Low Back Pain

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Differential Diagnosis of Low Back Pain

- Back Strain
- Acute disc herniation
- Osteoarthritis
- Spinal Stenosis
- Spondylolysis/Spondylolisthesis
- Ankylosing Spondylitis
- Infection
- Malignancy
- Compression fracture

Terminology of Spine Imaging

- DDD
- DJD
- Spondylosis
- Spondylolysis/Spondylolisthesis
- Foraminal and central stenosis
- Disc Herniation/Protrusion/Bulge

Low Back Pain

- When should you order an imaging study
- Which imaging study should be requested
- Unknown cases

When should you order an imaging study

Unknown Case #1

- 34 year old male with acute onset low back pain following a lifting injury at work.

- What study should be ordered?

Which study should you order for 34 year old with acute onset back pain?

- MRI L-spine
- CT L-spine
- L spine x-ray
- Bone scan

Do not image uncomplicated acute low back pain

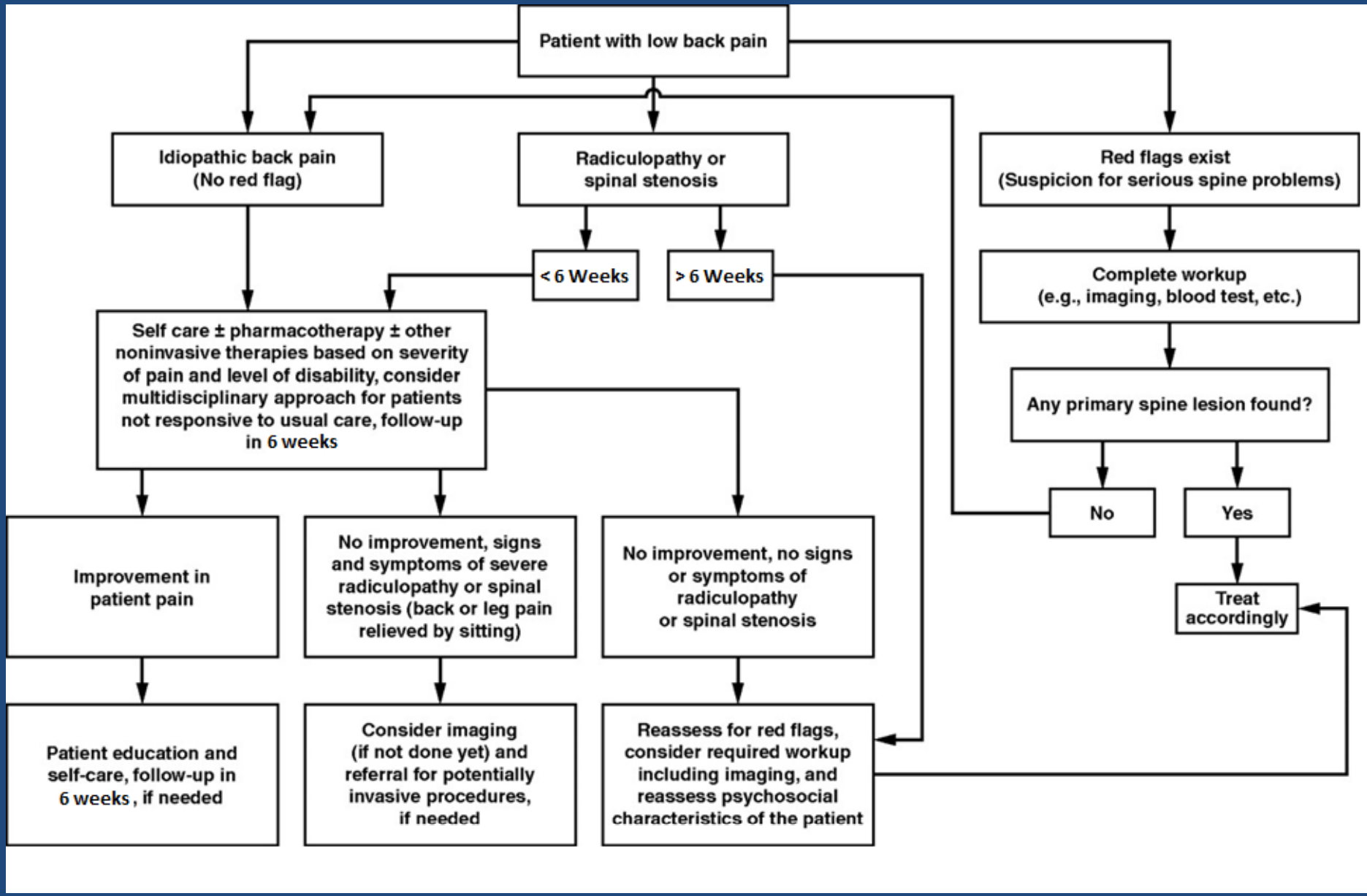
- Acute low back pain (LBP) with or without radiculopathy is one of the most common health problems in the United States and is the leading cause of disability for persons younger than age 45. The cost of evaluating and treating acute LBP runs into billions of dollars annually, not including time lost from work.
- It is now clear that *uncomplicated* acute LBP or radiculopathy is a benign, self-limited condition that does not warrant any imaging studies.

ACR Guidelines

Consider imaging for those with no improvement after 6 weeks or the following red flags

- Indications of a more complicated status include back pain/radiculopathy in the following settings:

- Trauma, cumulative trauma
- Unexplained weight loss, insidious onset
- Age >50 years, especially women, and males with osteoporosis or compression fracture
- Unexplained fever, history of urinary or other infection
- Immunosuppression, diabetes mellitus
- History of cancer
- Intravenous (IV) drug use
- Prolonged use of corticosteroids, osteoporosis
- Age >70
- Focal neurologic deficit(s) with progressive or disabling symptoms, cauda equina syndrome
- Duration longer than 6 weeks
- Prior surgery


Patient with low back pain
Idiopathic back pain
(No red flag)
Radiculopathy or
spinal stenosis
Red flags exist
(Suspicion for serious spine problems)
< 6 Weeks
> 6 Weeks
Complete workup
(e.g., imaging, blood test, etc.)
Self care ± pharmacotherapy ± other noninvasive therapies based on severity of pain and level of disability, consider multidisciplinary approach for patients not responsive to usual care, follow-up in 6 weeks
Any primary spine lesion found?
No
Yes
Improvement in
patient pain
No improvement, signs and symptoms of severe radiculopathy or spinal stenosis (back or leg pain relieved by sitting)
No improvement, no signs or symptoms of radiculopathy or spinal stenosis
Treat
accordingly
Patient education and self-care, follow-up in 6 weeks, if needed
Consider imaging
(if not done yet) and
referral for potentially
invasive procedures,
if needed
Reassess for red flags, consider required workup including imaging, and reassess psychosocial characteristics of the patient

Which imaging study should be requested

American College of Radiology (ACR)

- ACR has established **appropriateness criteria** for many clinical situations.
- On the ACR website, you can find these criteria
- http://www.acr.org/Quality-Safety/Appropriateness-Criteria/Diagnostic
- These criteria are a great reference for deciding the best imaging study to order.
- AMI Radiologists

Appropriateness Criteria (ACR) Low Back Pain

- Variant 1: Uncomplicated acute low back pain and/or radiculopathy, nonsurgical presentation. No red flags.
- Variant 2: Patient with one or more of the following: low velocity trauma, osteoporosis, focal and/or progressive deficit, prolonged symptom duration, age >70.
- Variant 3: Patient with one or more of the following: Suspicion of cancer, infection, and/or immunosuppression.

Appropriateness Criteria (ACR)
Low Back Pain

- Variant 4: Low back pain and/or radiculopathy. Surgery or interventional candidate.
- Variant 5: Prior lumbar surgery.
- Variant 6: Cauda equina syndrome, multifocal deficits or progressive deficit.

Clinical Condition: Low Back Pain

Variant 1: Uncomplicated acute low back pain and/or radiculopathy, nonsurgical presentation. No red flags. (Red flags defined in the text below.)

Radiologic Procedure	Rating	Comments	RRL*
MRI lumbar spine without contrast	2		O
X-ray lumbar spine	2		☢☢☢
Myelography and postmyelography CT lumbar spine	2	In some cases postinjection CT imaging may be done without plain-film myelography.	☢☢☢☢
X-ray myelography lumbar spine	2		☢☢☢
Tc-99m bone scan with SPECT spine	2		☢☢☢
CT lumbar spine without contrast	2		☢☢☢
CT lumbar spine with contrast	2		☢☢☢
MRI lumbar spine without and with contrast	2		O
CT lumbar spine without and with contrast	1		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Average annual human exposure to ionizing radiation (millisievert)

Radiation source	World[1]	USA[2]	Japan[3]	Remark
Inhalation of air	1.26	2.28	0.40	mainly from radon, depends on indoor accumulation
Ingestion of food & water	0.29	0.28	0.40	(K-40, C-14, etc.)
Terrestrial radiation from ground	0.48	0.21	0.40	depends on soil and building material
Cosmic radiation from space	0.39	0.33	0.30	depends on altitude
sub total (natural)	2.40	3.10	1.50	sizeable population groups receive 10-20 mSv
Medical	0.60	3.00	2.30	world-wide figure excludes radiotherapy; US figure is mostly CT scans and nuclear medicine.
Consumer items	-	0.13		cigarettes, air travel, building materials, etc.
Atmospheric nuclear testing	0.005	-	0.01	peak of 0.11 mSv in 1963 and declining since; higher near sites
Occupational exposure	0.005	0.005	0.01	world-wide average to all workers is 0.7 mSv, mostly due to radon in mines;[1] US is mostly due to medical and aviation workers.[2]
Chernobyl accident	0.002	-	0.01	peak of 0.04 mSv in 1986 and declining since; higher near site
Nuclear fuel cycle	0.0002		0.001	up to 0.02 mSv near sites; excludes occupational exposure
Other	-	0.003		Industrial, security, medical, educational, and research
sub total (artificial)	0.61	3.14	2.33	
Total	3.01	6.24	3.83	**millisievert per year**

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).

Variant 2: Patient with one or more of the following: low velocity trauma, osteoporosis, focal and/or progressive deficit, prolonged symptom duration, age >70 years.

Radiologic Procedure	Rating	Comments	RRL*
MRI lumbar spine without contrast	8		O
CT lumbar spine without contrast	6	MRI preferred. CT useful if MRI is contraindicated or unavailable, and/or for problem solving.	☢☢☢
X-ray lumbar spine	6		☢☢☢
Tc-99m bone scan with SPECT spine	4	SPECT/CT may be useful for anatomic localization and problem solving.	☢☢☢
MRI lumbar spine without and with contrast	3		O
CT lumbar spine with contrast	3		☢☢☢
CT lumbar spine without and with contrast	1		☢☢☢☢
Myelography and postmyelography CT lumbar spine	1	In some cases postinjection CT imaging may be done without plain-film myelography.	☢☢☢☢
X-ray myelography lumbar spine	1		☢☢☢
X-ray discography lumbar spine	1		☢☢
X-ray discography and post-discography CT lumbar spine	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 3: Patient with one or more of the following: suspicion of cancer, infection, and/or immunosuppression.

Radiologic Procedure	Rating	Comments	RRL*
MRI lumbar spine without and with contrast	8	Contrast useful for neoplasia subjects suspected of epidural or intraspinal disease. See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI lumbar spine without contrast	7	Noncontrast MRI may be sufficient if there is low risk of epidural and/or intraspinal disease.	O
CT lumbar spine with contrast	6	MRI preferred. CT useful if MRI is contraindicated or unavailable, and/or for problem solving.	☢☢☢
CT lumbar spine without contrast	6	MRI preferred. CT 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	5	SPECT/CT may be useful for anatomic localization and problem solving.	☢☢☢
CT lumbar spine without and with contrast	3		☢☢☢☢
X-ray myelography lumbar spine	2		☢☢☢
Myelography and postmyelography CT lumbar spine	2	In some cases postinjection CT imaging may be done without plain-film myelography.	☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 4: Low back pain and/or radiculopathy. Surgery or intervention candidate.

Radiologic Procedure	Rating	Comments	RRL*
MRI lumbar spine without contrast	8		O
CT lumbar spine with contrast	5	MRI preferred. CT useful if MRI is contraindicated or unavailable, and/or for problem solving.	☢☢☢
CT lumbar spine without contrast	5	MRI preferred. CT useful if MRI contraindicated or unavailable, and/or for problem solving.	☢☢☢
MRI lumbar spine without and with contrast	5	Indicated if noncontrast MRI is nondiagnostic or indeterminate. See statement regarding contrast in text under "Anticipated Exceptions."	O
Myelography and postmyelography CT lumbar spine	5	MRI preferred. May be indicated if MRI is contraindicated or nondiagnostic. In some cases postinjection CT imaging may be done without plain-film myelography.	☢☢☢☢
X-ray discography and post-discography CT lumbar spine	5		☢☢☢
X-ray lumbar spine	4	Usually not sufficient for decision making without MR and/or CT imaging.	☢☢☢
Tc-99m bone scan with SPECT spine	4	May be particularly useful for facet arthropathy, stress fracture, and spondylolysis. SPECT/CT may be useful for anatomic localization and problem solving.	☢☢☢
X-ray discography lumbar spine	4		☢☢
CT lumbar spine without and with contrast	3		☢☢☢☢
X-ray myelography lumbar spine	2		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

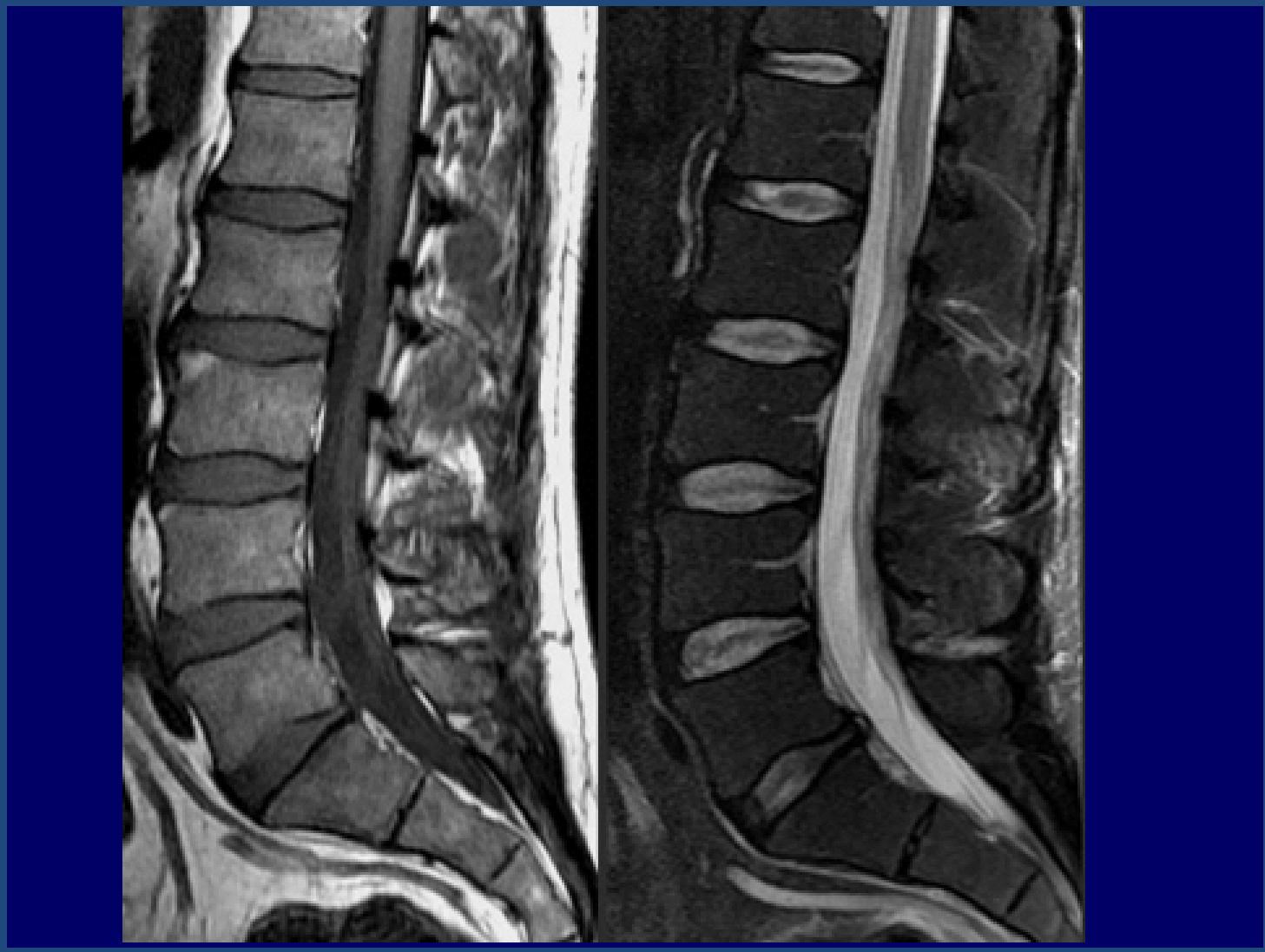
Variant 5: Prior lumbar surgery.

Radiologic Procedure	Rating	Comments	RRL*
MRI lumbar spine without and with contrast	8	Can differentiate disc from scar. See statement regarding contrast in text under "Anticipated Exceptions."	O
CT lumbar spine with contrast	6	Most useful in postfusion patients or when MRI is contraindicated or indeterminate.	☢☢☢
CT lumbar spine without contrast	6	Most useful in postfusion patients or when MRI is contraindicated or indeterminate.	☢☢☢
MRI lumbar spine without contrast	6	Contrast often necessary.	O
Myelography and postmyelography CT lumbar spine	5	In some cases postinjection CT imaging may be done without plain-film myelography.	☢☢☢☢
X-ray lumbar spine	5	Flex/extension may be useful.	☢☢☢
Tc-99m bone scan with SPECT spine	5	Helps detect and localize painful pseudoarthrosis. SPECT/CT may be useful for anatomic localization and problem solving.	☢☢☢
X-ray discography and post-discography CT lumbar spine	5		☢☢☢
X-ray discography lumbar spine	4		☢☢
CT lumbar spine without and with contrast	3		☢☢☢☢
X-ray myelography lumbar spine	2		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

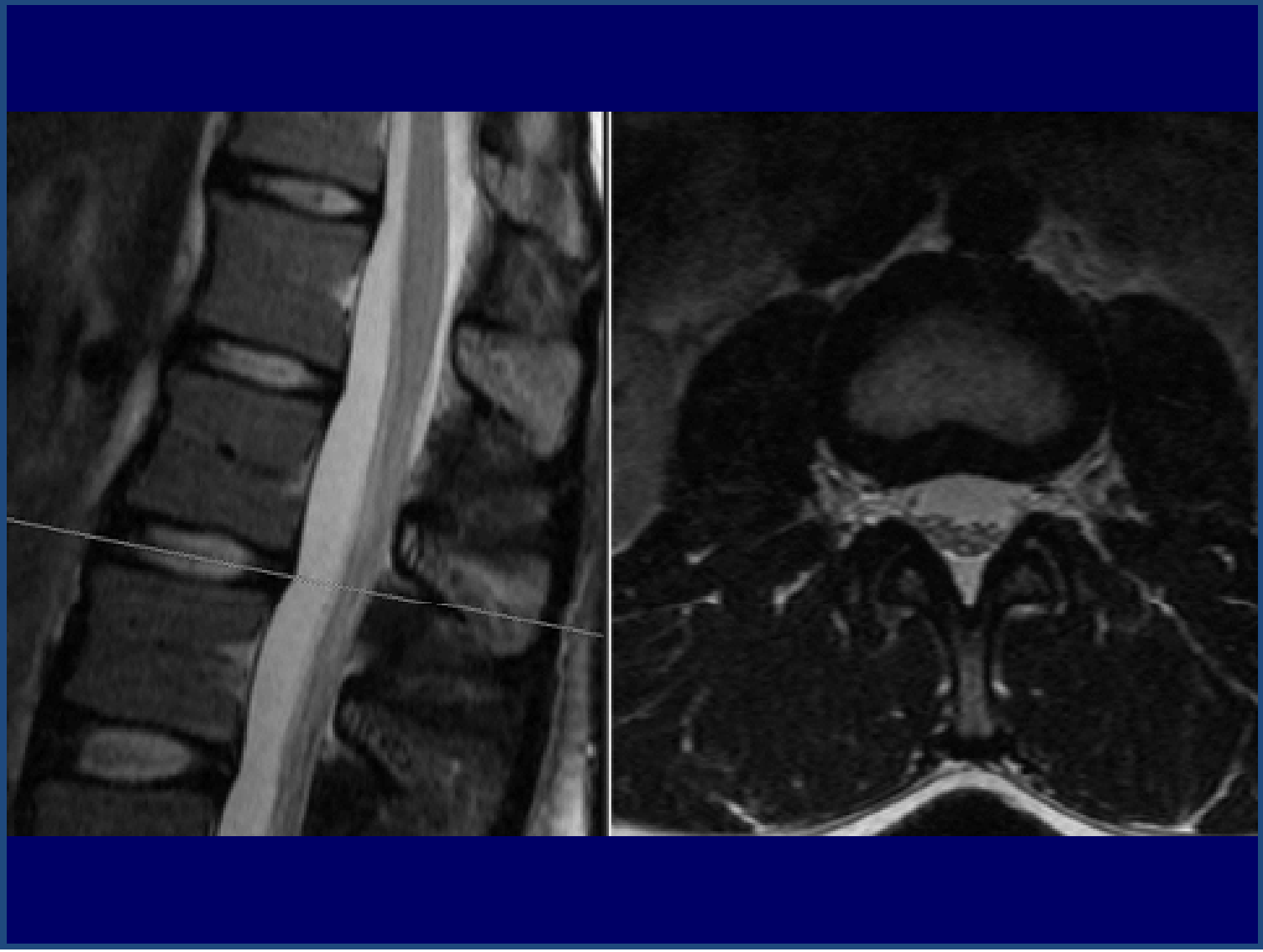
Variant 6: Cauda equina syndrome, multifocal deficits or progressive deficit.

Radiologic Procedure	Rating	Comments	RRL*
MRI lumbar spine without contrast	9	Use of contrast depends on clinical circumstances.	O
MRI lumbar spine without and with contrast	8	Use of contrast depends on clinical circumstances. See statement regarding contrast in text under "Anticipated Exceptions."	O
Myelography and postmyelography CT lumbar spine	6	Useful if MRI is nondiagnostic or contraindicated. In some cases postinjection CT imaging may be done without plain-film myelography.	☢☢☢☢
CT lumbar spine with contrast	5		☢☢☢
CT lumbar spine without contrast	5		☢☢☢
X-ray lumbar spine	4		☢☢☢
CT lumbar spine without and with contrast	3		☢☢☢☢
Tc-99m bone scan with SPECT spine	2		☢☢☢
X-ray myelography lumbar spine	2		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Unremarkable MRI Lumbar Spine



MRI L2-L3 level



Unknown Case

- 81 year old woman with history of osteoporosis presents with acute onset back pain.

- Does she require imaging?

Consider imaging for those with no improvement after 6 weeks or the following red flags

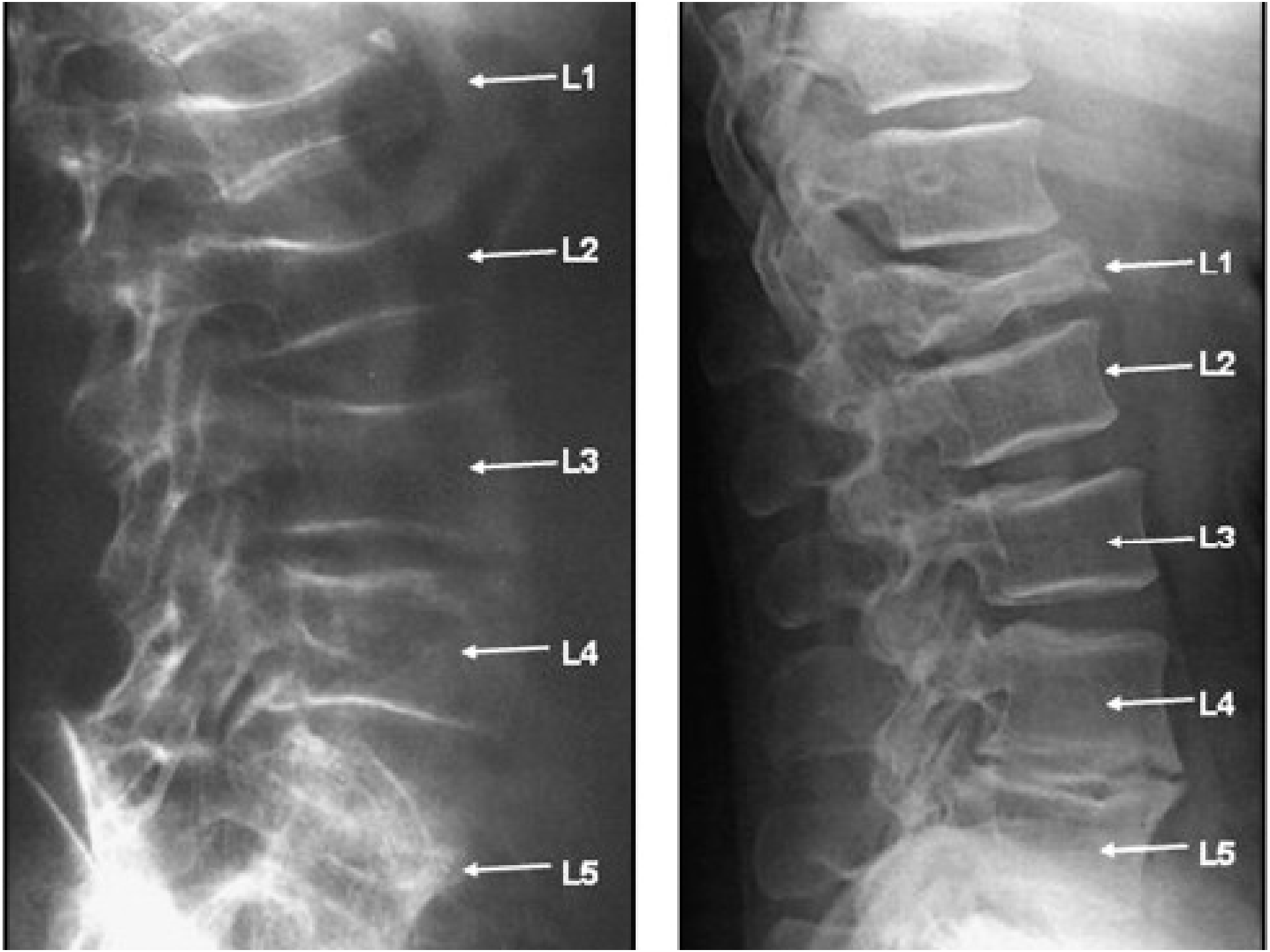
- Indications of a more complicated status include back pain/radiculopathy in the following settings:

- Trauma, cumulative trauma
- Unexplained weight loss, insidious onset
- Age >50 years, especially women, and males with osteoporosis or compression fracture
- Unexplained fever, history of urinary or other infection
- Immunosuppression, diabetes mellitus
- History of cancer
- Intravenous (IV) drug use
- Prolonged use of corticosteroids, osteoporosis
- Age >70
- Focal neurologic deficit(s) with progressive or disabling symptoms, cauda equina syndrome
- Duration longer than 6 weeks
- Prior surgery

- For the 81 year old osteoporotic, which imaging study should be ordered?

Low Back Pain
Indications for Radiographs

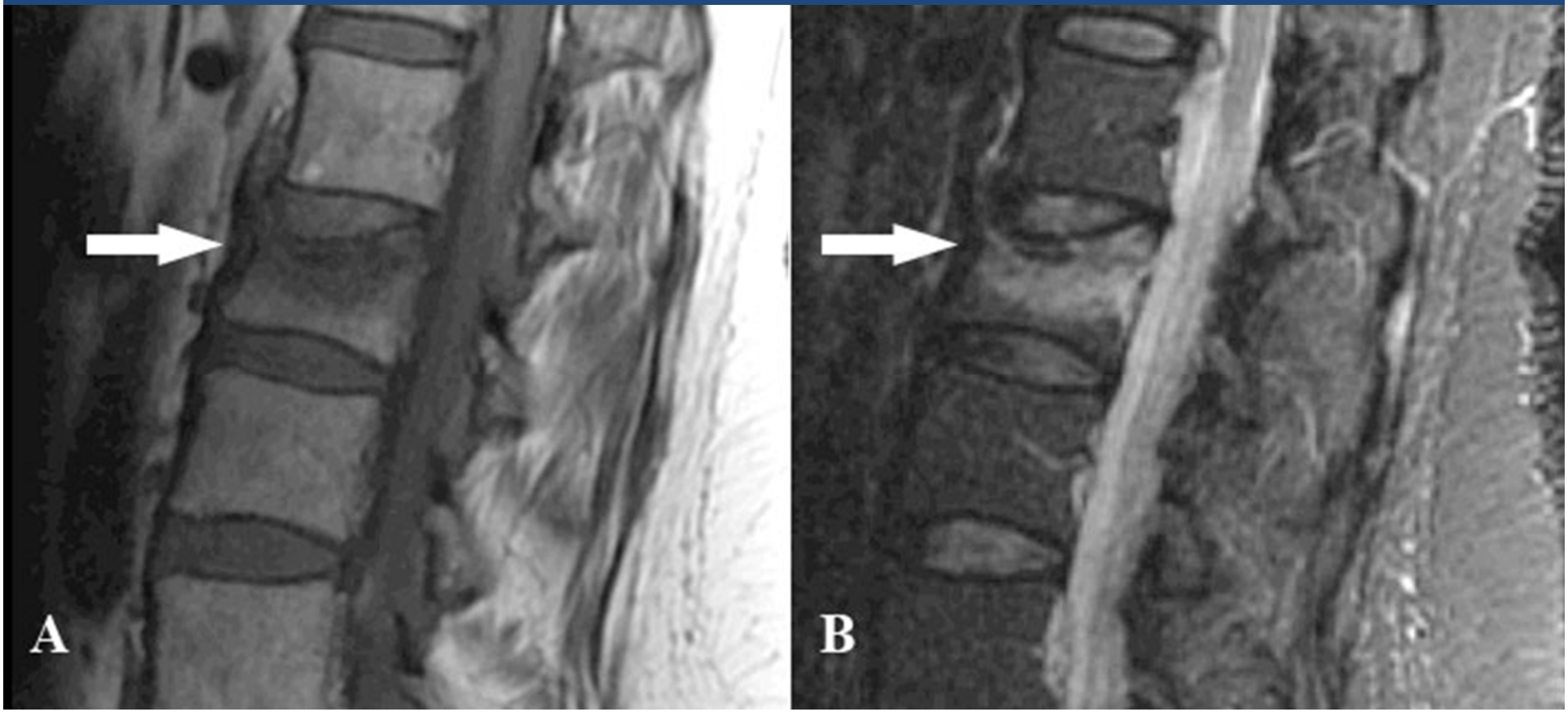
- Radiographs may be useful in any of the red flag categories. Lumbar radiographs may be sufficient for the initial evaluation of the following red flags, with further imaging indicated for treatment planning if findings are abnormal or inconclusive:
- Recent significant trauma (at any age)
- Osteoporosis
- Age >70 years
- The initial evaluation of the LBP patient may also require further imaging if other red flags such as suspicion of cancer or infection are present.


L1
L2
L3
L4
L5
L1
L2
L3
L4
L5

Differentiating Acute vs Chronic Compression Fractures on MRI

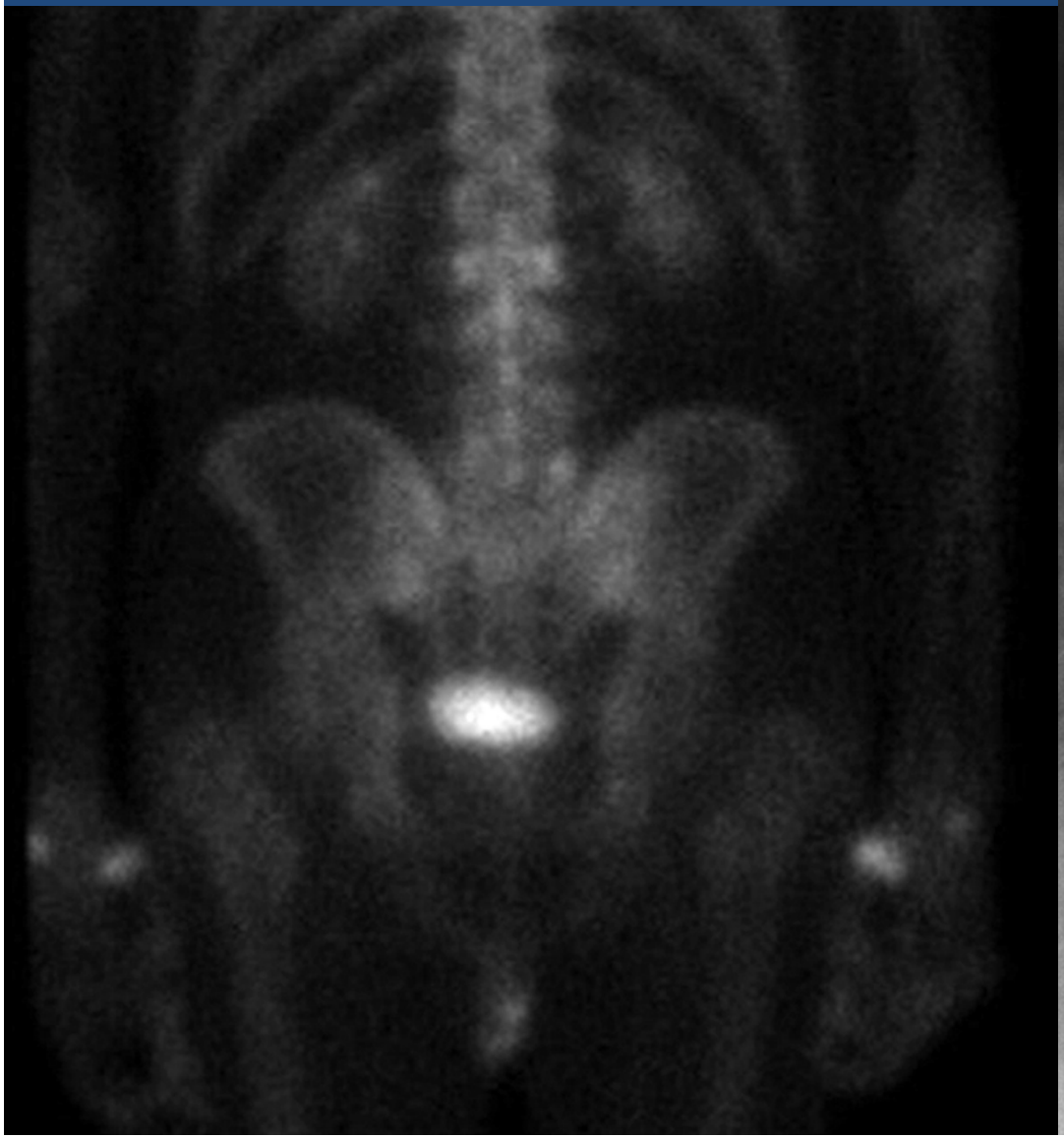
- Acute/Subacute (marrow edema)
- Chronic (normal marrow signal)

Acute vs Chronic Fracture L2?



Bone Scan to differentiate acute/subacute vs chronic fractures

- Total body bone scan using Tc 99m MDP



What is your diagnosis?

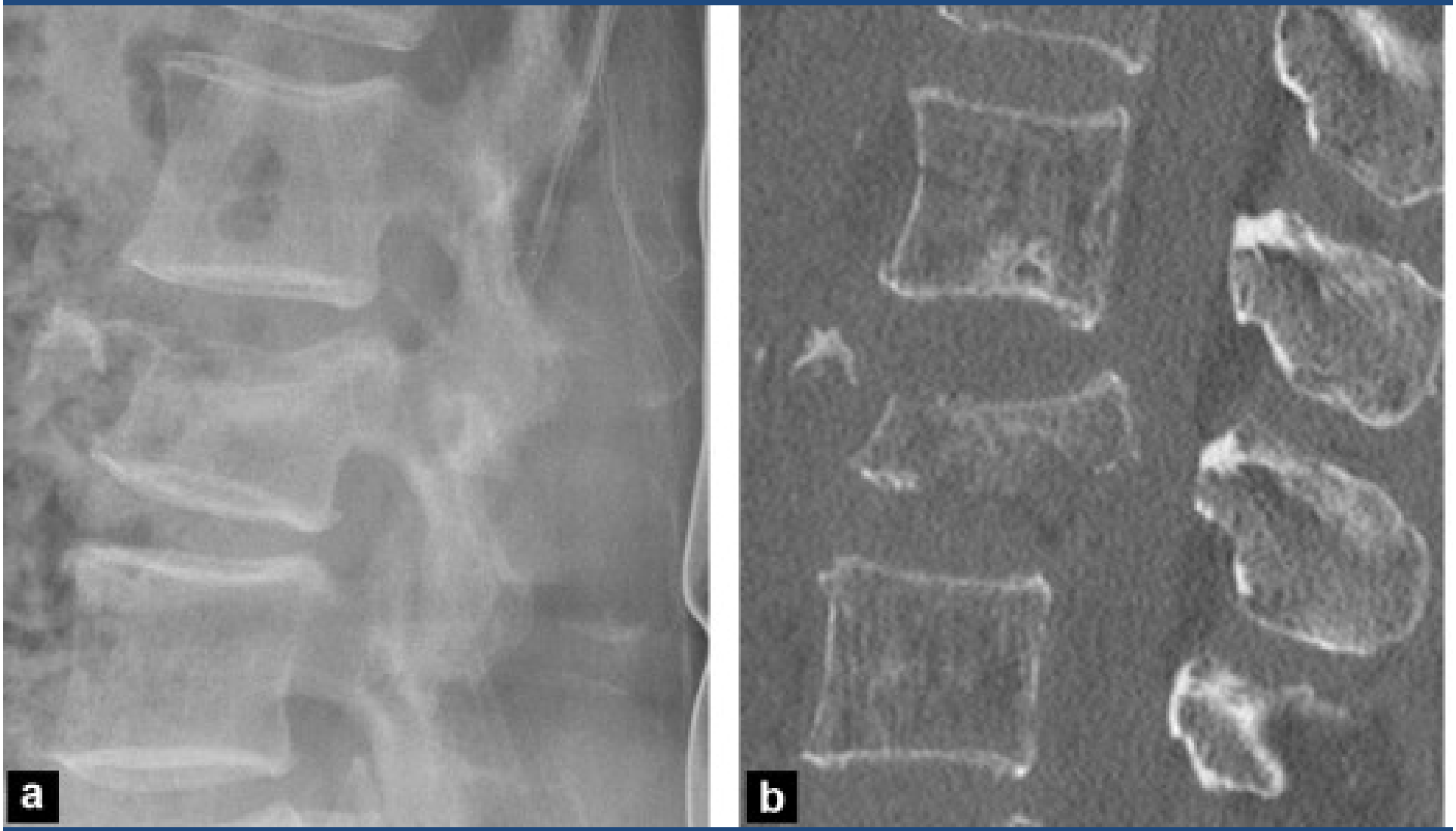
27-year-old man with vertebral hemangioma

Benign hemangioma?

Unknown case

- Trauma (mva) with leg weakness, saddle anesthesia, bladder dysfunction and decreased rectal tone.

Diagnosis?



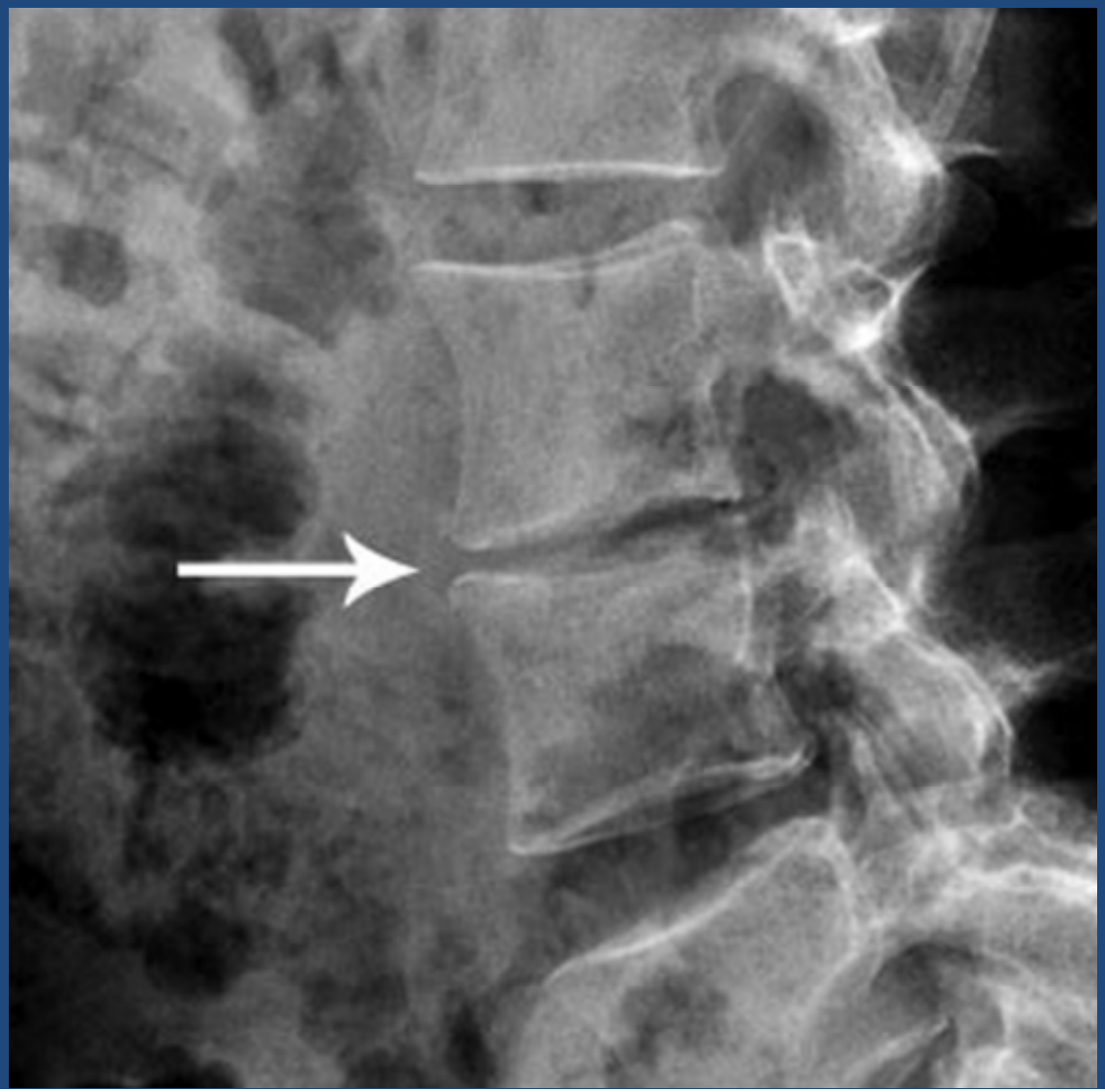
Cauda Equina Syndrome

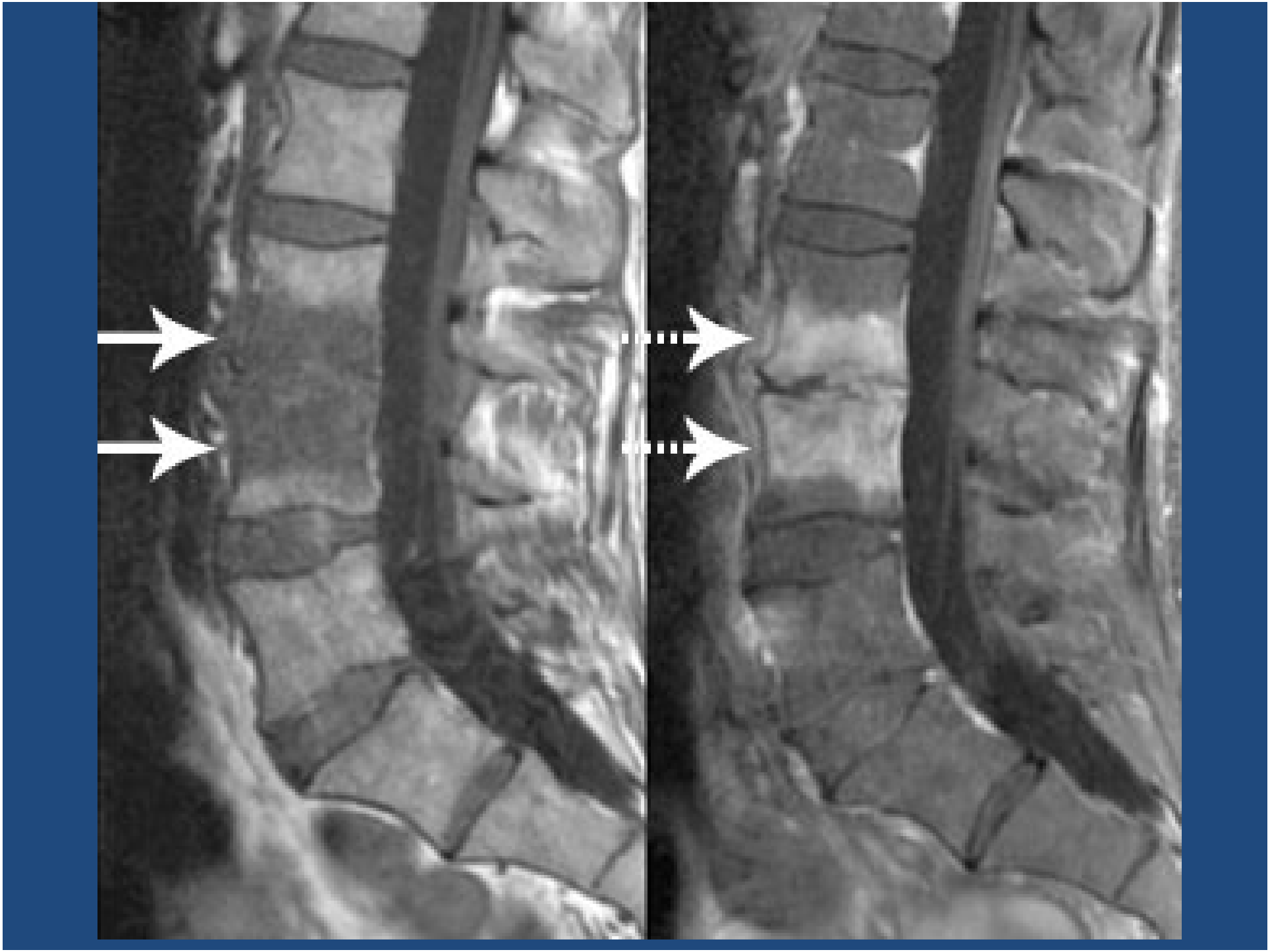
- Results from any lesion that compresses the cauda equina.
- Symptoms include low back pain, sciatica (unilateral or, usually, bilateral), saddle sensory disturbances, bladder and bowel dysfunction, and variable lower extremity motor and sensory loss
- The prognosis for cauda equina syndrome (CES) improves if a definitive cause is identified and management is instituted early.

Unknown case

- 58 year old male with 5 week history of worsening low back pain and fever

Subtle plain film findings

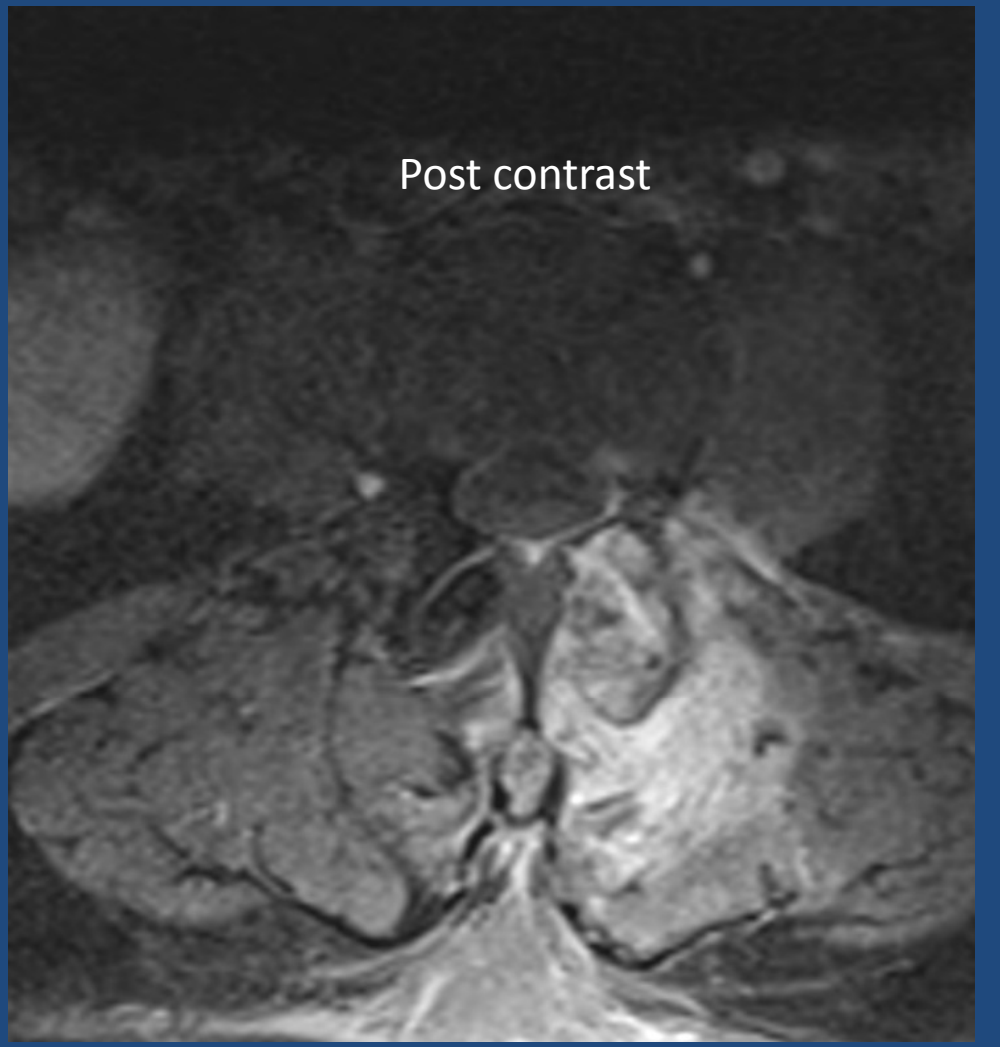




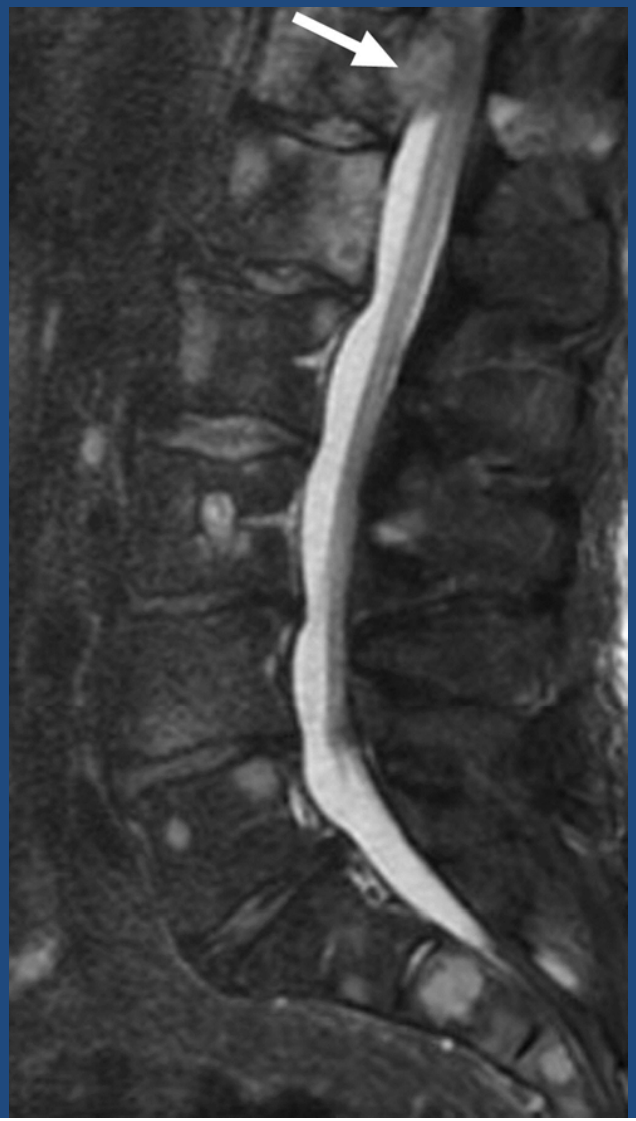
Comparison of Imaging Modalities for the Diagnosis of Vertebral Osteomyelitis		
Modality	**Strengths**	**Weaknesses**
Plain film x-ray	Sensitive when infection well established Readily accessible	Signs do not develop until 10-21 days after start of infection
MRI	Most sensitive for early detection (edema) No radiation exposure	Moderate specificity Contraindications to MR, e.g. claustrophobia, pacer, etc.
CT	More sensitive than plain film for detecting bone and disc erosions	Less sensitive than MR to soft tissue lesions and abscesses Iodinated contrast administered
Gallium-Bone Scan	May be useful if CT and/or MRI equivocal	Low spatial resolution Requires 2 days

Back pain with fever
Diagnosis?

Diagnosis?

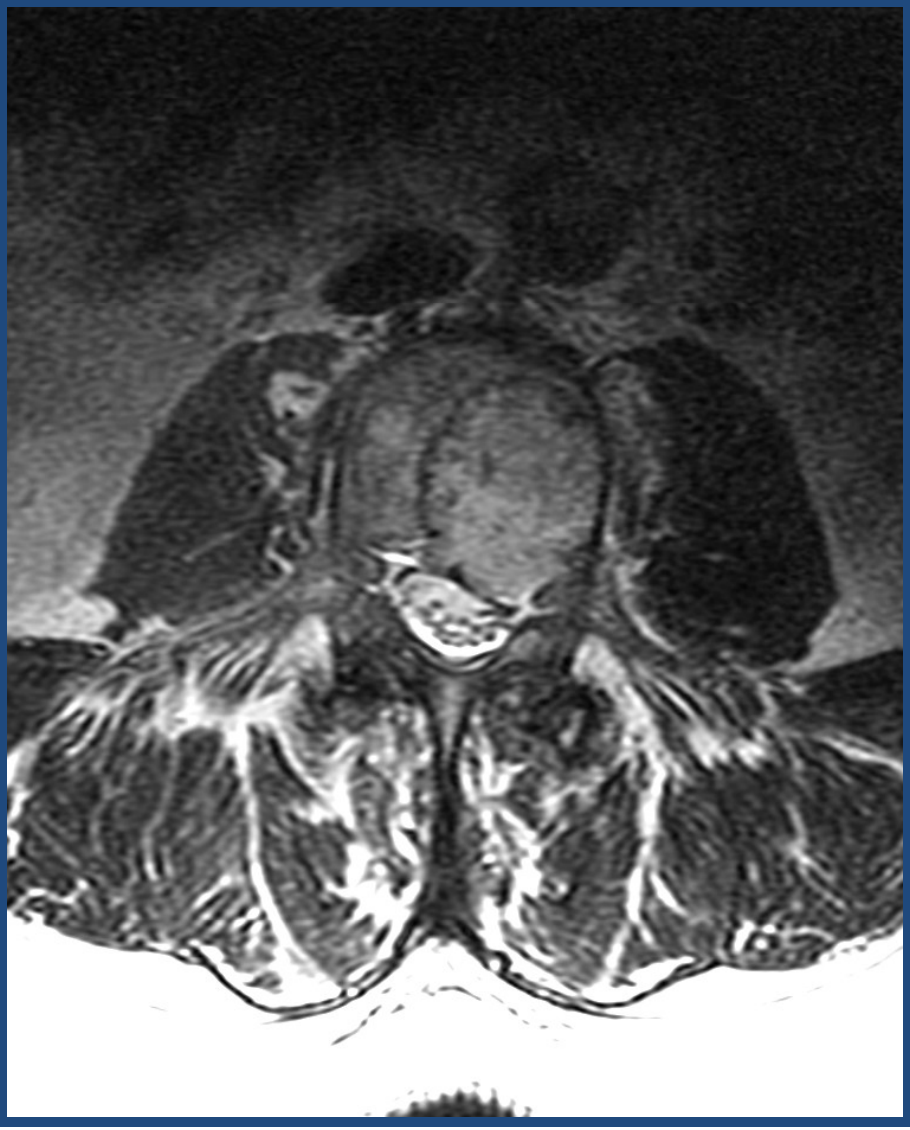


Two different patients with similar findings but two different diagnoses.



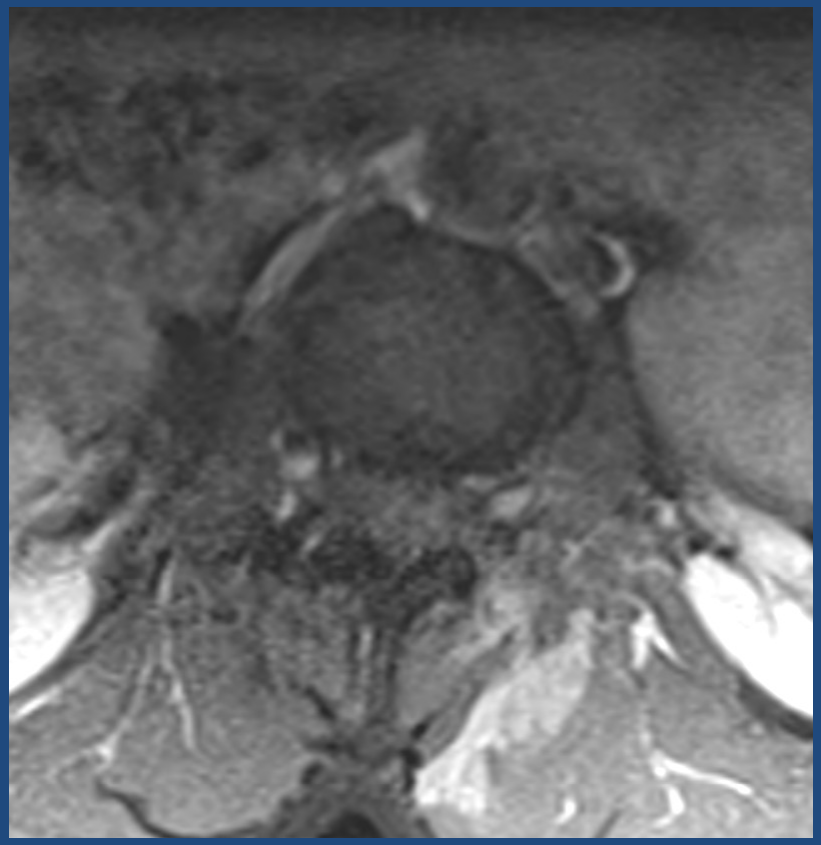
Diagnosis?

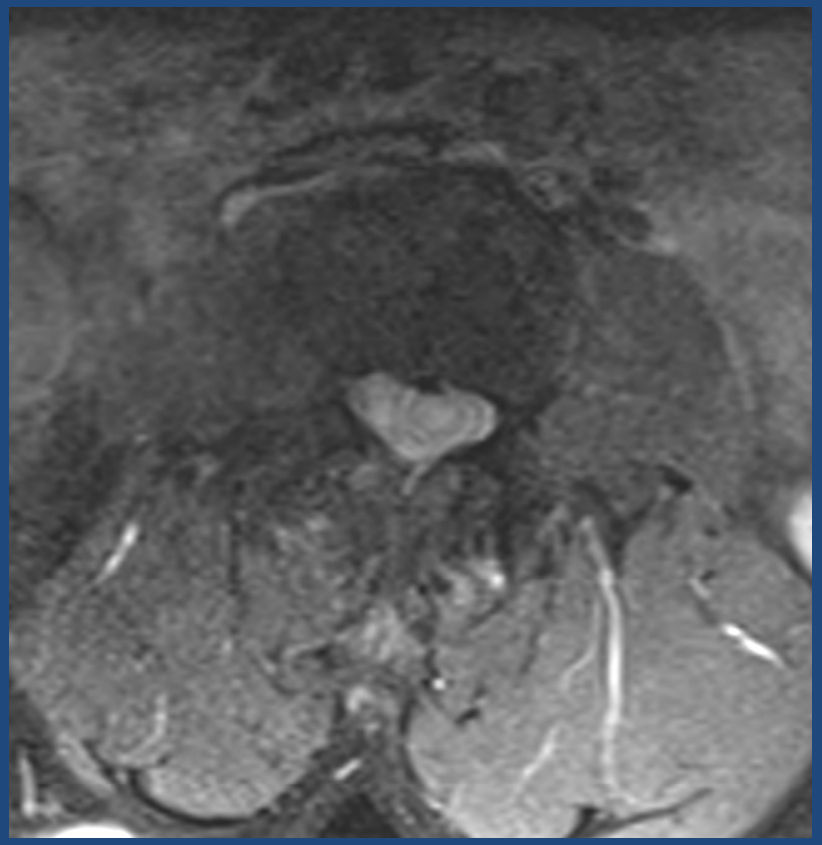
L3



Intradural lymphoma

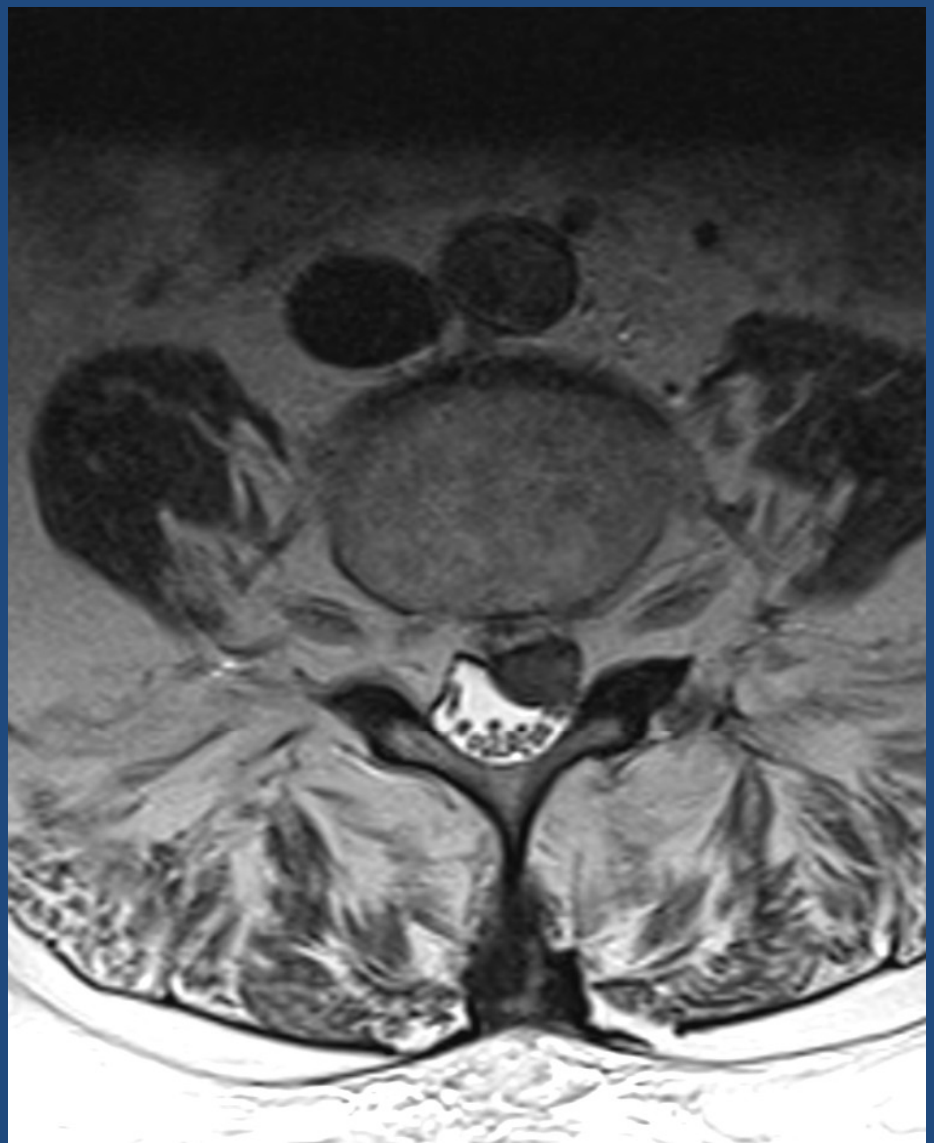
Intradural lymphoma



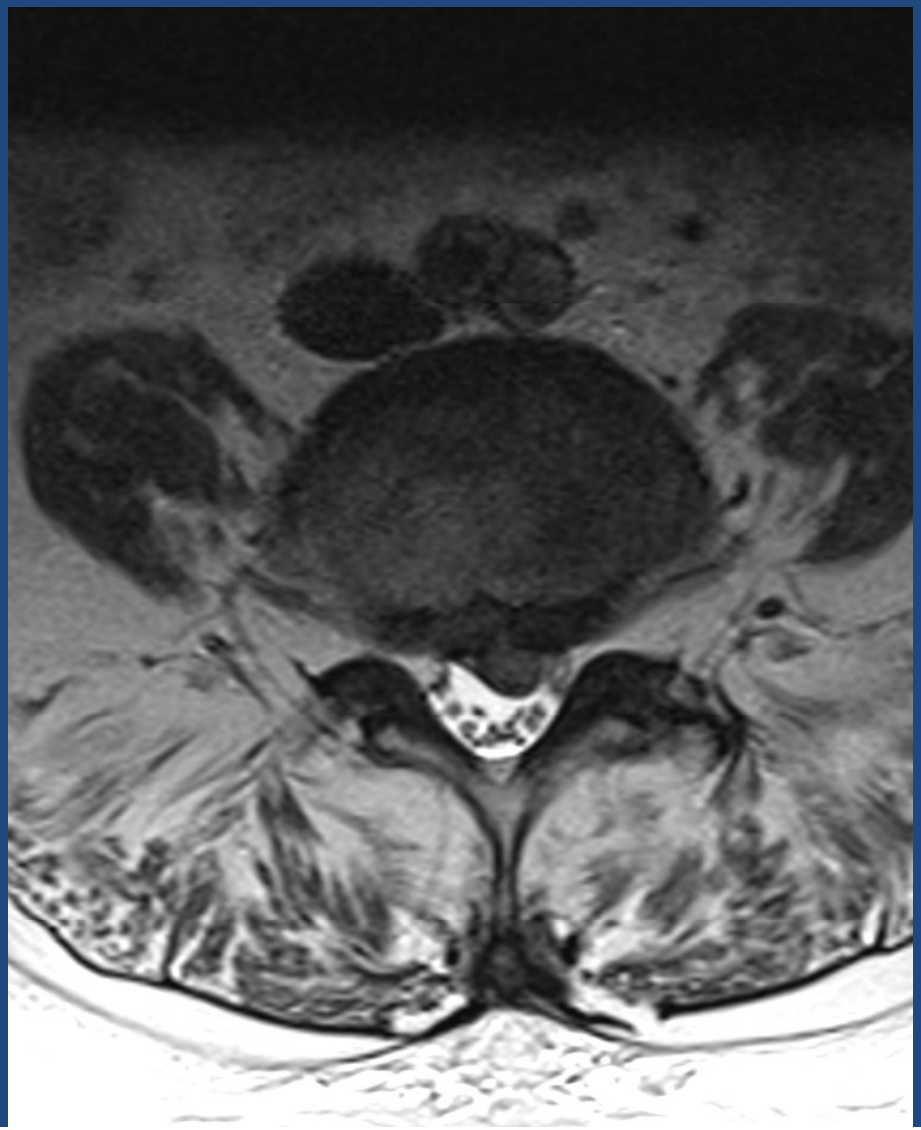


Unknown case

L4-L5



L4-L5

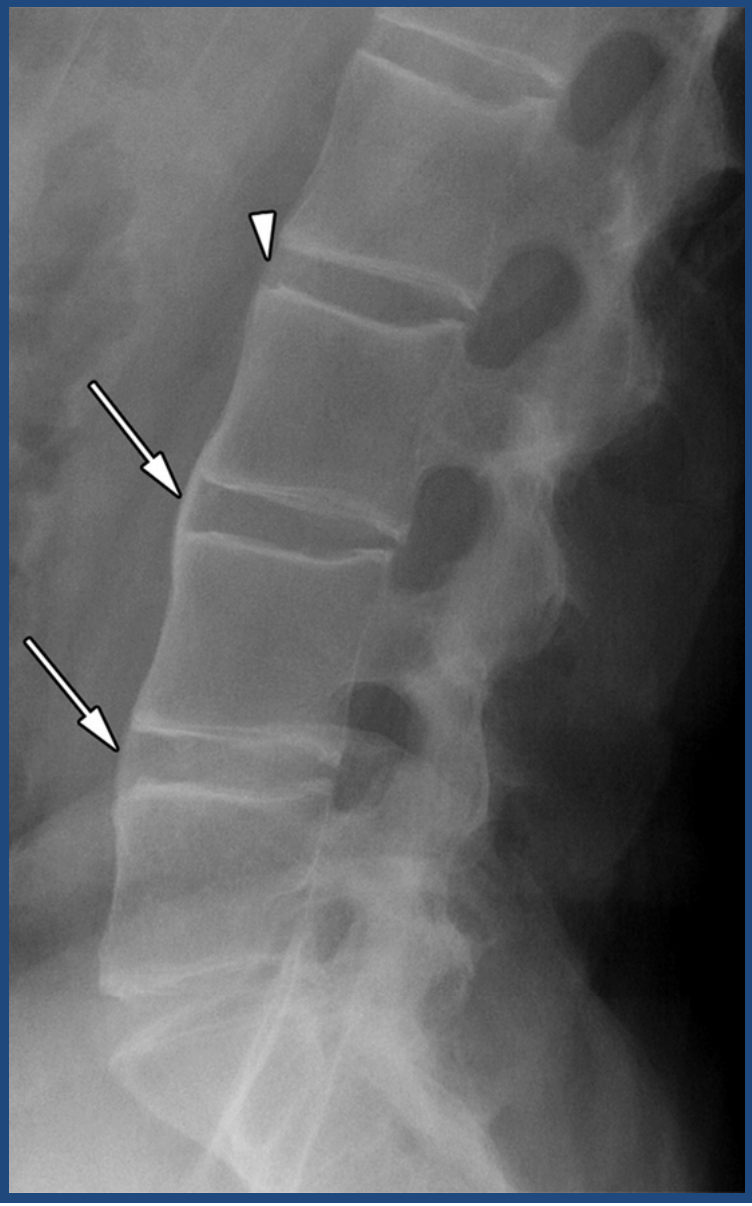


Lumbar Spinal Stenosis

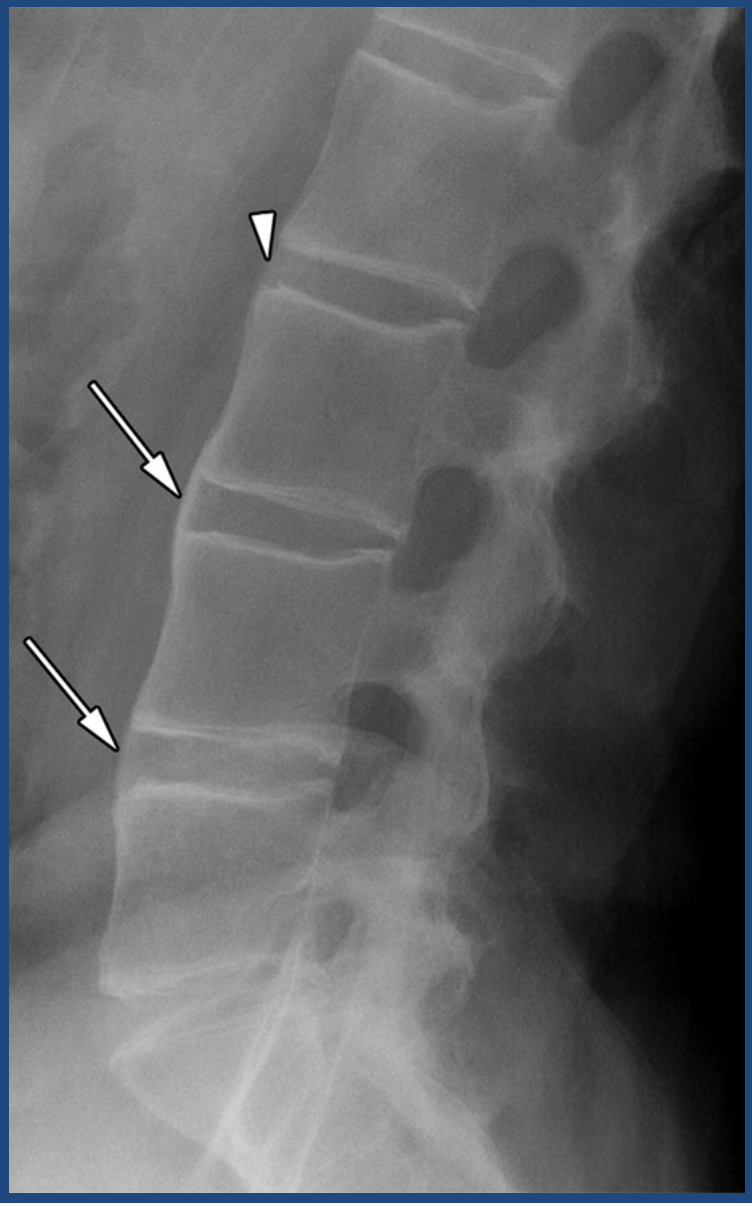
Unknown case

- 36 year old male with low back and buttock pain

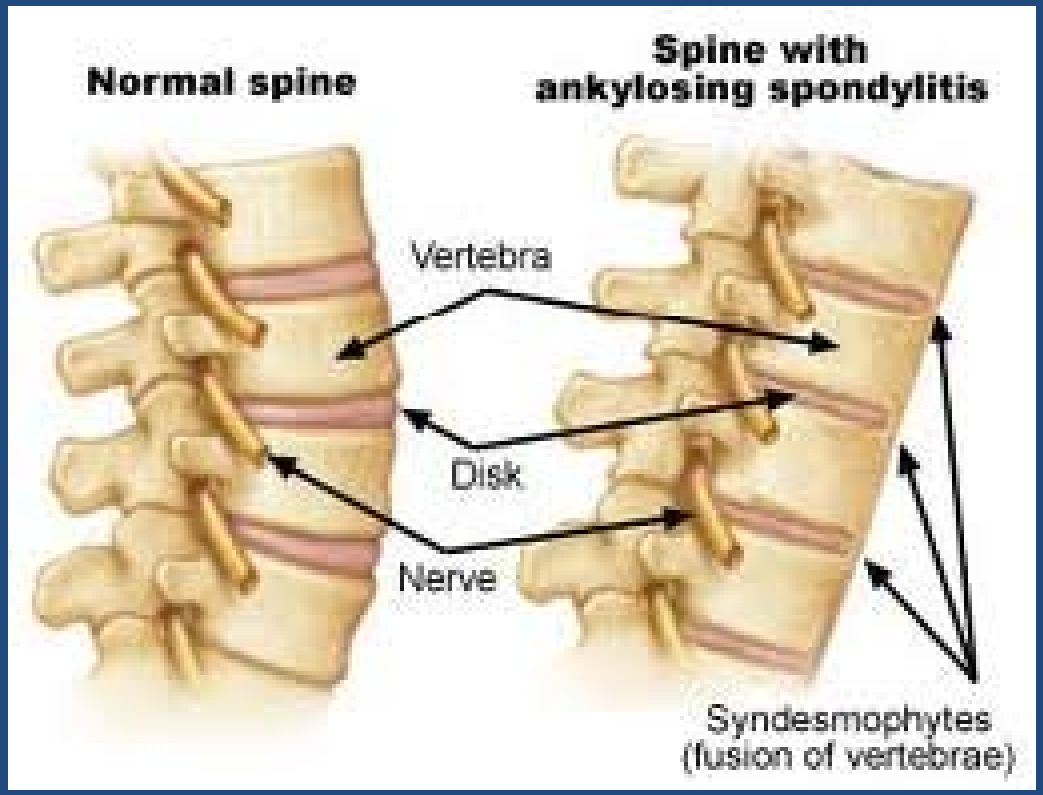
36 year old with low back and buttock pain

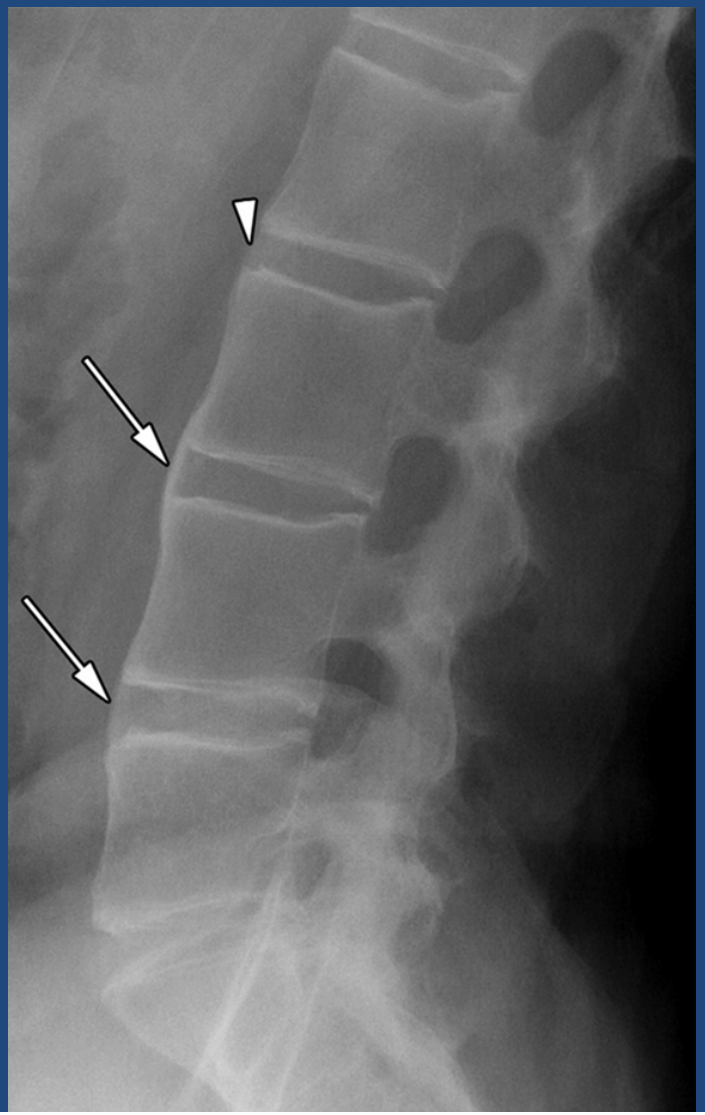


What is the diagnosis?

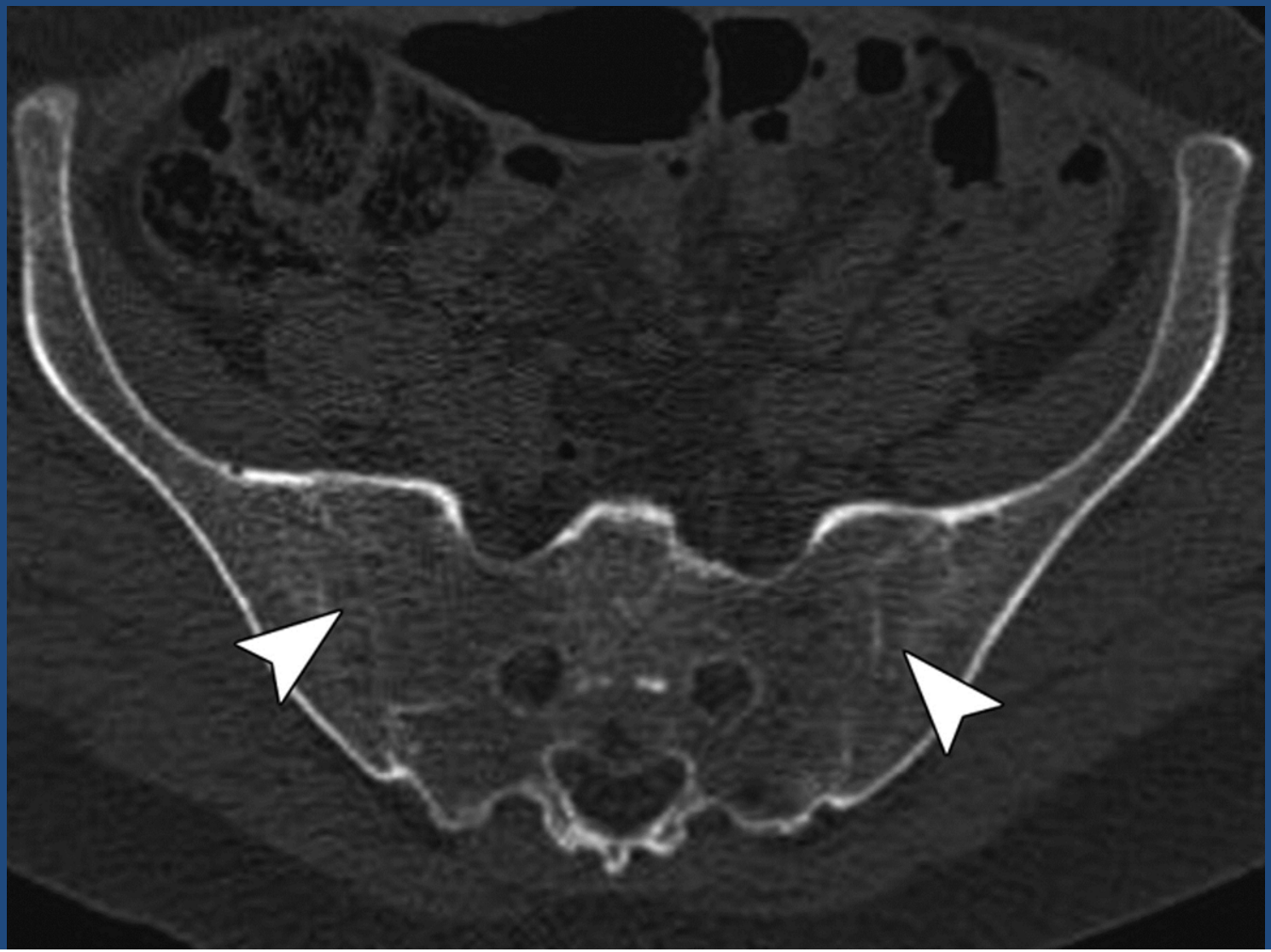


Ankylosing Spondylitis

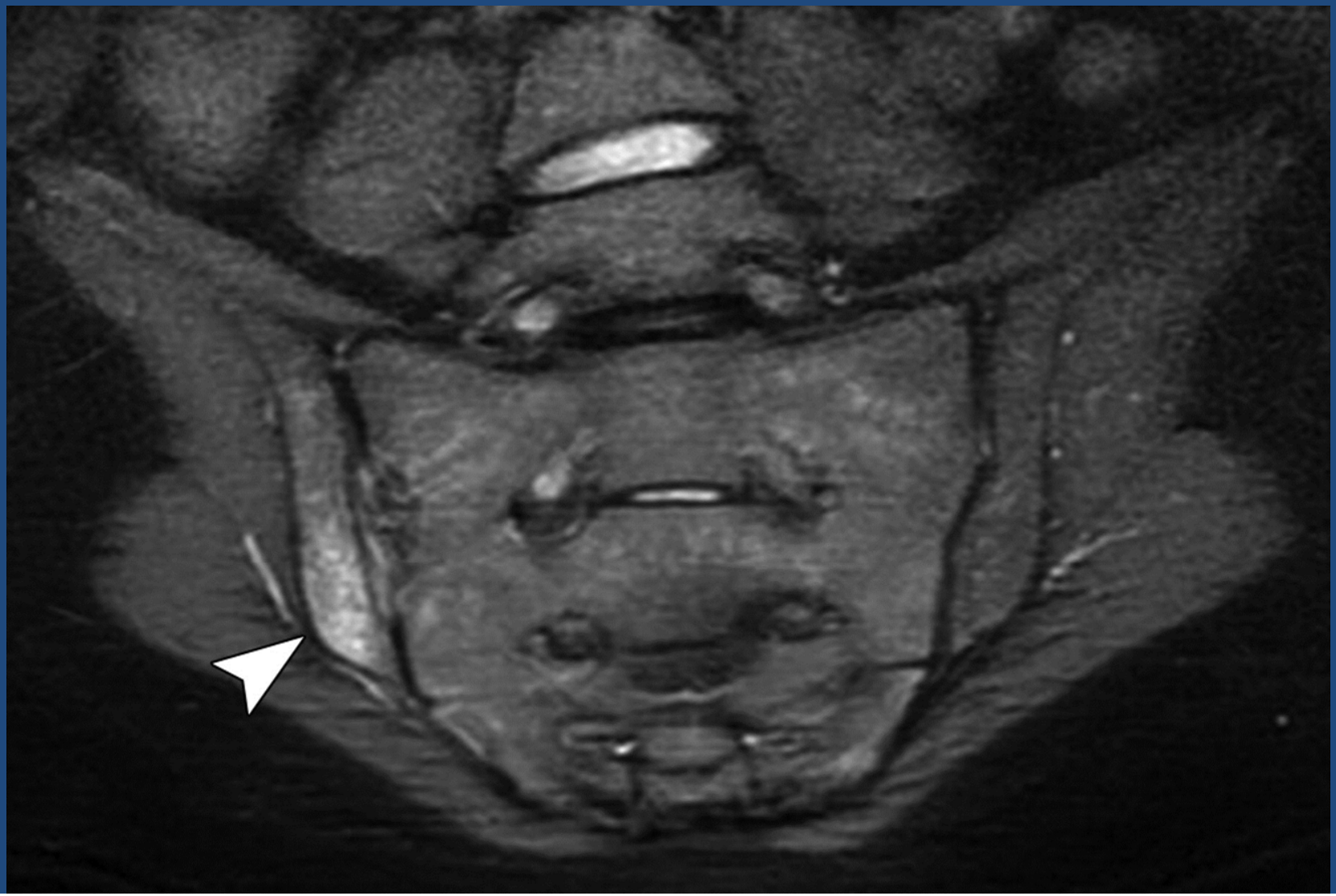




Ankylosing Spondylitis

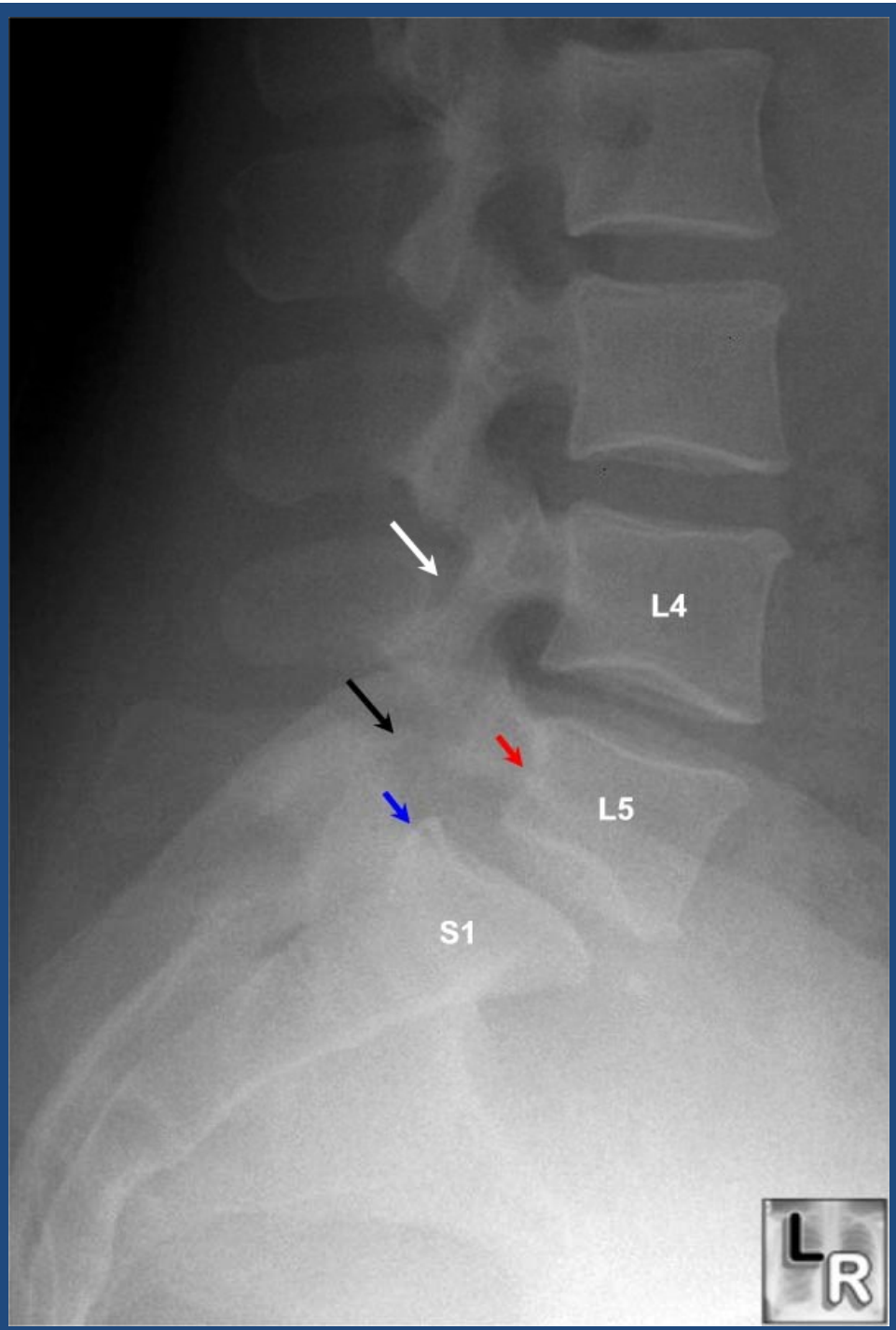


Unilateral Sacroiliitis



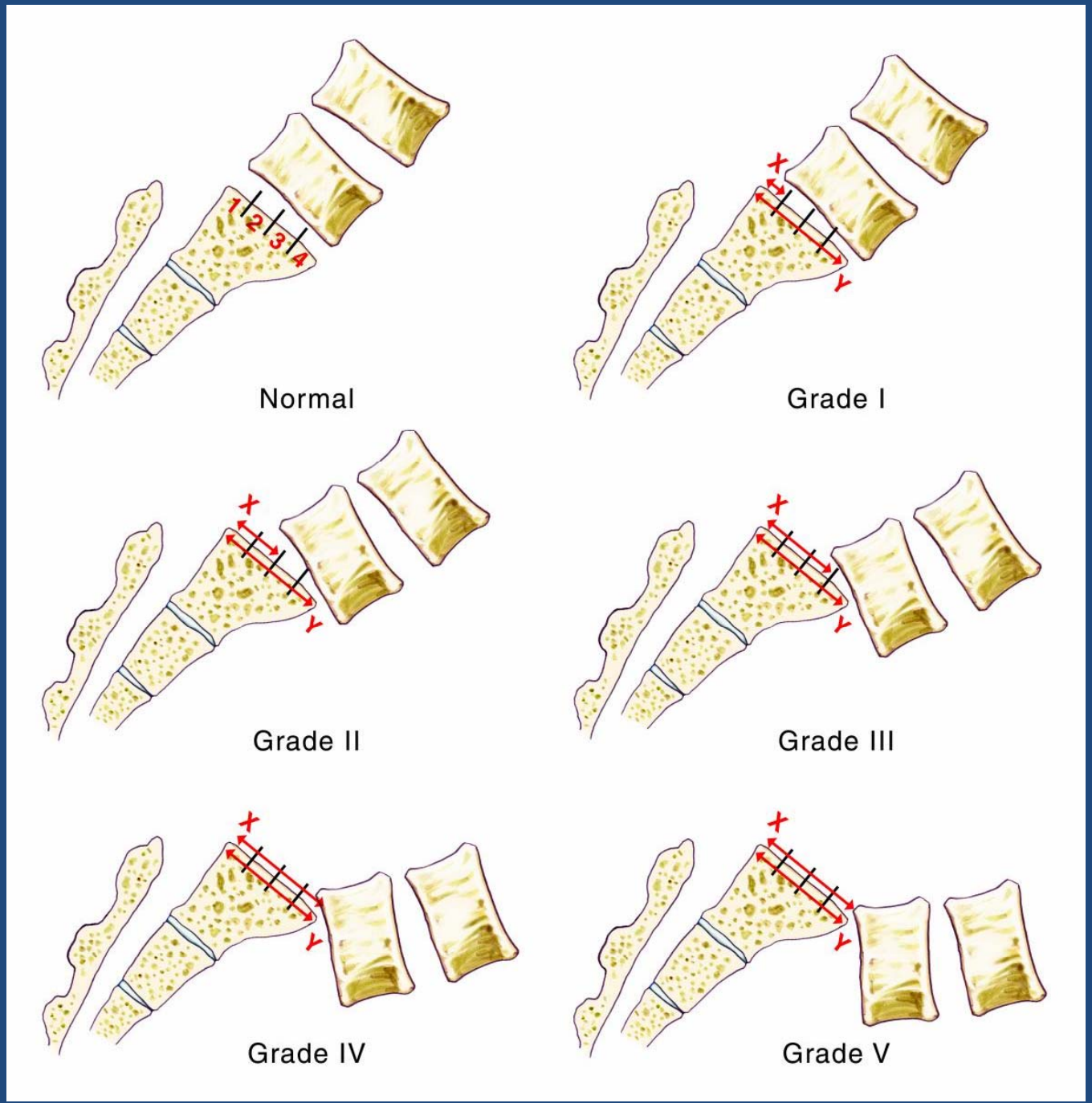
Unknown case
42 year old woman with back pain and bilateral radiculopathy


L
R

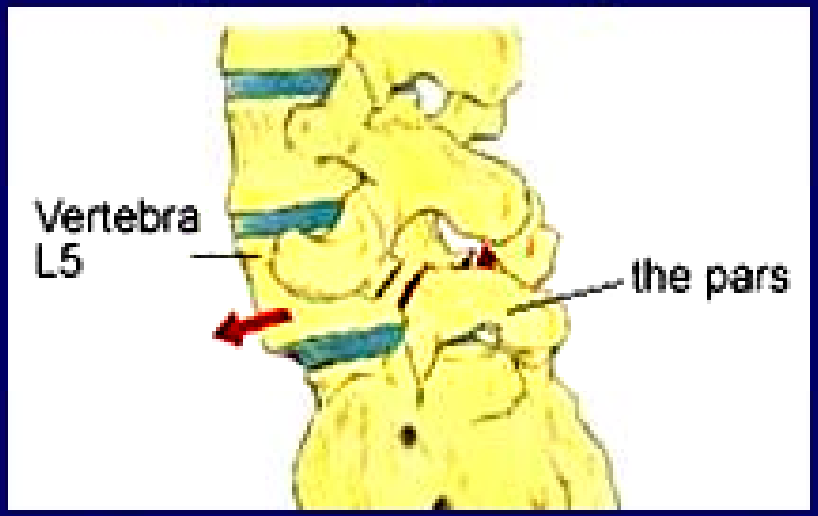

L4
L5
S1
L
R

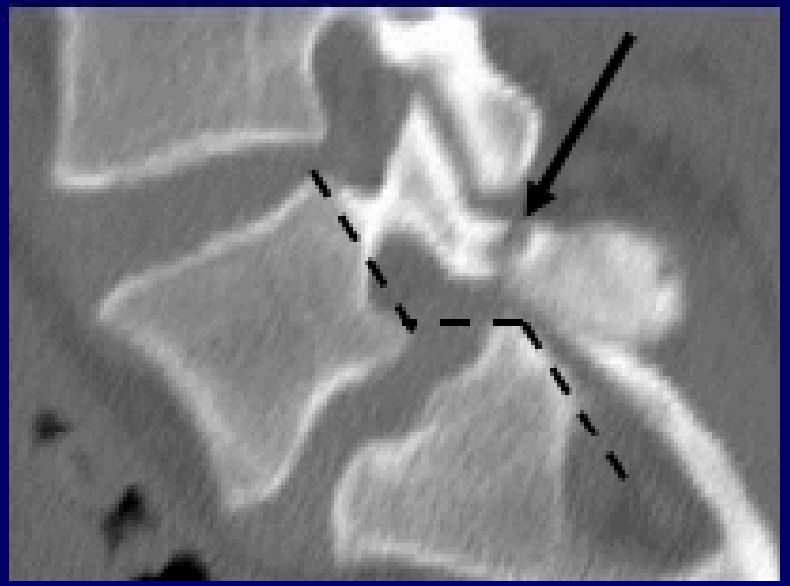
Spondylolisthesis

- Grade I is a slip of up to 25%,
- grade II is between 26%-50%,
- grade III is between 51%-75%,
- grade IV is between 76% and 100%, and
- Grade V, or spondyloptosis occurs when the vertebra has completely fallen off the next vertebra.

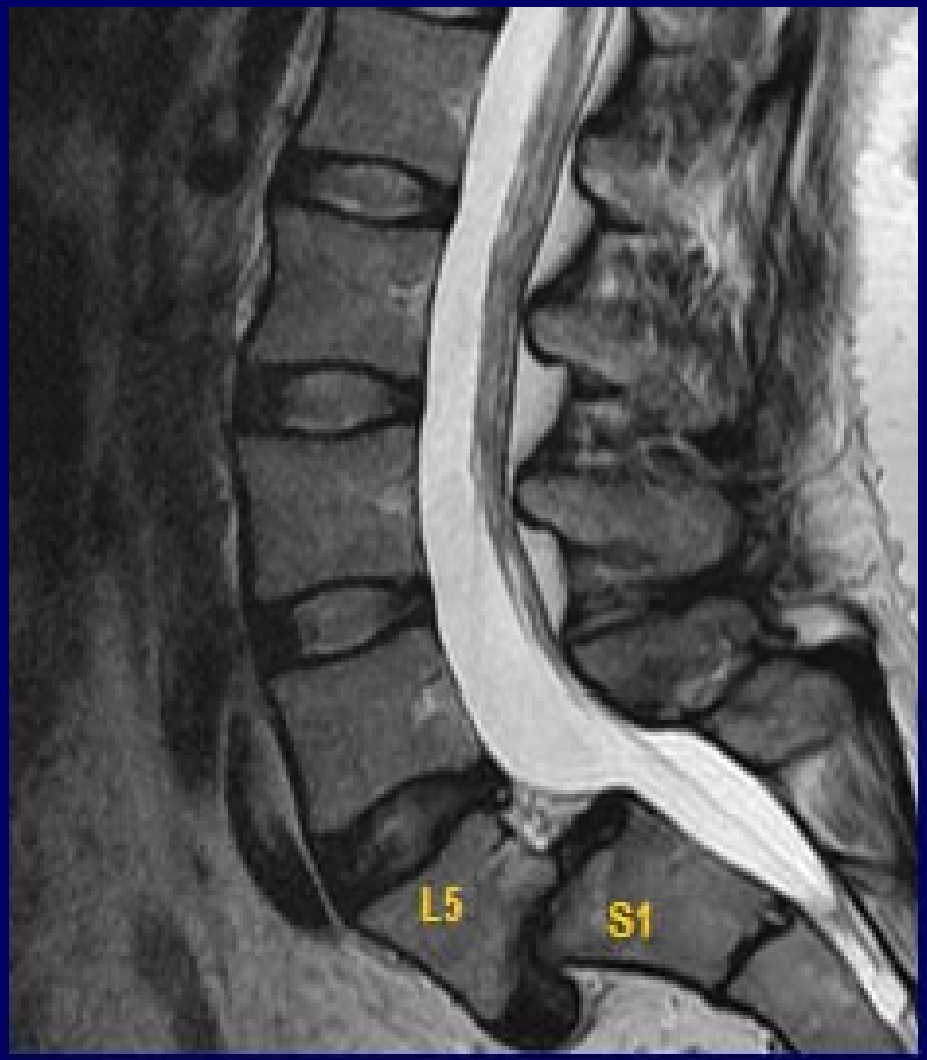

1
2
3
4
Normal
X
Y
Grade I
X
Y
Grade II
X
Y
Grade III
X
Y
Grade IV
X
Y
Grade V

Spondylolysis / Spondylolisthesis





Spondylolisthesis

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2

Common distribution of tumors of the spine

Multiple?
-metastasis
-myeloma
-lymphoma
-enostosis
-hemangioma
-eosinophilic granuloma

Involvement of adjacent vertebral levels?
-osteosarcoma
-chondrosarcoma
-myeloma,† plasmocytoma †
-lymphoma
-Ewing sarcoma
-chordoma
-ABC †
-giant cell tumor †

† may extend through the intervertebral disk

Common distribution of tumors of the spine

Location in vertebra?

Malignant
-metastasis
-myeloma ‡
-plasmocytoma ‡
-lymphoma
-chordoma

Exceptions
-hemangioma
-eosinophilic granuloma
-giant cell tumor ‡

‡ common extension in the neural arch

Benign
-osteoid osteoma
-osteoblastoma #
-osteochondroma
-ABC #

Exceptions (sarcomas)
-chondrosarcoma #
-osteosarcoma #
-Ewing sarcoma #

 # common extension in the vertebral body