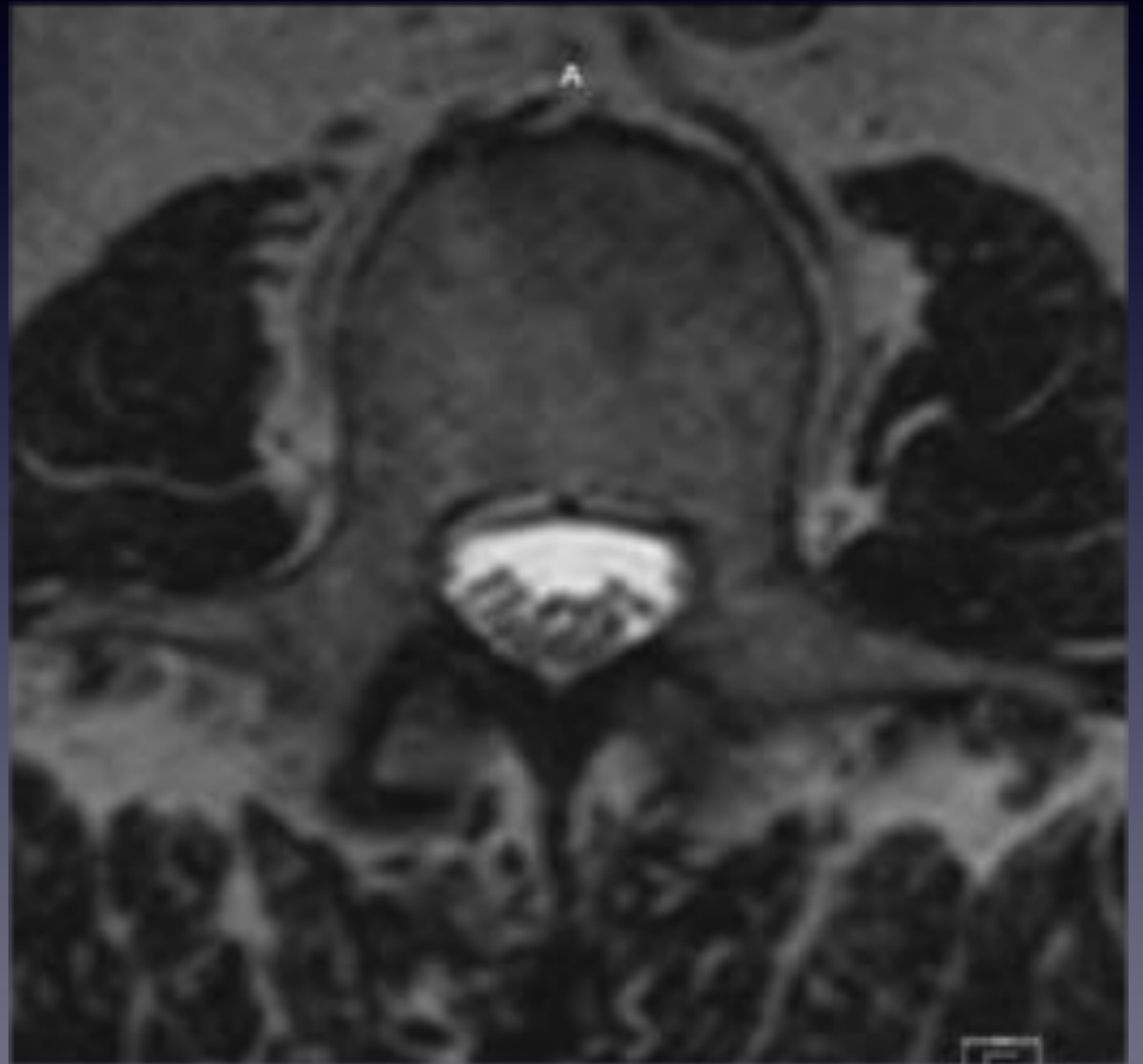
# Disc Extrusion: Extraforaminal- Far Lateral



# Some Disc Herniations Resorb: Another reason not to rush to image



# Some Disc Herniations Resorb: Another reason not to rush to image

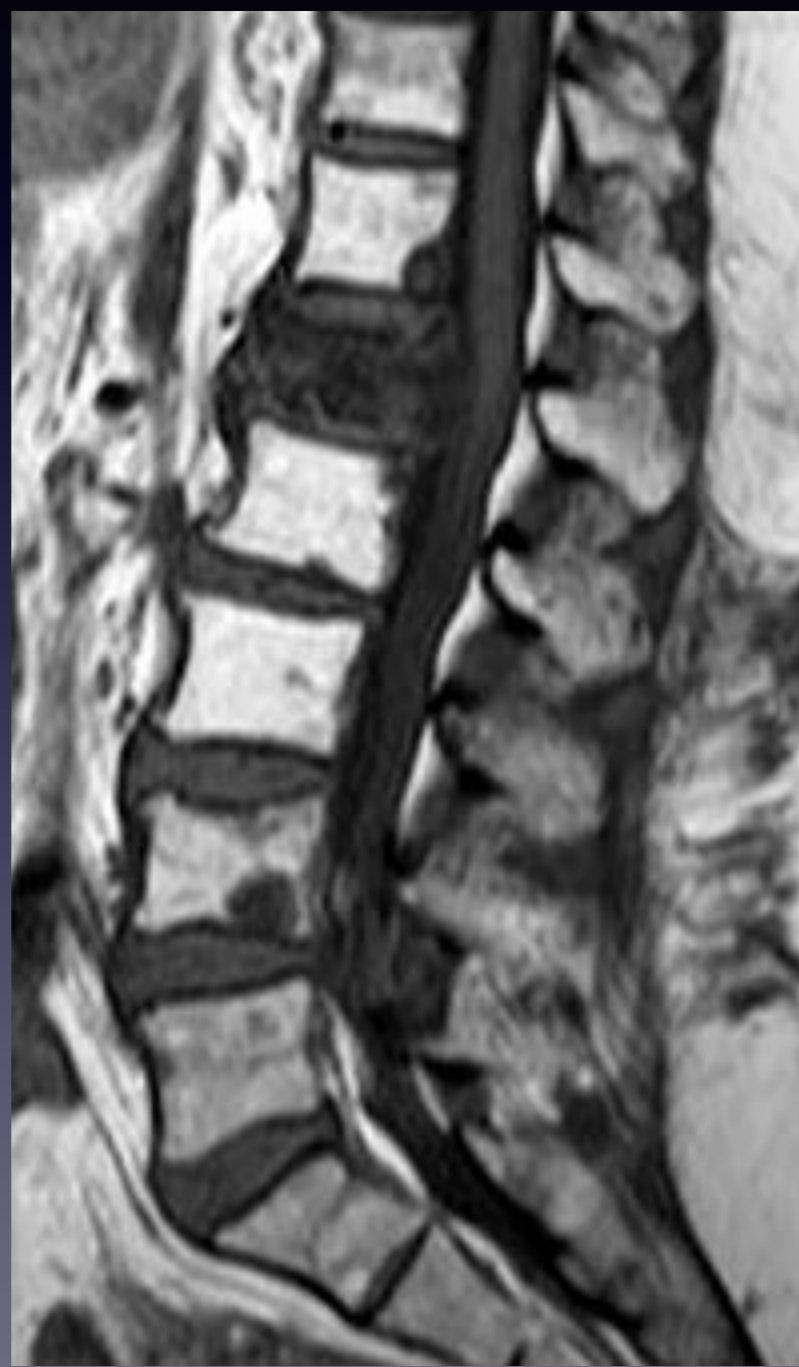
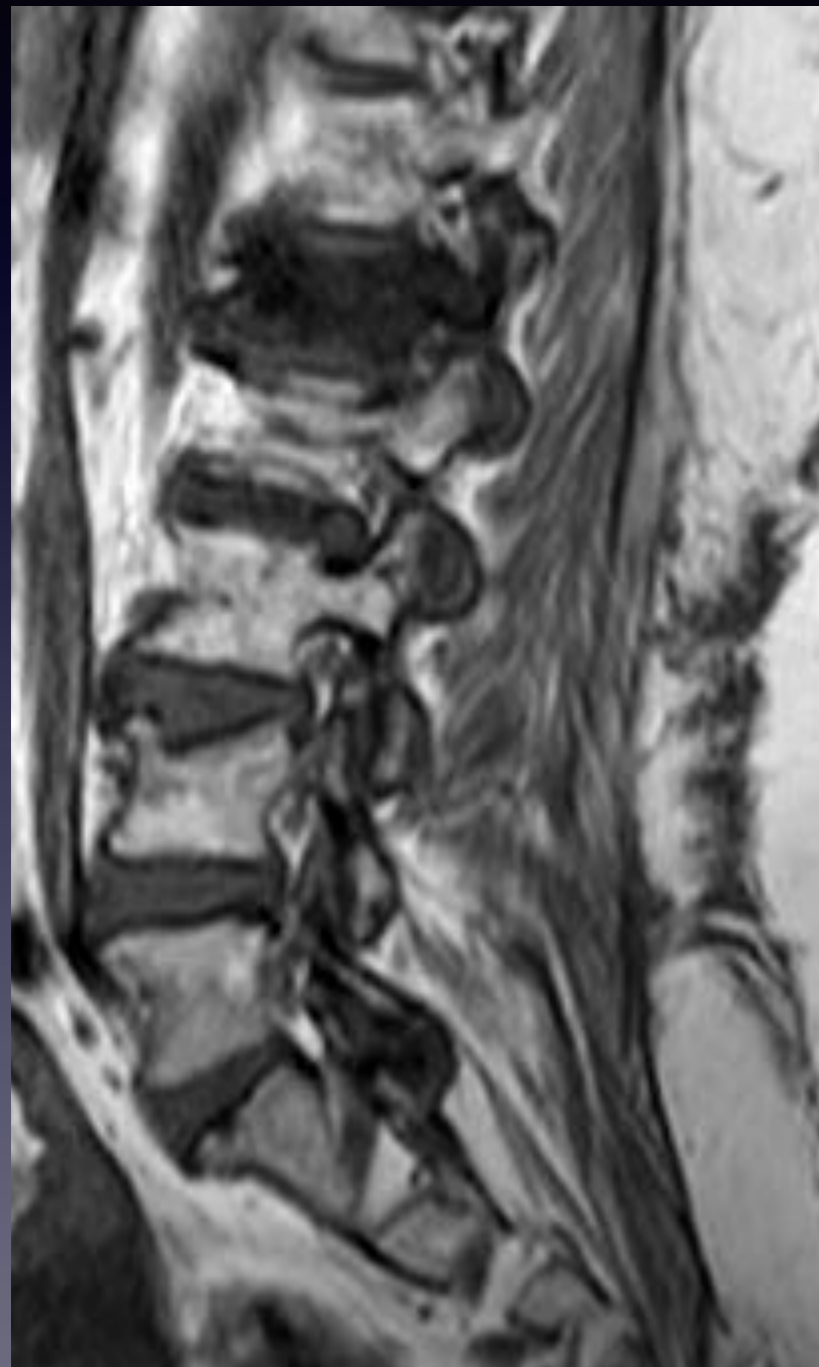




# Case 3

- 60 year old female with history of breast carcinoma treated five years previous. Patient is experiencing worsening back pain and limb numbness over past 3 weeks without radiation to an extremity. Next step regarding imaging?
- Conservative treatment as there is no radiculopathy and cancer was treated five or more years ago
- Nuclear bone scan is best first step to look for fracture or metastasis
- MRI without contrast to look for disc disease
- MRI with contrast to look for metastatic disease

# Pathologic Fracture



Case courtesy of Dr Amr Farouk, Radiopaedia.org, rID: 56160

# Imaging Appropriate?

## Yes

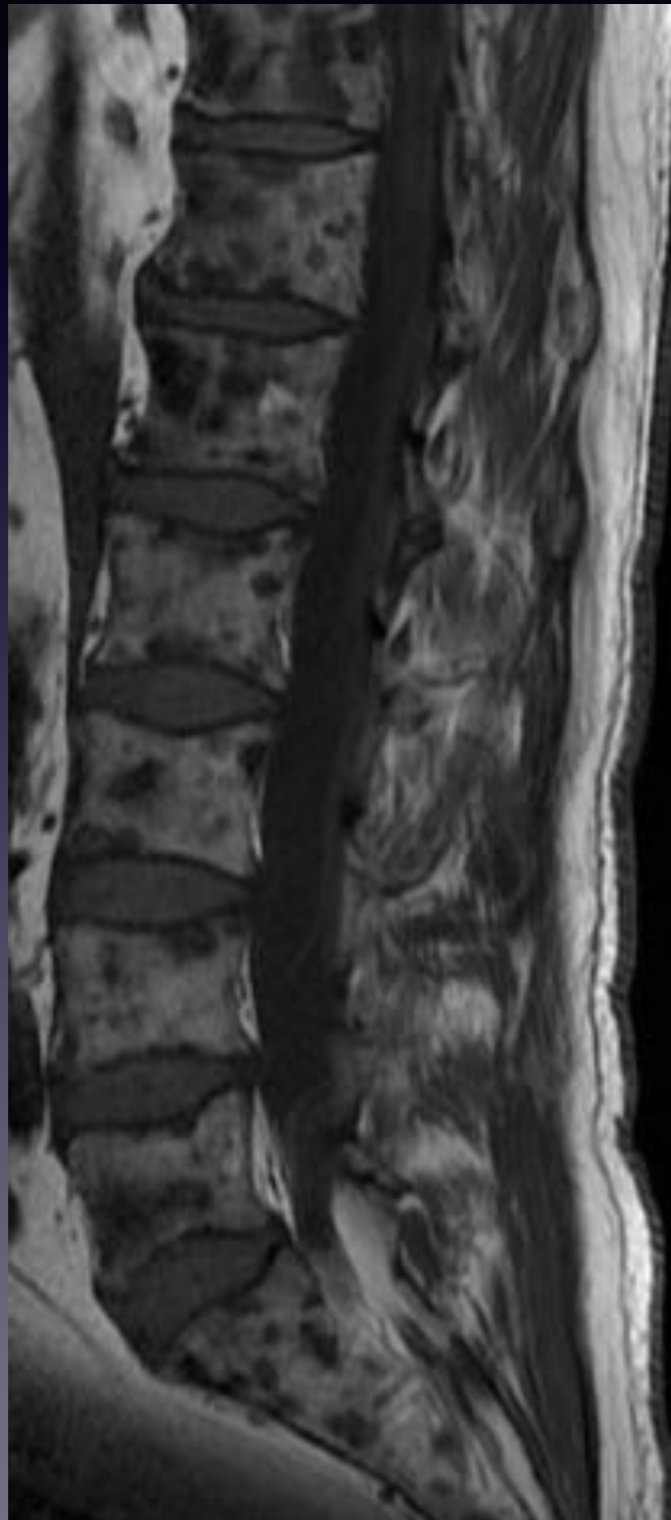
**Clinical Condition:** Low Back Pain

**Variant 3:** Acute, subacute, or chronic low back pain or radiculopathy. One or more of the following: suspicion of cancer, infection, or immunosuppression.

Radiologic Procedure	Rating	Comments	RRL*
MRI lumbar spine without and with IV contrast	8	Contrast is useful for neoplasia patients suspected of epidural or intraspinal disease.	○
MRI lumbar spine without IV contrast	7	Noncontrast MRI can be sufficient if there is low risk of epidural and/or intraspinal disease.	○
CT lumbar spine with IV contrast	6	MRI is preferred. CT is useful if MRI is contraindicated or unavailable and/or for problem solving.	☐☐☐
CT lumbar spine without IV contrast	6	MRI is preferred. CT is useful if MRI is contraindicated or unavailable and/or for problem solving.	☐☐☐
X-ray lumbar spine	5		☐☐☐
Tc-99m bone scan whole body with SPECT spine	4	SPECT/CT can be useful for anatomic localization and problem solving, in particular if looking for widespread tumor burden. It is valuable when multifocal metastases are suspected.	☐☐☐
FDG-PET/CT whole body	4	MRI is preferred. This procedure can be indicated if MRI is contraindicated or nondiagnostic. It can distinguish benign versus malignant compression fractures.	☐☐☐☐
CT lumbar spine without and with IV contrast	3	MRI is preferred. This procedure can be indicated if MRI is contraindicated or nondiagnostic.	☐☐☐☐
CT myelography lumbar spine	3	MRI is preferred. This procedure can be indicated if MRI is contraindicated or nondiagnostic and can be useful for anatomic localization and problem solving.	☐☐☐☐
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level



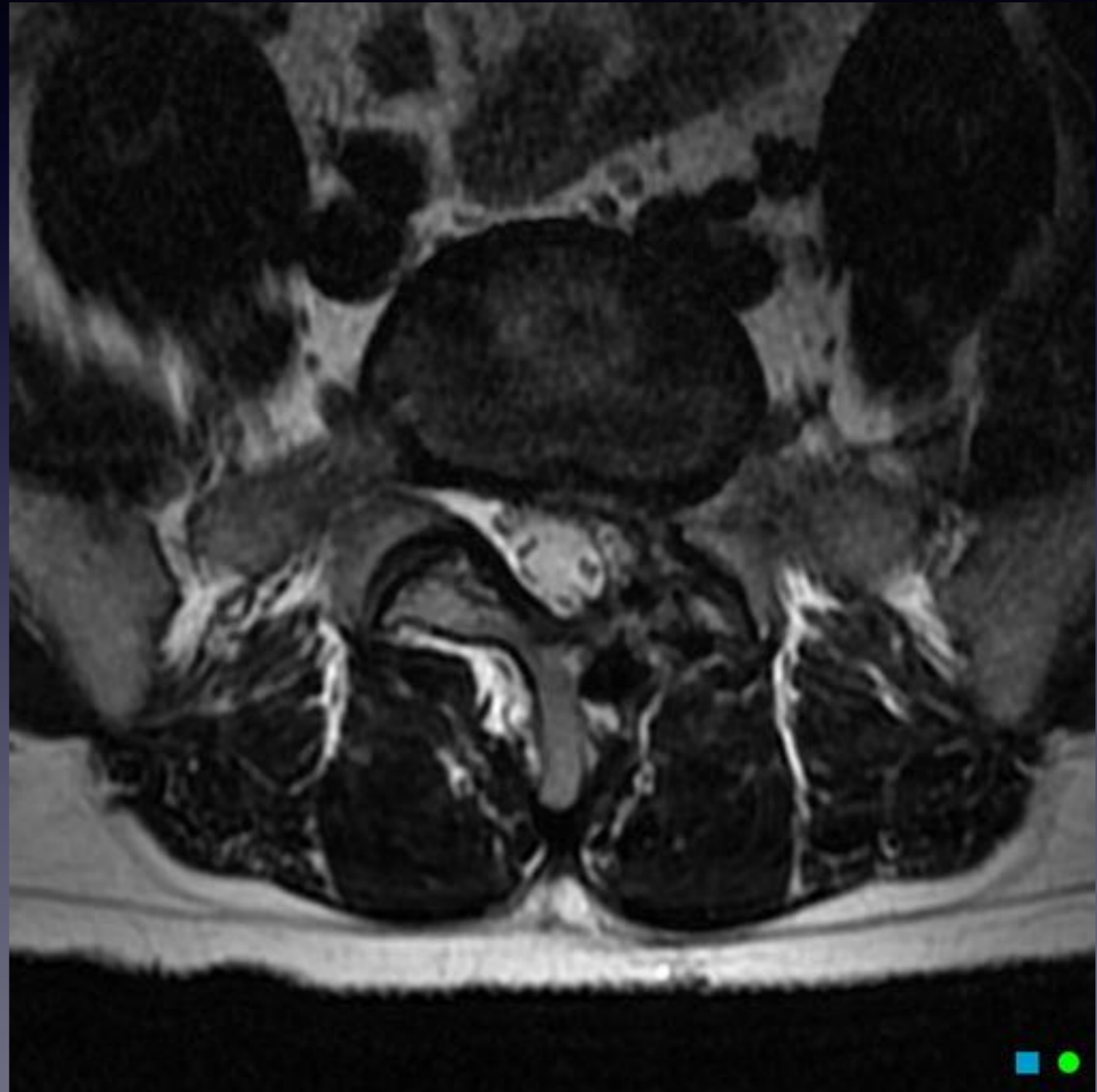
# Metastases vs Mimics



# Case 4

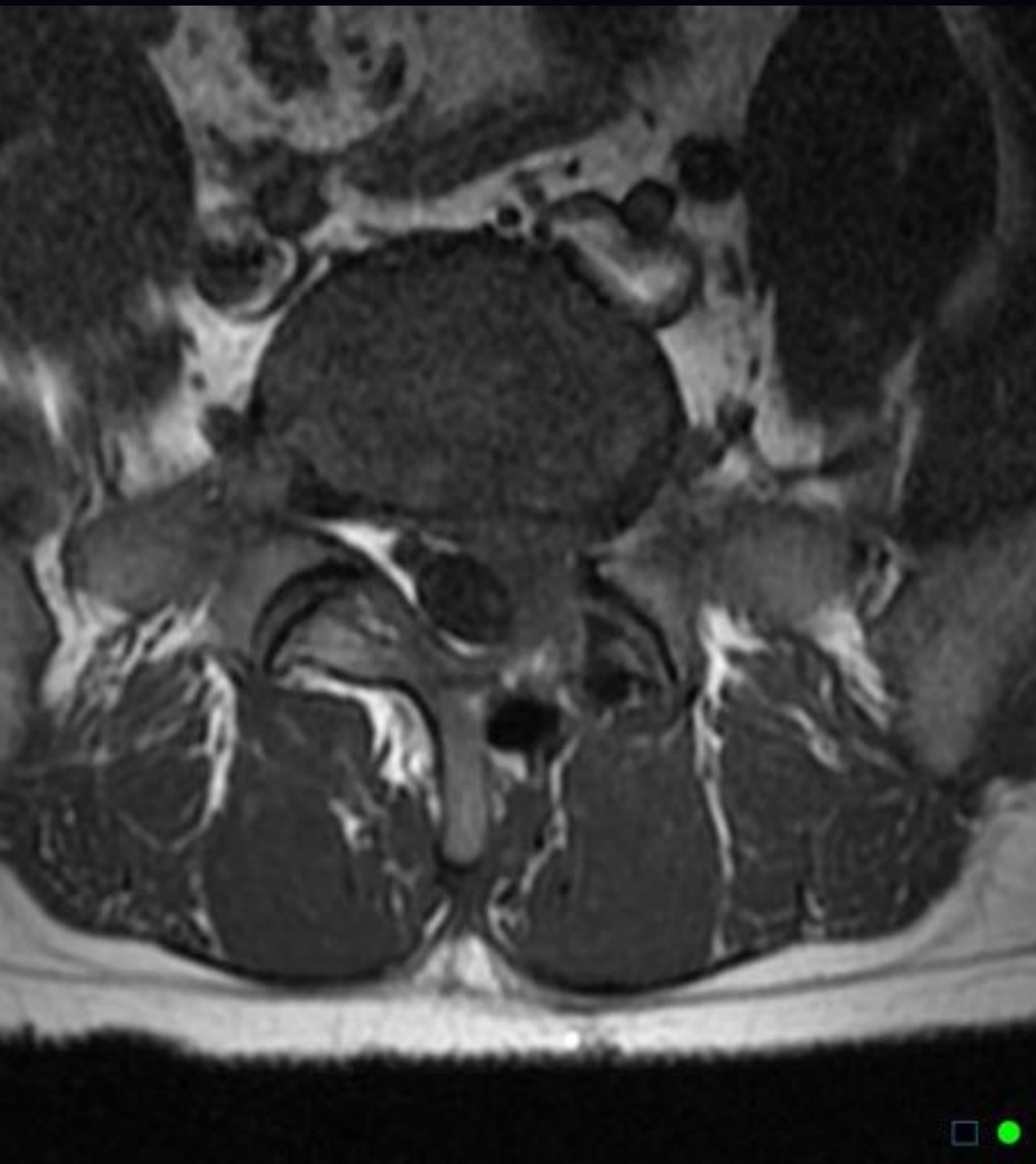
- 30 year old male with history of lumbar surgery 6 months ago. Patient now presents with back pain extending to left lower extremity in same distribution as preoperatively. What is next step?
  - No imaging immediately. Treat conservatively for 6-8 weeks.
  - No imaging will be needed. Patient has already been operated so there is nothing to do except treat pain.
  - Get an MRI without contrast
  - Get an MRI with and without contrast
  - Get an x-ray to start with

# Scar Tissue or Recurrent Disc Herniation?





# Scar Tissue Enhances



# Imaging Appropriate?

## Yes

**Clinical Condition:** Low Back Pain

**Variant 5:** Low back pain or radiculopathy. New or progressing symptoms or clinical findings with history of prior lumbar surgery.

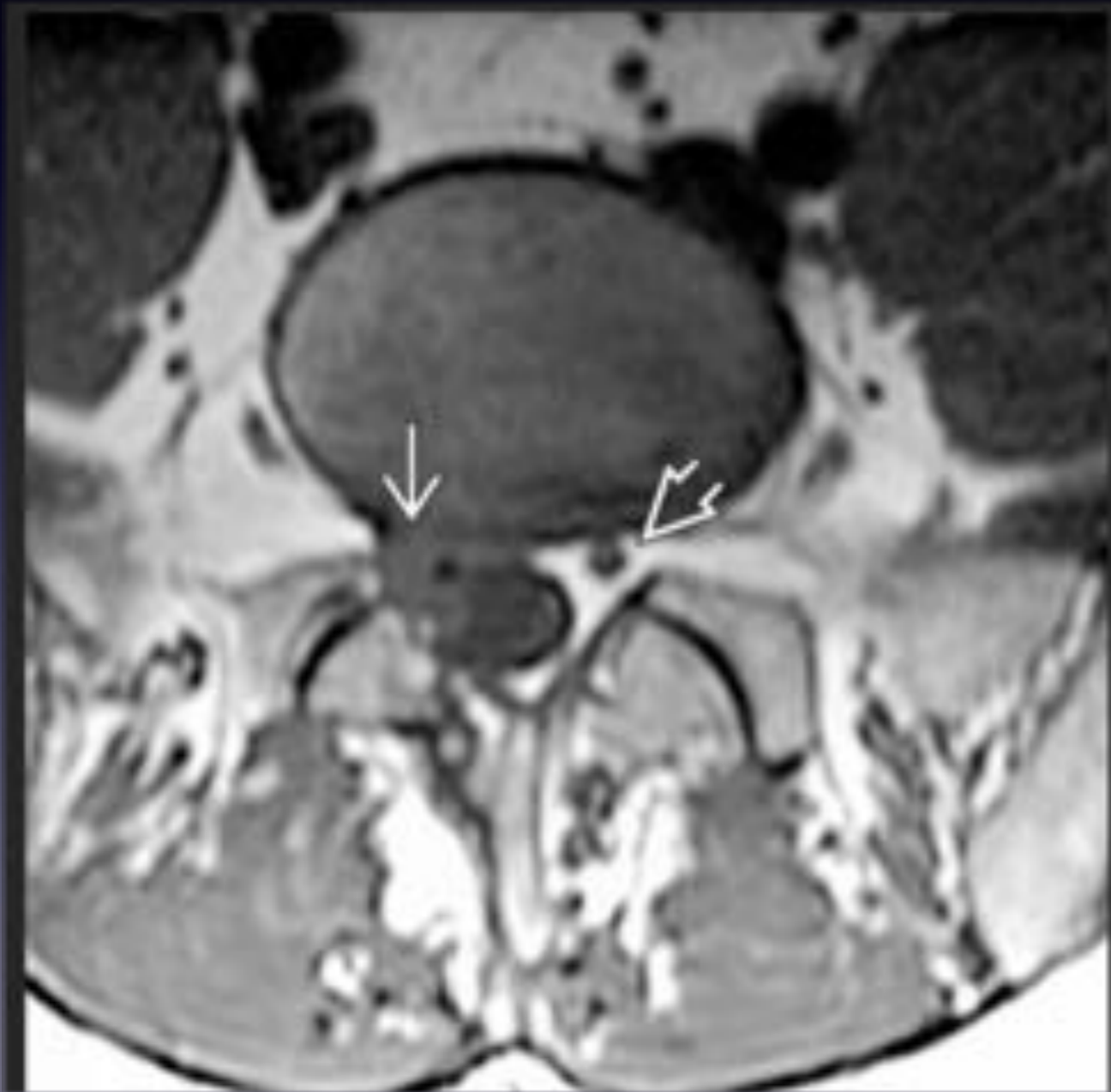
Radiologic Procedure	Rating	Comments	RRL*
MRI lumbar spine without and with IV contrast	8	This procedure can differentiate disc from scar.	○
CT lumbar spine with IV contrast	6	This is most useful in postfusion patients or when MRI is contraindicated or indeterminate.	●●●●
CT lumbar spine without IV contrast	6	This is most useful in postfusion patients or when MRI is contraindicated or indeterminate.	●●●●
MRI lumbar spine without IV contrast	6	Contrast is often necessary.	○
CT myelography lumbar spine	5		●●●●●
X-ray lumbar spine	5	Flexion and extension views can be useful.	●●●●
Tc-99m bone scan with SPECT spine	5	This procedure helps detect and localize painful pseudarthrosis. SPECT/CT can be useful for anatomic localization and problem solving.	●●●●
Discography and post-discography CT lumbar spine	5		●●●●
CT lumbar spine without and with IV contrast	3		●●●●●
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

# Recurrent Disc Herniation Does Not Enhance





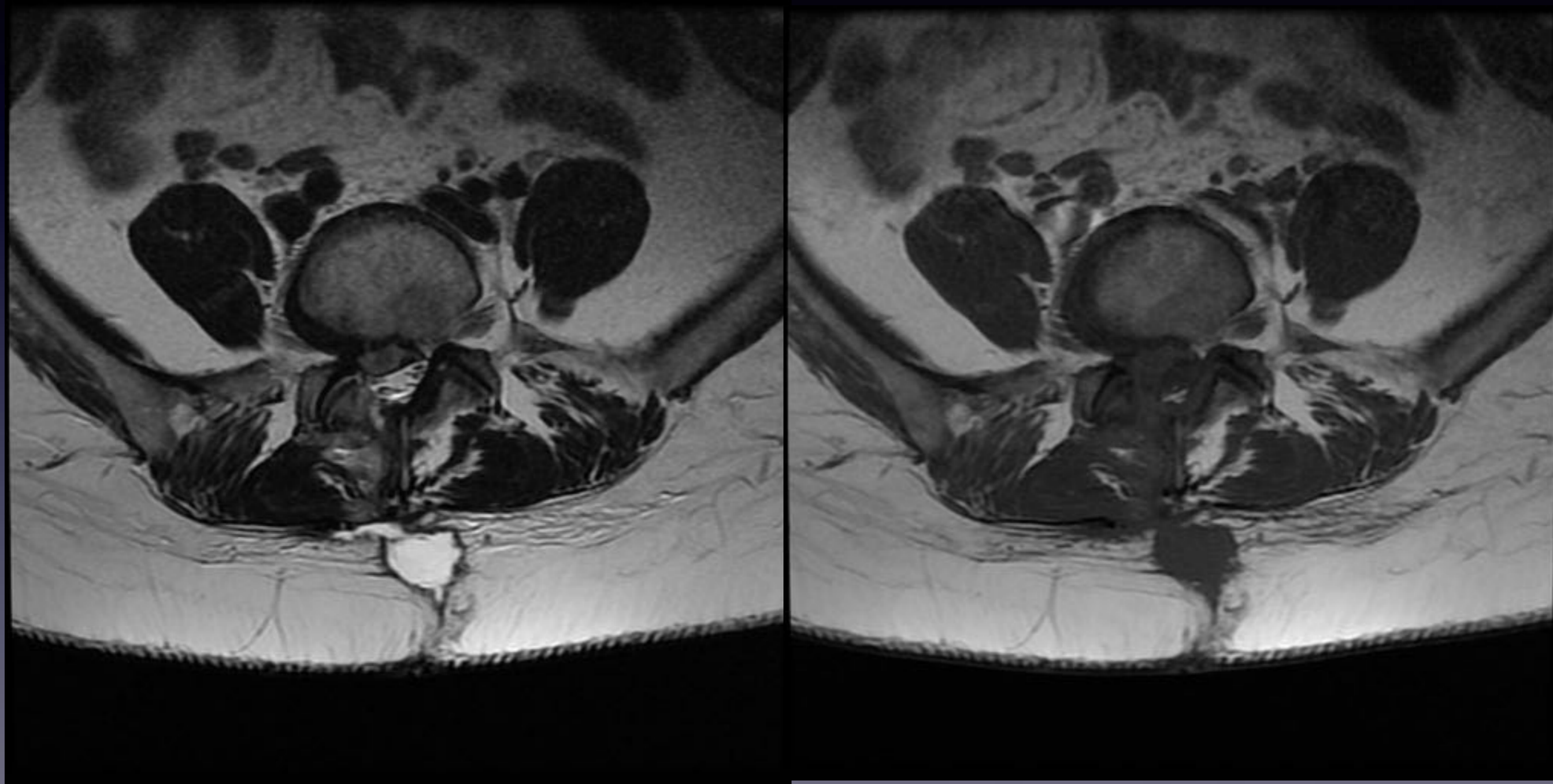
# Recurrent Disc Herniation Does Not Enhance



# Recurrent Disc Herniation Does Not Enhance



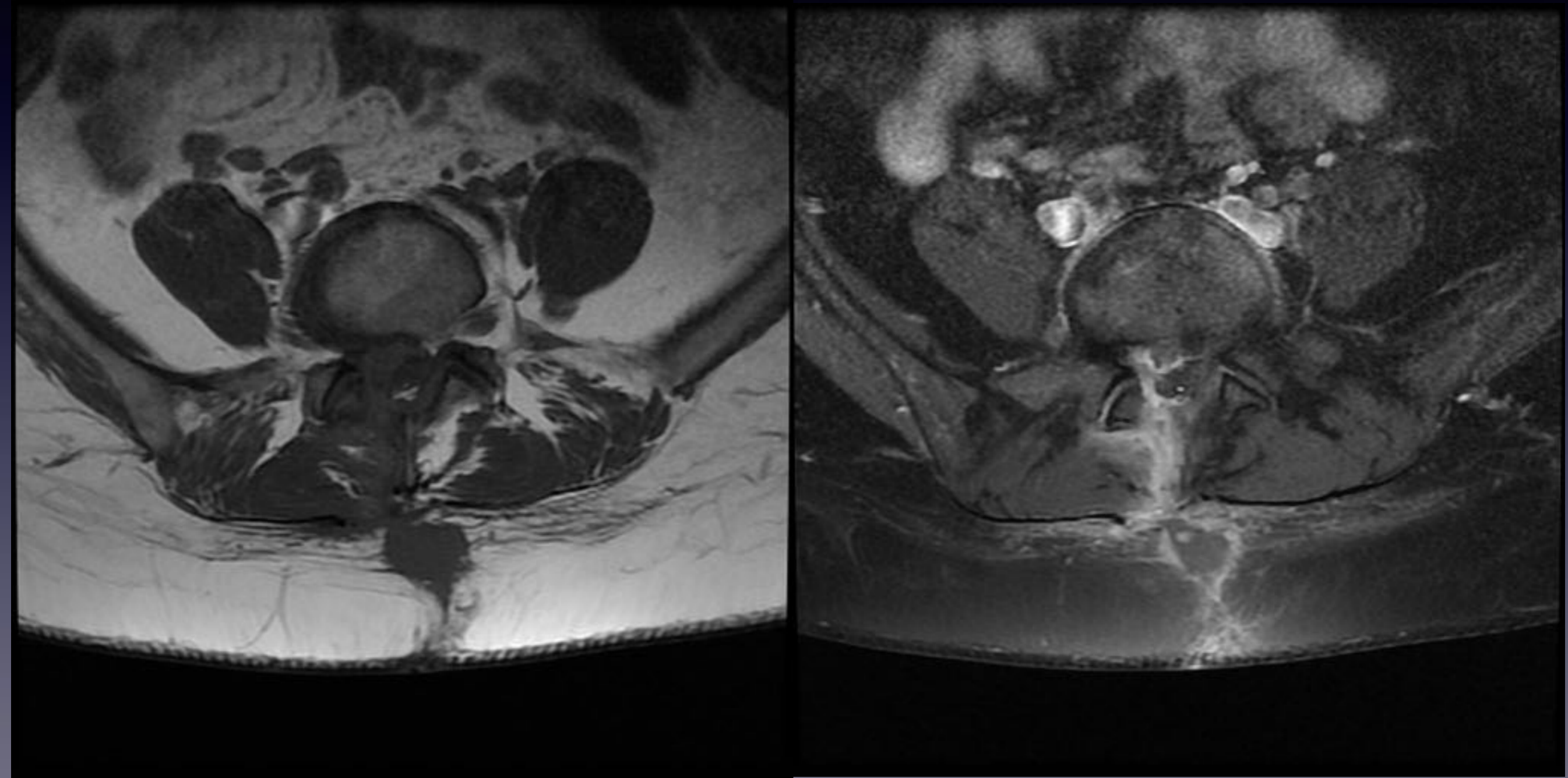
# Post Operative Infection



Case courtesy of Dr Mohammad A. ElBeialy, Radiopaedia.org, rID: 25529



# Post Operative Infection



Case courtesy of Dr Mohammad A. ElBeialy, Radiopaedia.org, rID: 25529

# Case 5

- 80 year old female who slipped from chair to floor. Now with low back pain. What imaging is indicated?
- None because this is a low velocity trauma and conservative therapy is next step.
- MRI without contrast
- CT without contrast
- X-ray
- MRI, CT or X-ray would be indicated

# Osteoporotic Compression Fracture



Case courtesy of Dr Usman Bashir, Radiopaedia.org, rID: 19198



# Imaging Appropriate?

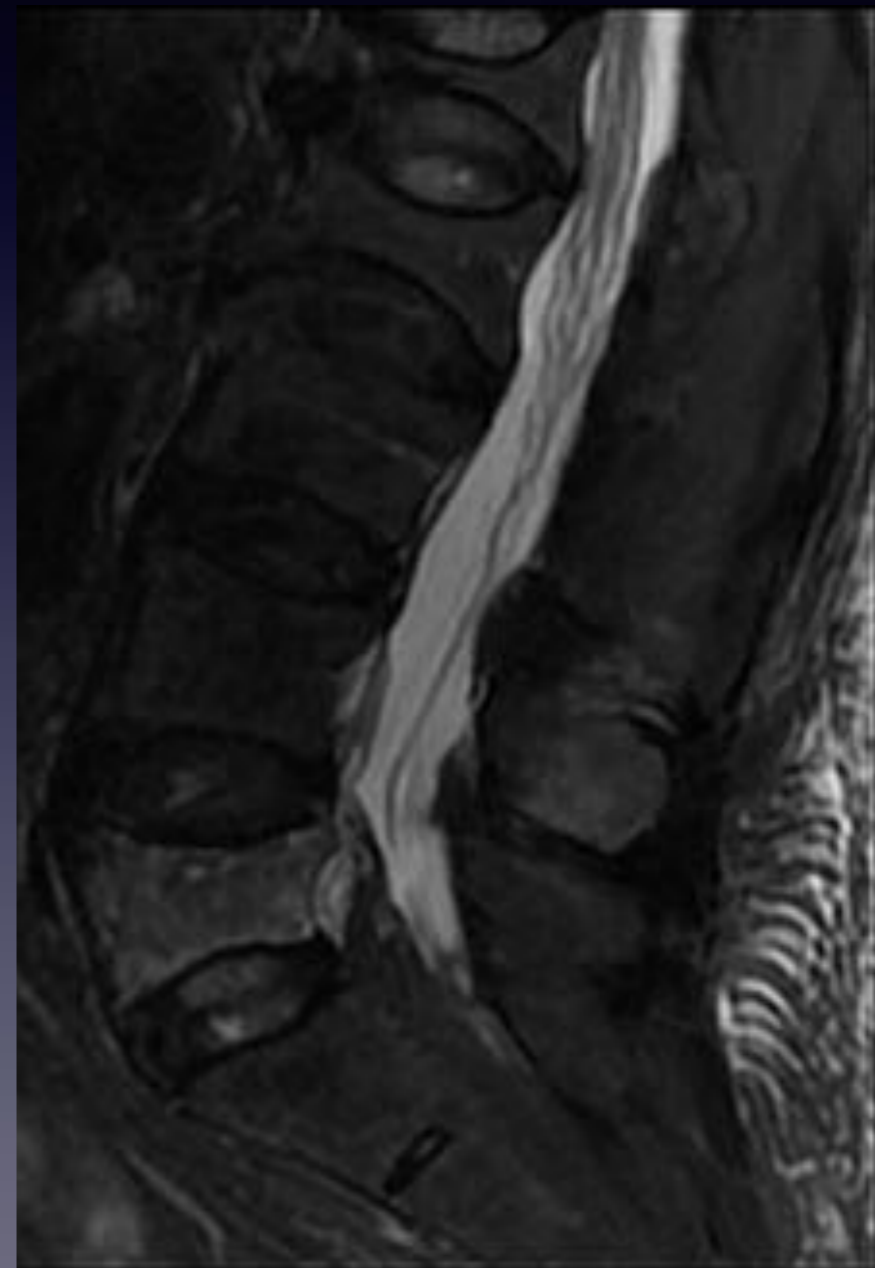
## Yes

**Clinical Condition:** Low Back Pain

**Variant 2:** Acute, subacute, or chronic uncomplicated low back pain or radiculopathy. One or more of the following: low velocity trauma, osteoporosis, elderly individual, or chronic steroid use.

Radiologic Procedure	Rating	Comments	RRL*
X-ray lumbar spine	7	This procedure is recommended as the initial imaging study, especially in patients with osteoporosis or history of steroid use.	☻☻☻
CT lumbar spine without IV contrast	7	If there remains concern for vertebral body fracture, detailed osseous analysis with CT can be performed for further evaluation.	☻☻☻
MRI lumbar spine without IV contrast	7	CT is preferred. MRI can be useful to evaluate for ligamentous injury or worsening neurologic deficit. MRI can depict marrow edema in these scenarios.	○
Tc-99m bone scan with SPECT spine	3	Bone scan with SPECT/CT can be useful for radiographically occult fractures and problem solving.	☻☻☻
CT lumbar spine with IV contrast	3		☻☻☻
CT lumbar spine without and with IV contrast	1		☻☻☻☻
CT myelography lumbar spine	1		☻☻☻☻
Discography and post-discography CT lumbar spine	1		☻☻☻
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

# Acute and Chronic Osteoporotic Fractures

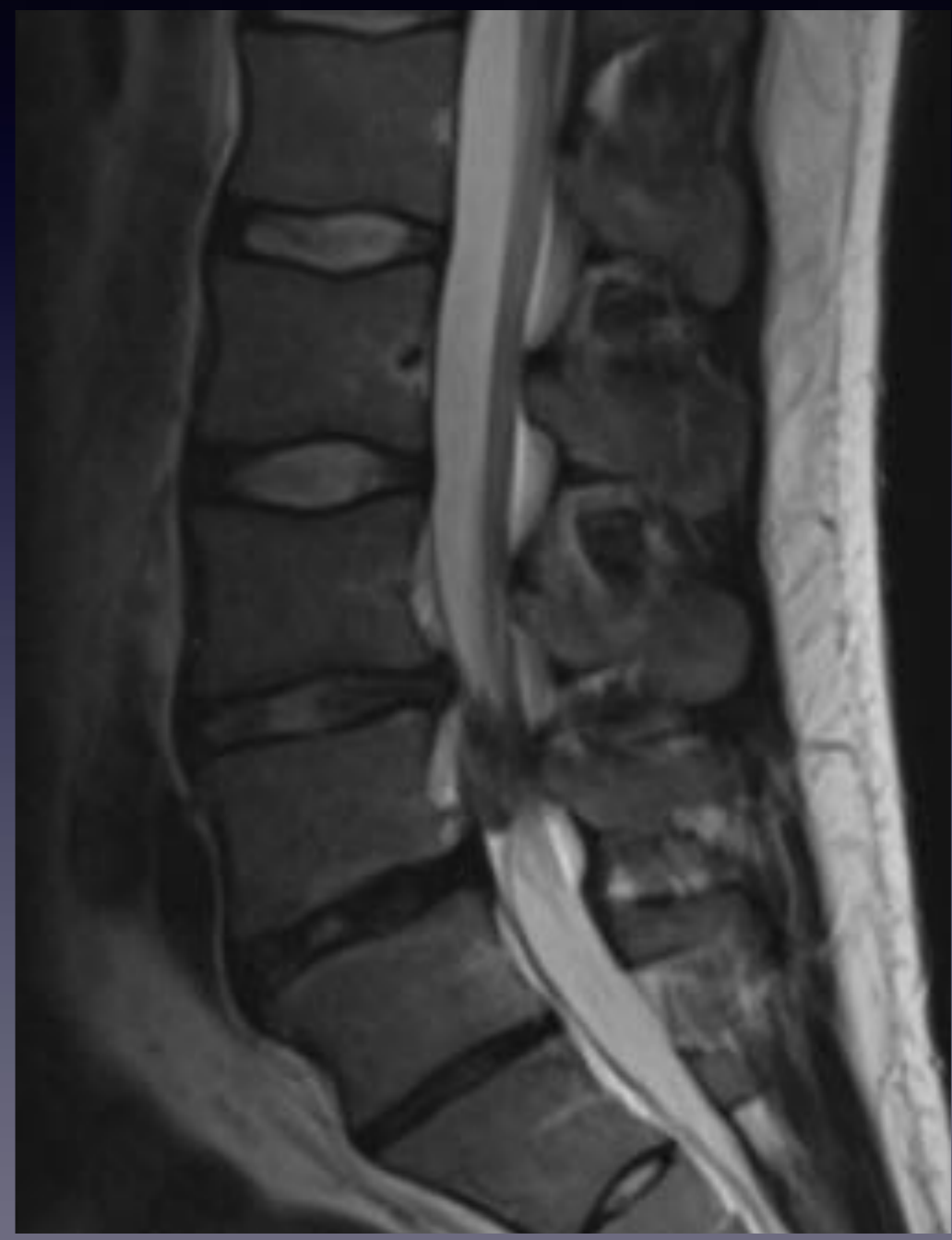
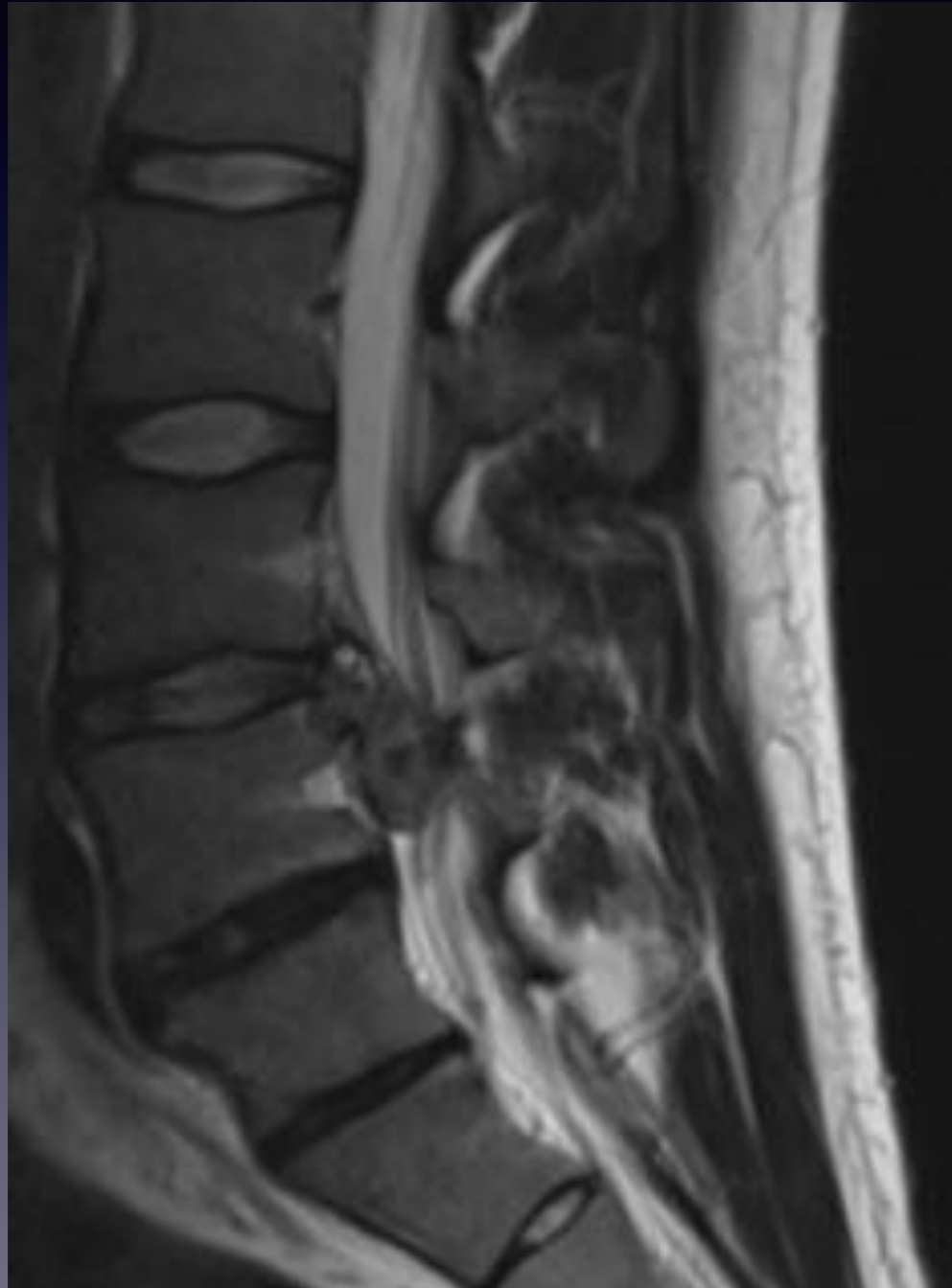


# Case 6

- 30 year old male with low velocity MVA one week ago presents with severe back pain. Patient says he cannot walk but is not sure if due to pain or weakness. There is decreased perineal sensation. No history of cancer? What is next step imaging-wise?
  - Conservative therapy as low velocity MVA
  - MRI without contrast
  - CT without contrast
  - Abdomen/Pelvis CT to look for organ or bowel injury

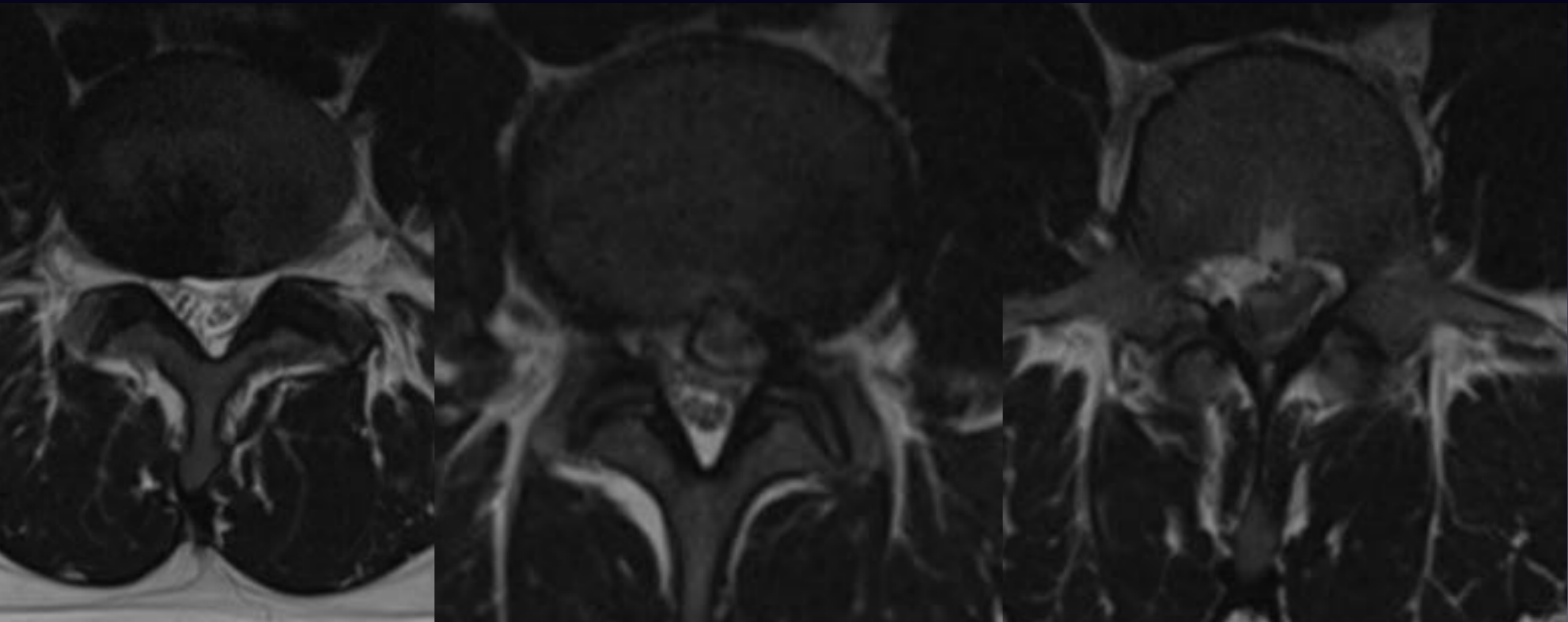


# Large Disc Herniation with Cauda Equina Compromise



Case courtesy of Dr Henry Knipe, Radiopaedia.org, rID: 53615

# Large Disc Herniation with Cauda Equina Compromise



# Imaging Appropriate?

## Yes

**Variant 6:**

**Low back pain with suspected cauda equina syndrome or rapidly progressive neurologic deficit.**

Radiologic Procedure	Rating	Comments	RRL*
MRI lumbar spine without IV contrast	9	Use of contrast depends on clinical circumstances.	○
MRI lumbar spine without and with IV contrast	8	Use of contrast depends on clinical circumstances.	○
CT myelography lumbar spine	6	This procedure is useful if MRI is nondiagnostic or contraindicated.	☼☼☼☼
CT lumbar spine with IV contrast	5		☼☼☼
CT lumbar spine without IV contrast	5		☼☼☼
X-ray lumbar spine	3		☼☼☼
CT lumbar spine without and with IV contrast	3		☼☼☼☼
Tc-99m bone scan with SPECT spine	2		☼☼☼
<p><b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate</p>			<p>*Relative Radiation Level</p>



# Take Home Points

- Low back pain has high incidence
- Need to be selective in determining: **WHEN DO WE IMAGE, WHY A PARTICULAR MODALITY, WHAT ARE WE LOOKING FOR**
- ACR Appropriateness Criteria can be helpful as a guideline.
- If in doubt - call your local, friendly Radiologist!

Thank you for your attention!



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