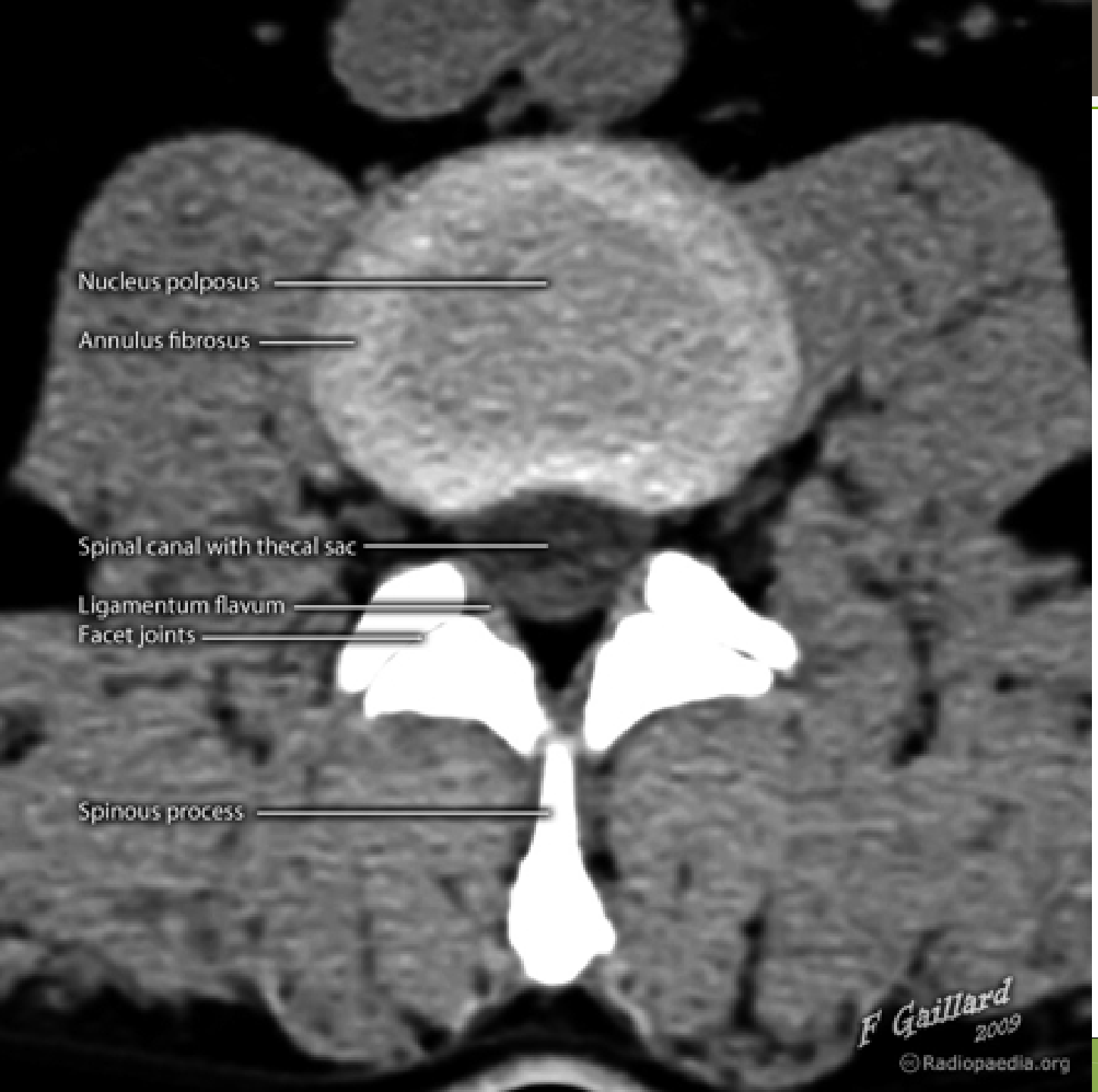
Evidence-Based Practice

MRI

Normal lumbar spine

PROLIFE


Nucleus polposus
Annulus fibrosus
Spinal canal with thecal sac
Ligamentum flavum
Facet joints
Spinous process
F Gaillard
2009
Radiopaedia.org

PROLIFE

PROLIFE

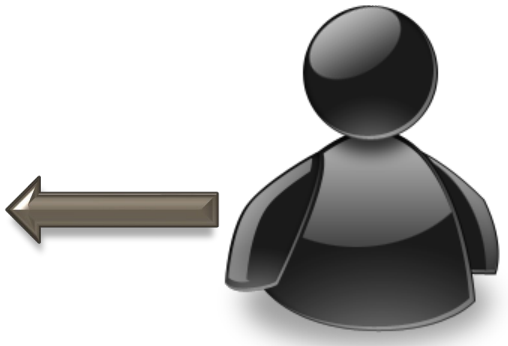
Disc Degeneration

PROLIFE

SPINE MRI

Imaging Workshop

T1

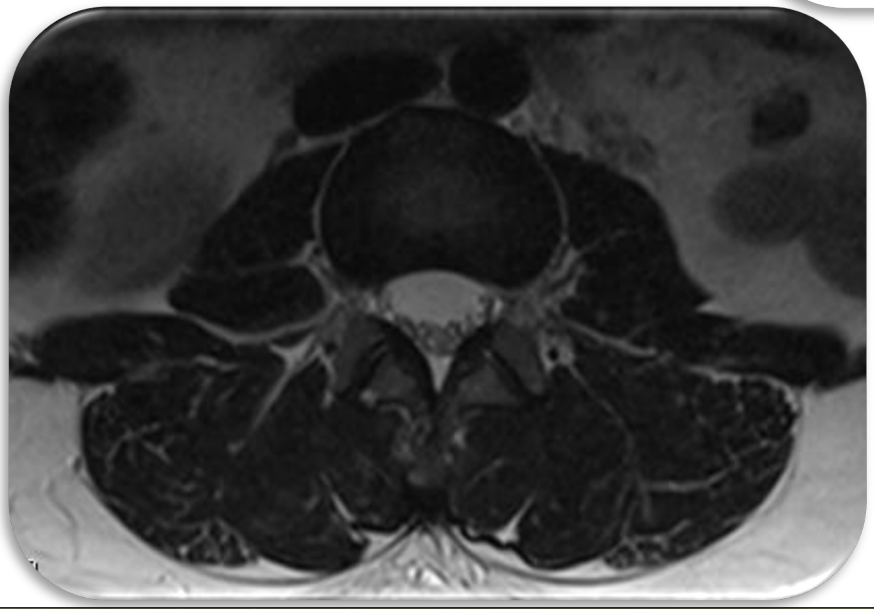


PROLIFE

T2

PROLIFE

PROLIFE



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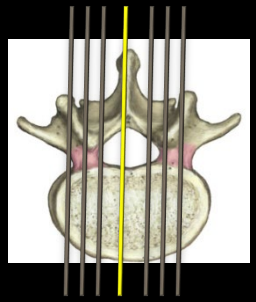

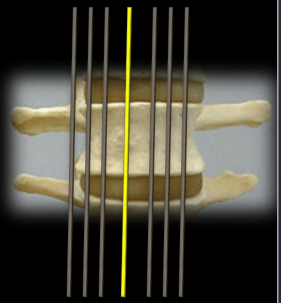

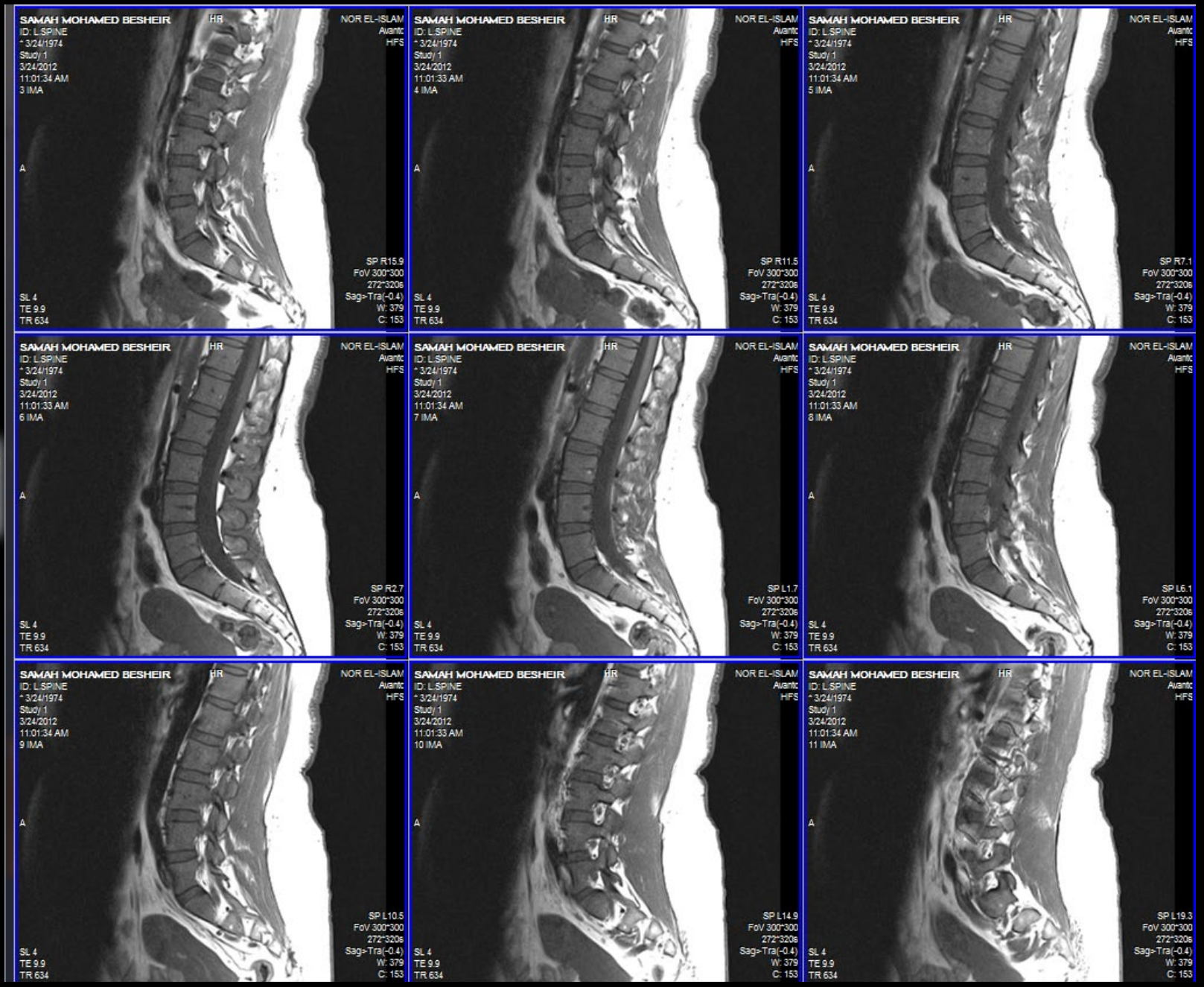
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Avanto
HFS
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FoV 300*300
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Sag>Tra(-0.4)
W: 379
C: 153
SL 4
TE 9.9
TR 634
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^ 3/24/1974
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SL 4
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TR 634
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HFS
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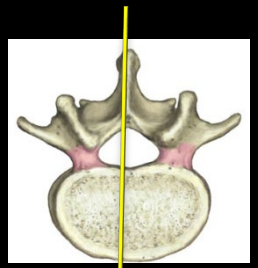
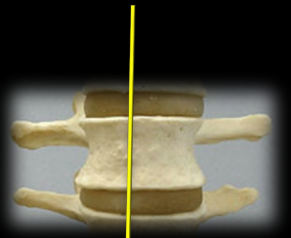
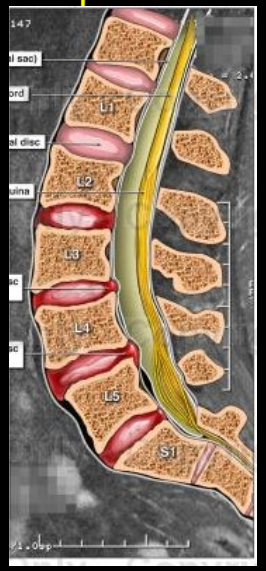
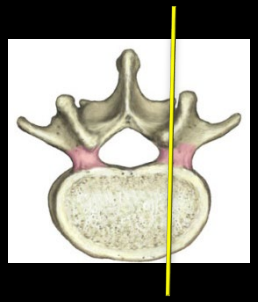


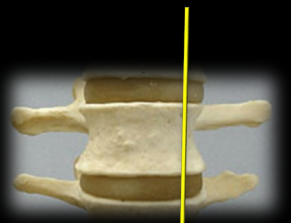



L1
L2
L3
L4
L5
S1


HR

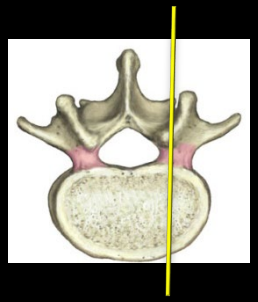

HR

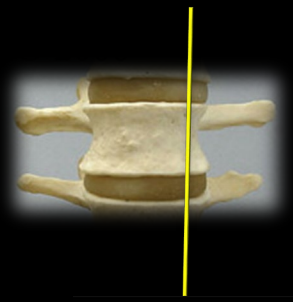


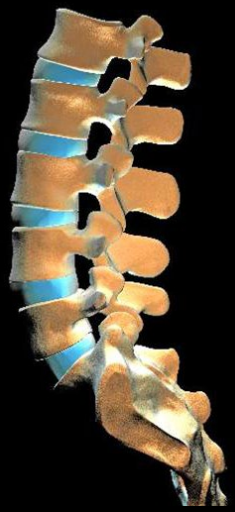


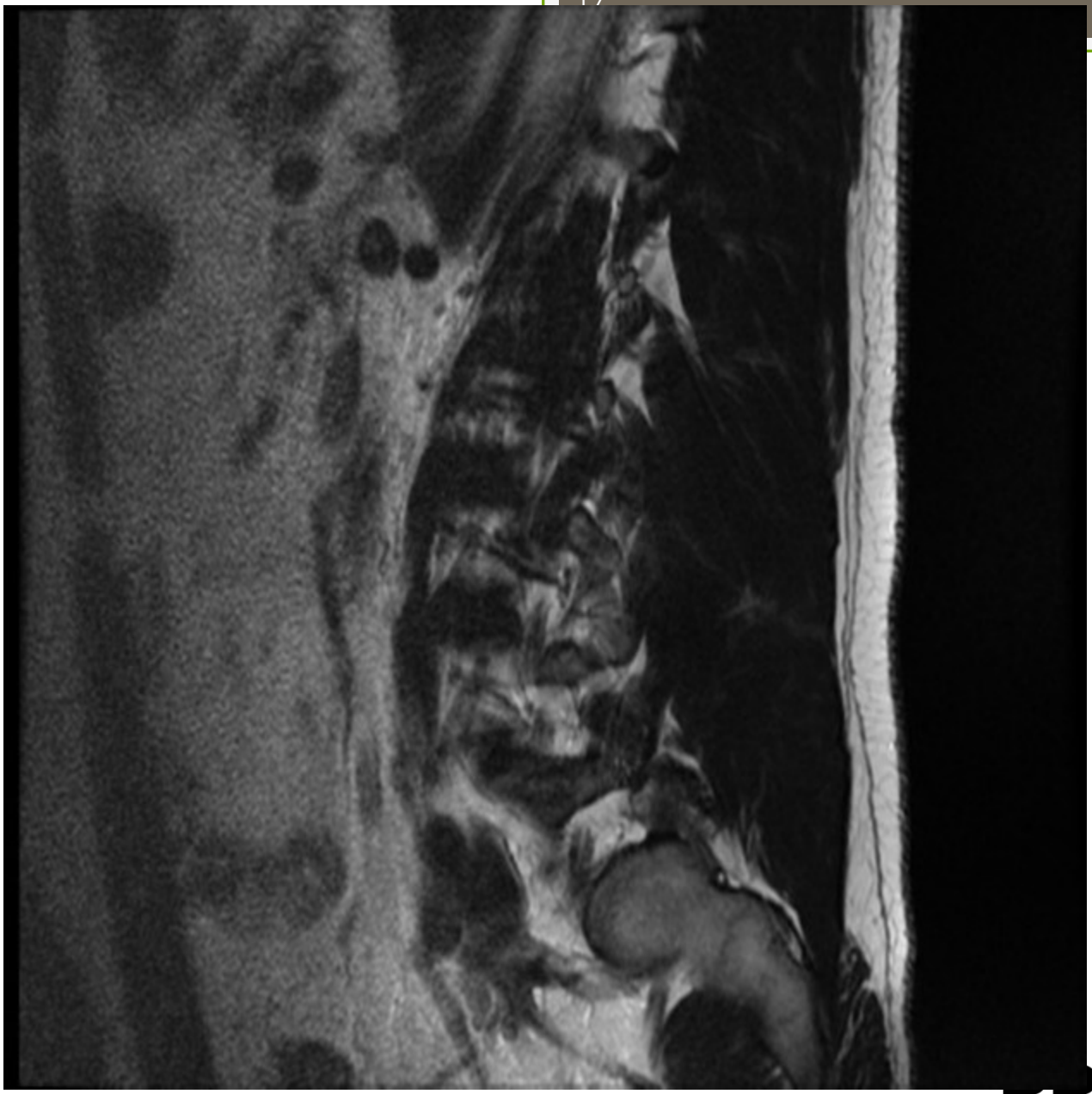

ED ▮...
HR


ED ▮...
HR









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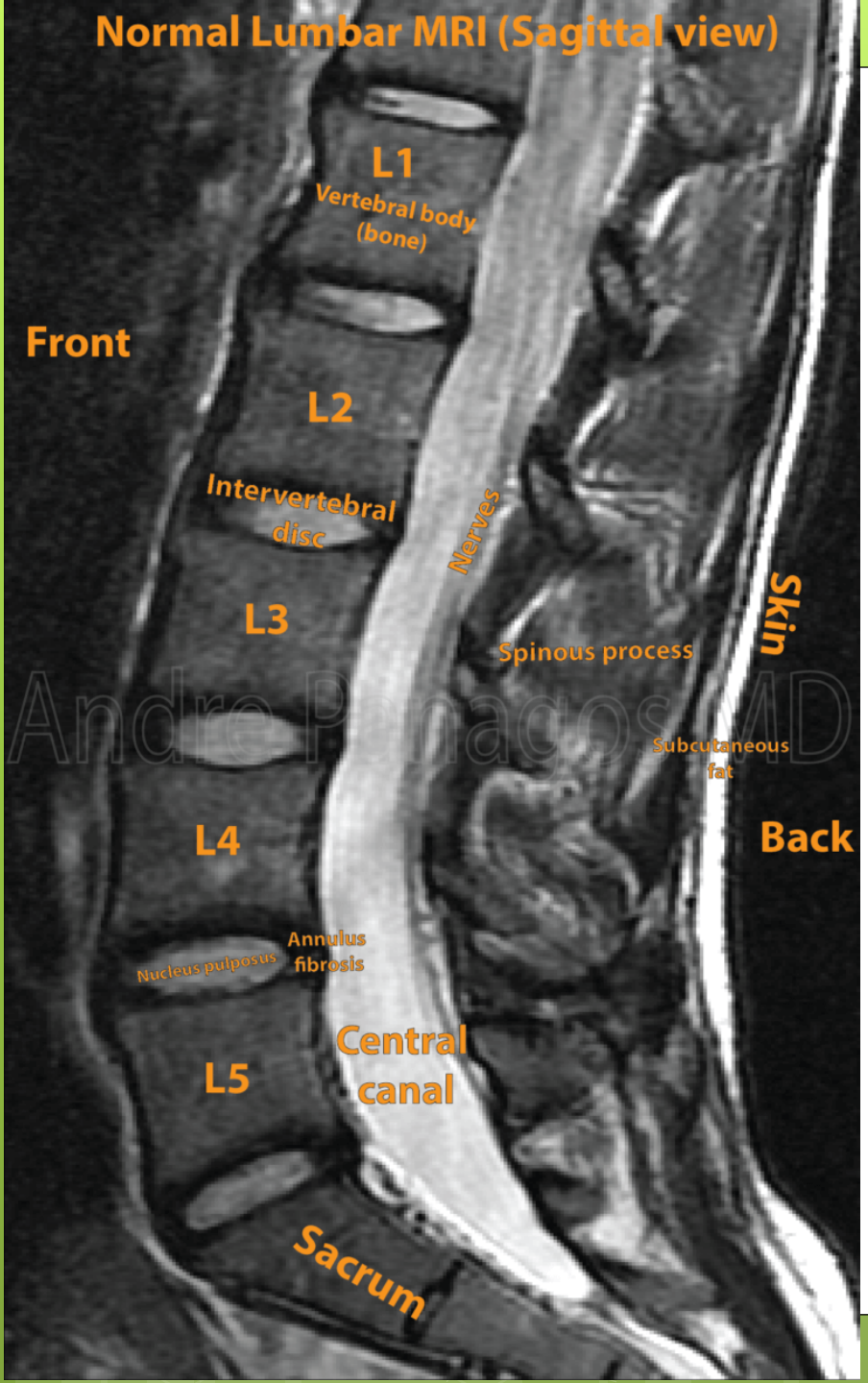
MRI lumbar spine sagittal T1 image. Since the sequence highlights fat, the cerebrospinal fluid within the central spinal canal is dark and the fat within the vertebral bodies is a light grey

PROLIFE

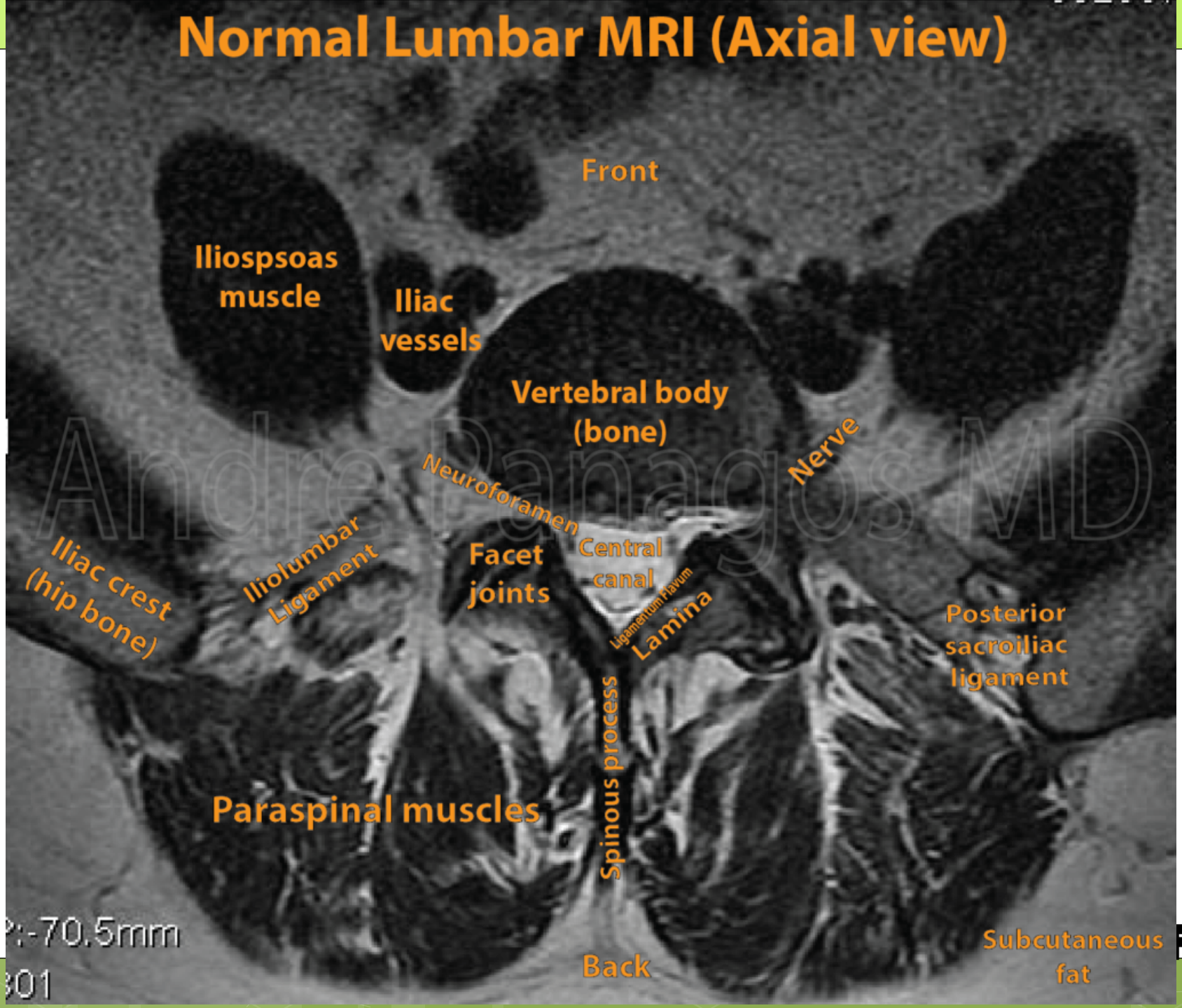
MRI lumbar spine sagittal T2 image. Since the sequence highlights water, the cerebrospinal fluid within the central spinal canal is white and the fat within the vertebral bodies is a dark grey.

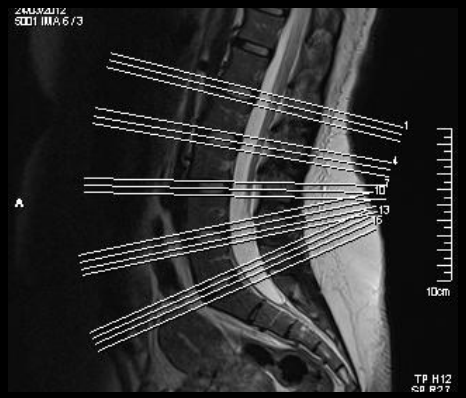
PROLIFE


Normal Lumbar MRI (Sagittal view)
L1
Vertebral body (bone)
Front
L2
Intervertebral disc
Nerves
Skin
L3
Spinous process
Subcutaneous fat
L4
Back
Annulus fibrosis
Nucleus pulposus
Central canal
L5
Sacrum

PROLIFE

PROLIFE


Normal Lumbar MRI (Axial view)
Front
Iliospsoas muscle
Iliac vessels
Vertebral body (bone)
Nerve
Neuroforamen
Iliac crest (hip bone)
Iliolumbar Ligament
Facet joints
Central canal
Ligamentum Flavum
Lamina
Posterior sacroiliac ligament
Spinous process
Paraspinal muscles
Back
Subcutaneous fat
Andrea Panagos, MD


SE01 IMA 6 / 3
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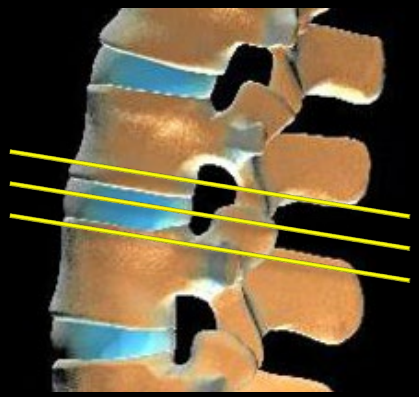
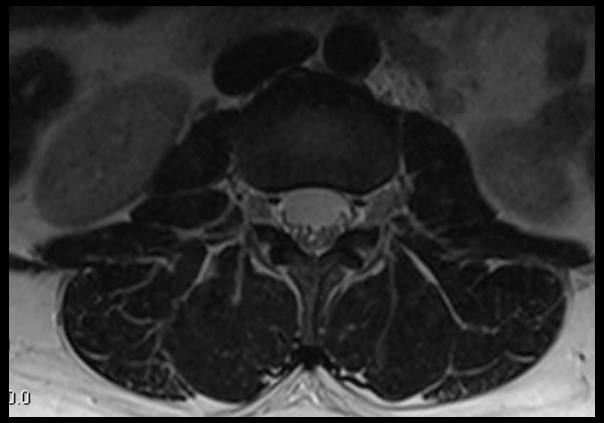
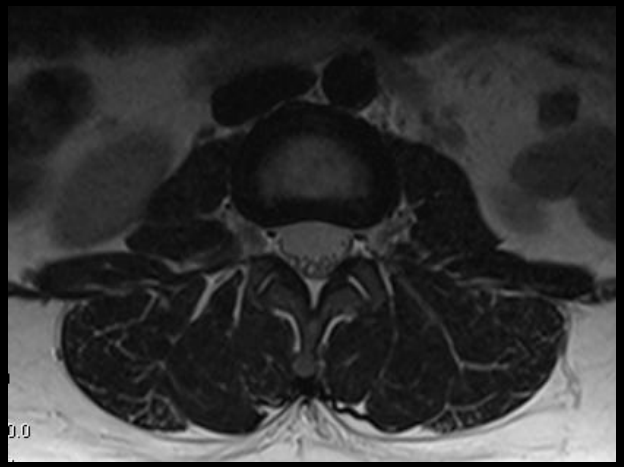
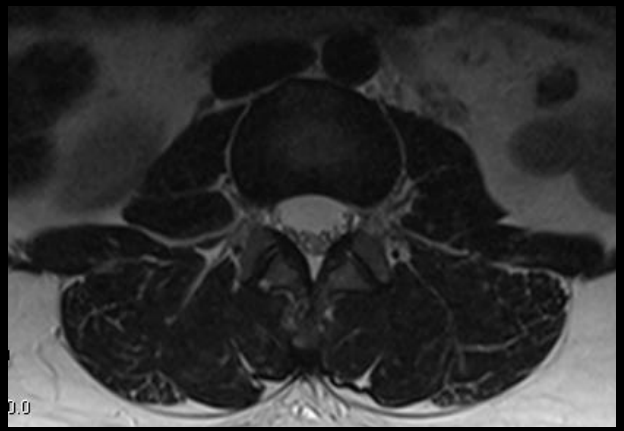
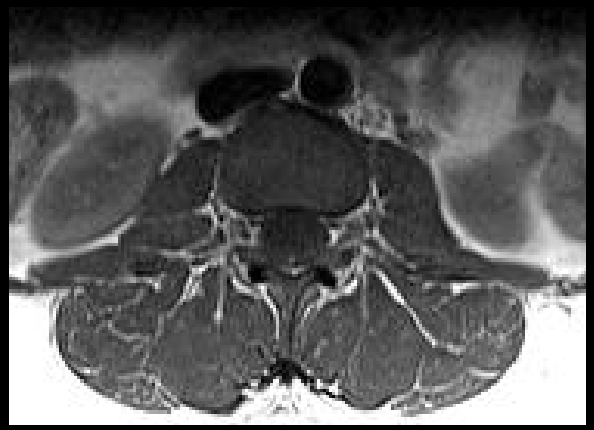
4
10
13
16
A
10cm
TP H12

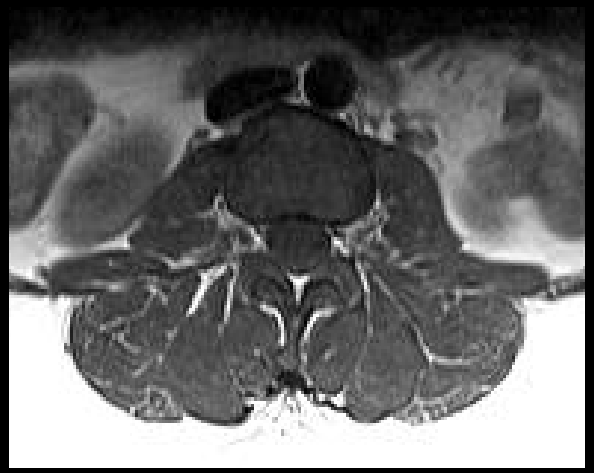


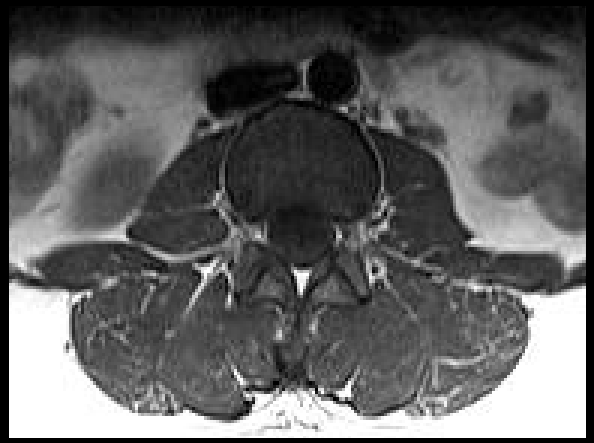




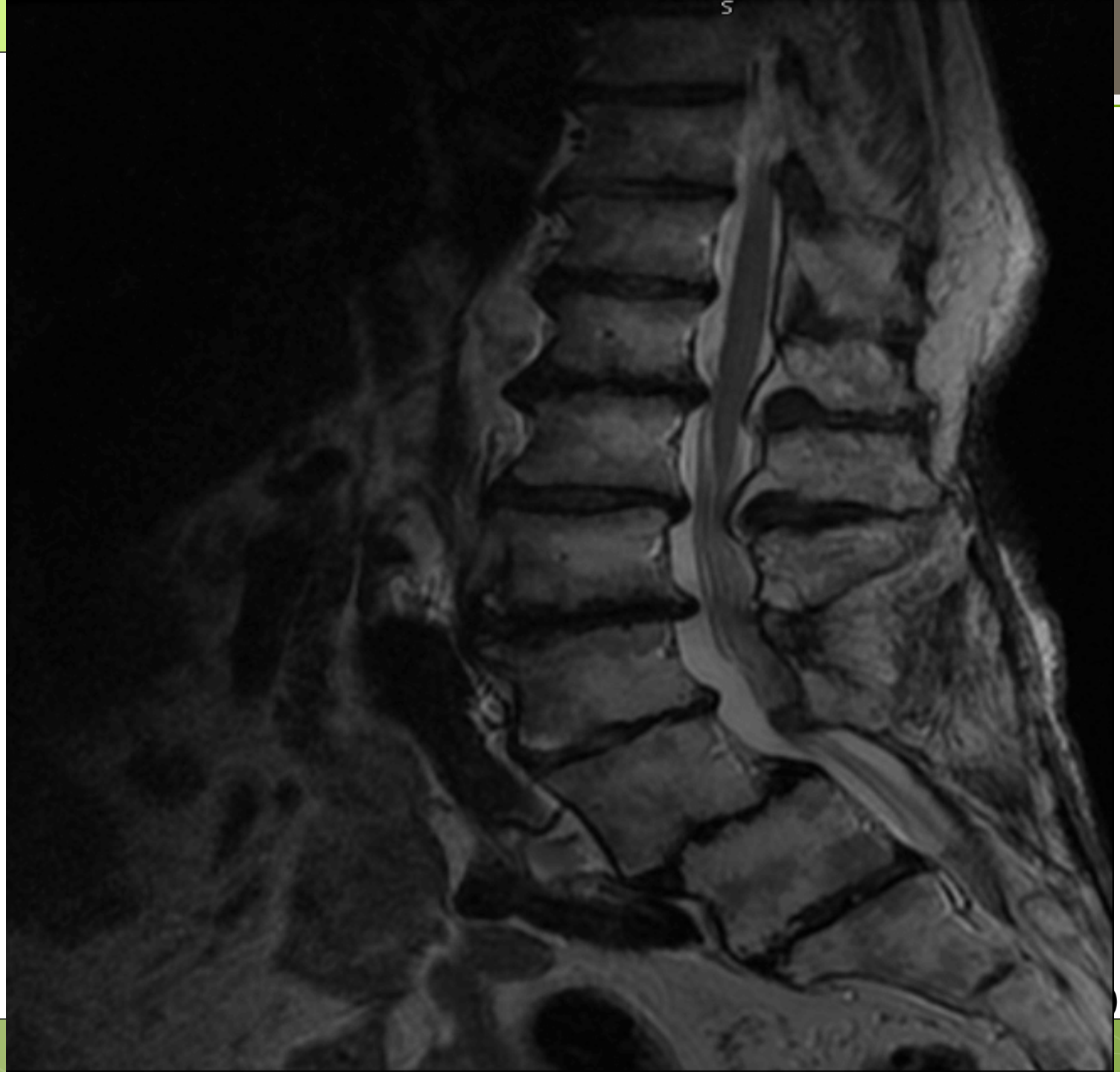






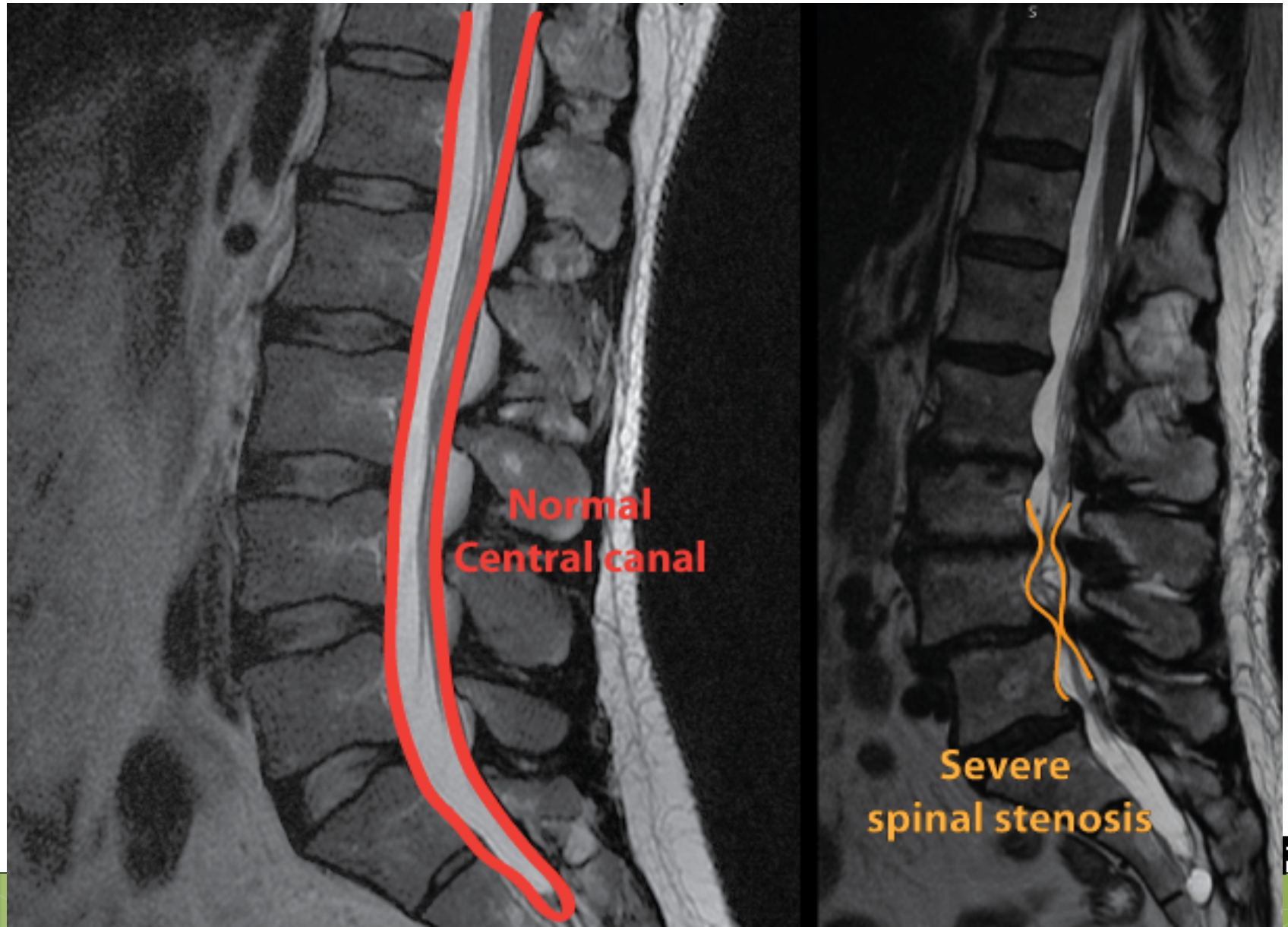


The Aging Process

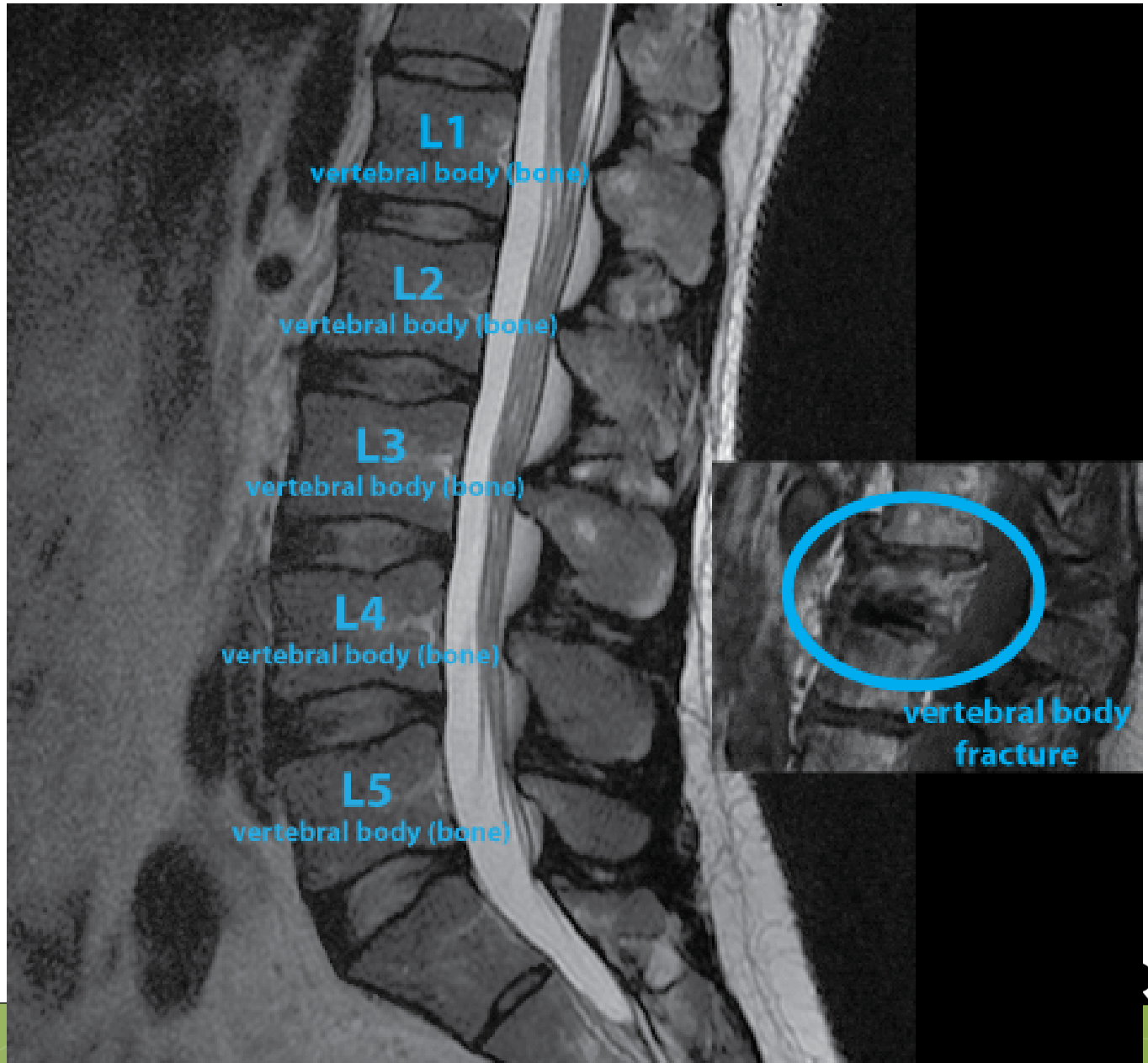


How to Read an MRI Lumbar Spine

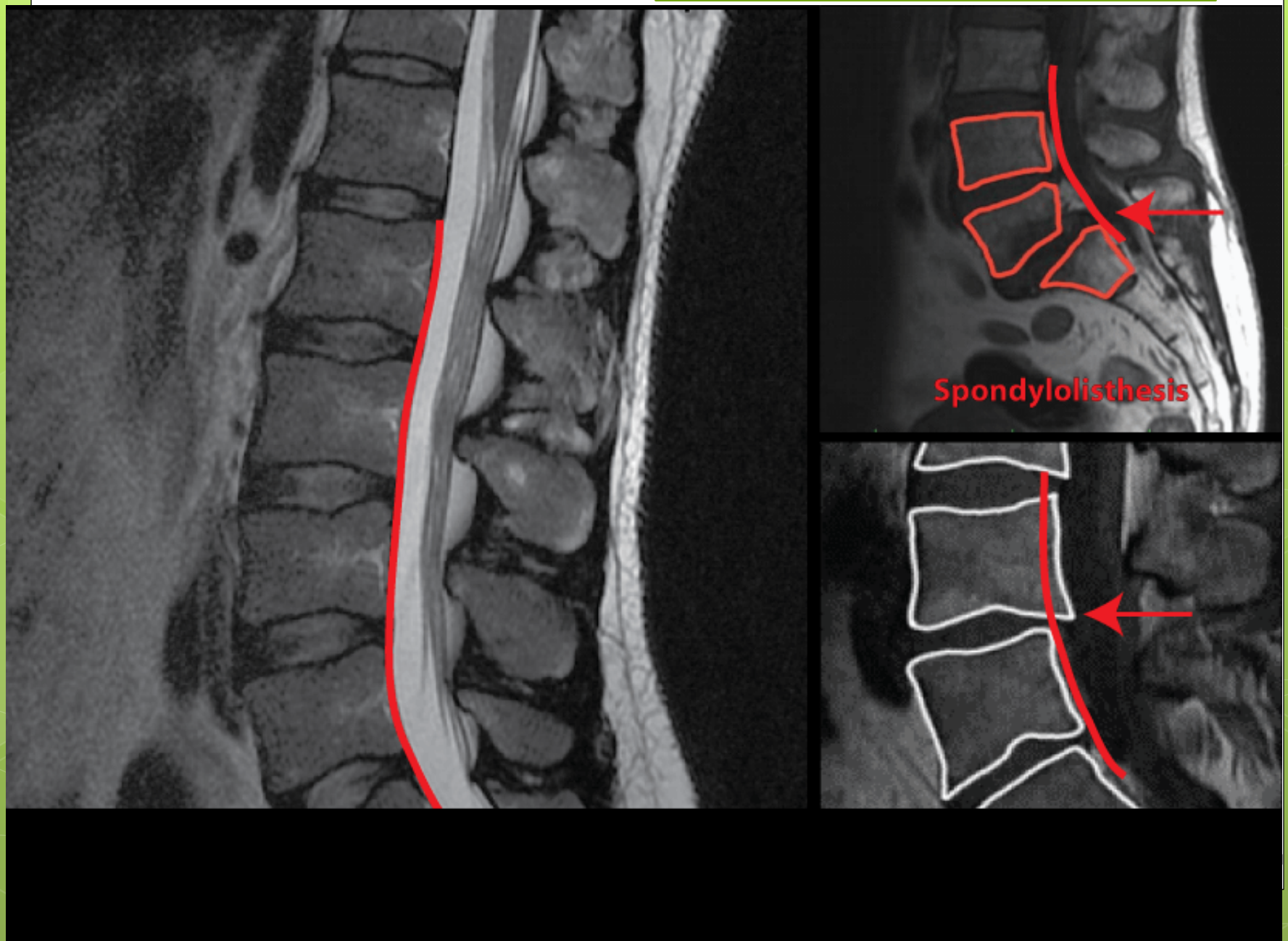
1. The Central Canal in the MRI Lumbar Spine

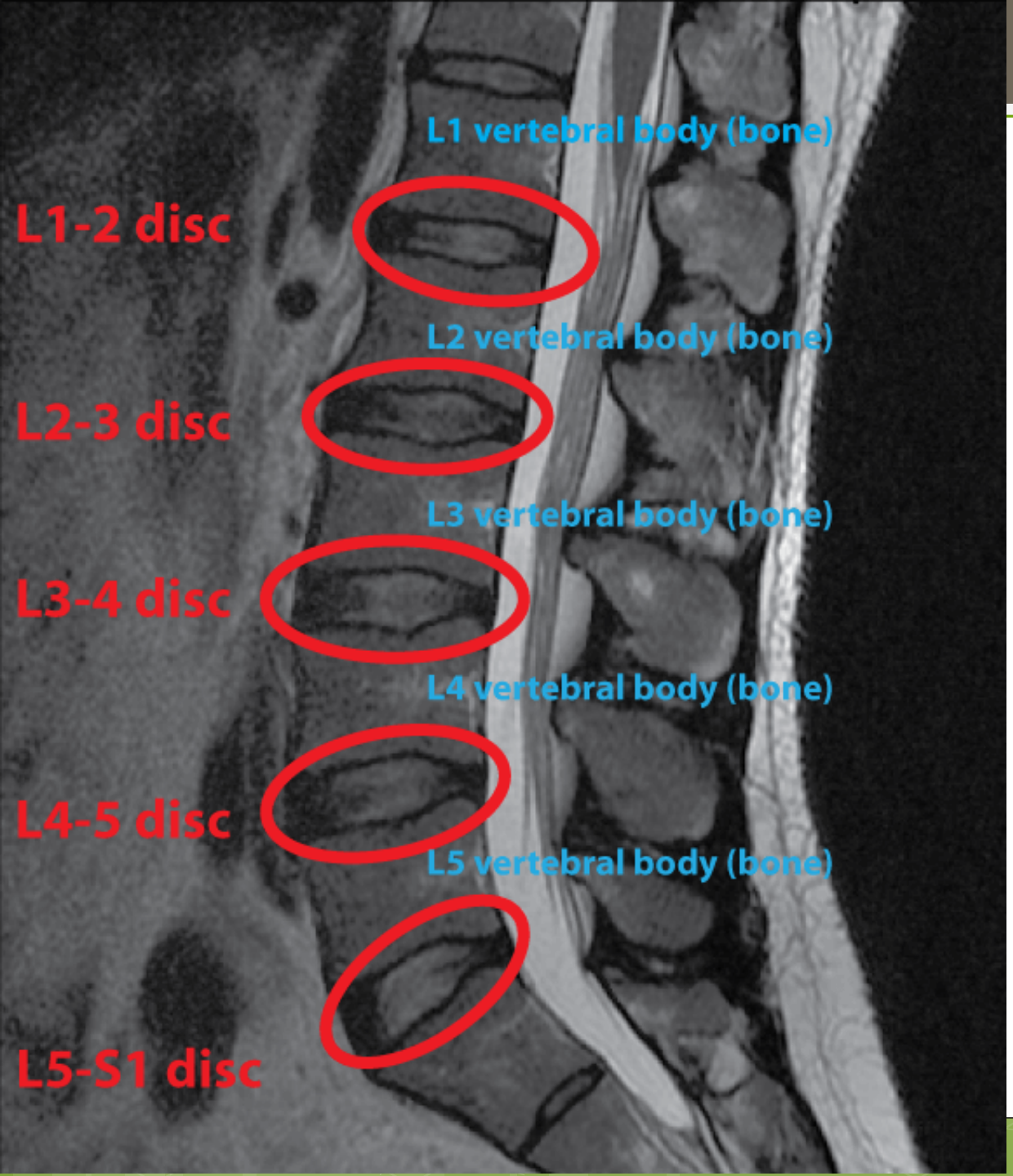


2. Vertebral body



3. Alignment





4. Intervertebral Discs

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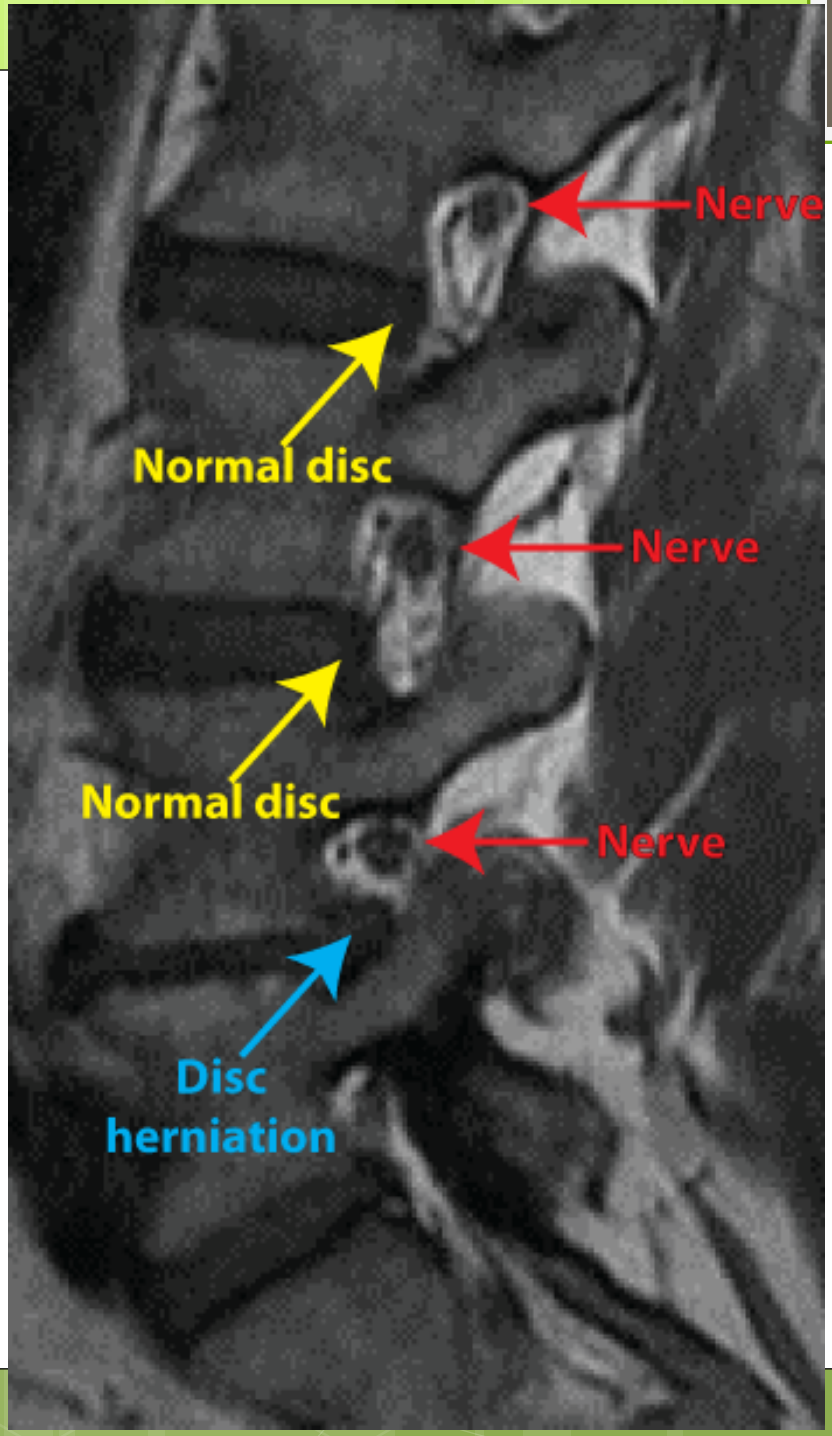
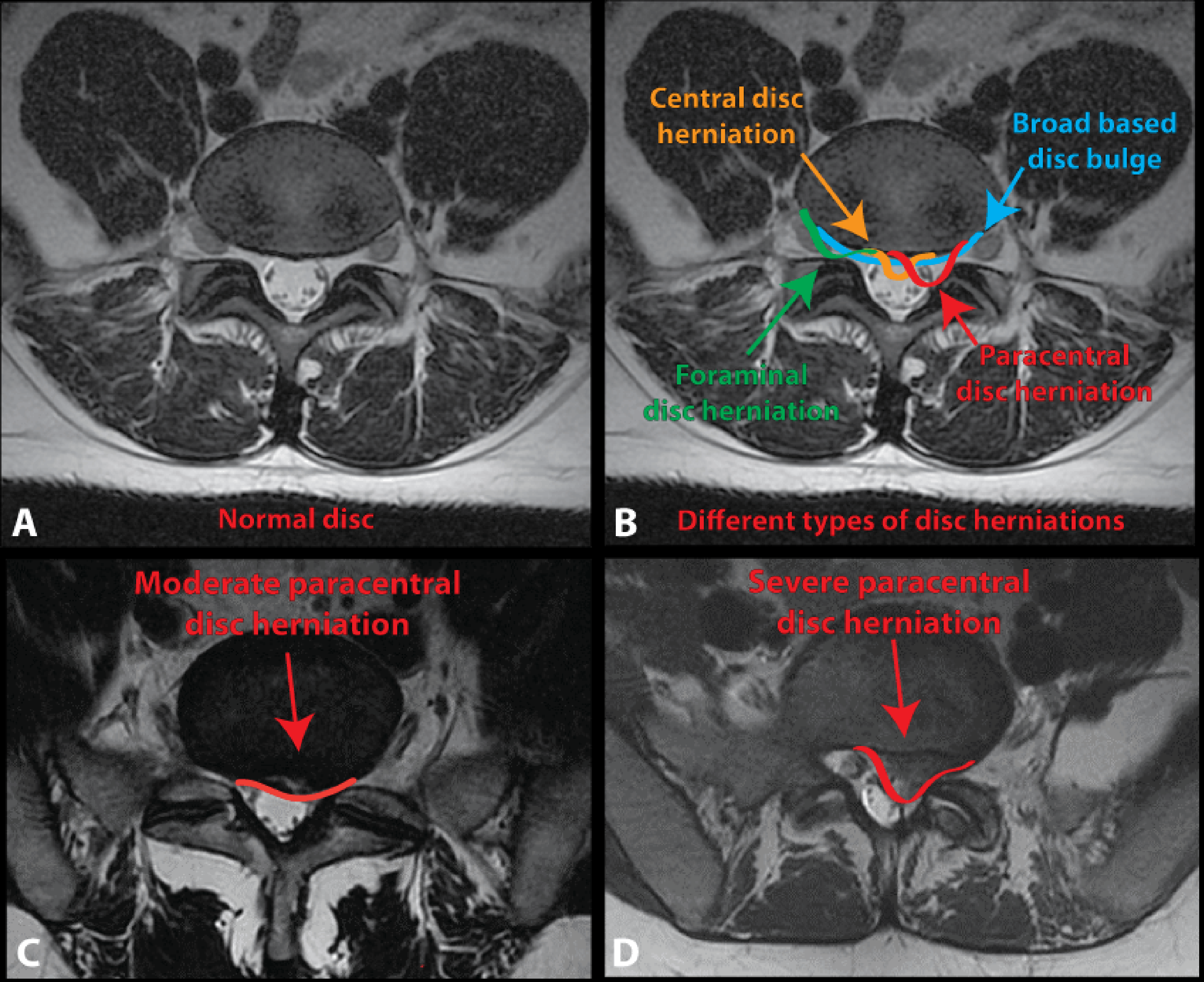
5. Disc herniation and degeneration

6. Nerves

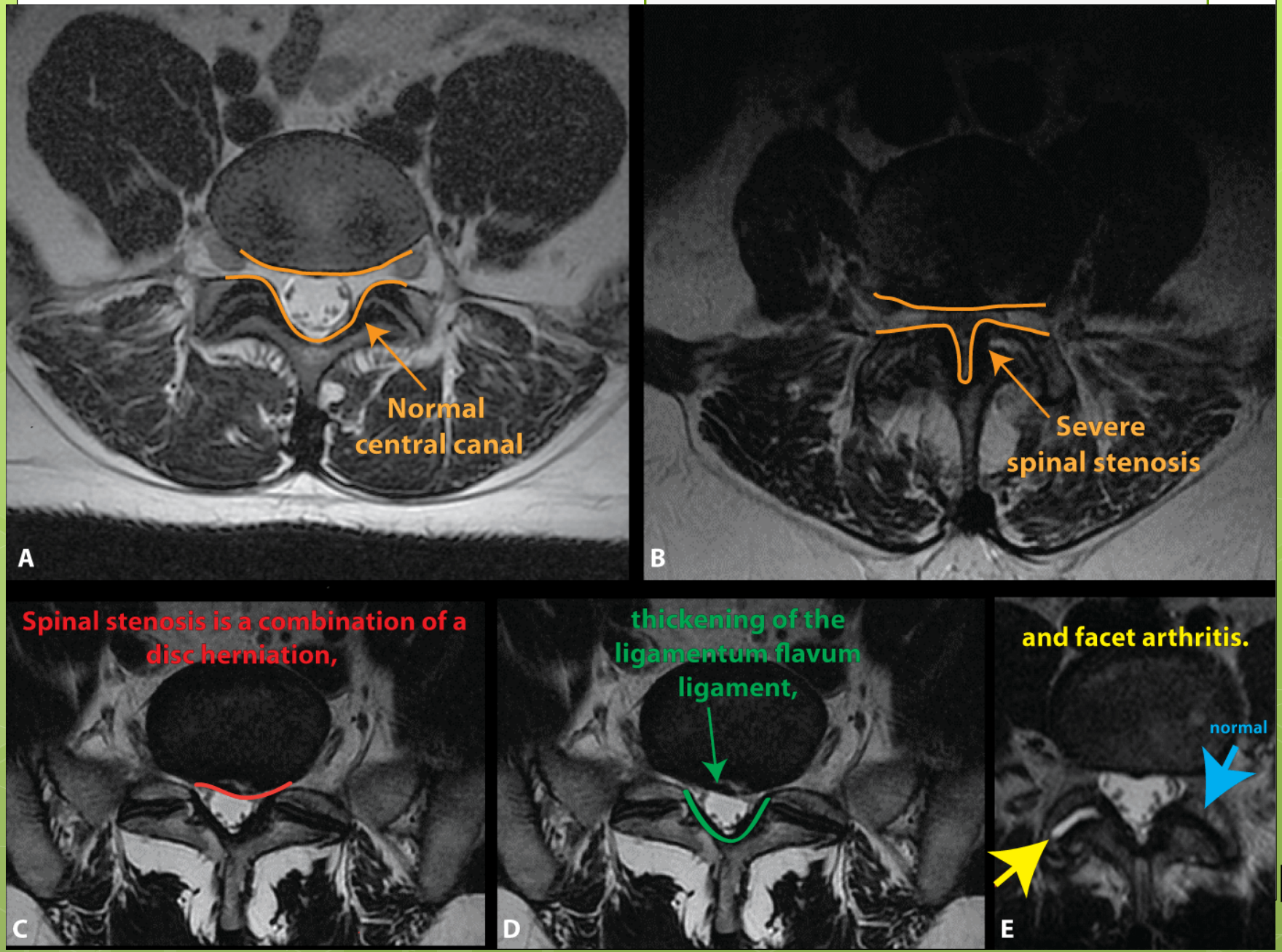


PROLIFE



7. Axial views

8. Spinal stenosis



Spinal Abnormalities

- DISC PATHOLOGY
- DEGENERATIVE CHANGES
- SPINAL STENOSIS
- POSTOPERATIVE CHANGES
- INFLAMMATORY CHANGES
- TRAUMATIC CHANGES
- OSSEOUS SPINE TUMORS
- SPINAL CANAL CONTENTS

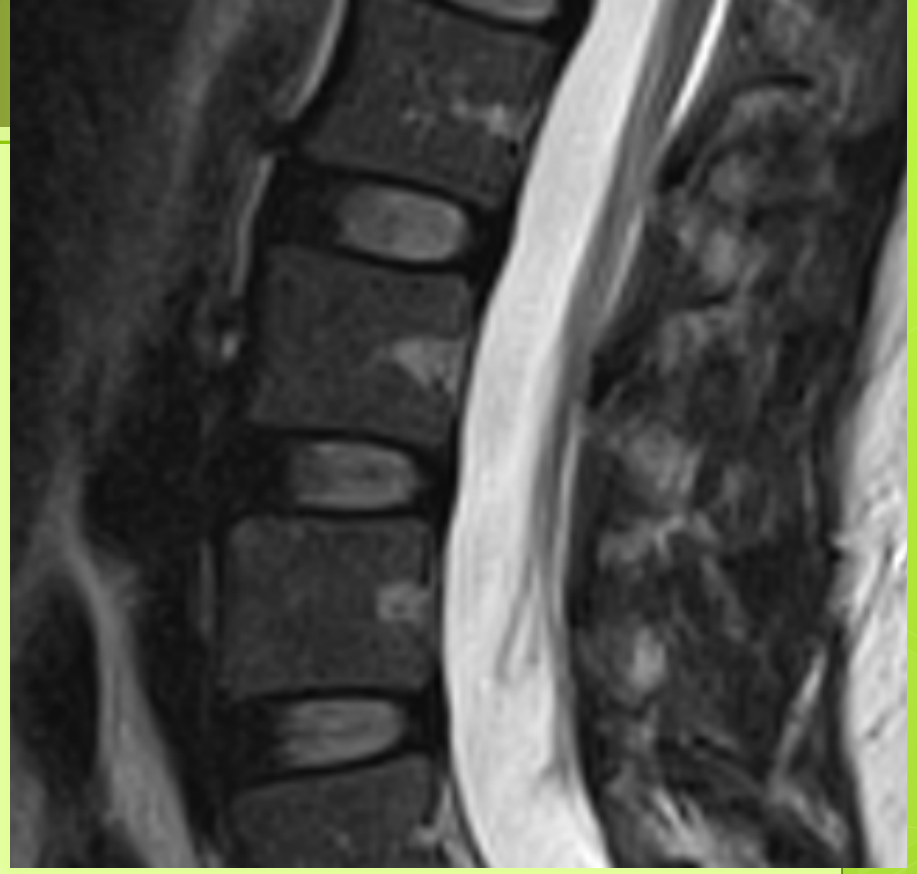
DISC PATHOLOGY

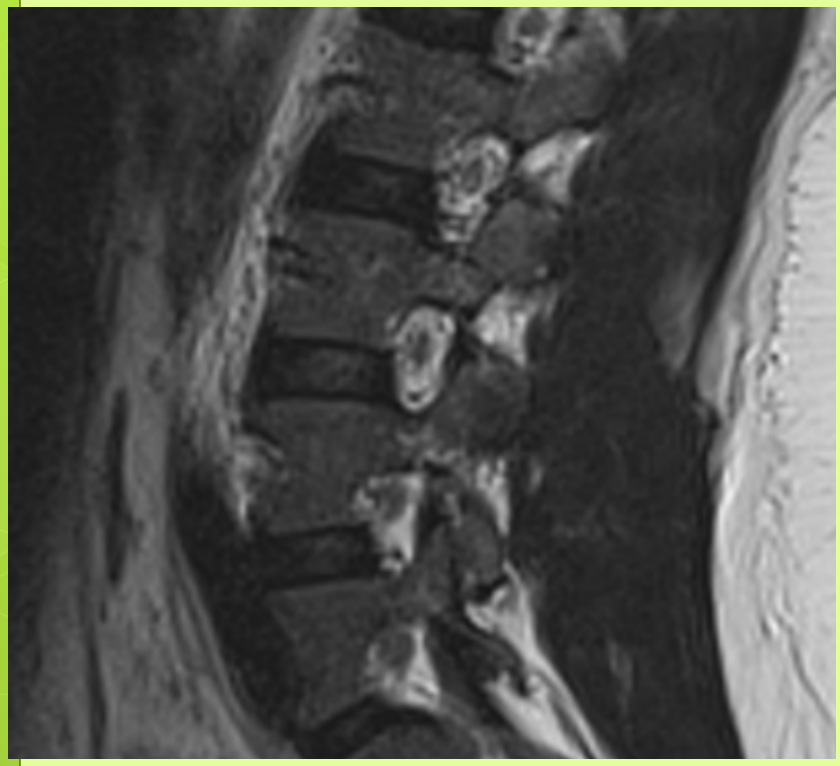
Normal Discs

- T1W images: low signal intensity on T1W images, slightly lower signal than adjacent normal red marrow and very similar to muscle
- T2W images: show diffuse high signal intensity throughout the Disc except for the outer fibers of the annulus, which are homogeneously low signal intensity
- Distinction between the nucleus pulposus and the inner annulus fibrosus is impossible by MRI

Normal Discs

- Normal Discs typically do not extend beyond the margins of the adjacent vertebral bodies; however, diffuse extension beyond the margins by 1 to 2 mm may occur in some histologically normal Discs.
- The posterior margins of Discs tend to be mildly concave in the upper lumbar spine, straight at the L4-5 level, and slightly convex at the lumbosacral junction.





PROLIFE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3/24/2012
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Avanto
HFS
RHP
SP H18.1
FoV 200*200
460*512
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W: 850
C: 317
SL 4
TE 98
TP 3500


Avanto
HFS
Tra>Cor(-1.3)>

PROLIFE


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3/24/2012
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Avanto
HFS
RPF
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460*512
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W: 650
C: 317
SL 4
TE 98
TR 3500


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3/24/2012
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RPF
SP F1.0
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192*256
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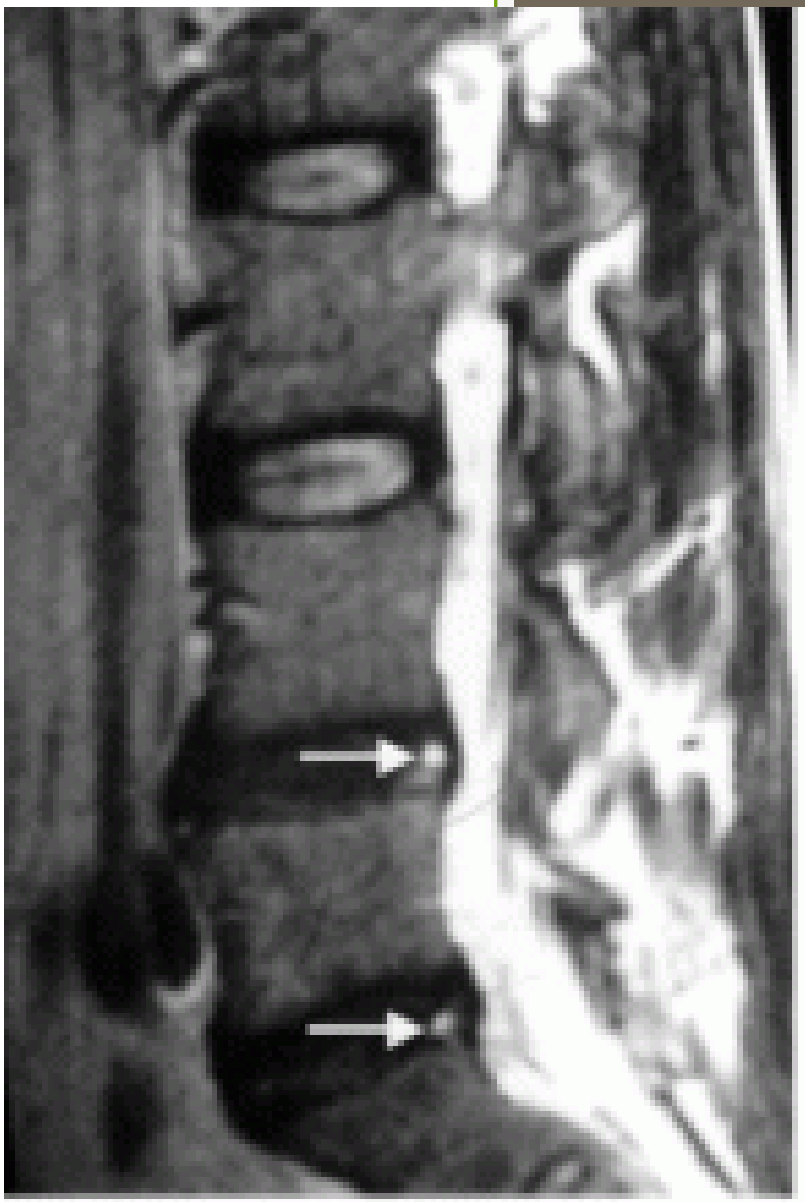
C: 282
SL 4
TE 12
TR 546

PROLIFE

Abnormal Nucleus

- With aging and degeneration, the intervertebral Discs lose hydration, lose proteoglycans, and gain collagen as they become more fibrous. A horizontally oriented fibrous intranuclear cleft develops in the nucleus.
- MRI shows the intranuclear cleft as a horizontal, low signal intensity line that divides the Disc into upper and lower halves on T2W sagittal images. Eventually, there is diffuse decreased signal intensity on T2W images from the increased collagen content in the nucleus. The Disc progressively loses height with increasing degrees of degeneration.



Abnormal Annulus

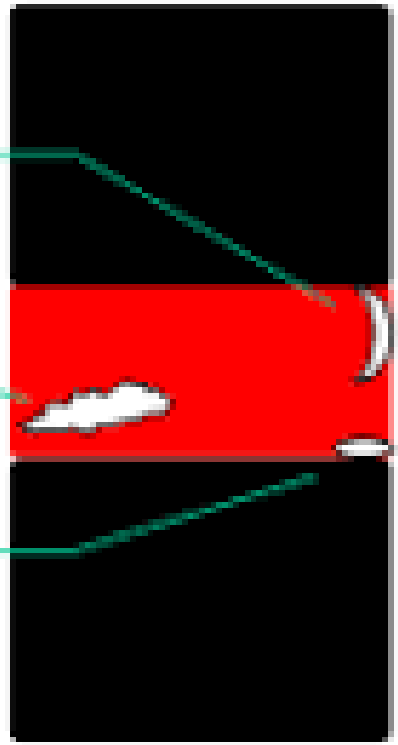
- Aging and biochemical changes in the Discs are associated with the development of multiple, focal annular tears. Three types of annular tears have been described, but only one type is of practical interest and that is the radial type of tear.

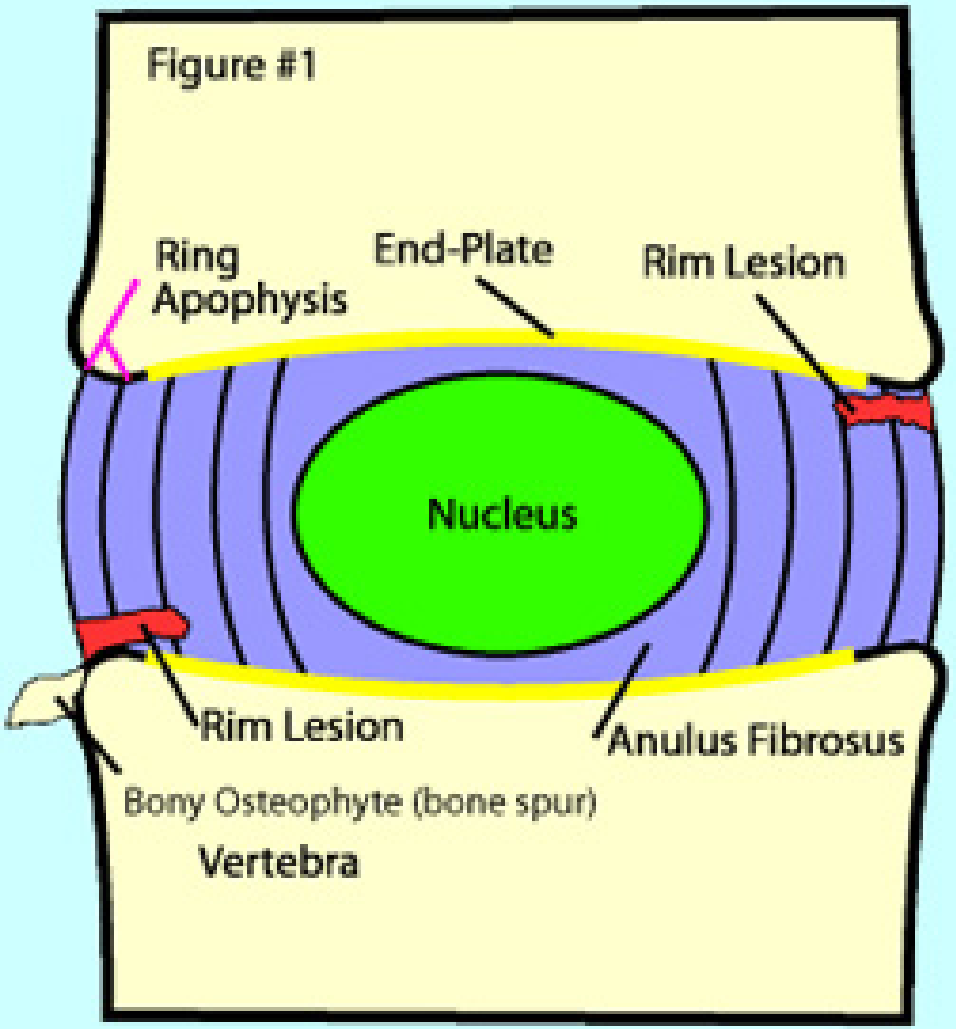
Typically, there are three distinct types of annular tears:

- **Radial Tear – Caused by the aging process and may lead to herniation of the disc.**
- **Concentric Tear – Often caused by sudden trauma or injury to the spine.**
- **Peripheral Tear – Often caused by injury and may cause the disc to break down over time.**

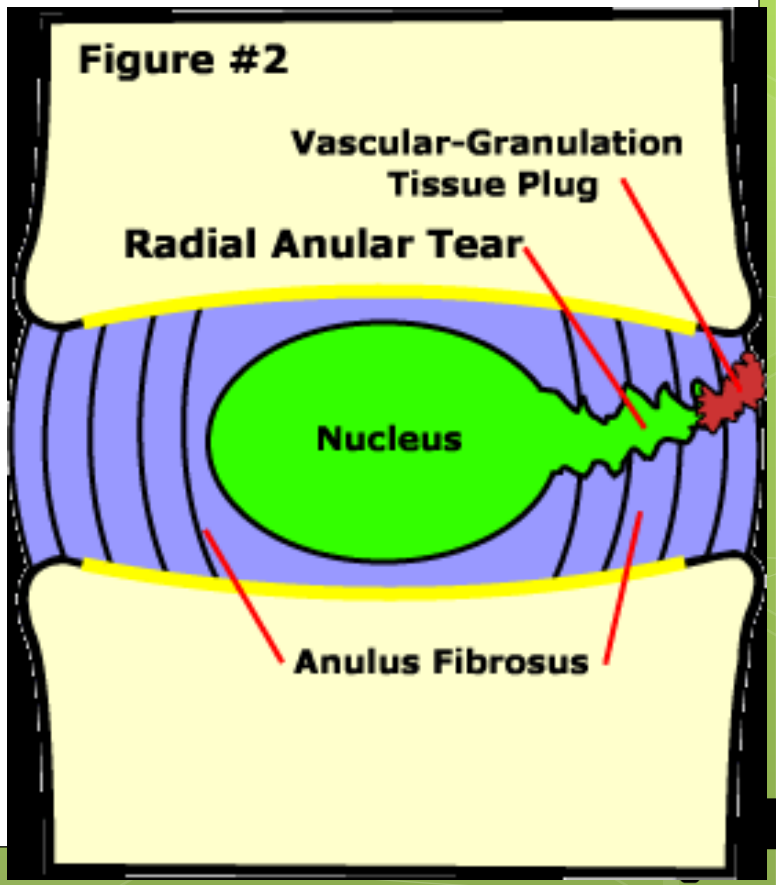
Anular Tears

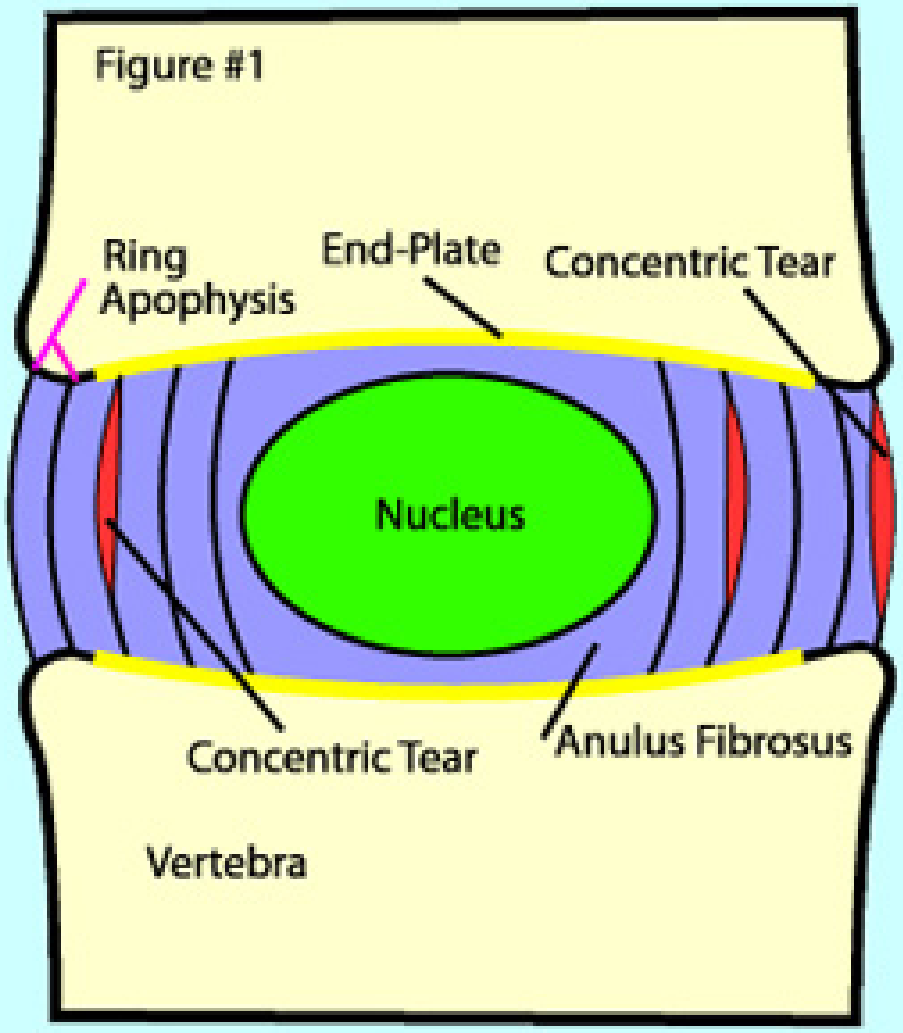
1. Concentric tears
2. Radial tears
3. Transverse tears





- A radial annular tear, often called a full-thickness annular tear, occurs when the annulus fibrosus develops a tear which extends from the nucleus, towards the periphery.





Concentric annular tears

- Concentric annular tear, also known as circumferential annular tears, result from a separation or splitting apart of the lamellae of the annulus fibrosus. the lamellae have split apart and in inflammation has occurred. If this occurs in the outer one third of the disc, which of course has the nociceptive fiber (pain sensors), it could result in significant chronic low back pain.

- Concentric tears are frequently seen in the middle and typically occur in the outer 1/3 of the anulus; they are rarely seen in the inner anulus.

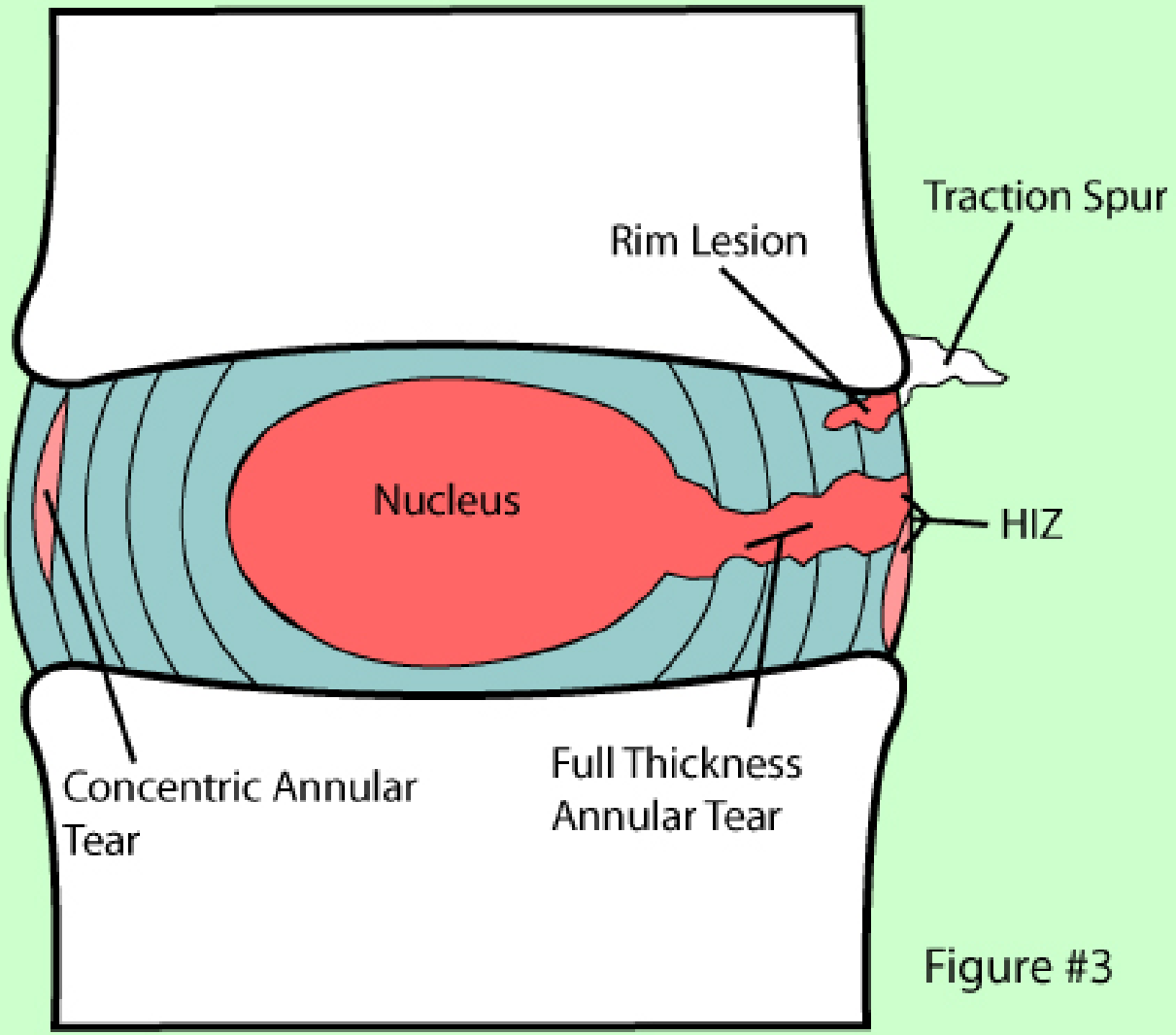
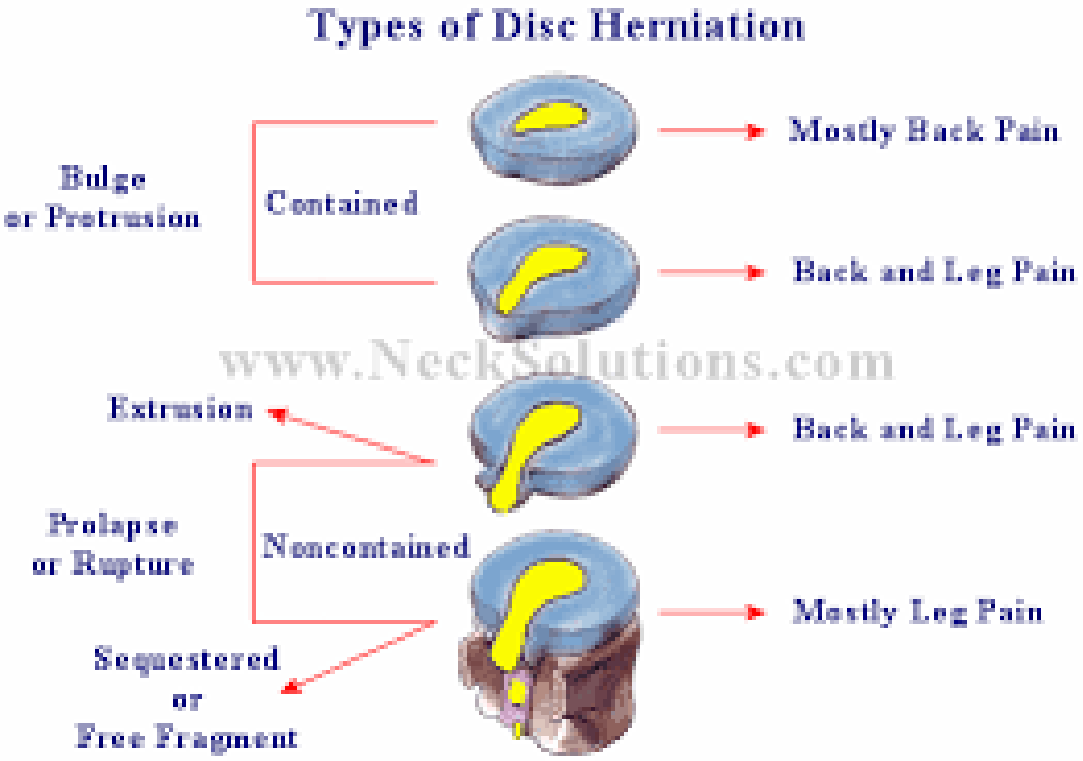
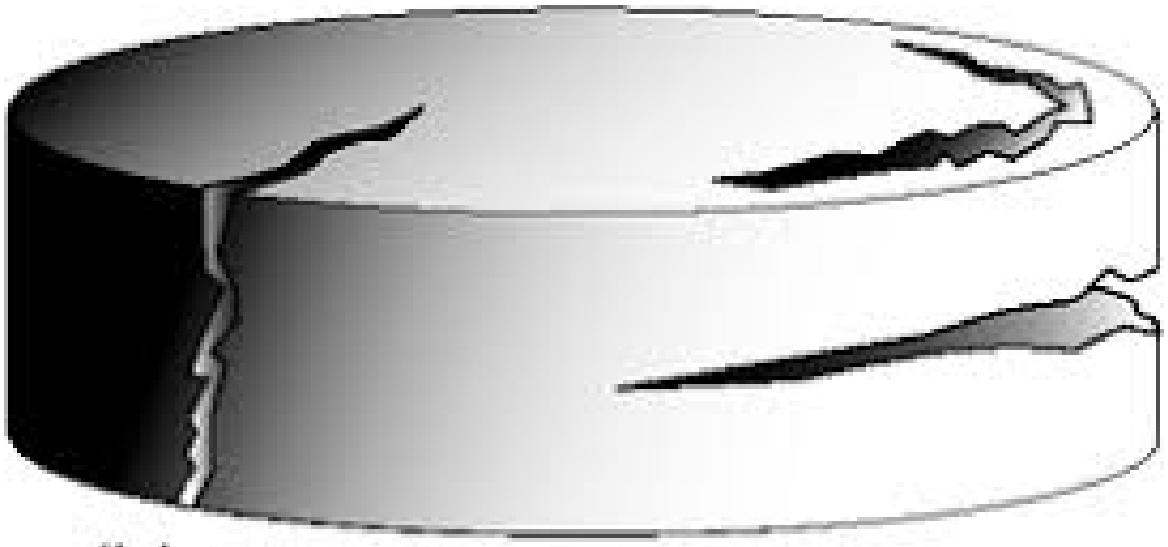


Figure #3

PROLIFE


Types of Disc Herniation
Bulge
or Protrusion
Contained
Mostly Back Pain
Back and Leg Pain
www.NeckSolutions.com
Extrusion
Back and Leg Pain
Prolapse
or Rupture
Noncontained
Mostly Leg Pain
Sequestered
or
Free Fragment


concentric tear
transverse tear
radial tear

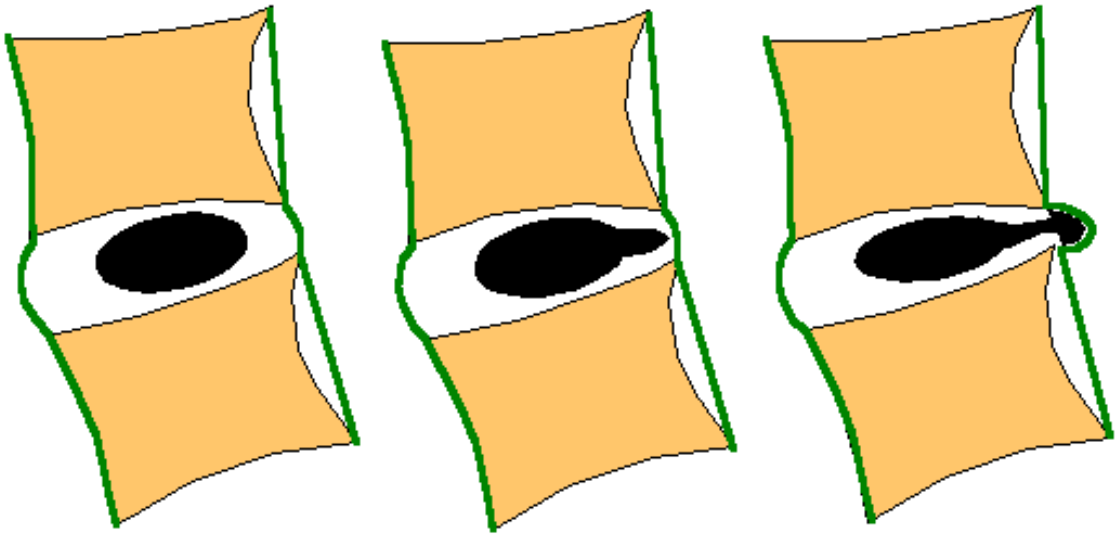
Disc AGING AND DEGENERATION

↓ Hydration ↓ Proteoglycans ↑ Collagen ↑ Fibrosis	Horizontal intranuclear cleft Diffuse ↓ signal, T2 ↓ Disk height
Annular tears	Focal ↑ signal, T2 Diffuse disk bulge
Nuclear herniation through annular tears	Focal disk contour abnormalities
Nitrogen-filled nuclear clefts (vacuum disk)	Horizontal signal void, T1 and T2 May fill with fluid when supine or flexed (↑ signal on T2)
Calcified disk	↑ Signal, T1 when small amounts ↓ Signal, T1 and T2 with more calcification

PROLIFE

Degenerative/traumatic lesion

- Anular tear
- Degeneration
- Herniation

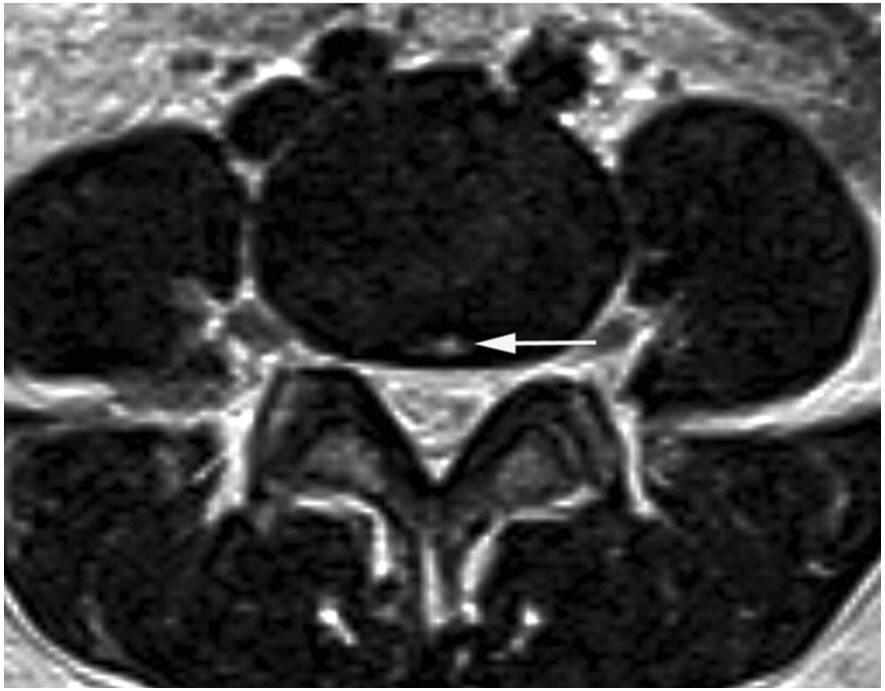


Fardon, 2001

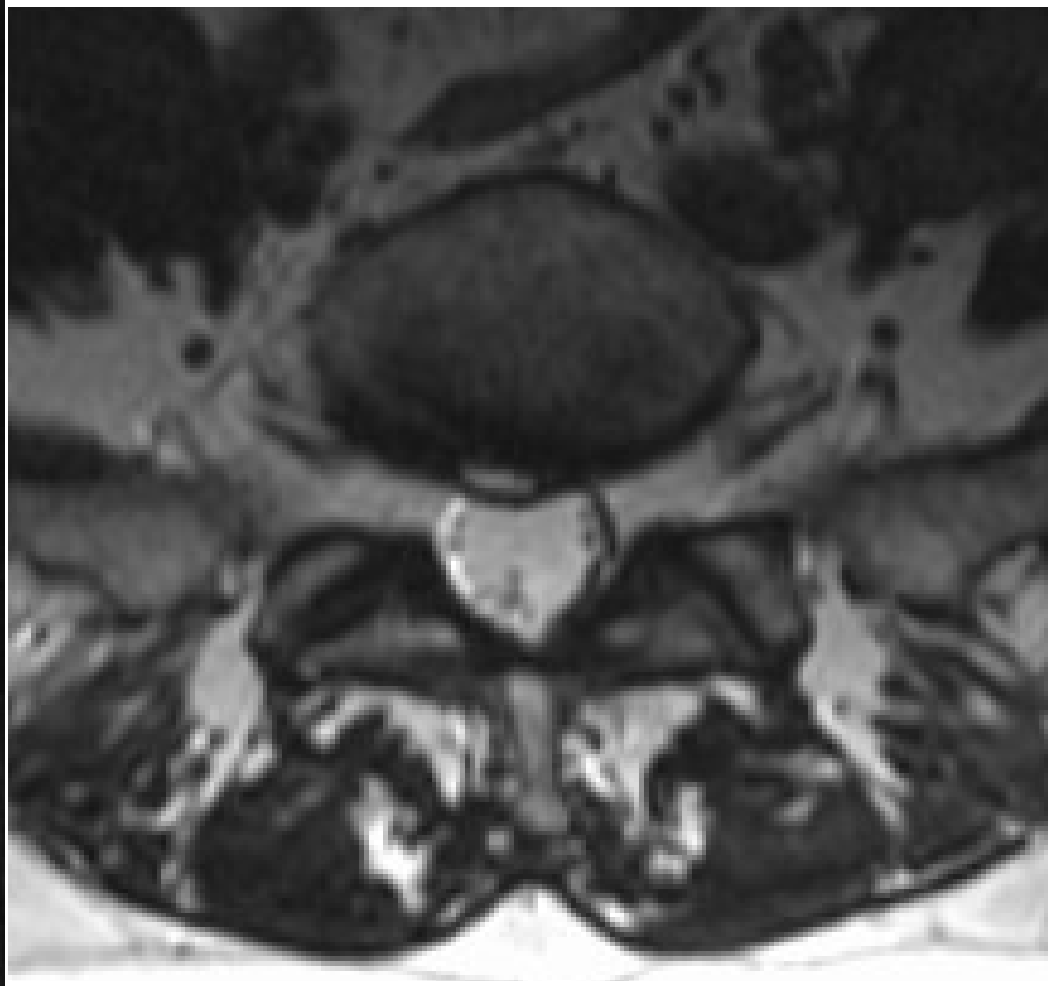
Radial Tears of the Annulus

- Also called *high intensity zones*
- Often painful
- Linear fissures through all or part of thickness of annulus
- Run perpendicular to long axis
- Usually in posterior annulus of lower lumbar Discs
- Nerve ingrowth from surface of Disc causes pain
- Globular or horizontal lines of increased signal in Disc substance, T2 and postcontrast T1

Annular Tear



PROLIFE



PROLIFE

Disc displacement/herniation

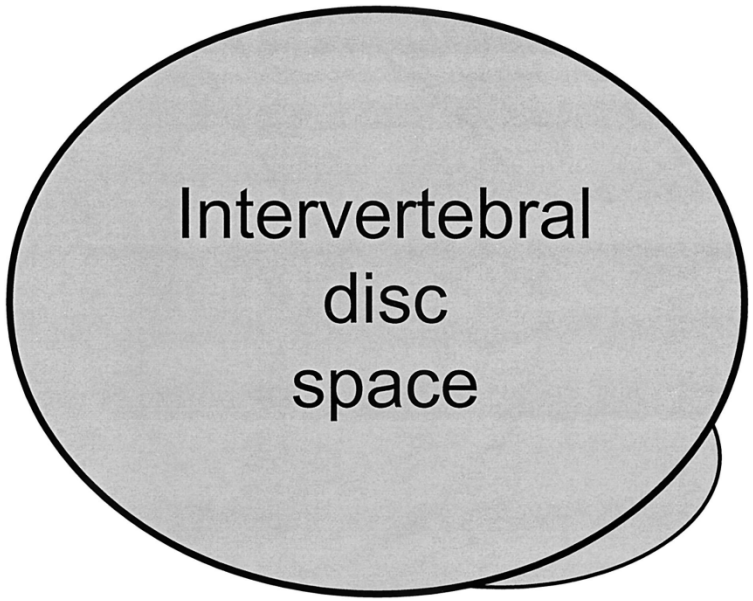
- Disc bulge
- Focal displacement/herniation
  - Disc protrusion
  - Disc extrusion
  - Disc sequestration

Fardon, 2001

PROLIFE

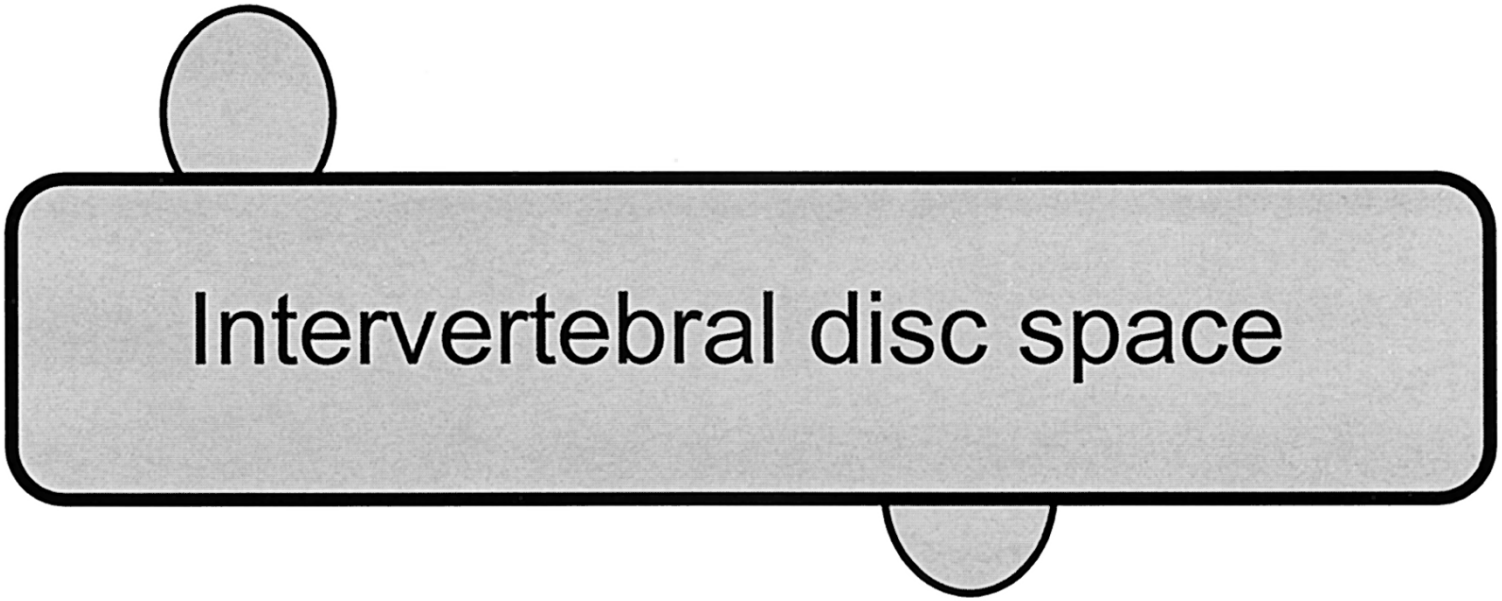
Disc displacement/herniation

- Focal herniation
  - Intervertebral
  - Protrusion
  - Extrusion
  - Sequestration



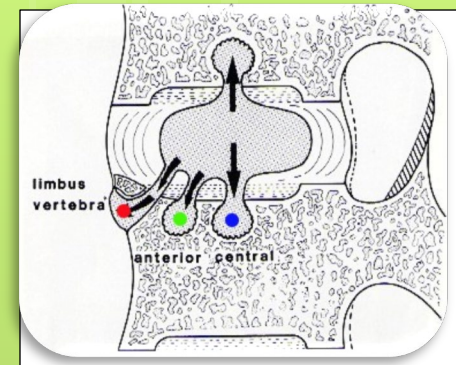
Herniation

Fardon, 2001

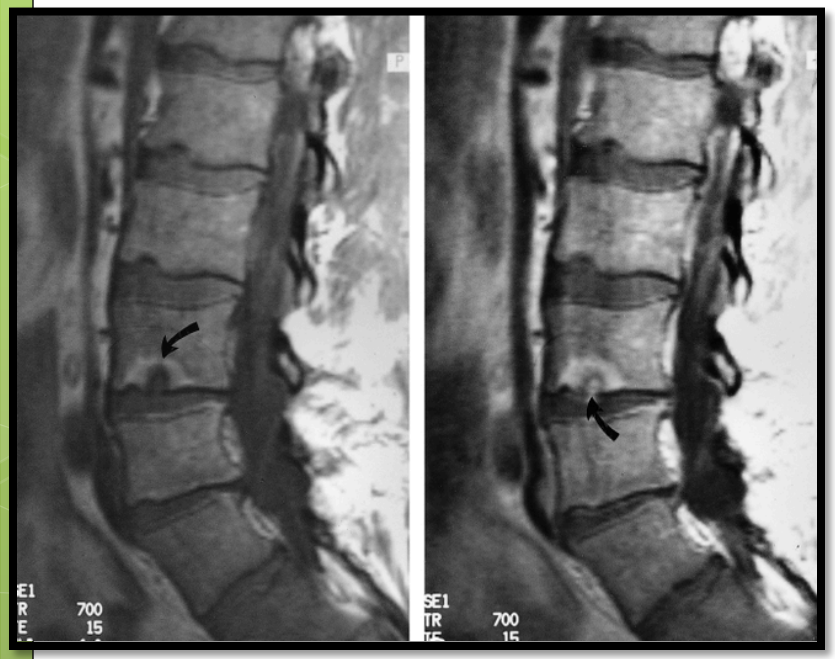


Intravertebral Herniations

Fardon, 2001

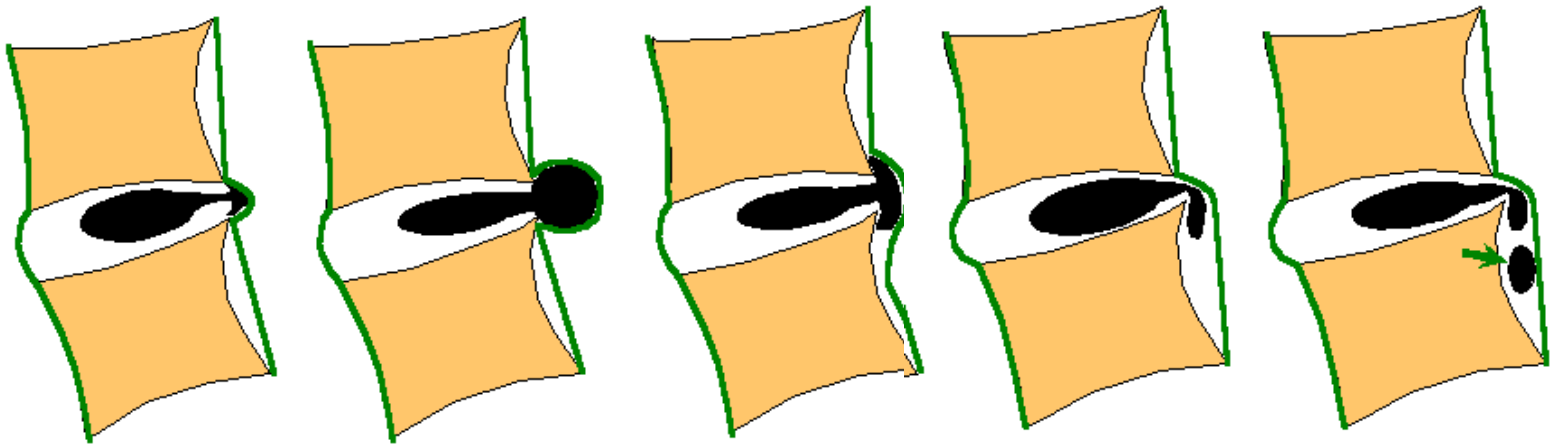

limbus
vertebra
anterior central


L1


E1
R 700
E 15
SE1
TR 700
15

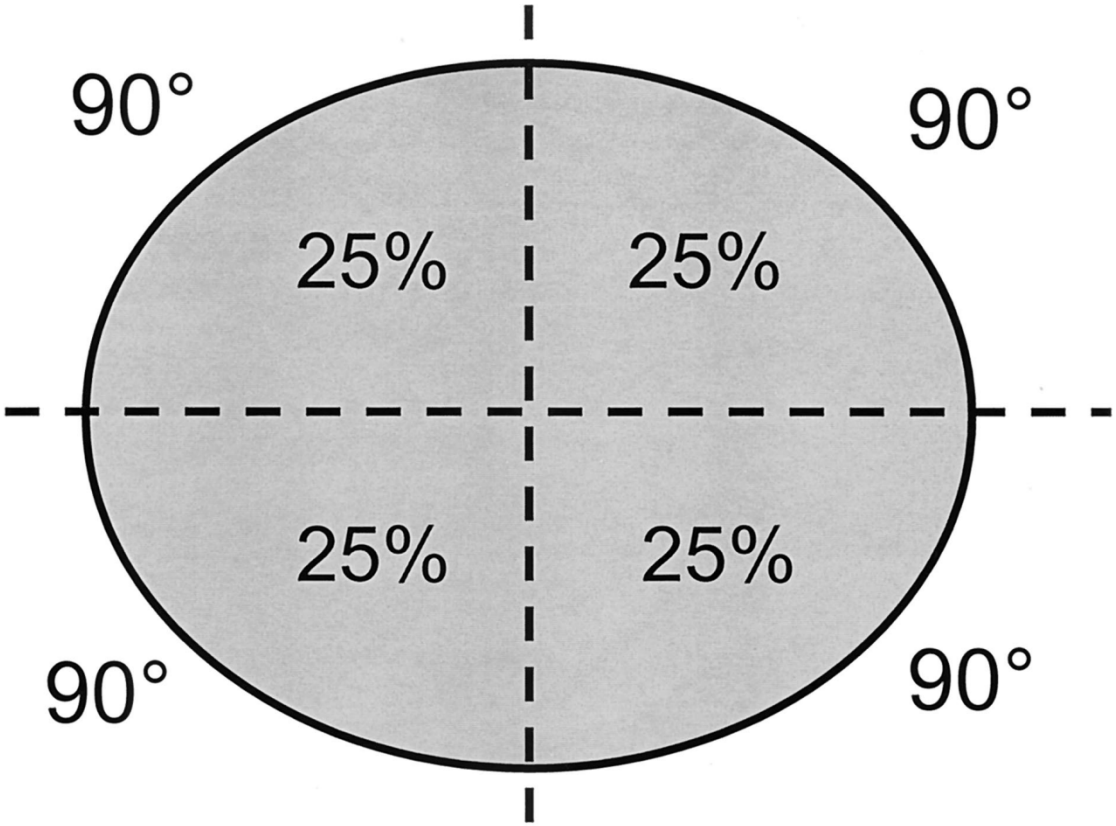
PROLIFE

Disc herniation



Fardon, 2001

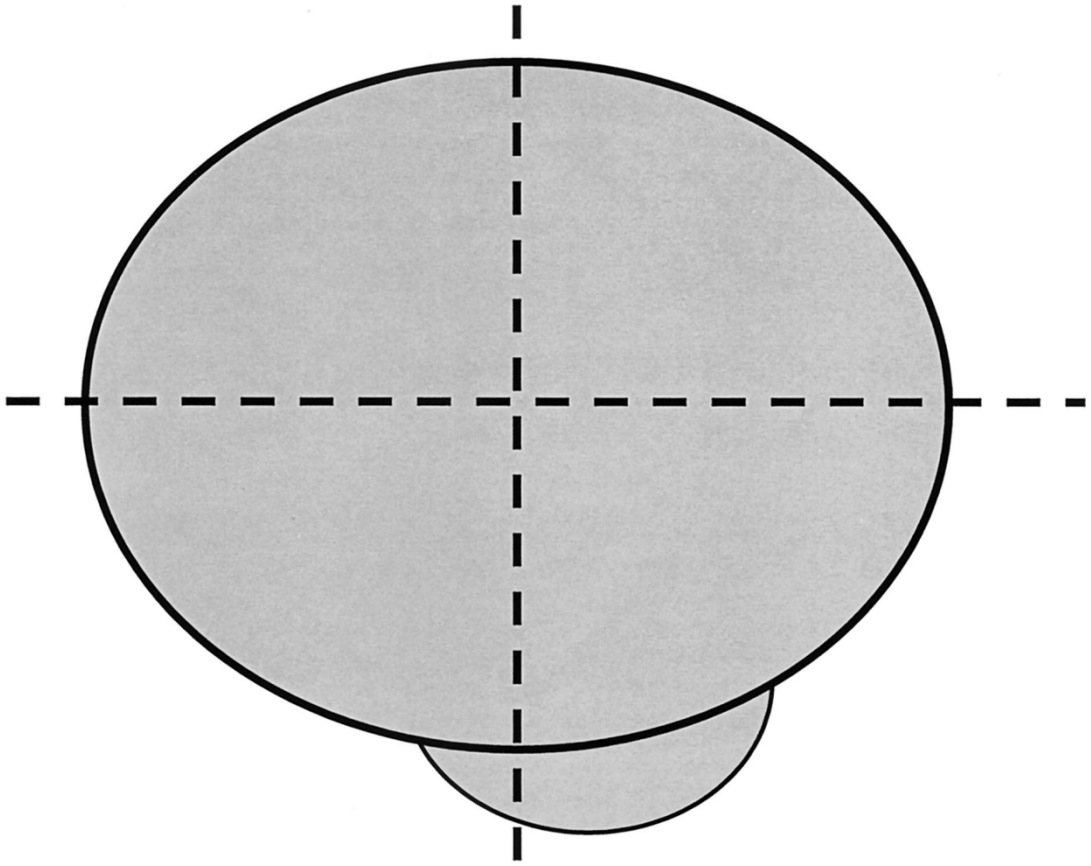
PROLIFE



Normal Disc

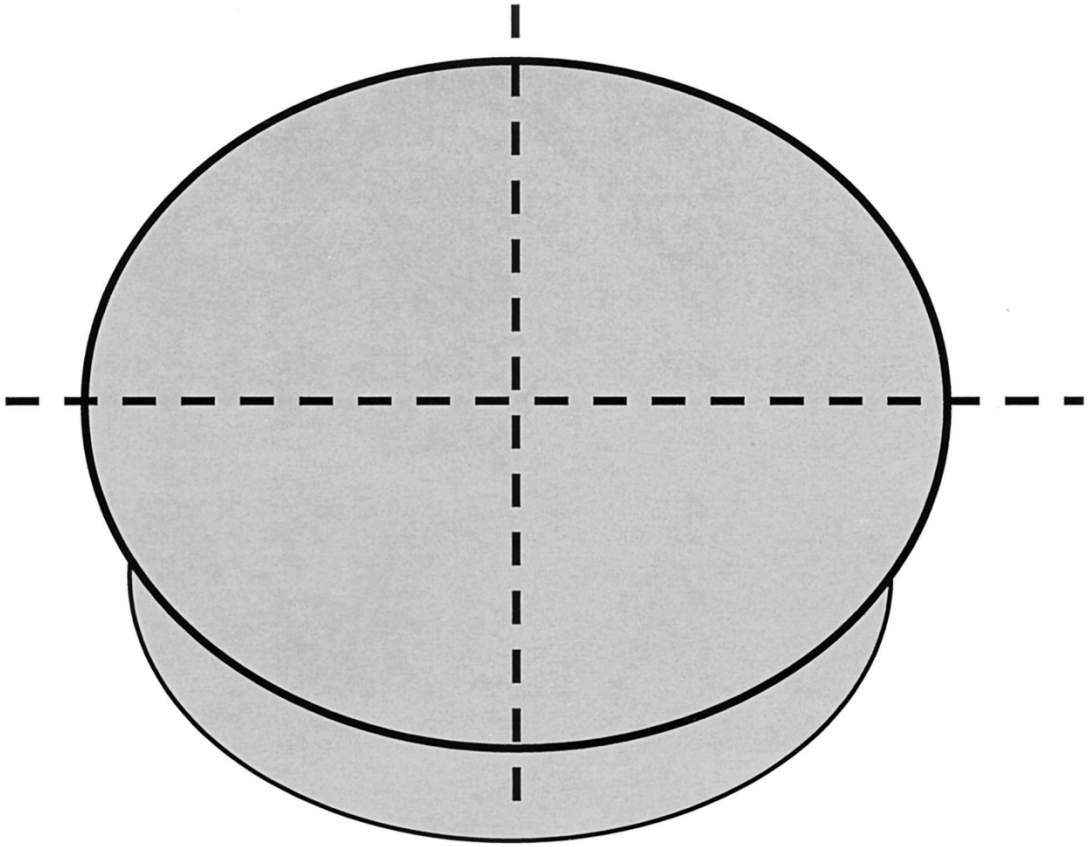
Fardon, 2001

PROLIFE



Focal Herniation

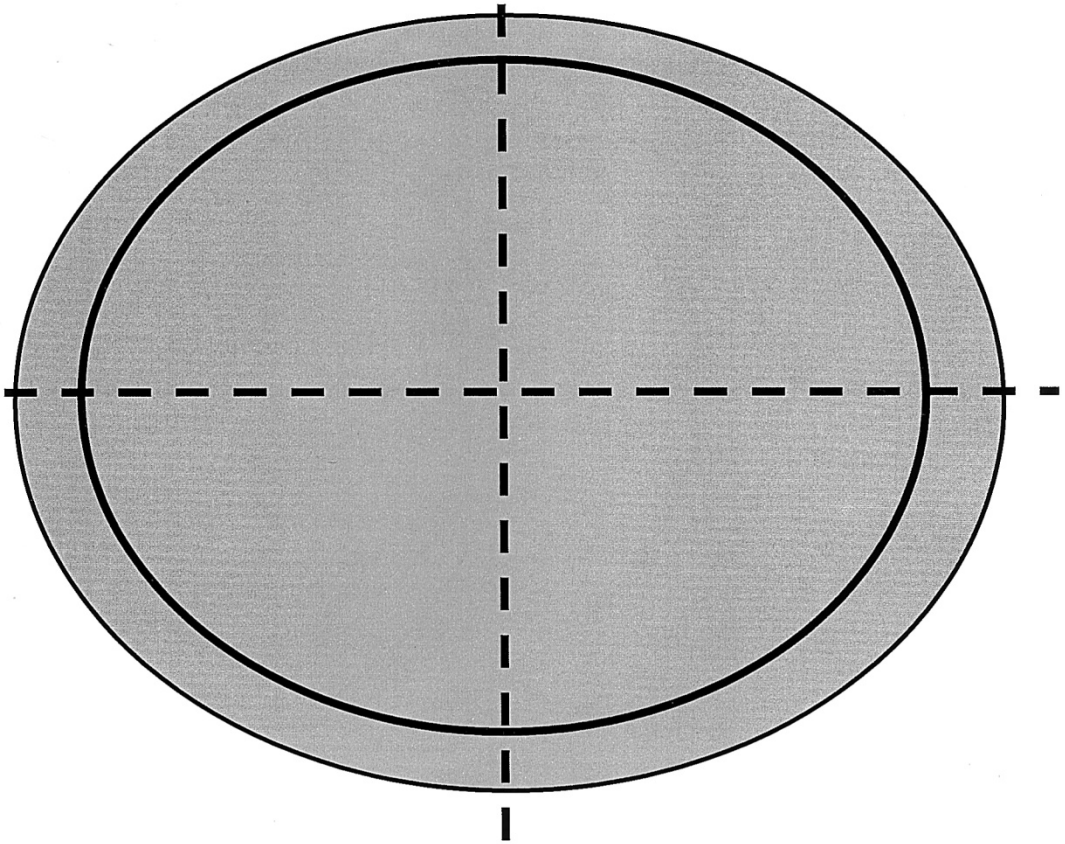
Fardon, 2001



Broad-based Herniation

Fardon, 2001

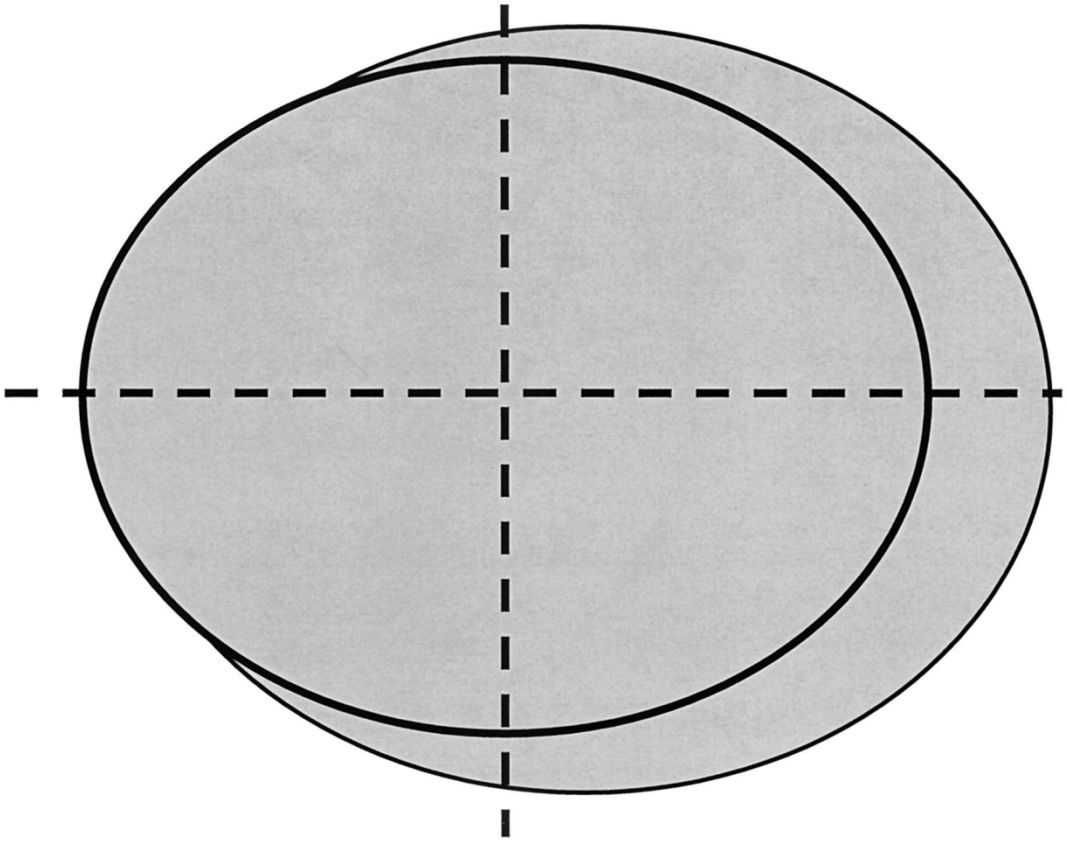
PROLIFE



"Symmetrical Bulging Disc"

Fardon, 2001

PROLIFE



"Asymmetrical Bulging Disc" Fardon, 2001

PROLIFE

Disc herniation

- **Protrusion-** displaced disc material smaller than the base of the herniation and can not exceed the height of the intervertebral disc space
  - Focal or broad base

Fardon, 2001

Disc herniation

- **Extrusion-** displaced disc material greater than the base of the herniation and can exceed the height of the intervertebral disc space

Fardon, 2001

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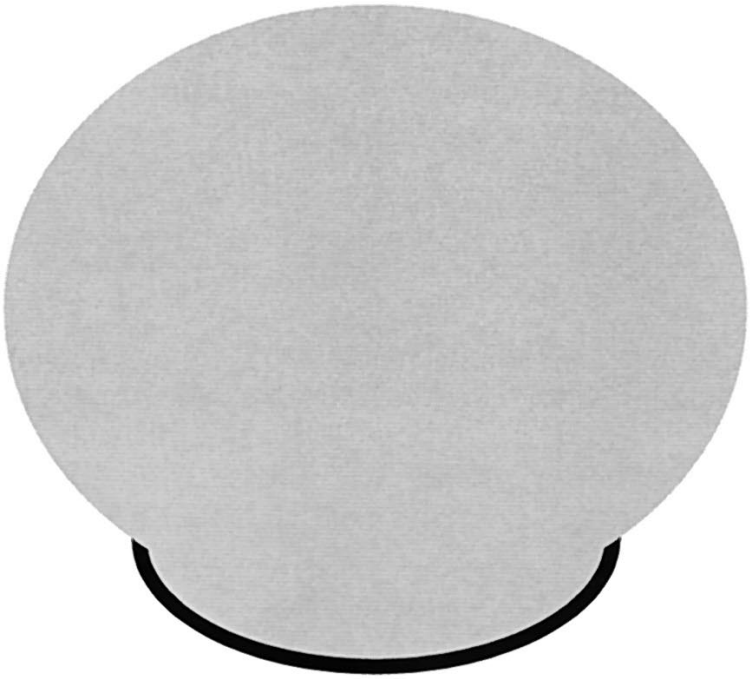
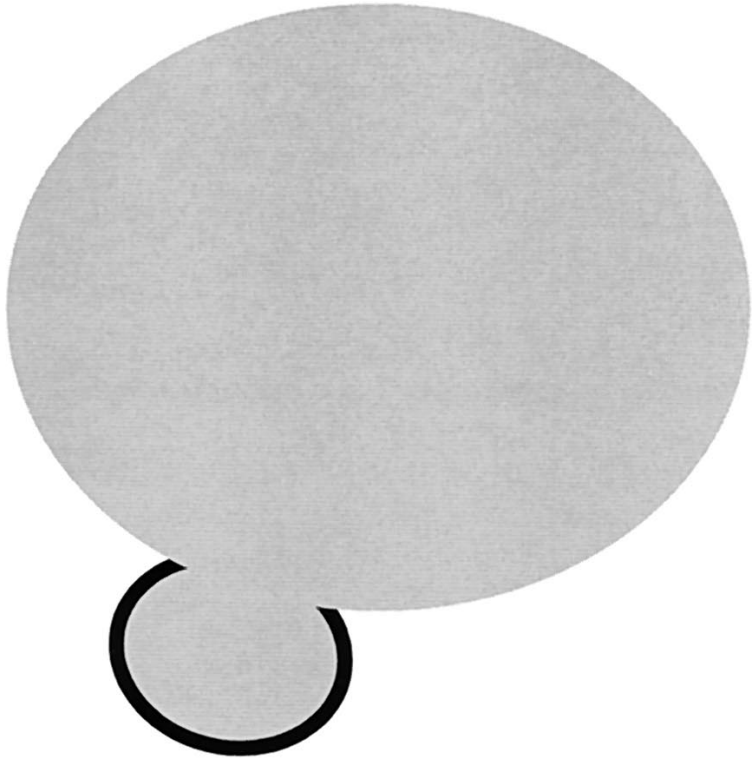
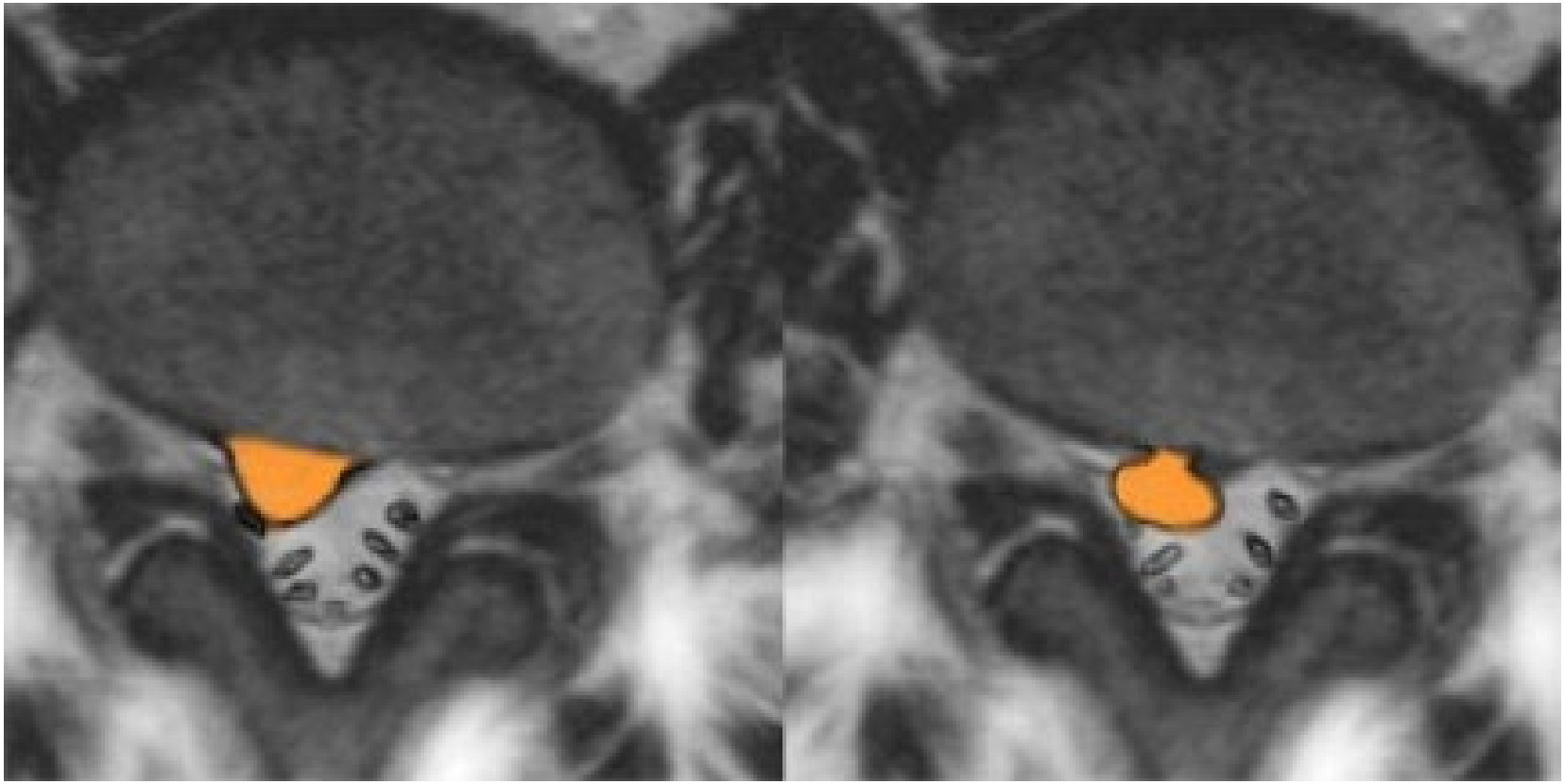


Protrusion



Extrusion

Fardon, 2001



Focal herniation

- Focal herniation- < 25% circumference

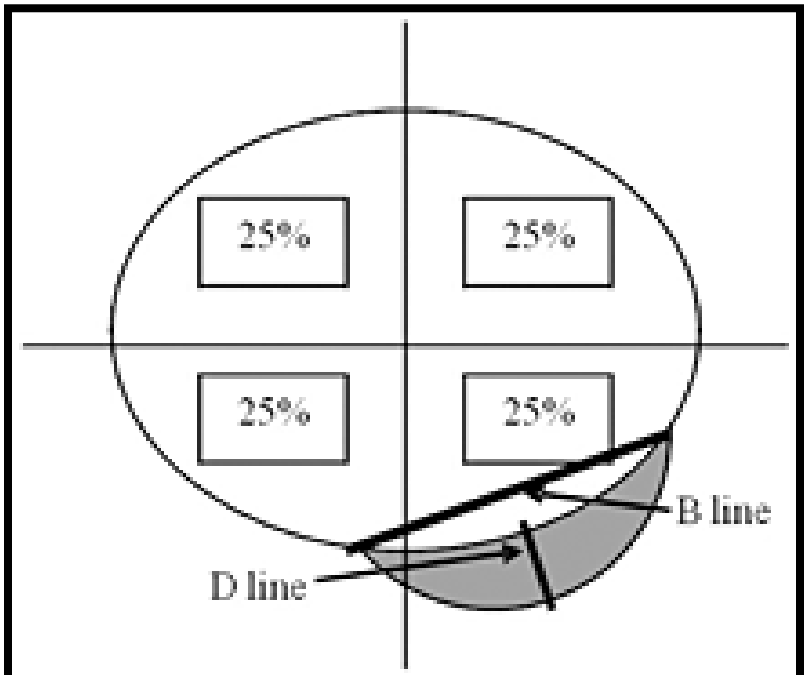


Figure 6 demonstrates a protrusion in which the base of the herniation (B line) is larger than the depth of the herniation (D line). This must hold true in all planes for herniation to be considered a protrusion.

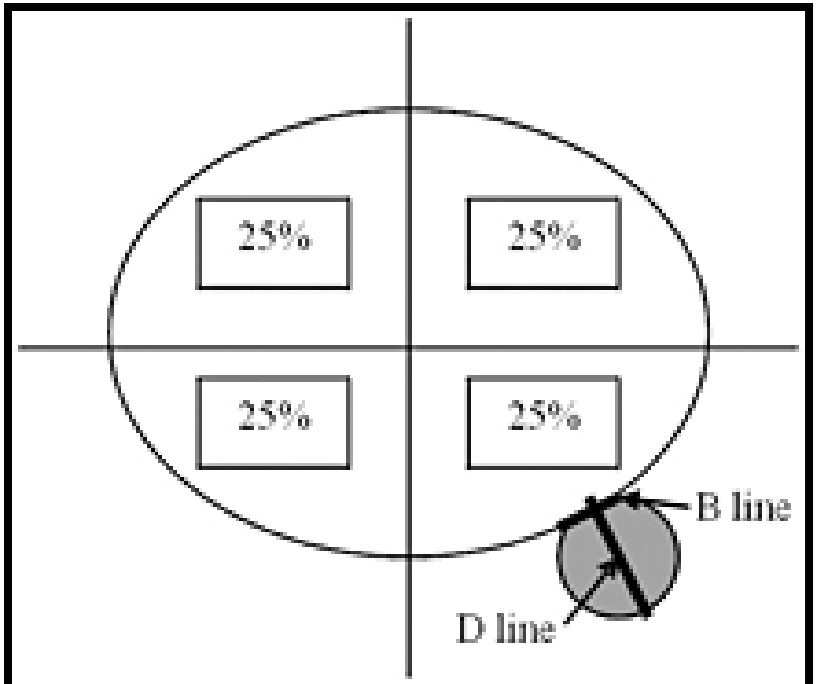
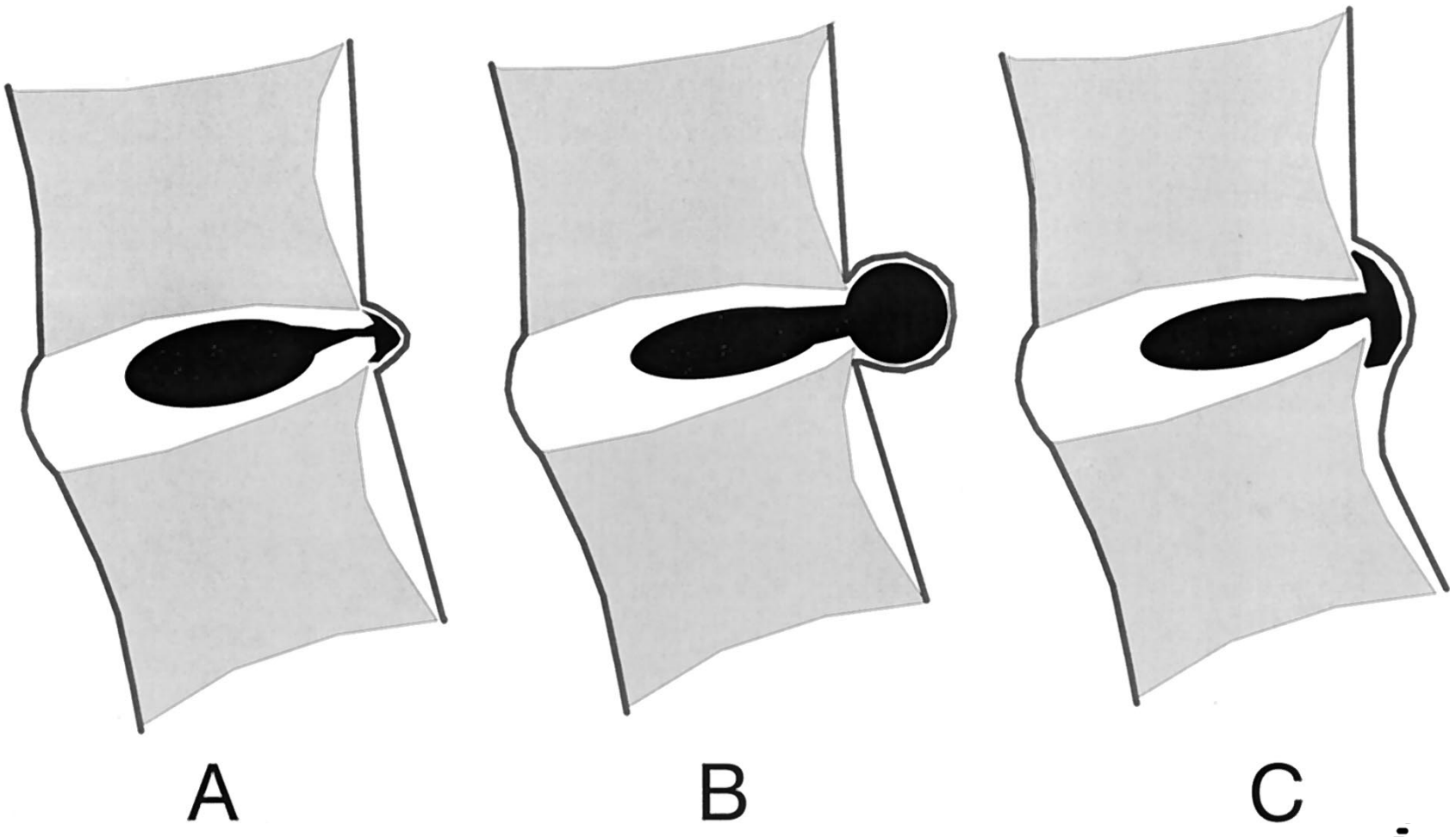


Figure 7 demonstrates an extrusion in which the base of the herniation (B line) is less than the depth of the herniation (D line) This can happen in any of the planes, i.e., axial or sagittal.



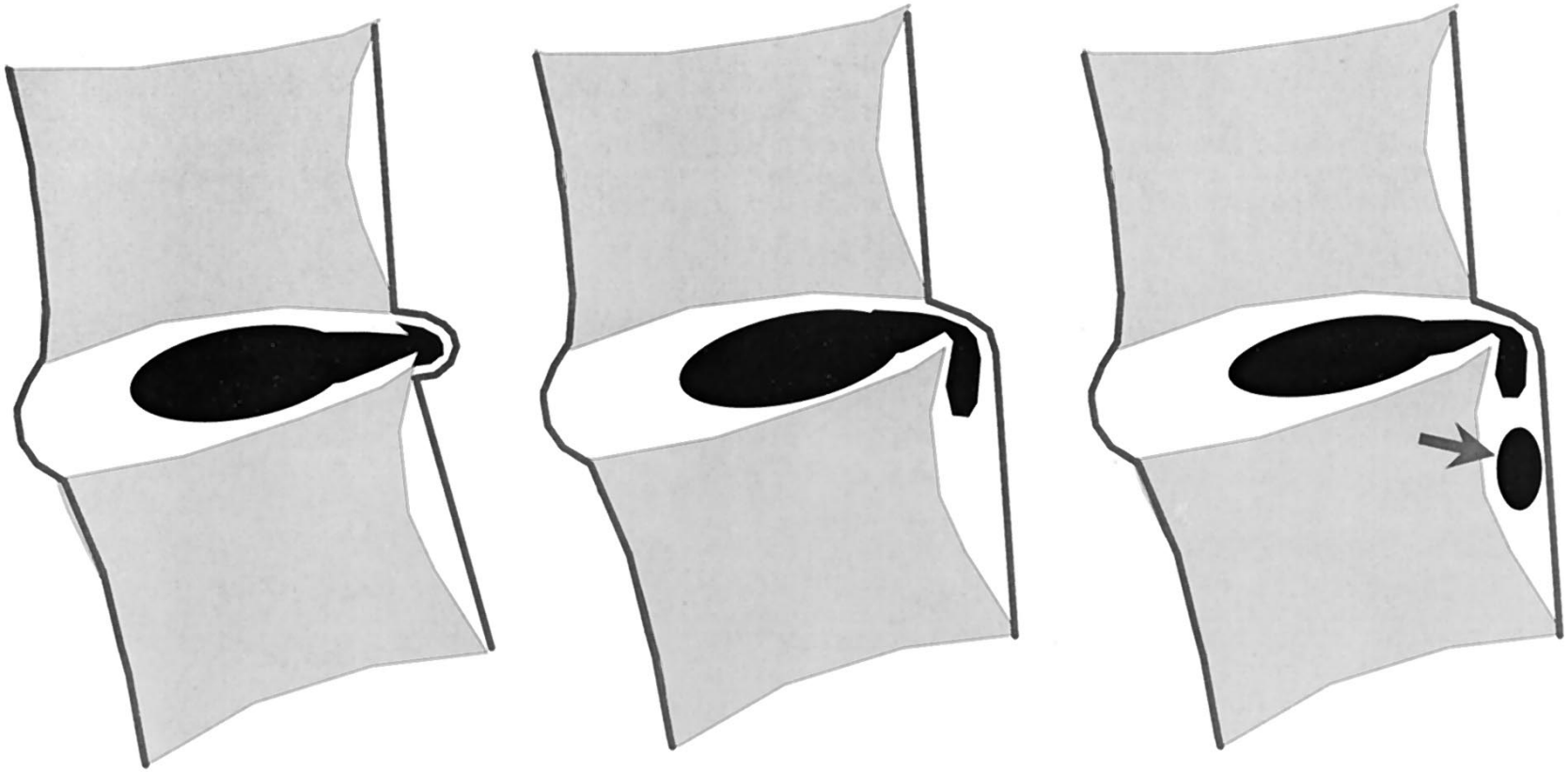
Fardon, 2001

Disc herniation

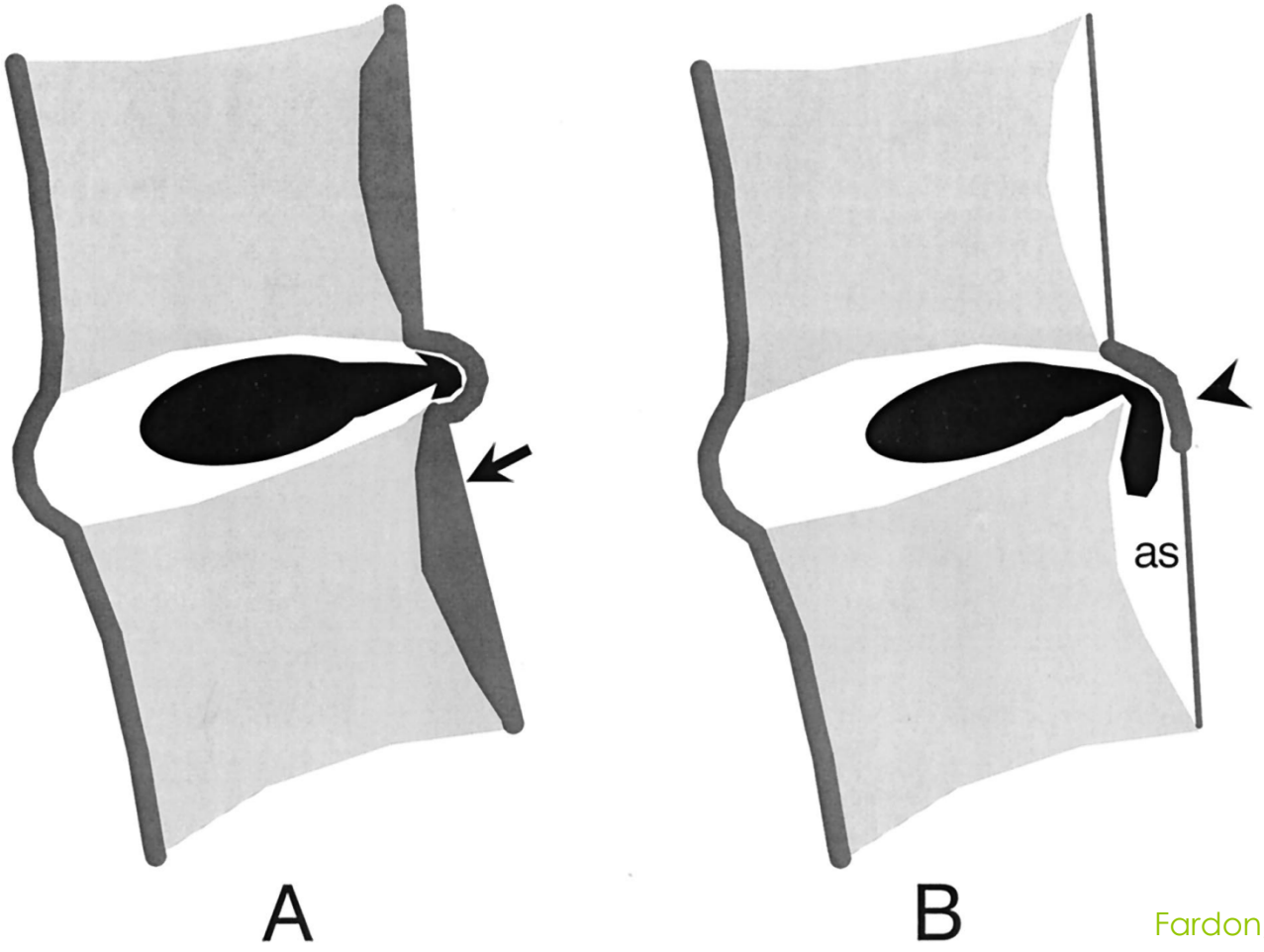
- **Sequestration-** displaced/extruded disc material that has no continuity with parent disc.

Fardon, 2001

PROLIFE



Fardon, 2001



Fardon, 2001

PROLIFE

Description of a Disc Herniation

- Morphology
  - Protrusion
  - Extrusion
  - Intravertebral
- Volume
- Location

Fardon, 2001

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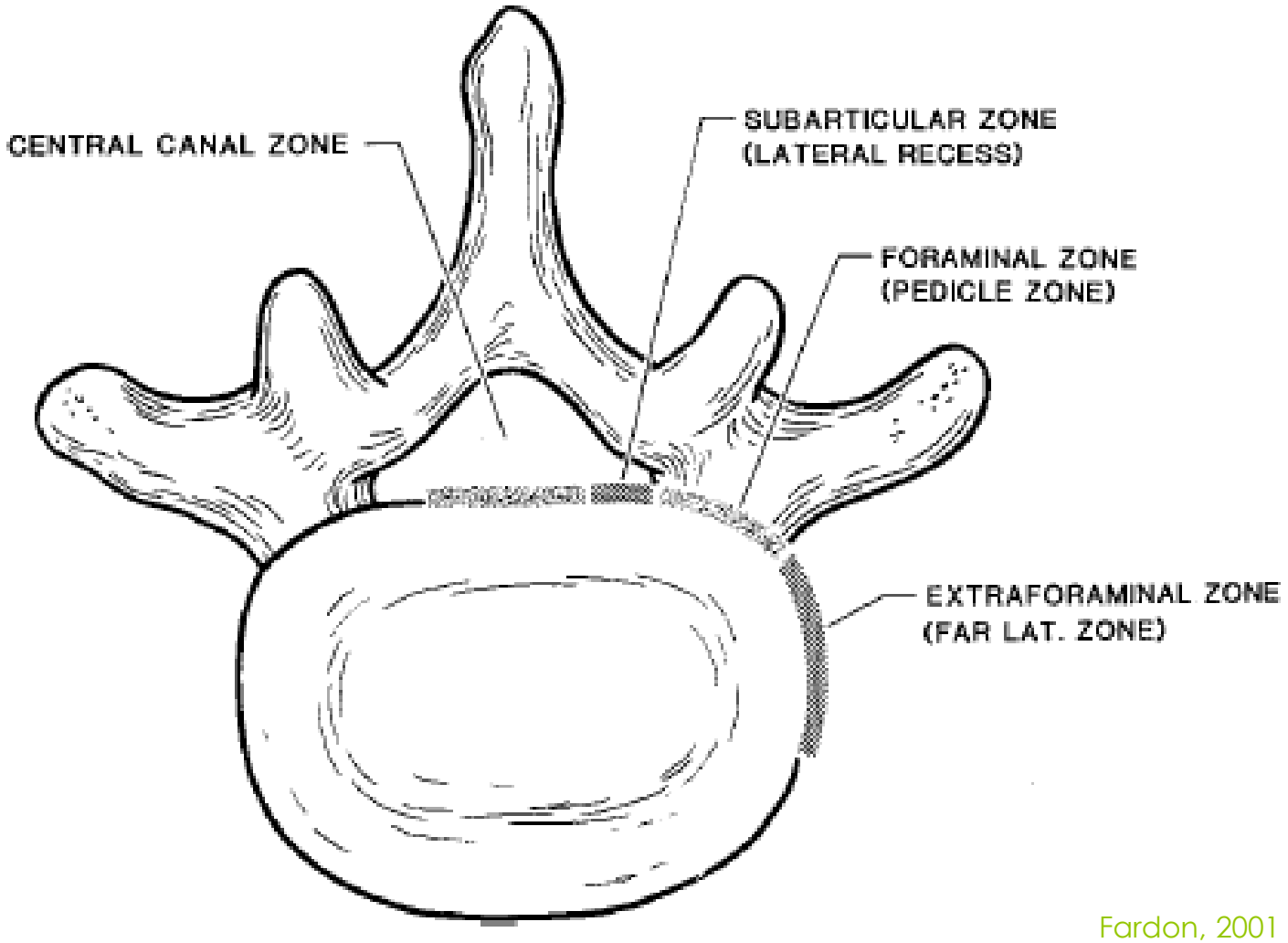
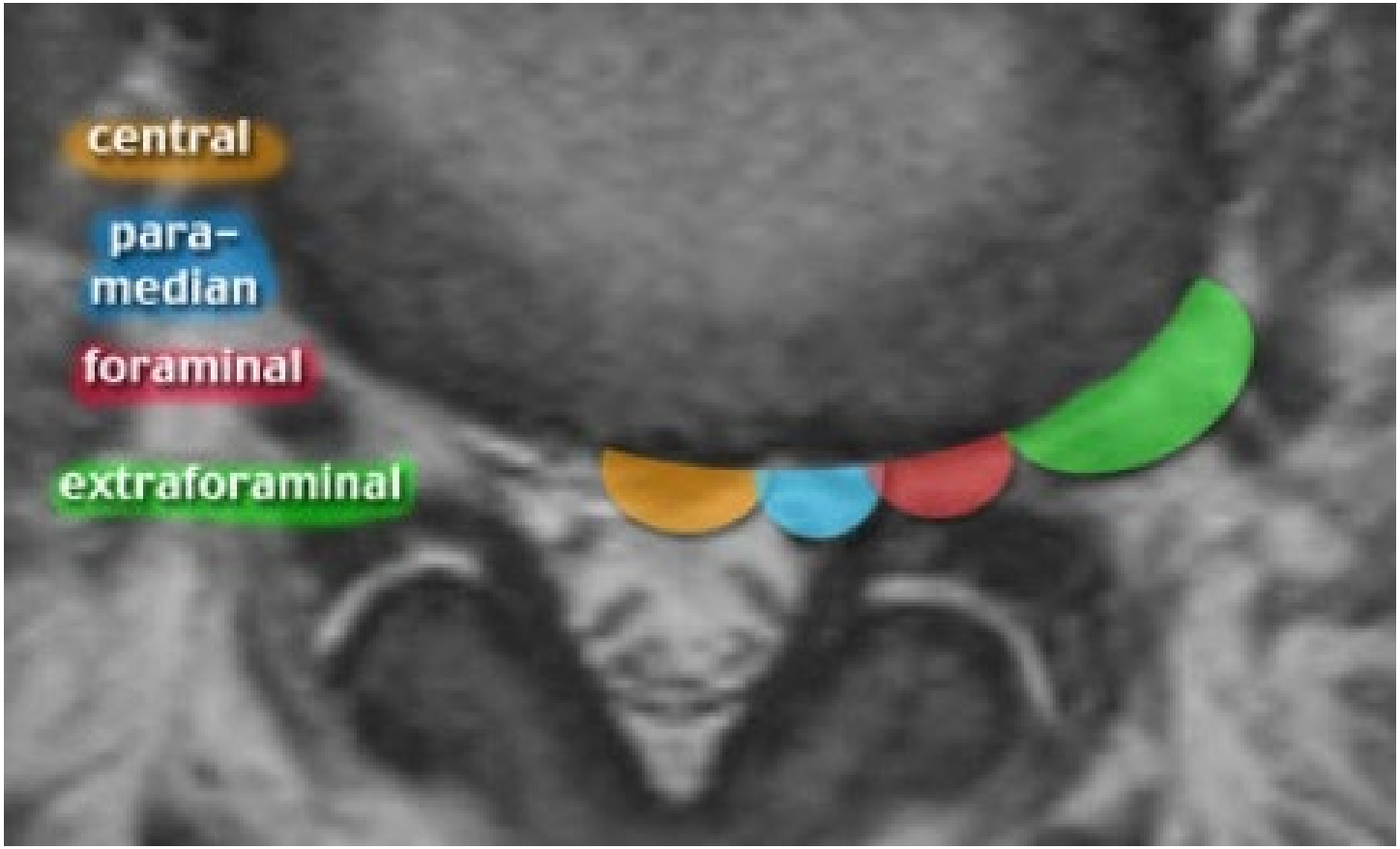
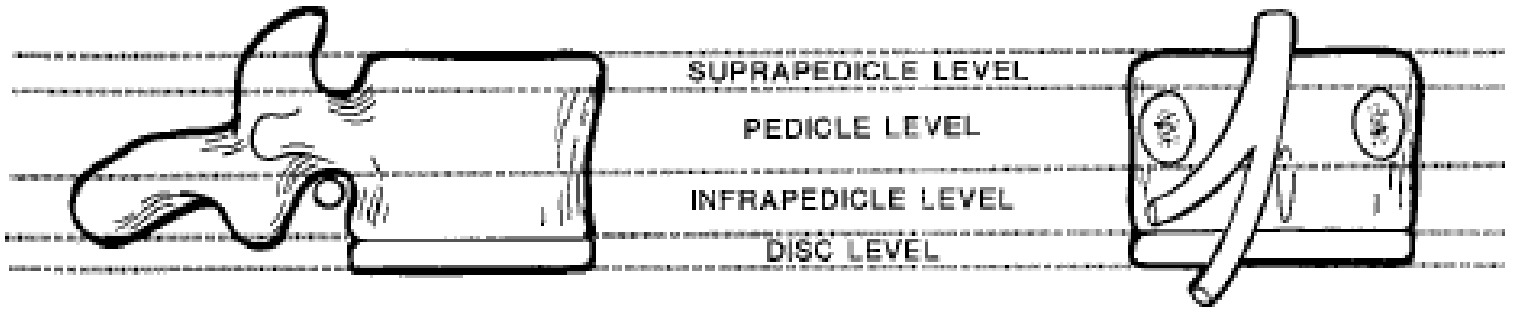


Fardon, 2001

PROLIFE





Fardon, 2001

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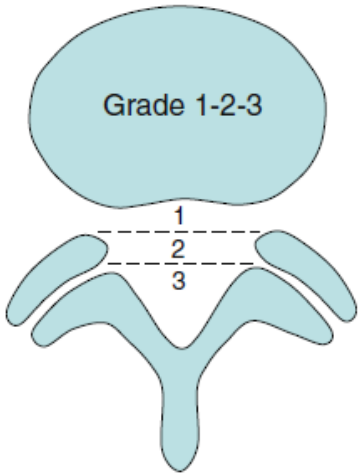
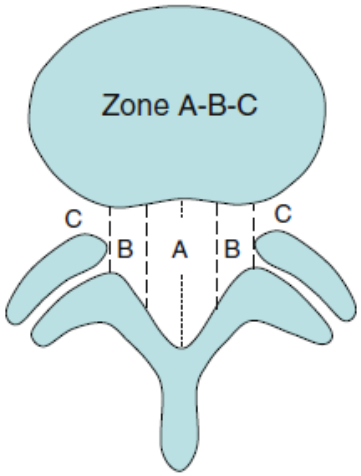
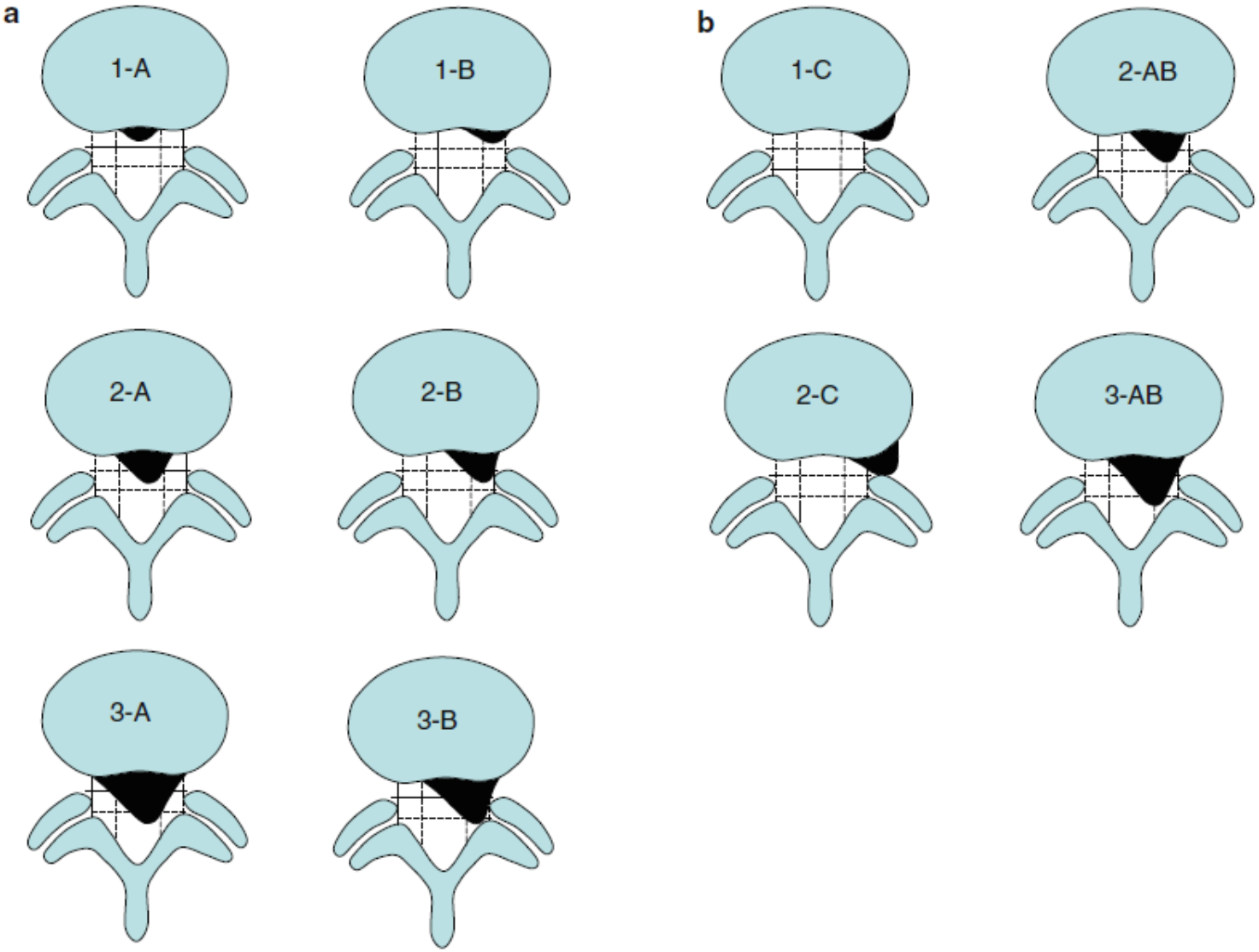
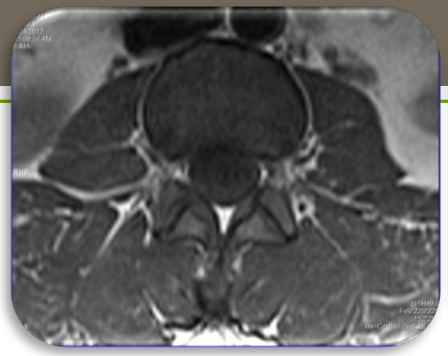
MSU Classification

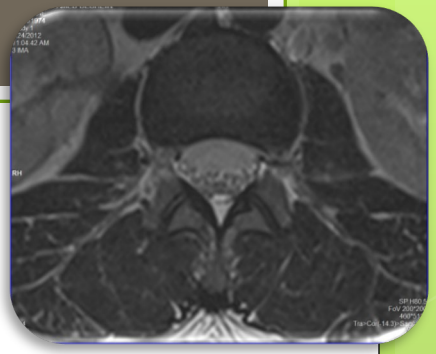


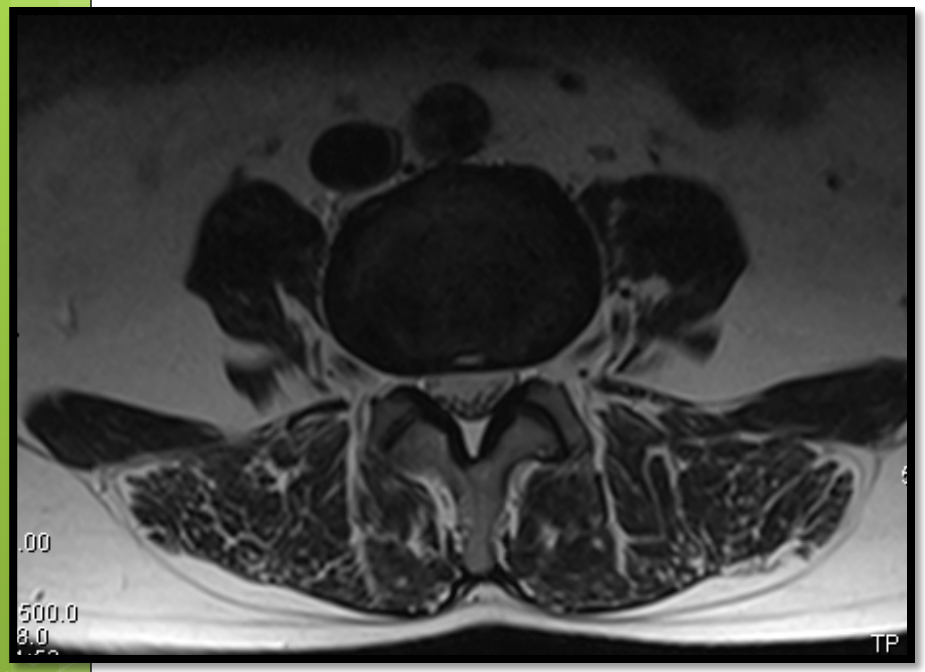


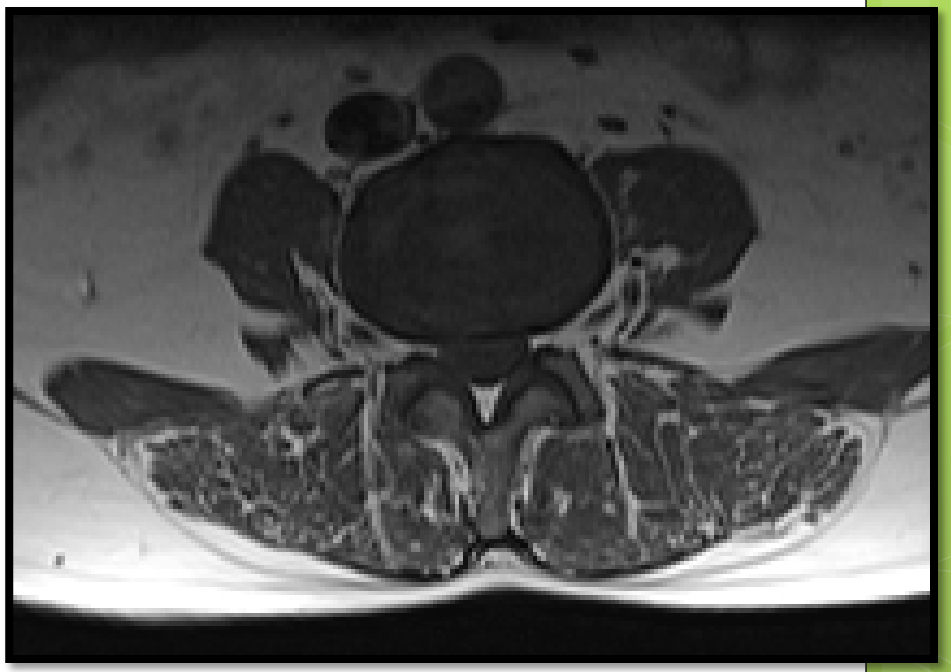

a
1-A
1-B
2-A
2-B
3-A
3-B
b
1-C
2-AB
2-C
3-AB

- Diagnosis Panel









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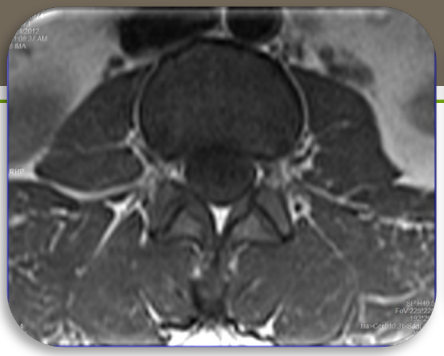

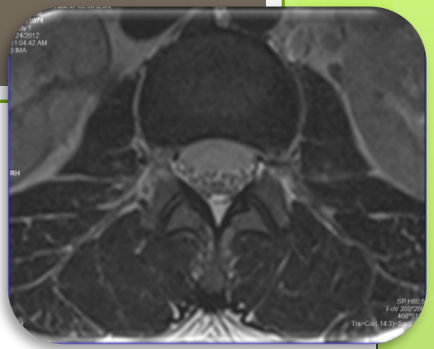


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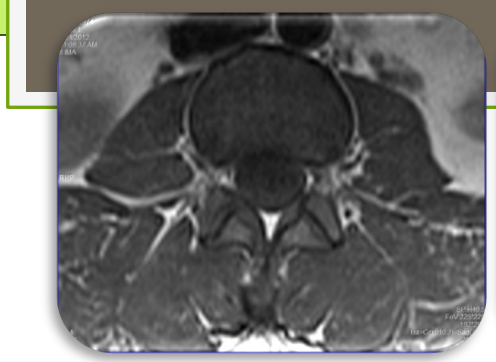
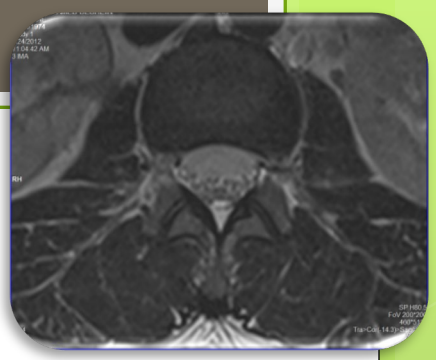
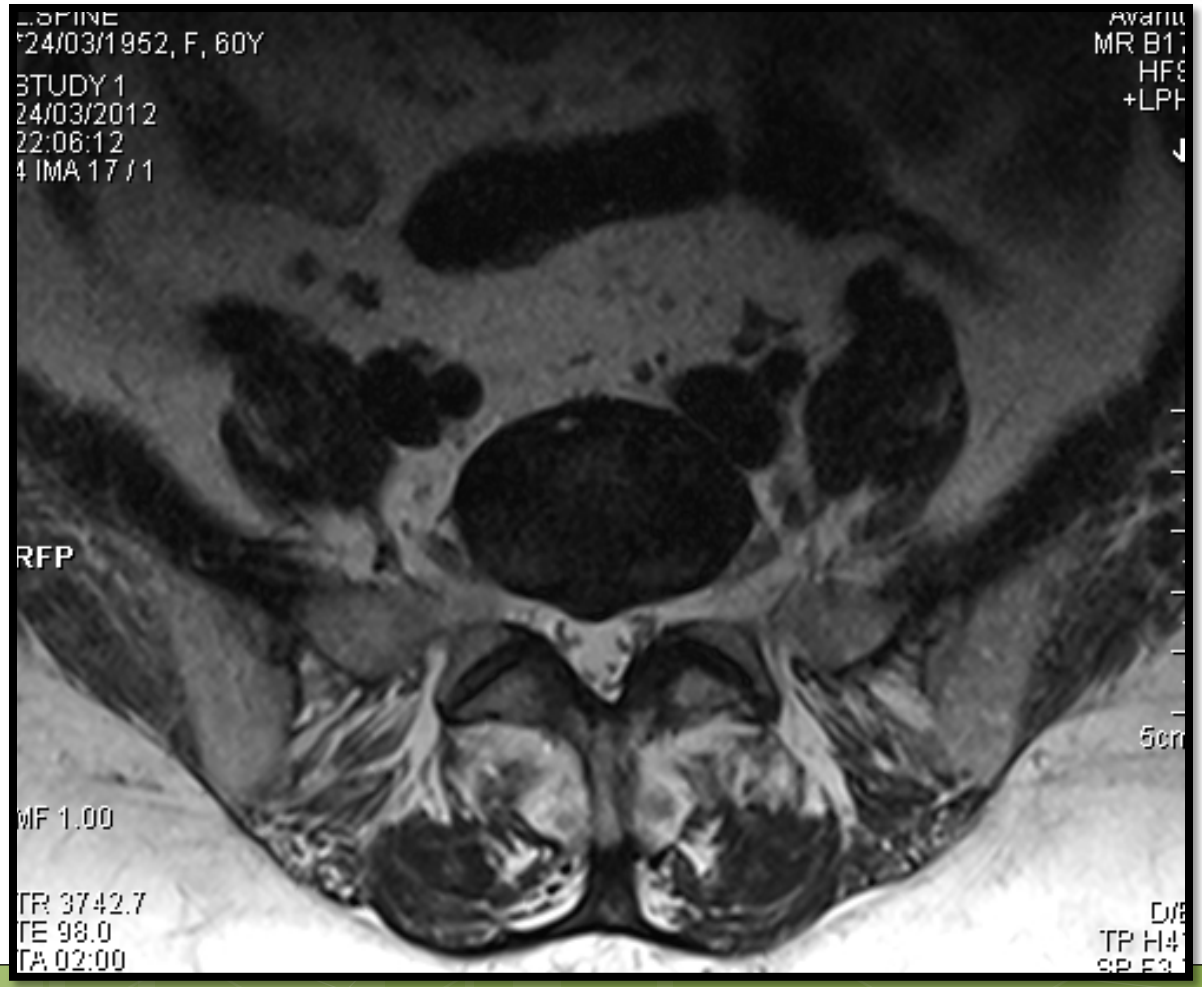
TA 02:41
BW 199.0
M/DIS2D/F M/FIL
D/E
TP H31
SP H5.9
SL 4.0/0.4
FoV 200*200
460*512

PROLIFE



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RFP
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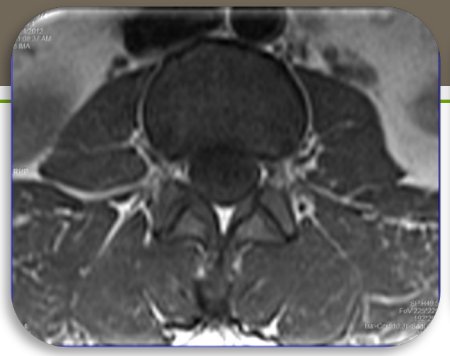
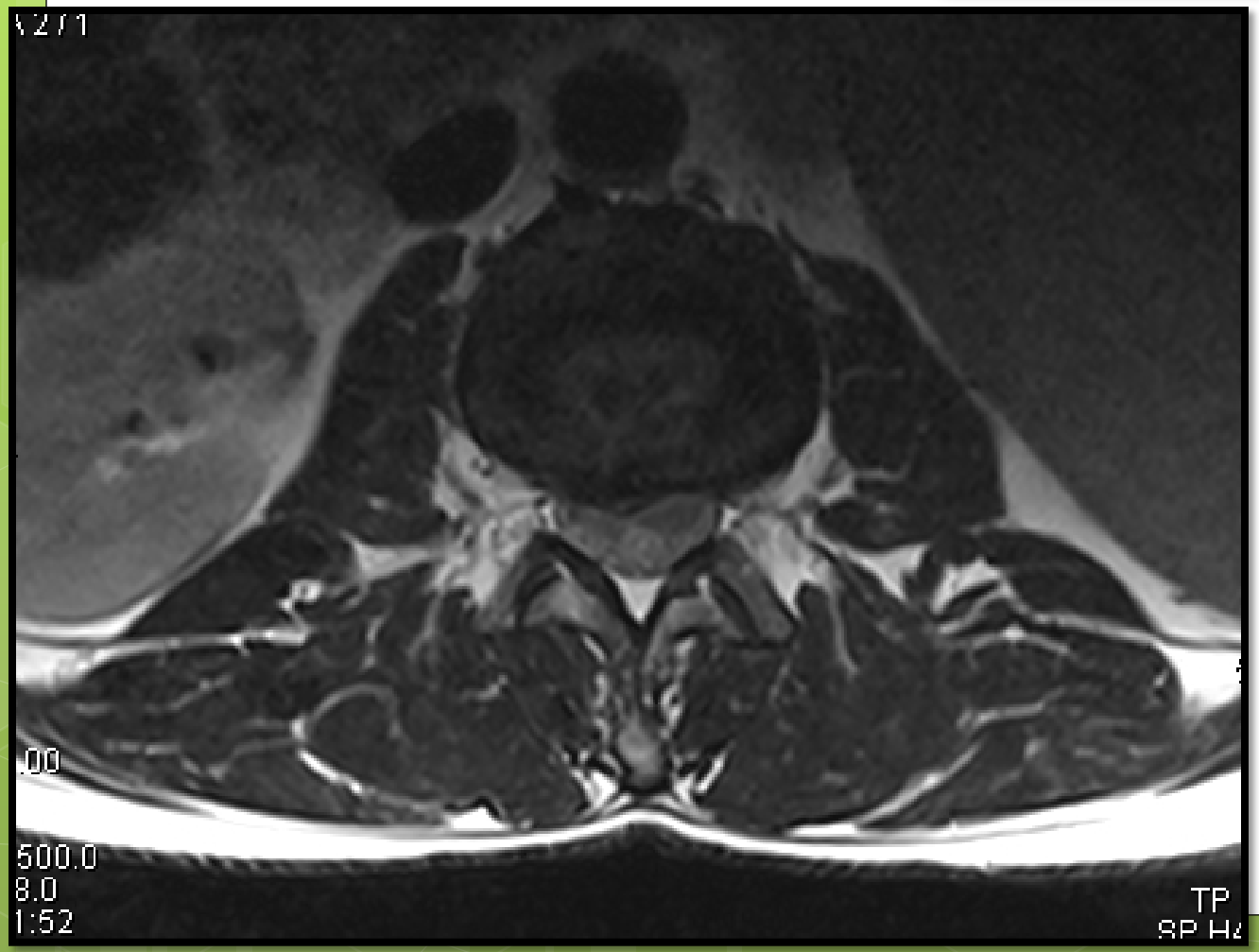
PROLIFE





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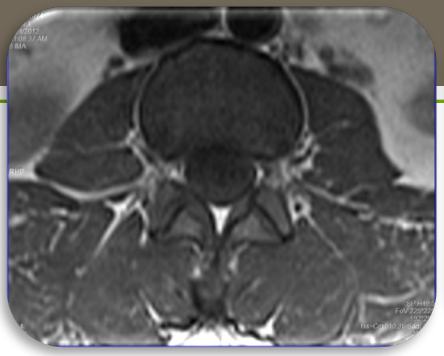

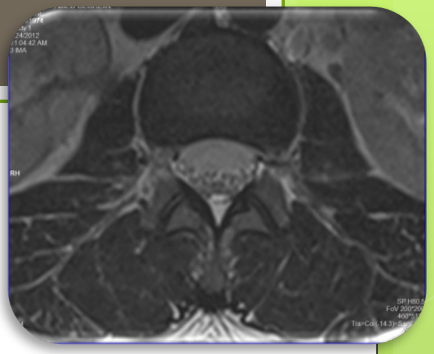

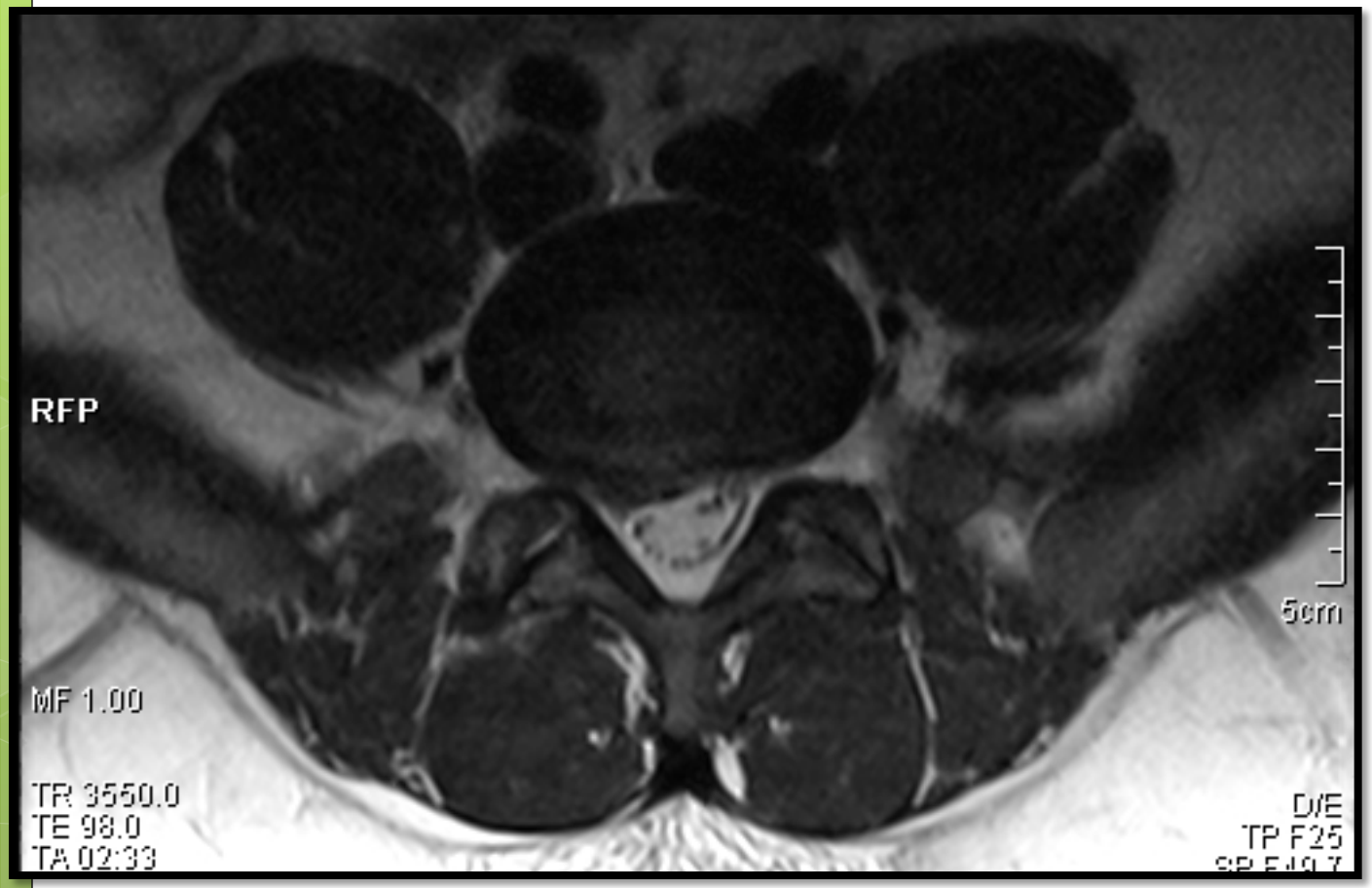

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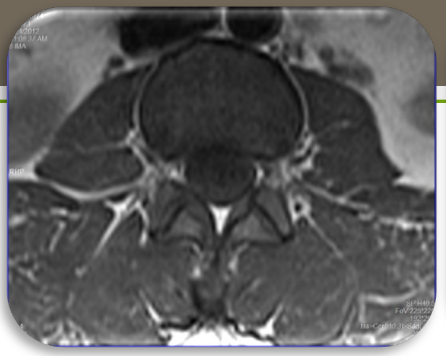

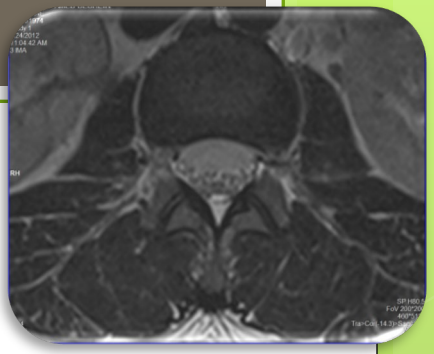

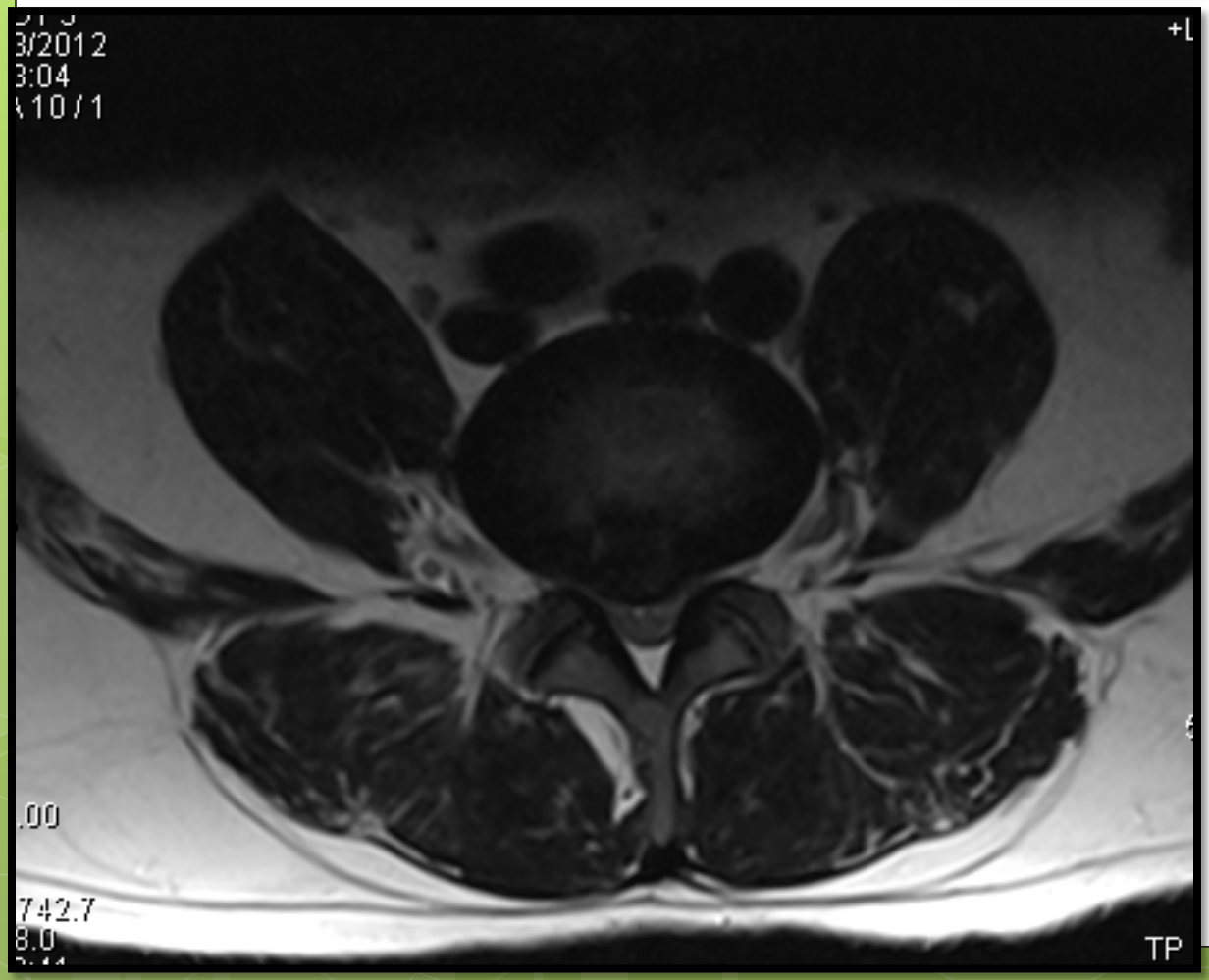

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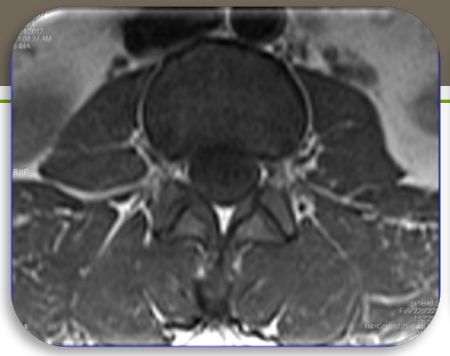

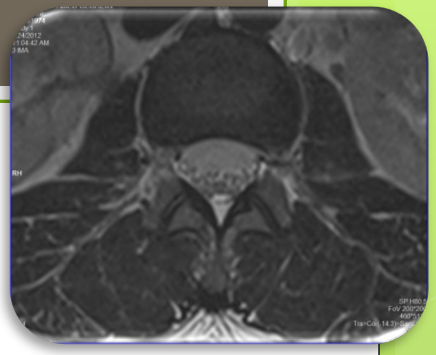

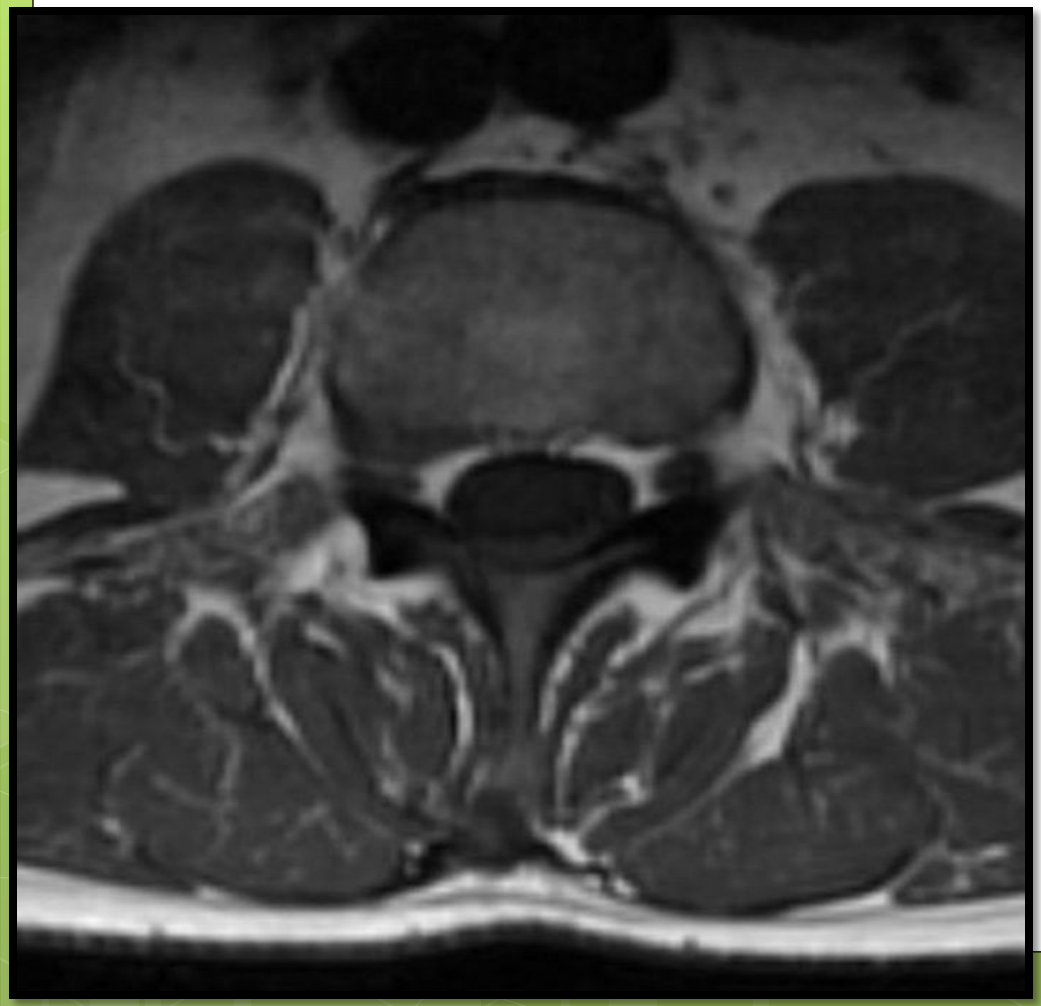

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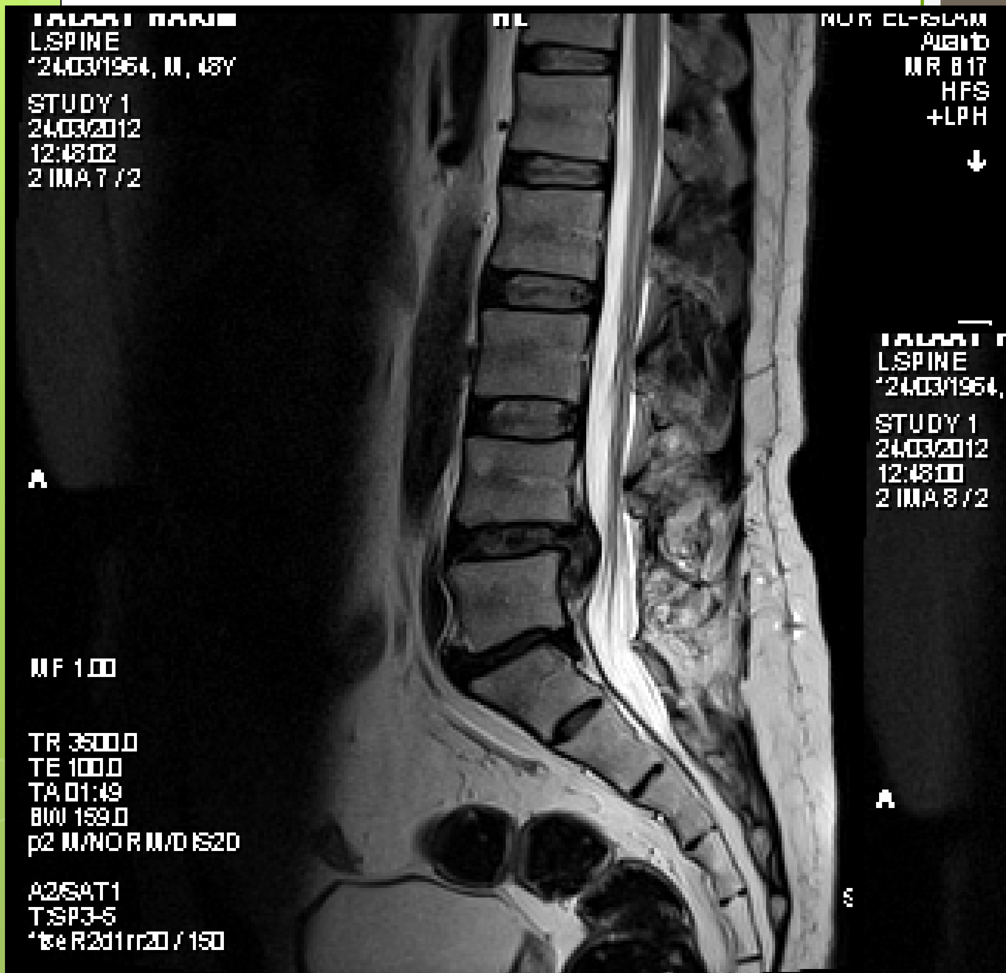
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24/03/2012
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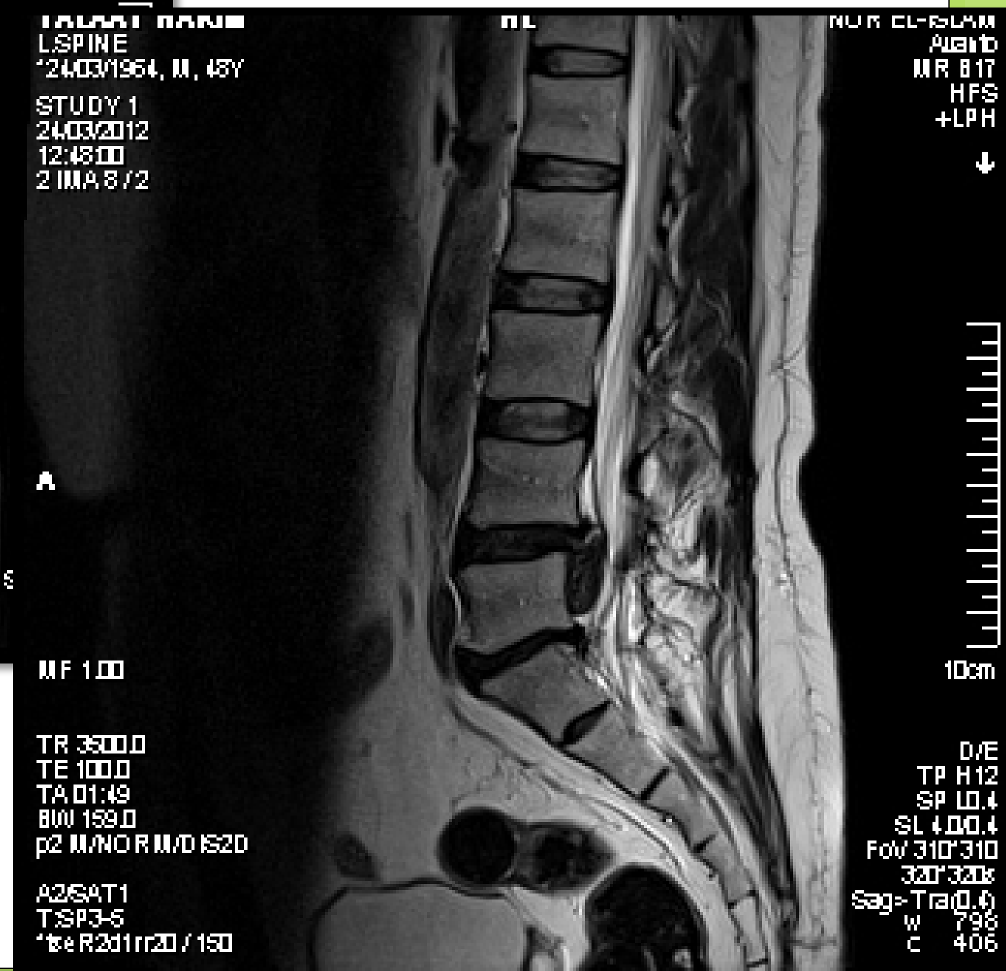
Avanto
MR B17
HFS
+LPH
A
MF 1.00
TR 3500.0
TE 100.0
TA 01:49
BW 159.0
p2 M/NORM/DIS2D
A2/SAT1
T:SP3-5
*tse R2d1rr20 / 150


L.SPINE
*24/03/1964, M, 48Y
STUDY 1
24/03/2012
12:48:00
2 IMA 8 / 2
Avanto
MR B17
HFS
+LPH
A
MF 1.00
10cm
TR 3500.0
TE 100.0
TA 01:49
BW 159.0
p2 M/NORM/DIS2D
A2/SAT1
T:SP3-5
*tse R2d1rr20 / 150
D/E
TP H12
SP L0.4
SL 4.0/0.4
FoV 310*310
320*320s
Sag>Tra(0.6)
W 798
C 406

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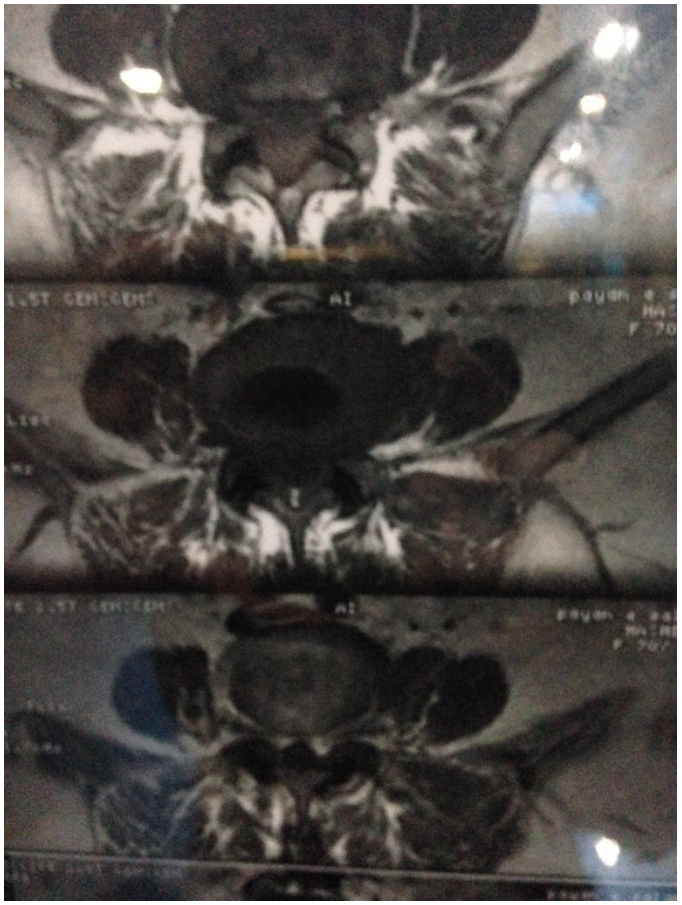
Vacuum Phenomena

- Vacuum phenomena involving the intervertebral discs are a result of accumulation of gas (principally nitrogen) with the crevices of the intervertebral discs or adjacentvertebrae.




Ex: 38664 HASHEMINASAB TAI.
Se: 3 F 70Y 93.8.19SALEH
Nov 10 2014
05:23:58 PM
ET:3
FSE-XL/90 /FL3sa
TR:460
TE:3.4/Ef
EC:1/1 41.7kHz

- **Disc Extrusion**
- Greater extension of focal Disc material than a protrusion
- Frequently symptomatic
- Anteroposterior ≥ mediolateral diameter
- May migrate craniocaudally, but maintains attachment to parent Disc
- Decreased signal on T1, decreased or increased on T2

- **Sequestered Disc**
- Loss of continuity between extruded Disc material and parent Disc
- Usually symptomatic
- Fragment migrates • Cranial or caudal (equally)
- Anterior or posterior to posterior longitudinal ligament
- Epidural, intrathecal, paraspinous

- Contraindication to limited Disc procedures
- Common cause of failed back surgery, if unrecognized
- Decreased signal on T1, decreased or increased on T2 or contrast T1

Discs at Risk

- Approximately one third of asymptomatic individuals have focal lumbar Disc contour abnormalities on MRI
- Only 1% of asymptomatic patients have a Disc extrusion by MRI
- About 90% of focal Disc contour abnormalities occur at L4-5 and L5-S1 in the lumbar region, and at C5-6 and C6-7 in the cervical spine
- >90% of focal Disc contour abnormalities in the lumbar spine affect the central and paracentral regions.

Disc related compressive mylopathy

- High signal intensity areas on T2W images can be seen within the spinal cord at the point of spinal stenosis secondary to a disk bulge or extrusion .
- This high signal intensity may be from focal myelomalacia owing to ischemia to the cord. These cord lesions may or may not disappear after decompressive surgery.

a

b

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DEGENERATIVE CHANGES

Bone

- Vertebral Bodies
- Facet Joints
- Posterior Spinous Processes (Baastrup's Disease)

Vertebral Bodies

- Osteophytes
- Marrow changes (Modic)

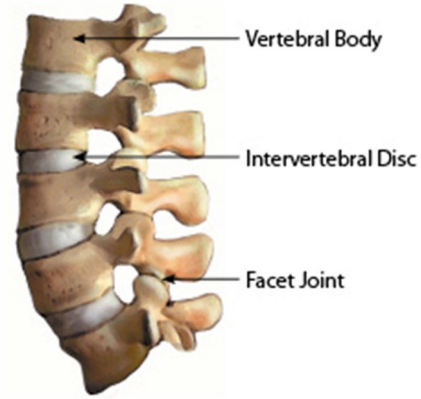
Focal or diffuse bands parallel to end plates

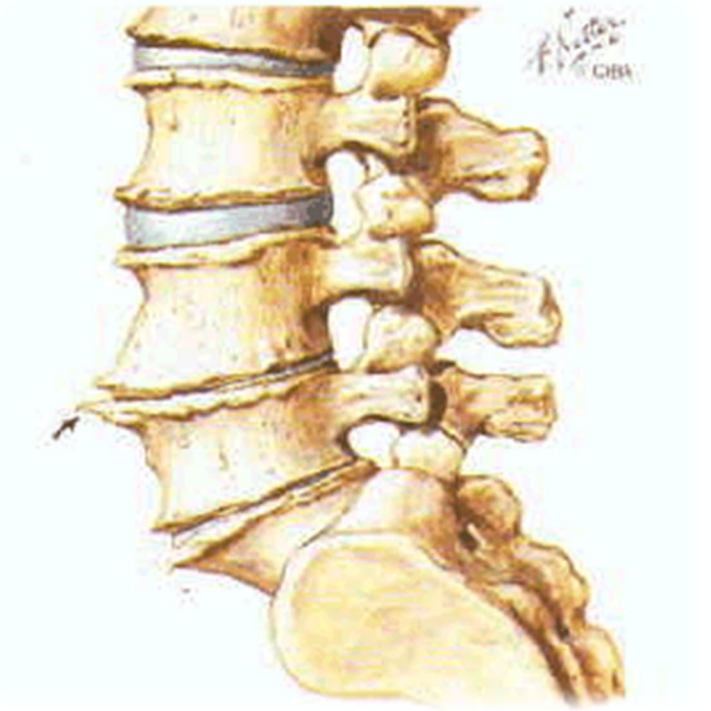
Type 1: Decreased signal T1, increased signal T2 (inflammatory tissue)

Type 2: Increased signal T1, follows fat on T2 (focal conversion to fat)

Type 3: Decreased signal T1 and T2 (sclerosis)

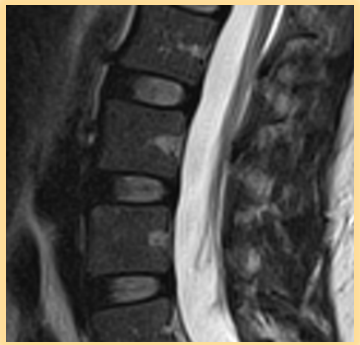
Oseophytosis



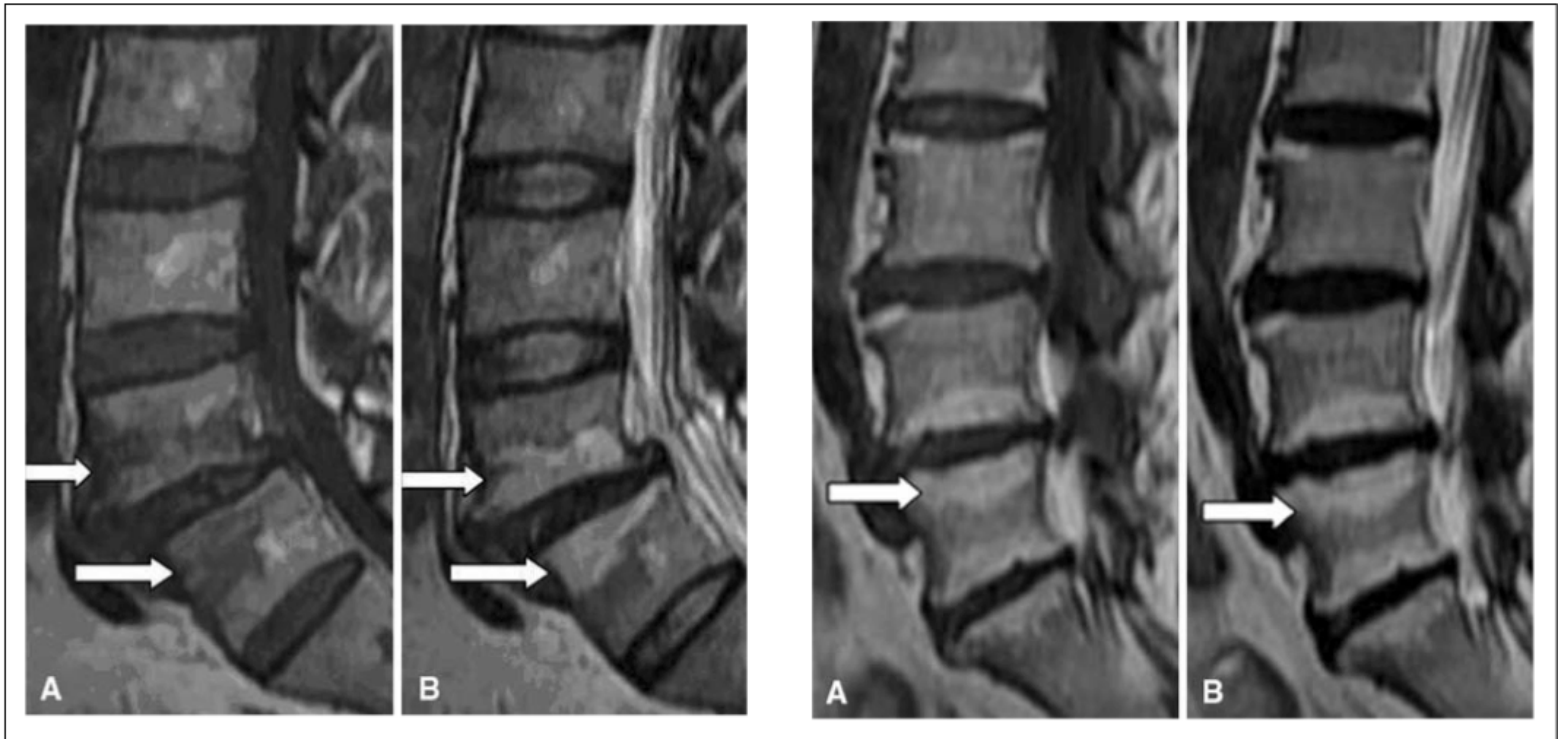


PROLIFE

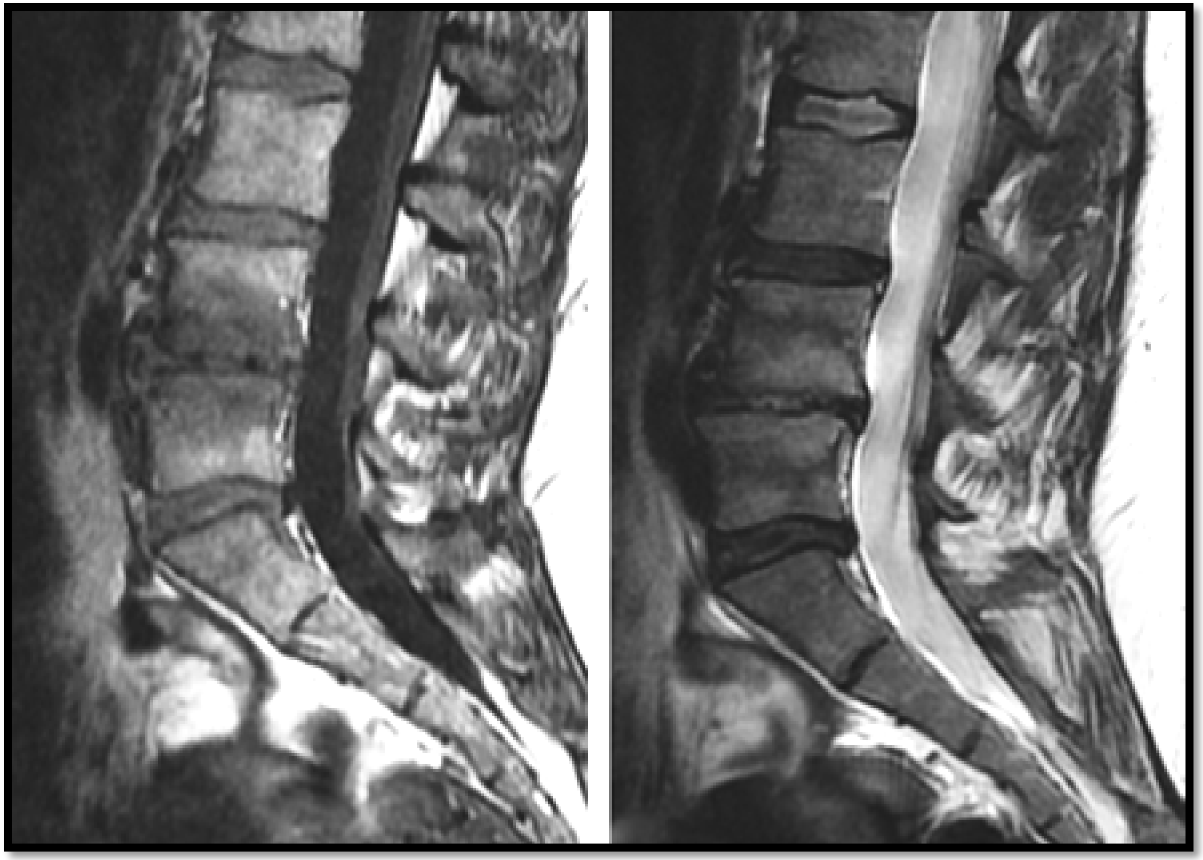
Oseophytosis



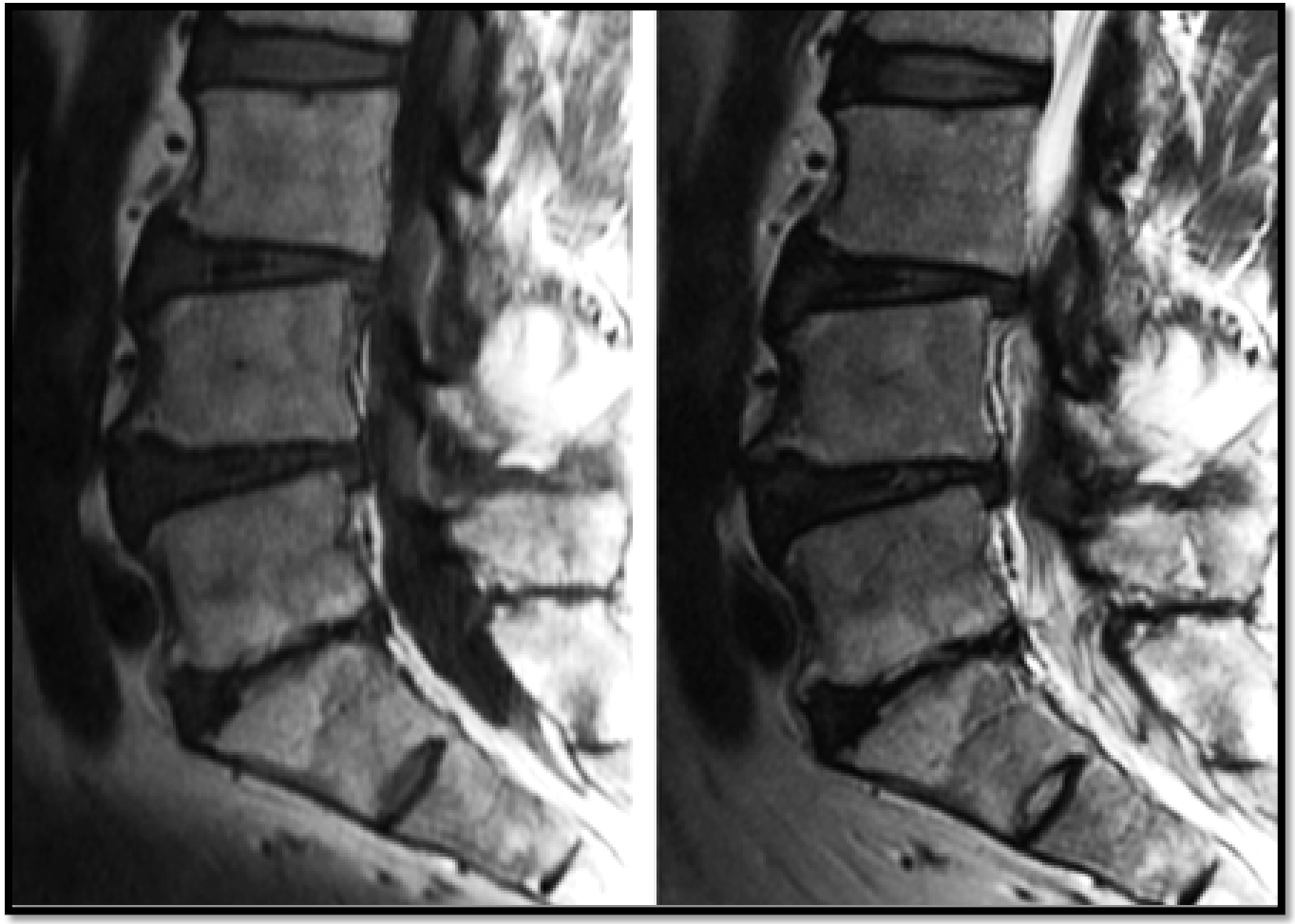
Modic

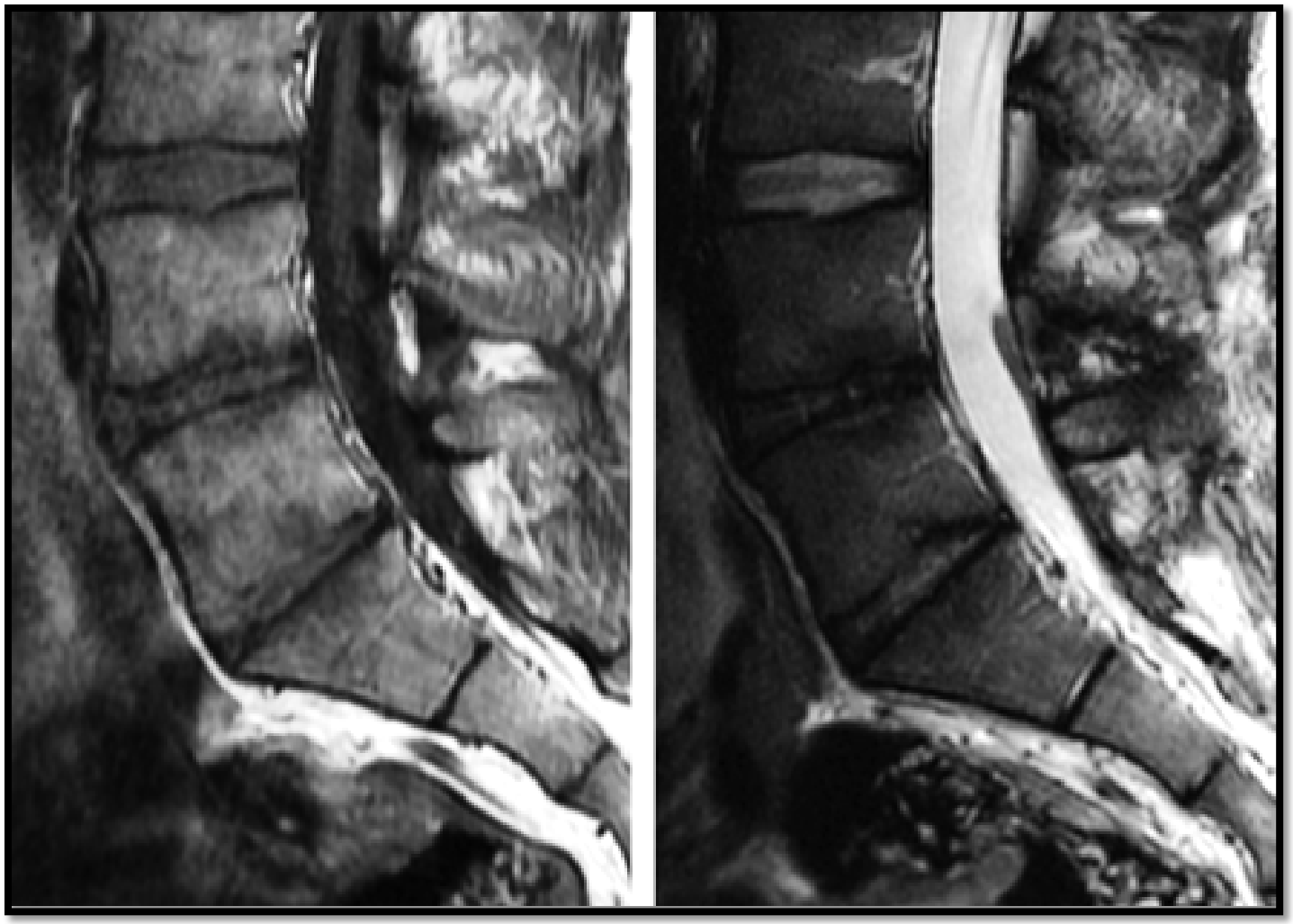


Diagnostic Panel



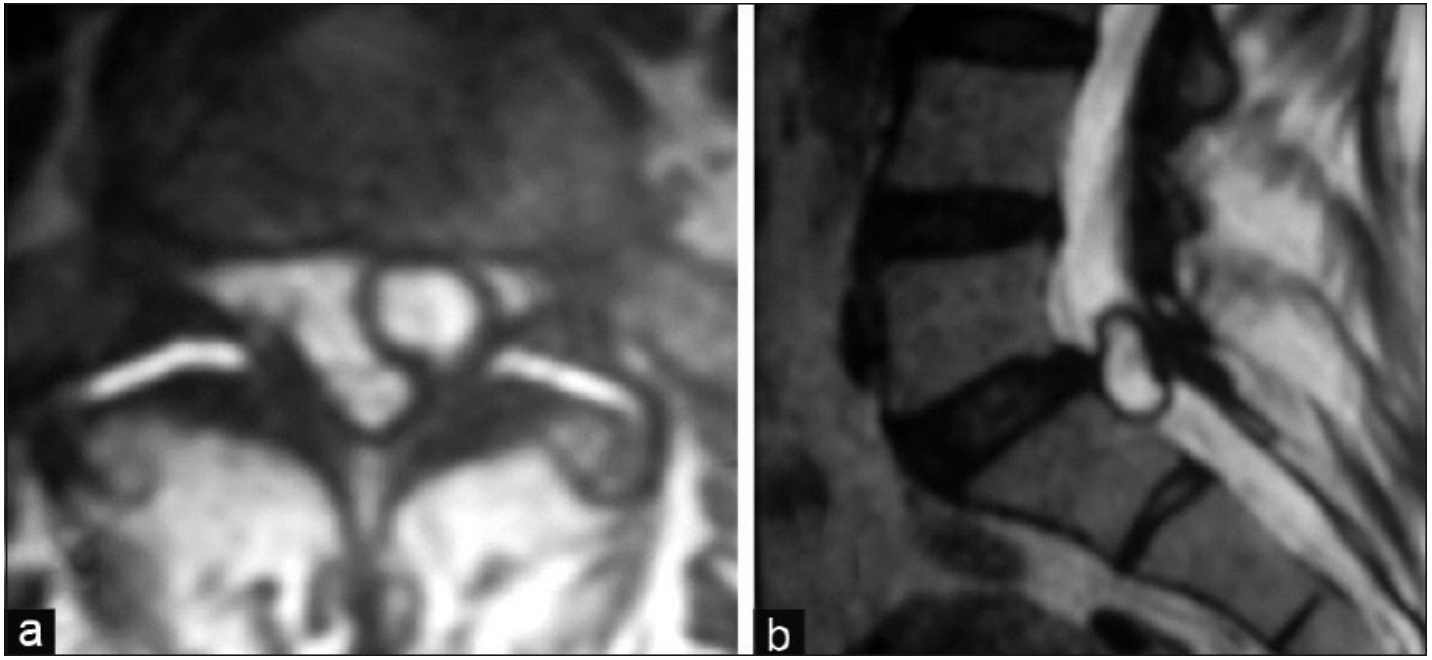
PROLIFE

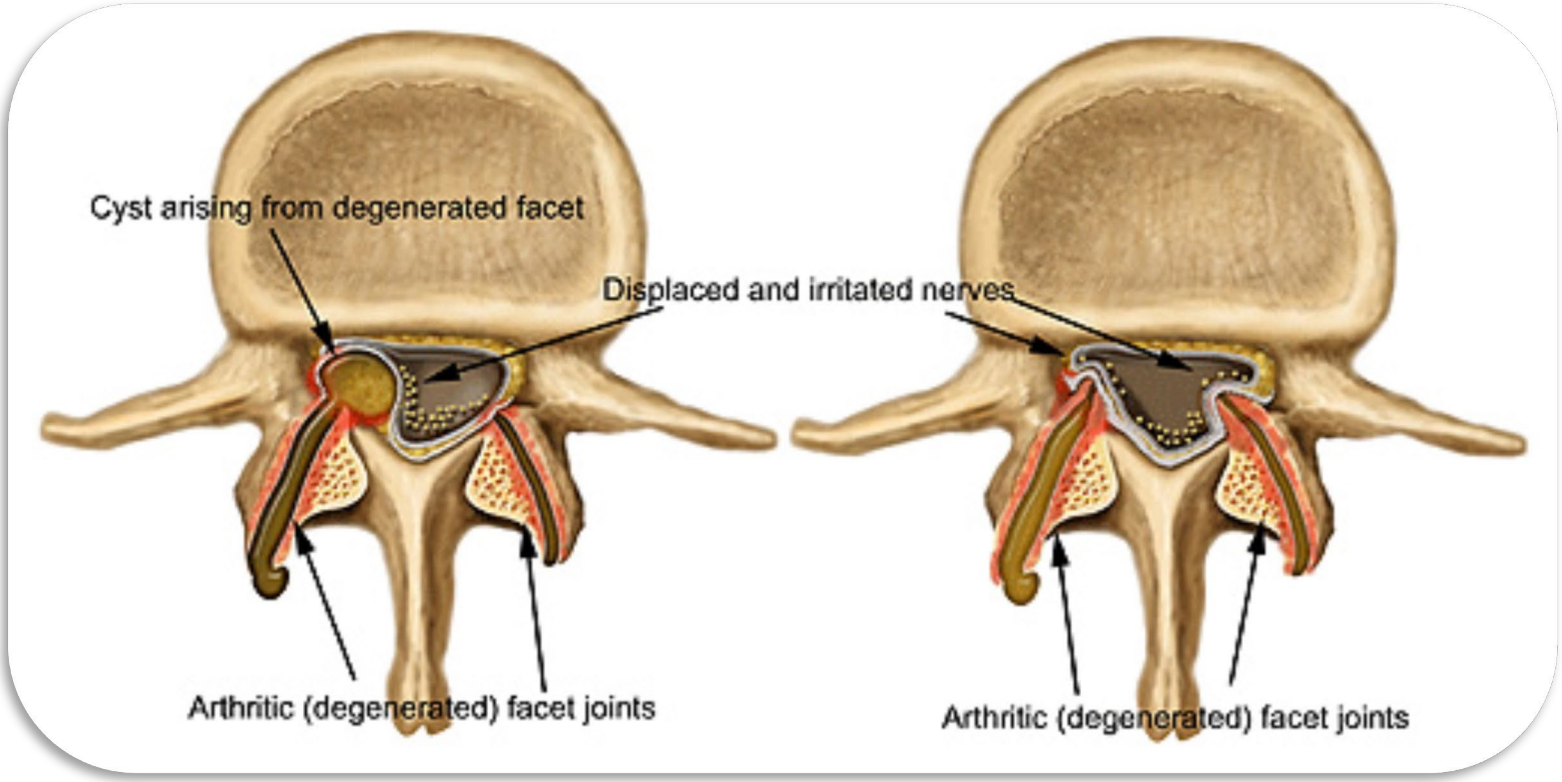




Facet Joints

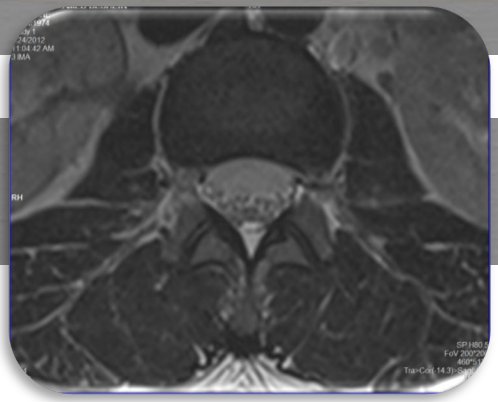
- Degenerative joint disease
- Cartilage loss, subchondral sclerosis, or cysts
- Osteophytes with overgrowth of articular processes
- Synovial cysts
- Buckling of ligamentum flavum into canal

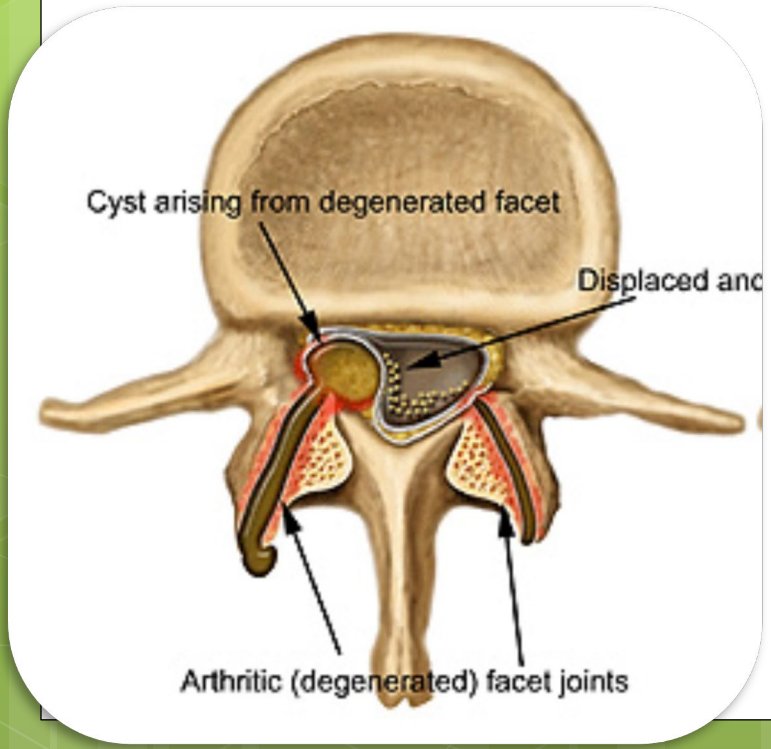


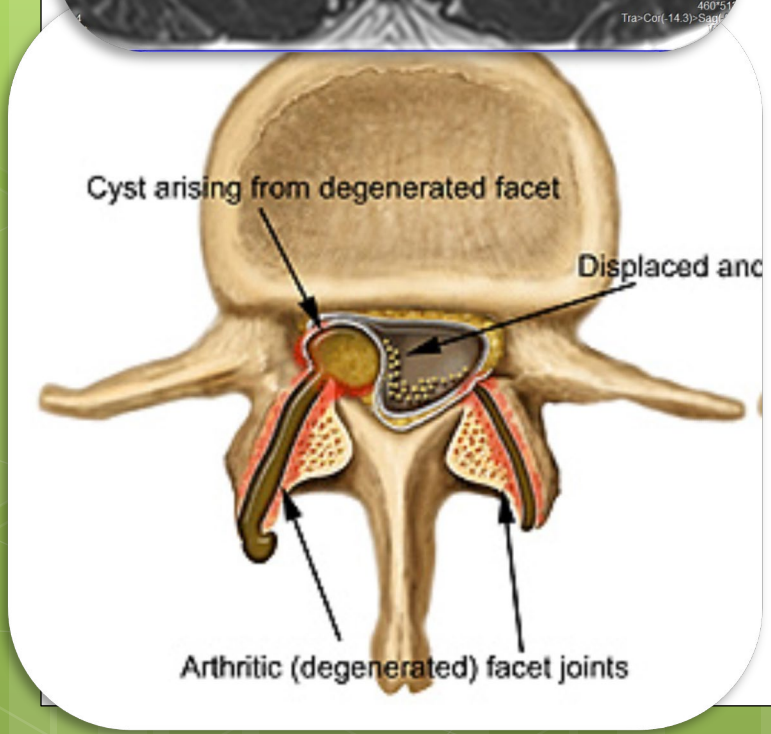

Cyst arising from degenerated facet
Displaced and irritated nerves
Arthritic (degenerated) facet joints
Arthritic (degenerated) facet joints

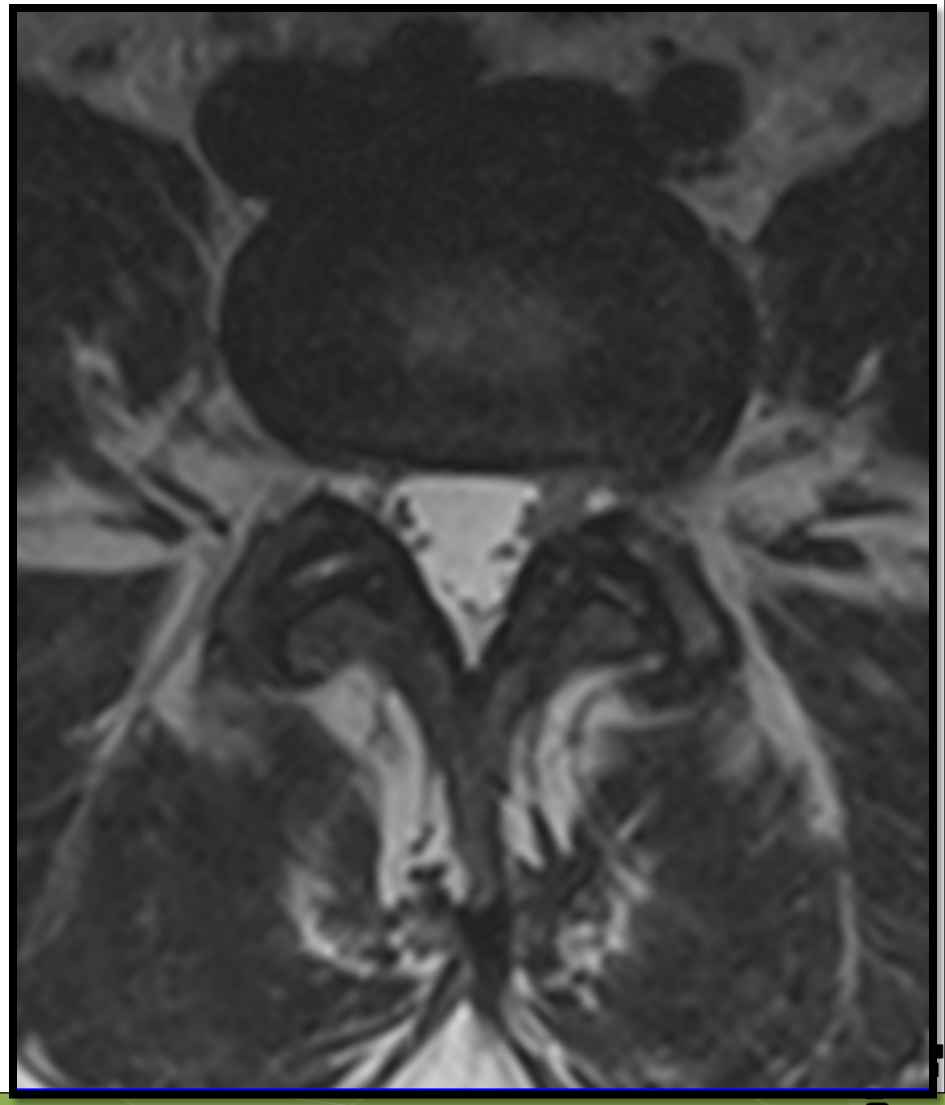
PROLIFE

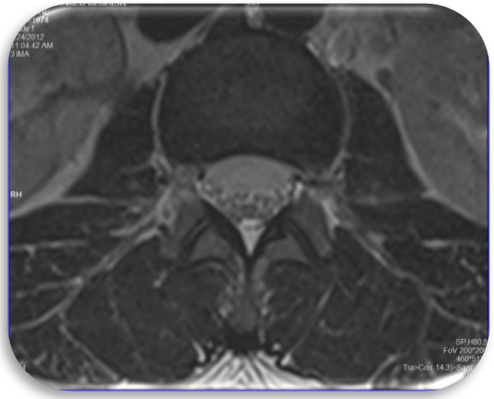
Apophyseal Joint

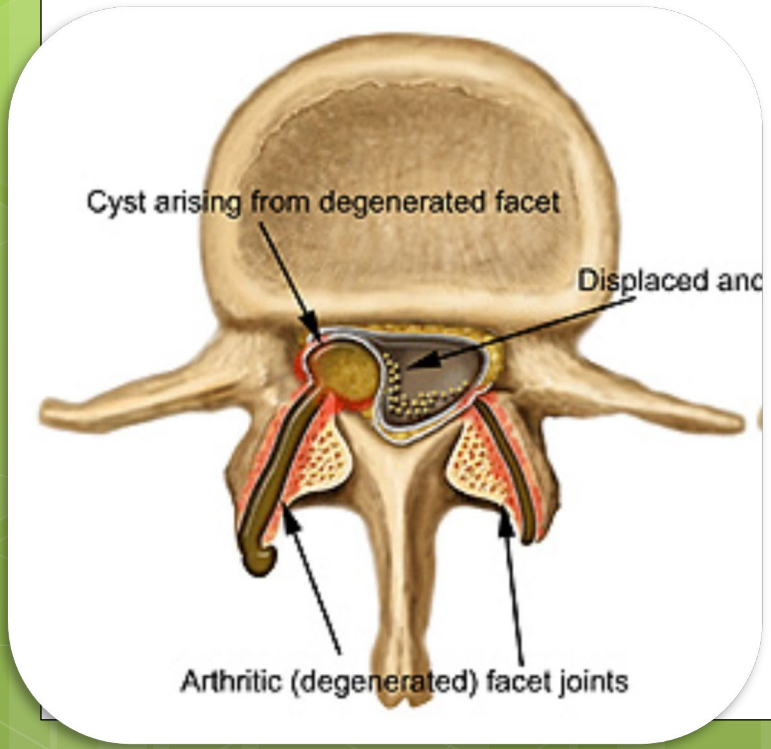


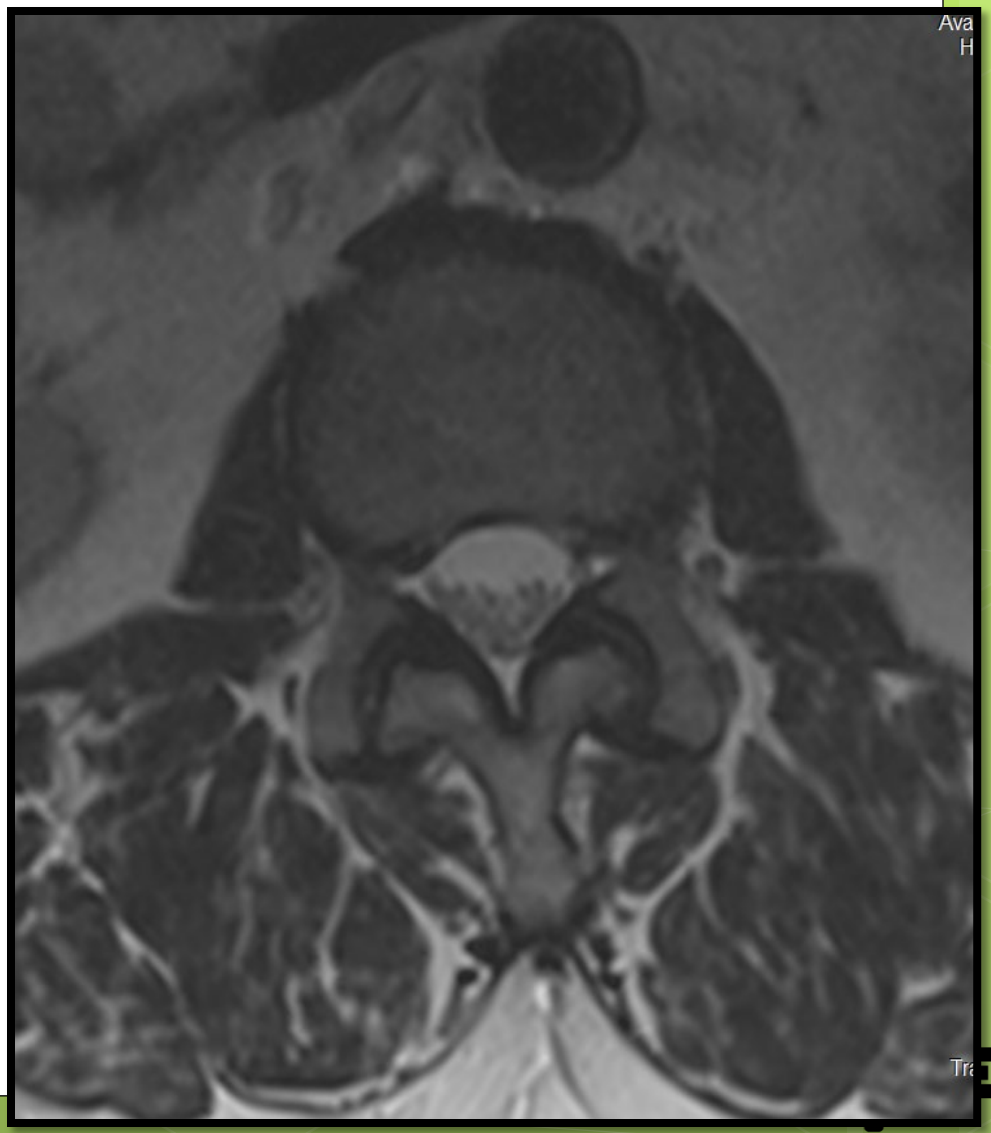



Cyst arising from degenerated facet
Displaced anc
Arthritic (degenerated) facet joints

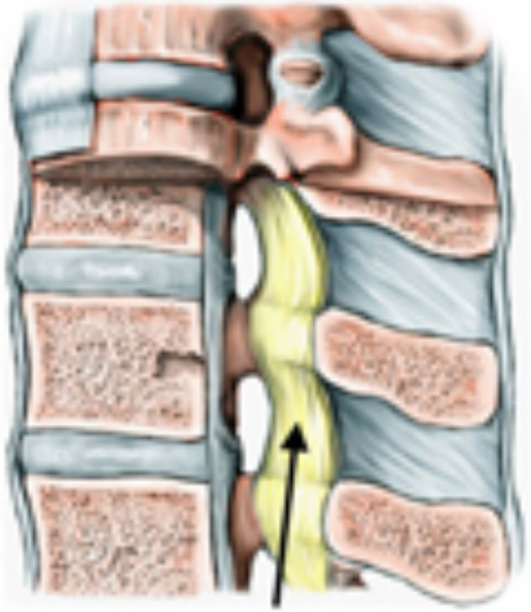




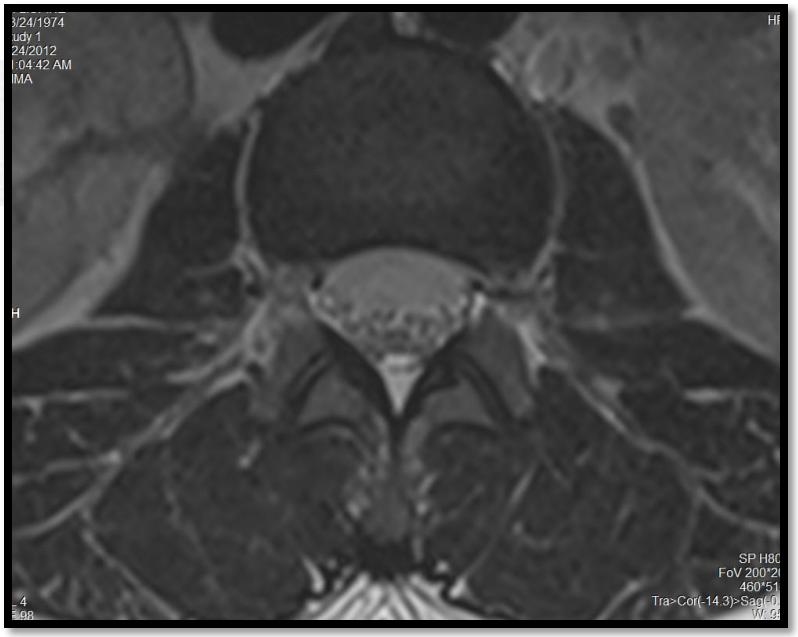

Cyst arising from degenerated facet
Displaced anc
Arthritic (degenerated) facet joints




ID: L SPINE
* 3/24/1974
Study 1
3/24/2012
11:04:42 AM
3 IMA
Avanto
HFS
RH
SP H80.5
FoV 200*200
460*512
Tra>Cor(-14.3)>Sag(-0.0)
W: 955
C: 336
SL 4
TE 98
TR 3500


Ligamentum
Flavum

PROLIFE


/24/1974
udy 1
24/2012
:04:42 AM
IMA
H
SP H80
FoV 200*2
460*51
Tra>Cor(-14.3)>Sag(-0
4

PROLIFE


thickening of
ligamentum flavum
from degeneration
normal
thickened

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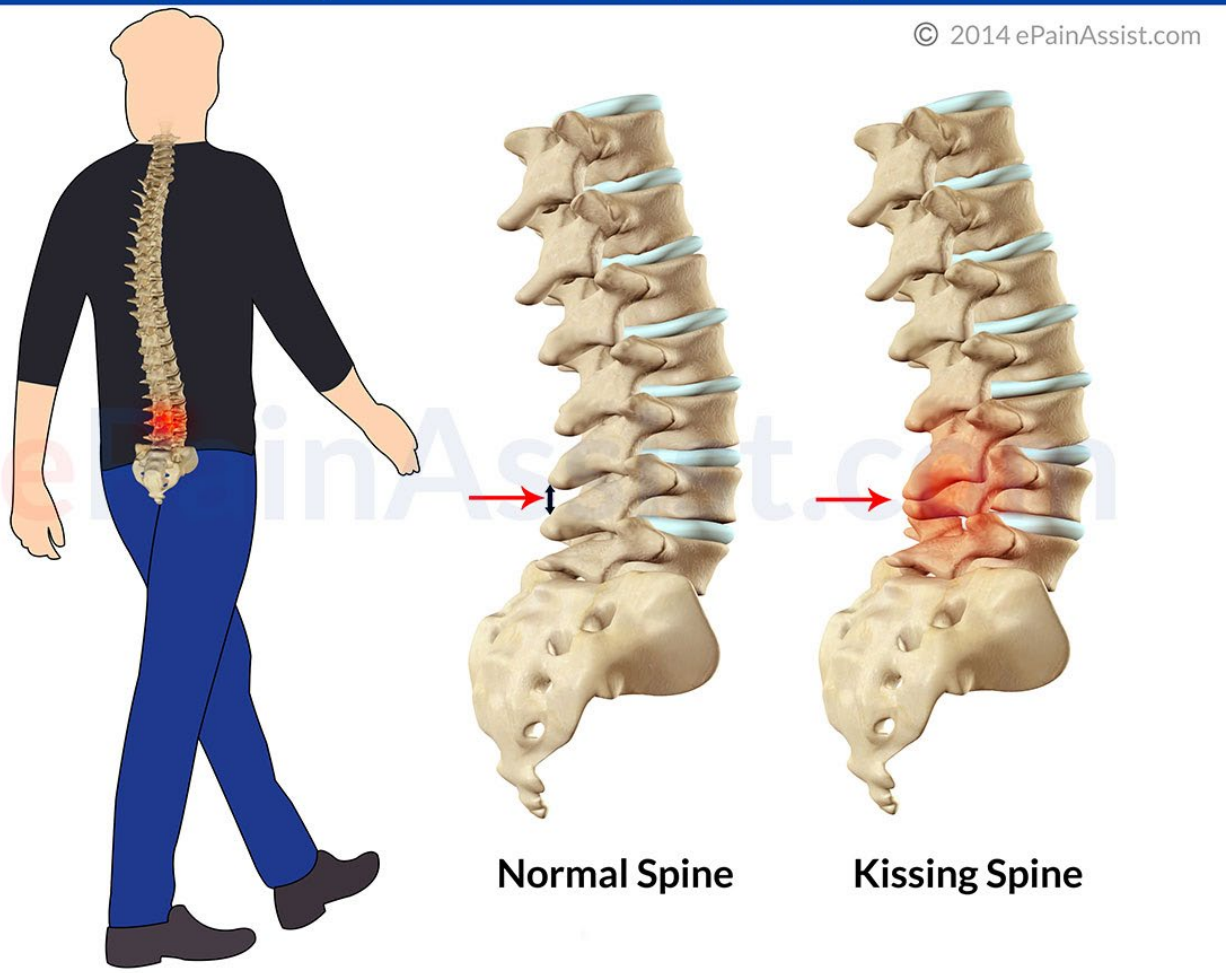
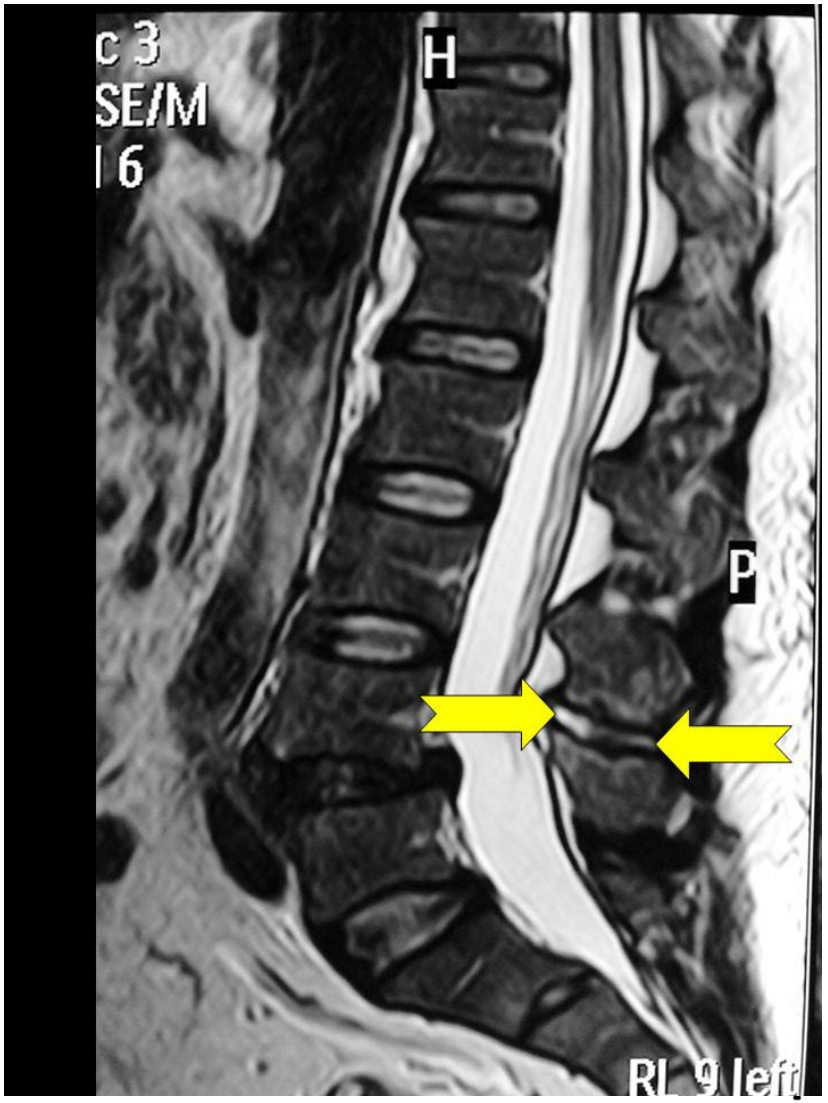
Posterior Spinous Processes (Baastrup's Disease)

- Associated with lordosis, facet degenerative joint disease, disk degeneration
  - Breakdown of interspinous ligaments
  - Bursae form between spinous processes (high signal on T2)
  - Decreased space between spinous processes

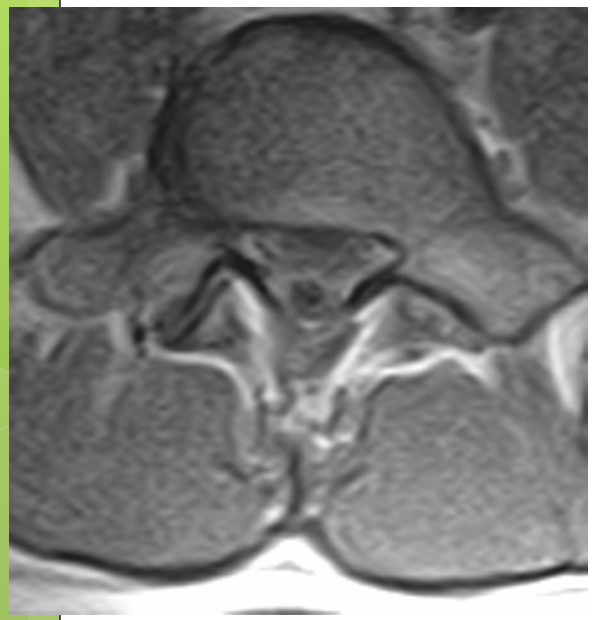
- Spinous processes in contact
  - Subcortical sclerosis, cysts
  - Faceted appearance
  - Osteophytes

Baastrup Syndrome or Kissing Spine Syndrome

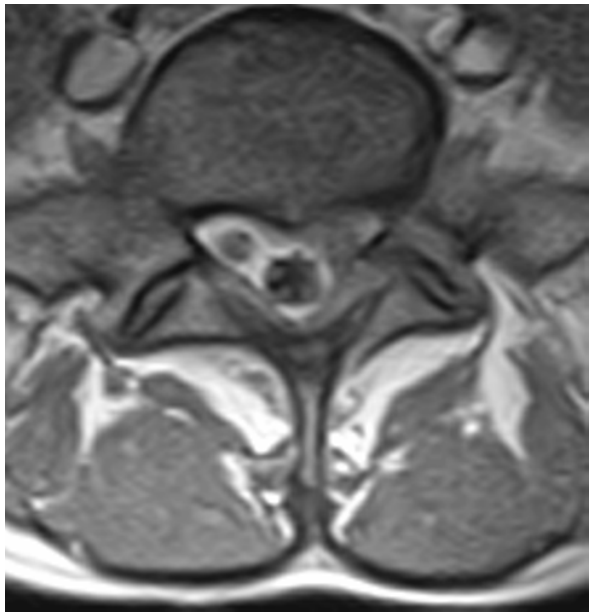




Fatty Infiltration of Multifidus



Grade 0



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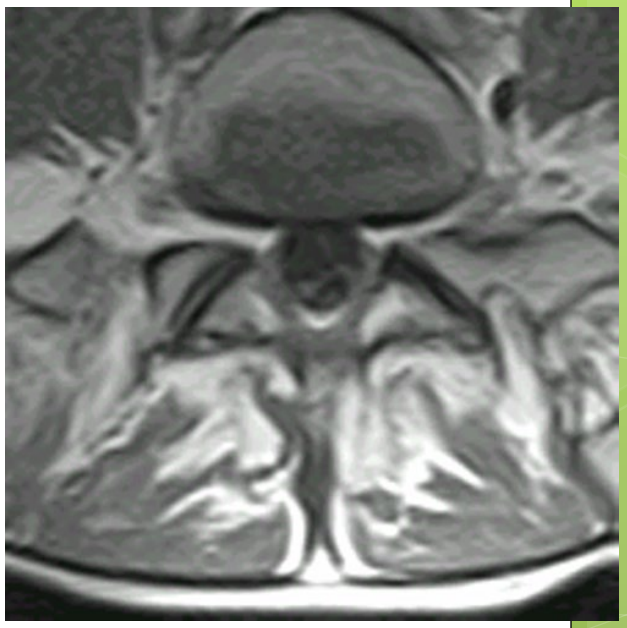
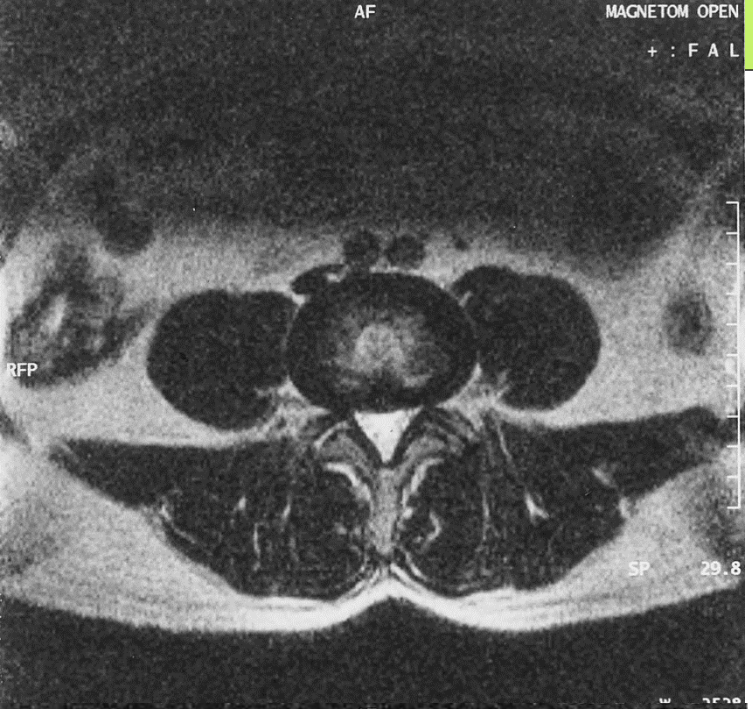
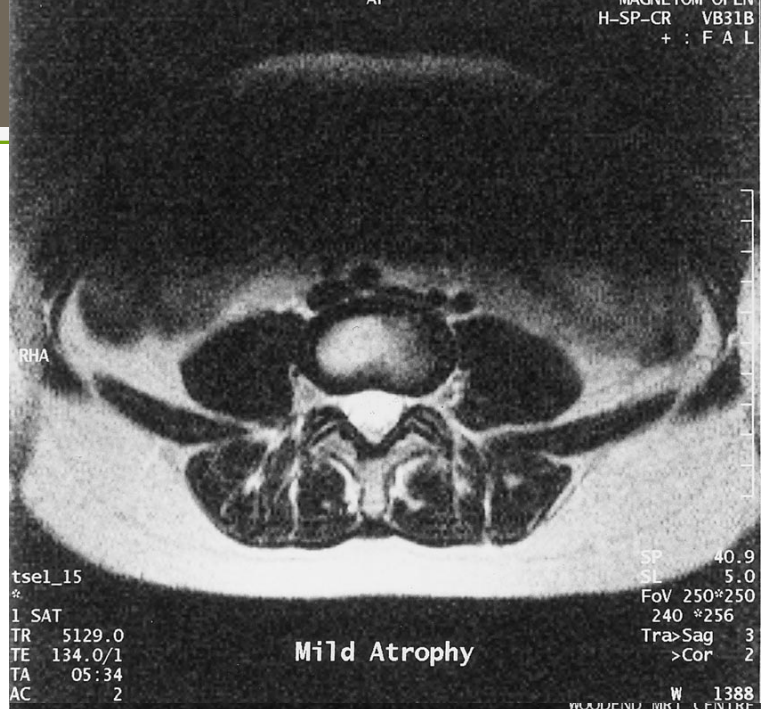


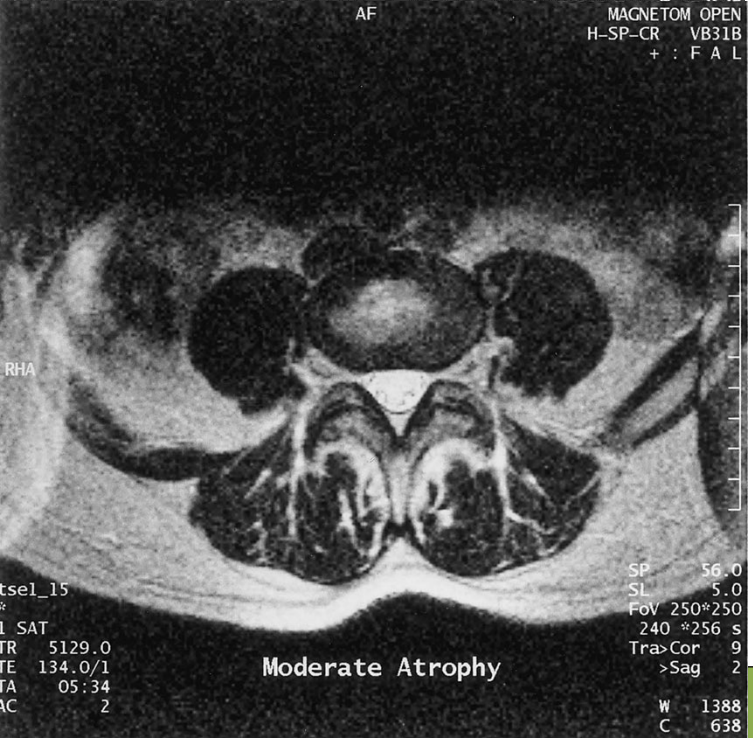
Grade 2

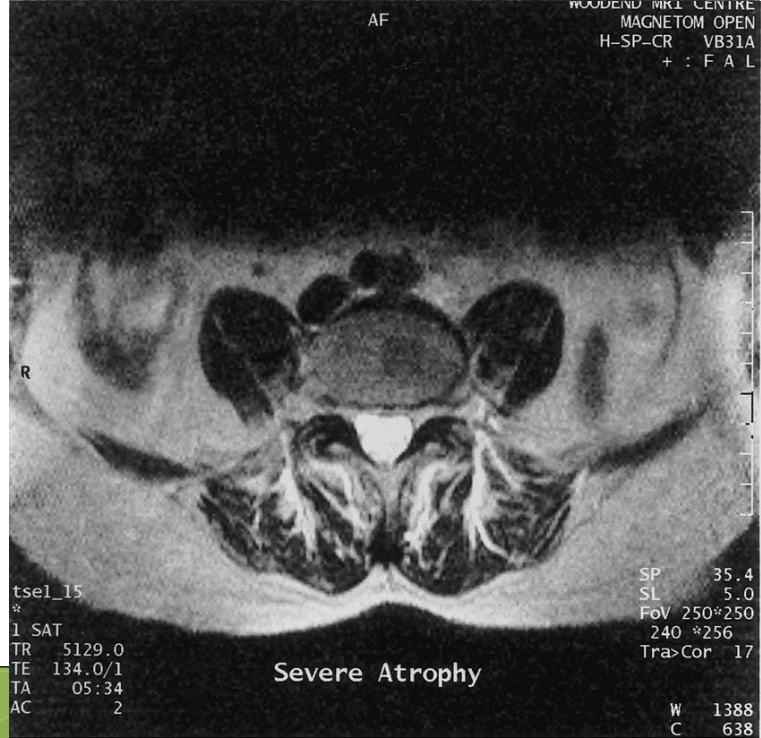
PROLIFE

Atrophy of Multifidus









SPINAL STENOSIS

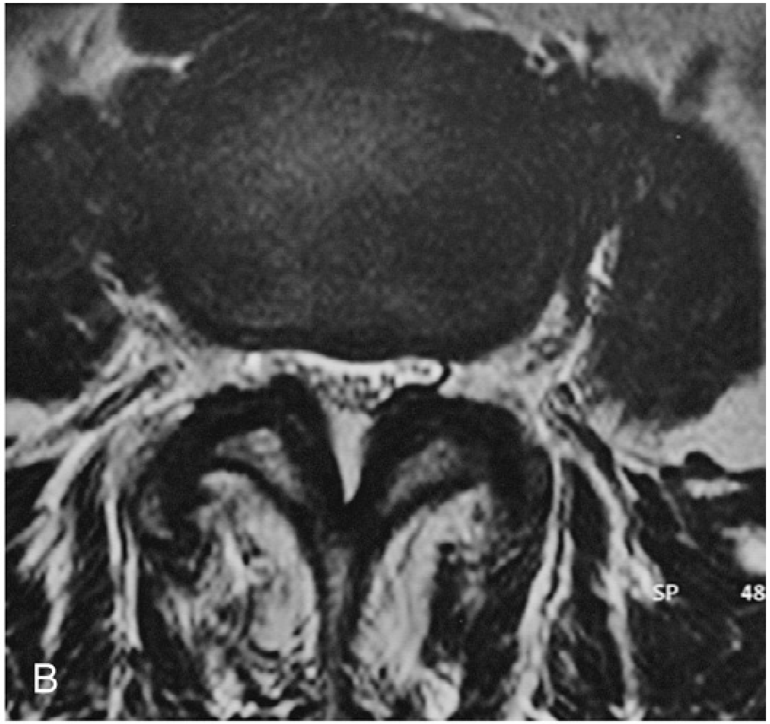
Spinal Stenosis

- **Sites of Involvement**
  - Central canal
  - Neural foramina
  - Lateral recesses

- **Complications**
  - Pain symptoms
  - Cord myelomalacia from ischemia
  - Nerve root edema

Causes

- Degenerative
- Disc contour abnormalities (bulges, herniations)
- Vertebral body osteophytes
- Degenerative spondylolisthesis
- Facet joint degeneration, osteophytes, synovial cysts
- Ligamentum flavum buckling
- Congenital short pedicles
- Usually requires superimposed degeneration to be symptomatic
- Any mass arising from bone, Disc, or within canal
- Ossification of posterior longitudinal ligament



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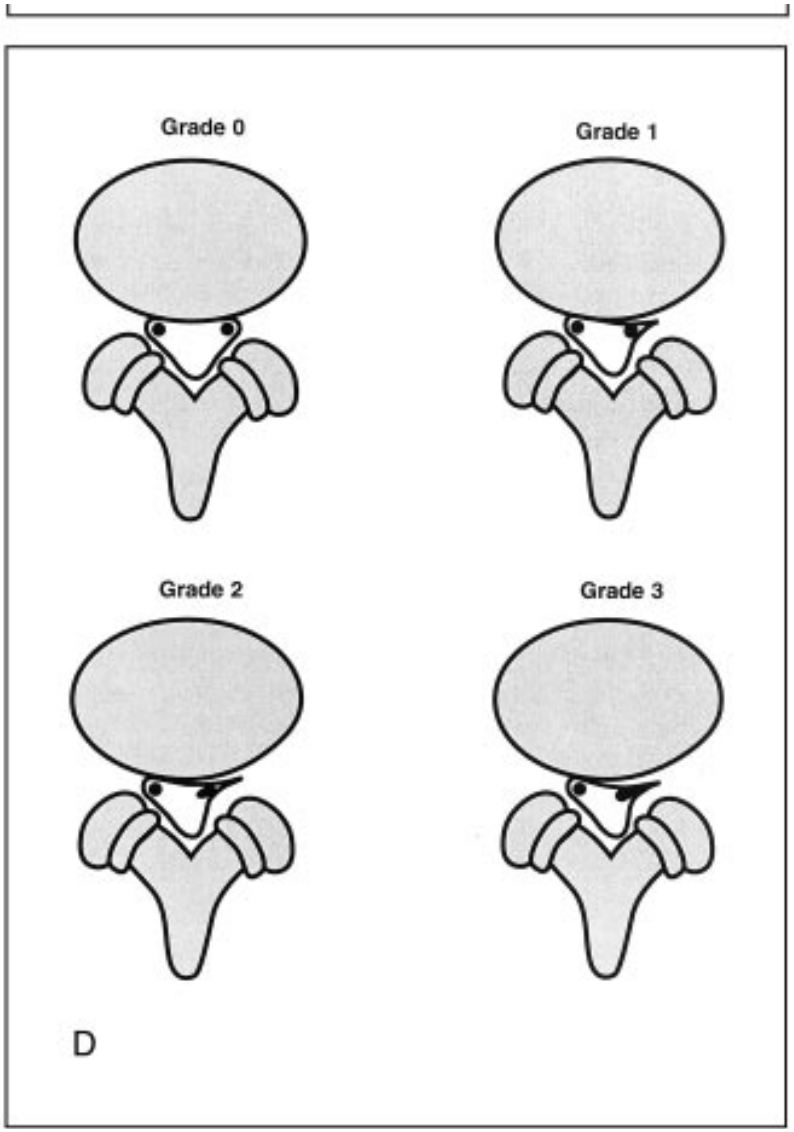
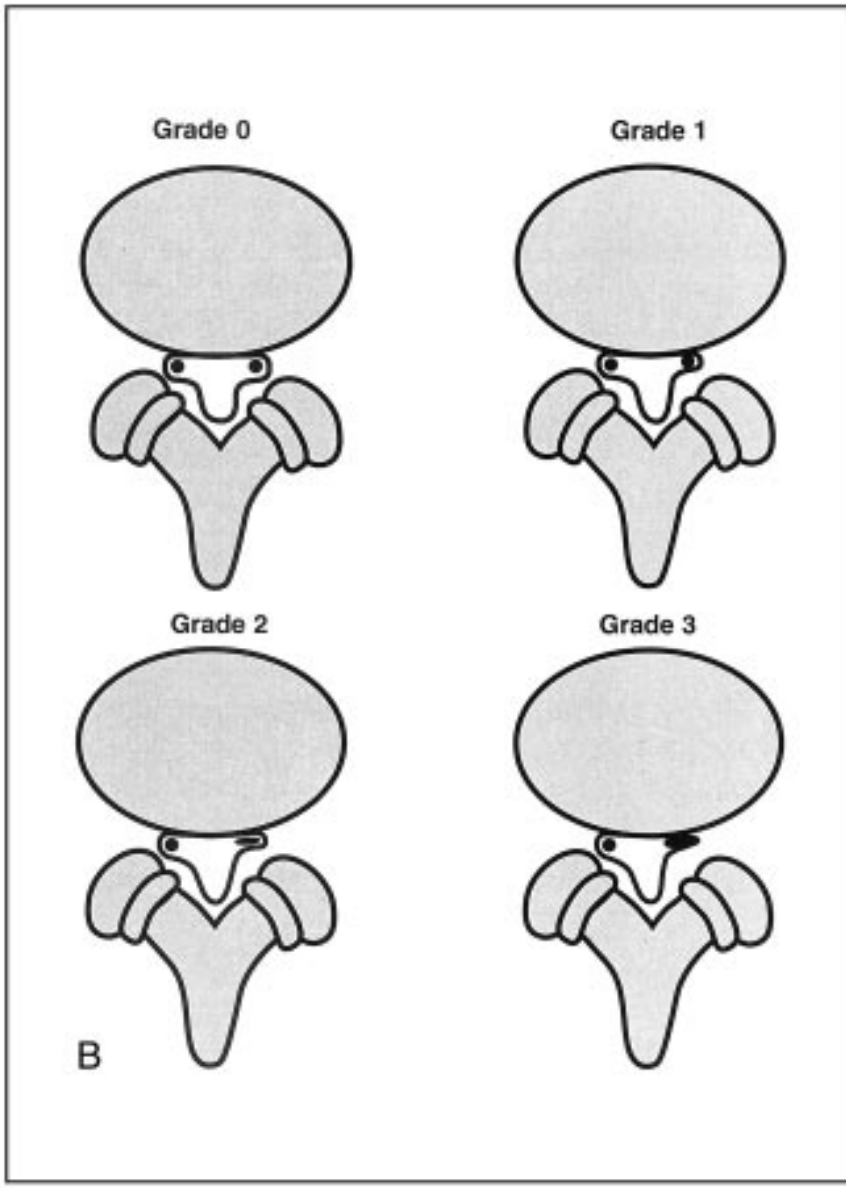
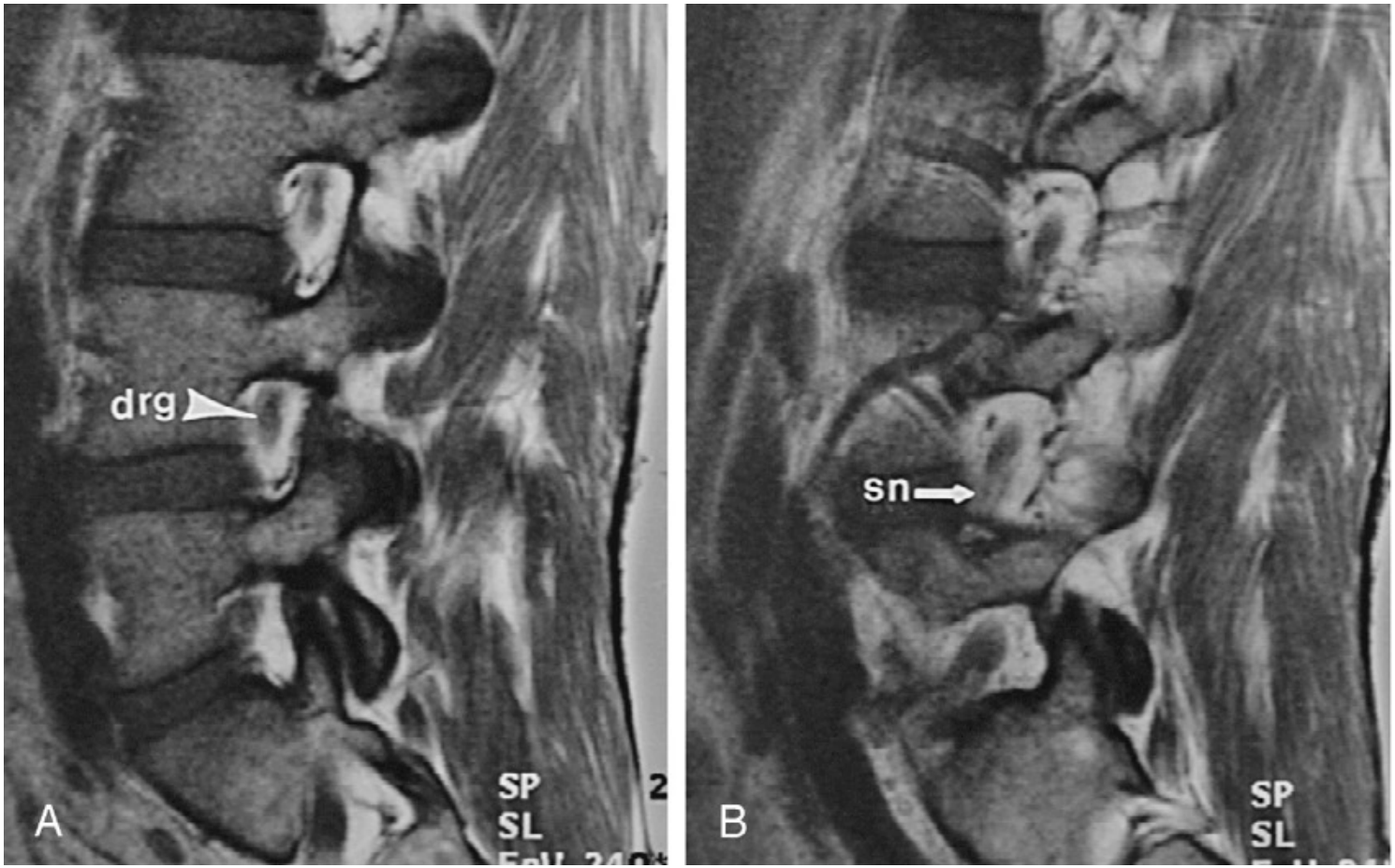
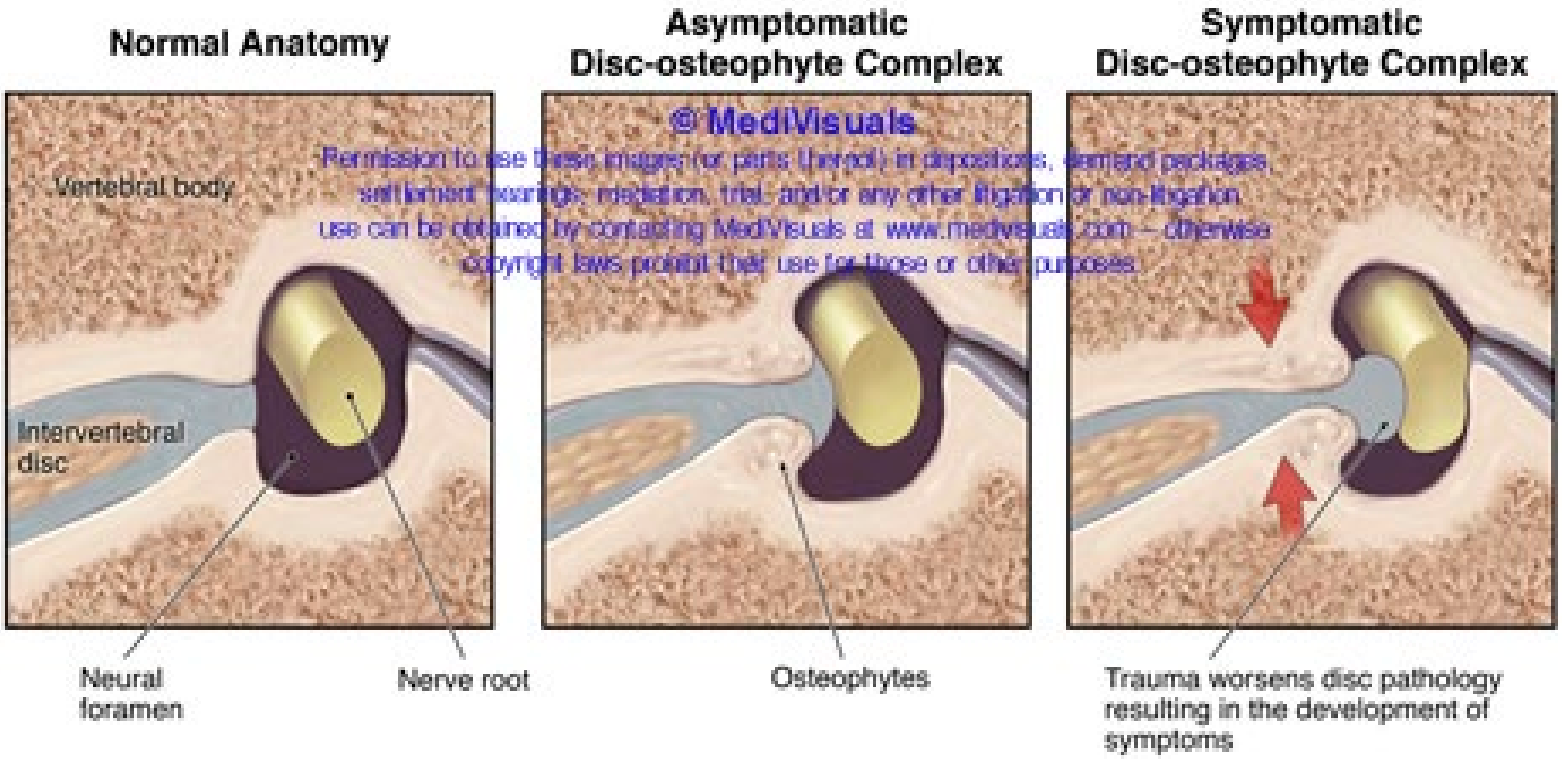




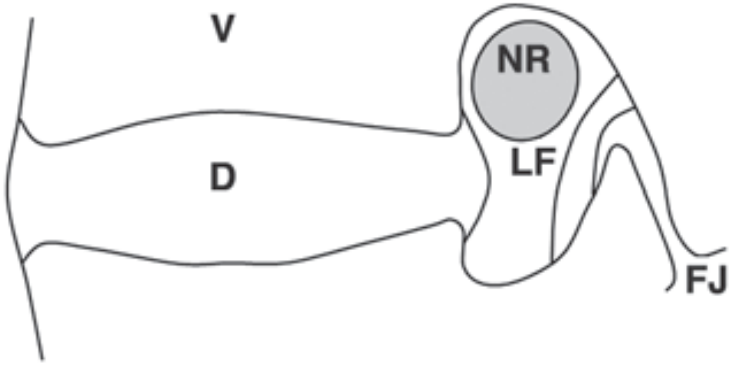

drg
A
SP
SL
sn
B
SP
SL

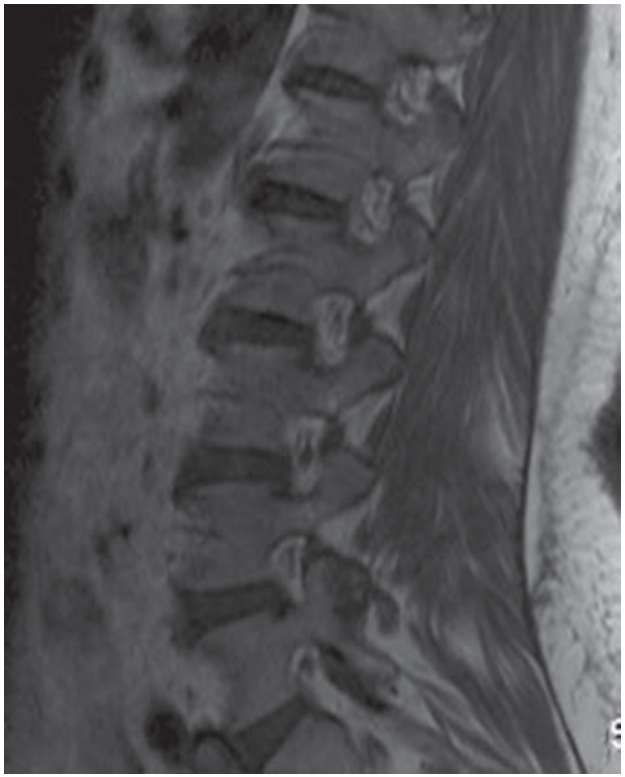


PROLIFE

A Practical MRI Grading System for Lumbar Foraminal Stenosis

κ value = 0.8 – 1.0

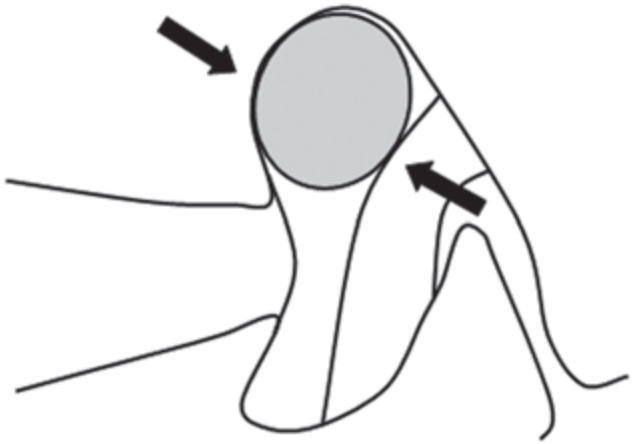


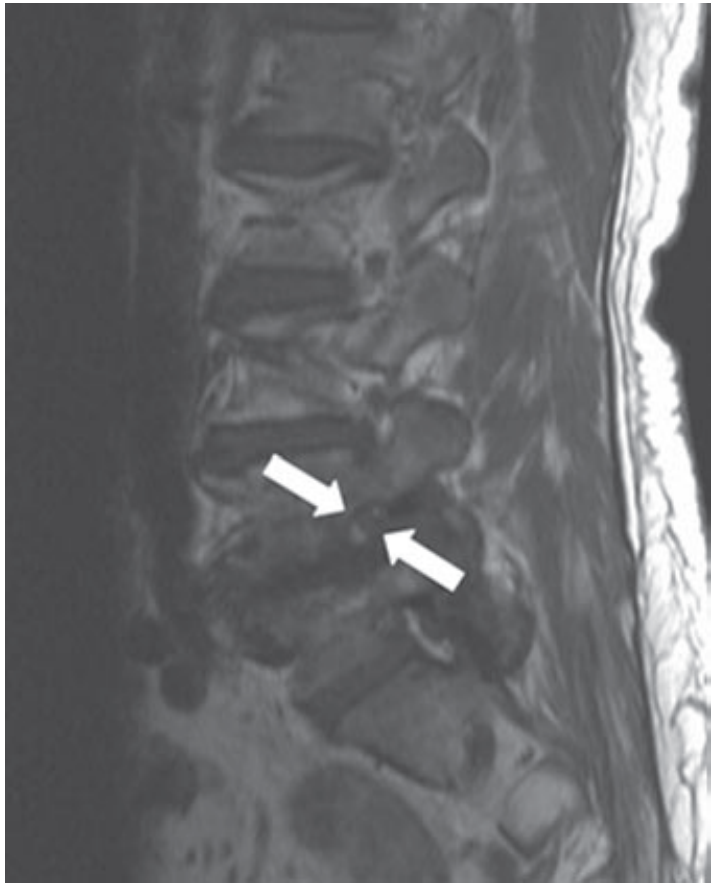


Lee et al. 2010

Grade 1 (mild degree of foraminal stenosis)

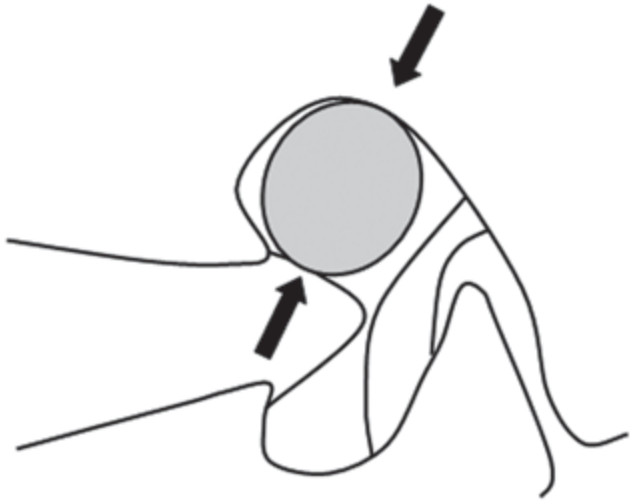
Slight foraminal stenosis and deformity of the epidural fat, with the remaining fat still completely surrounding the exiting nerve root

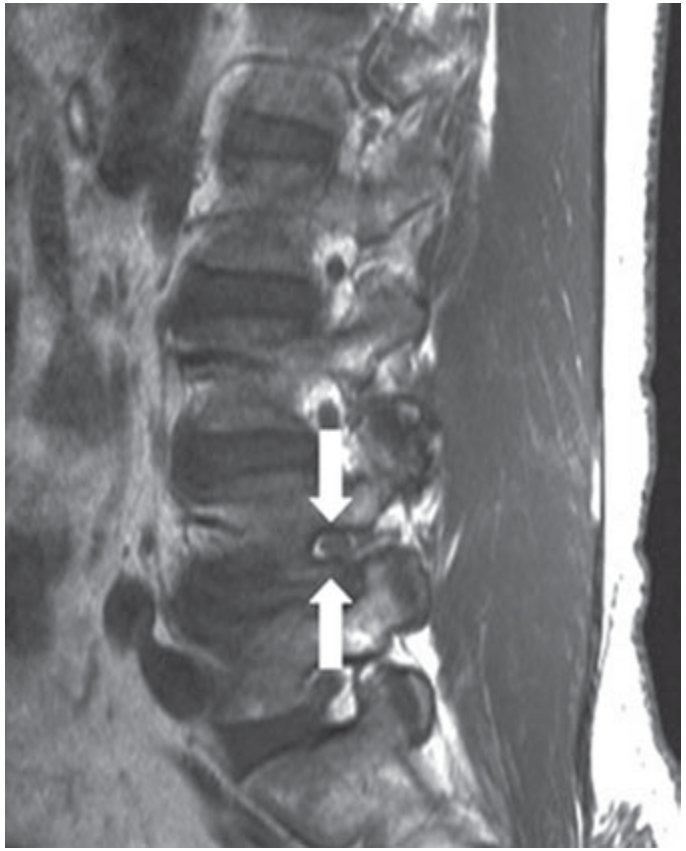




Lee et al, 2010

Grade 1 (mild degree of foraminal stenosis)

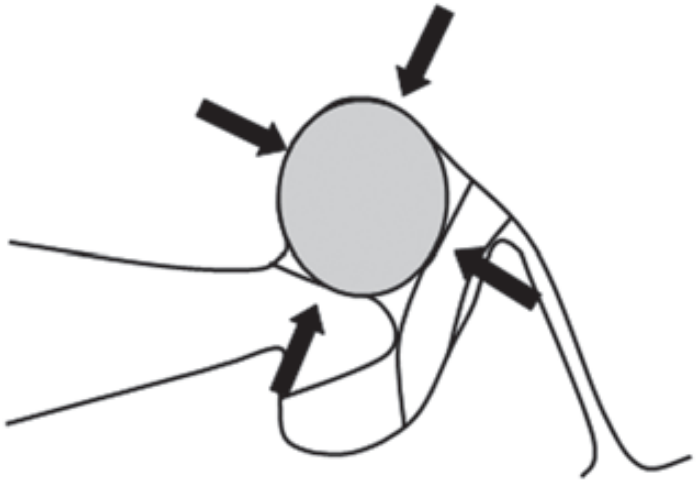




Lee et al. 2010

Grade 2 (moderate degree of foraminal stenosis)

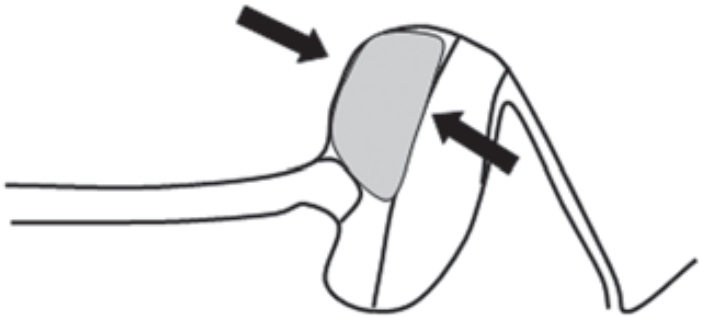
Marked foraminal stenosis with epidural fat only partially surrounding the nerve root



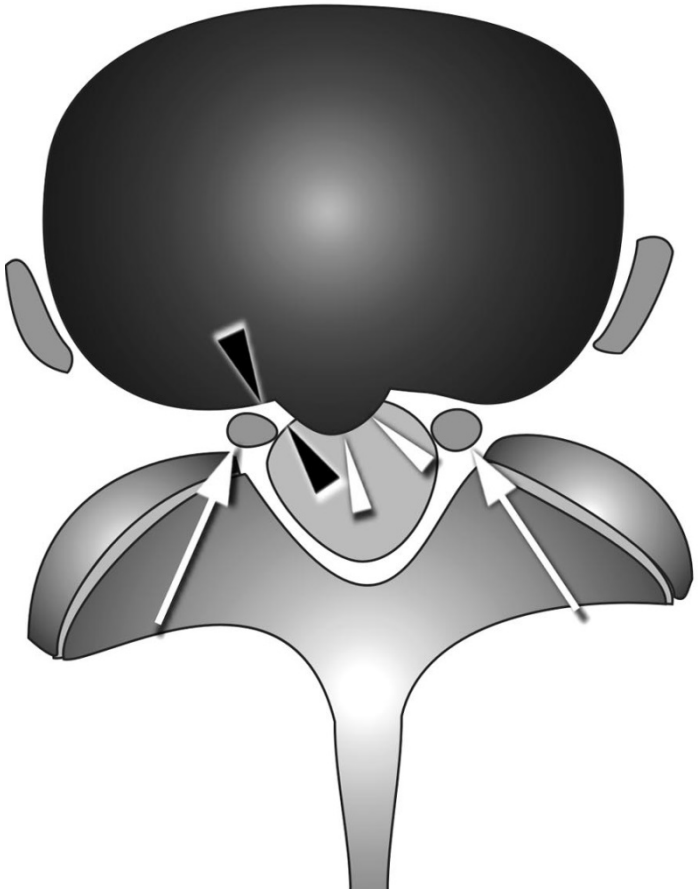
Lee et al, 2010

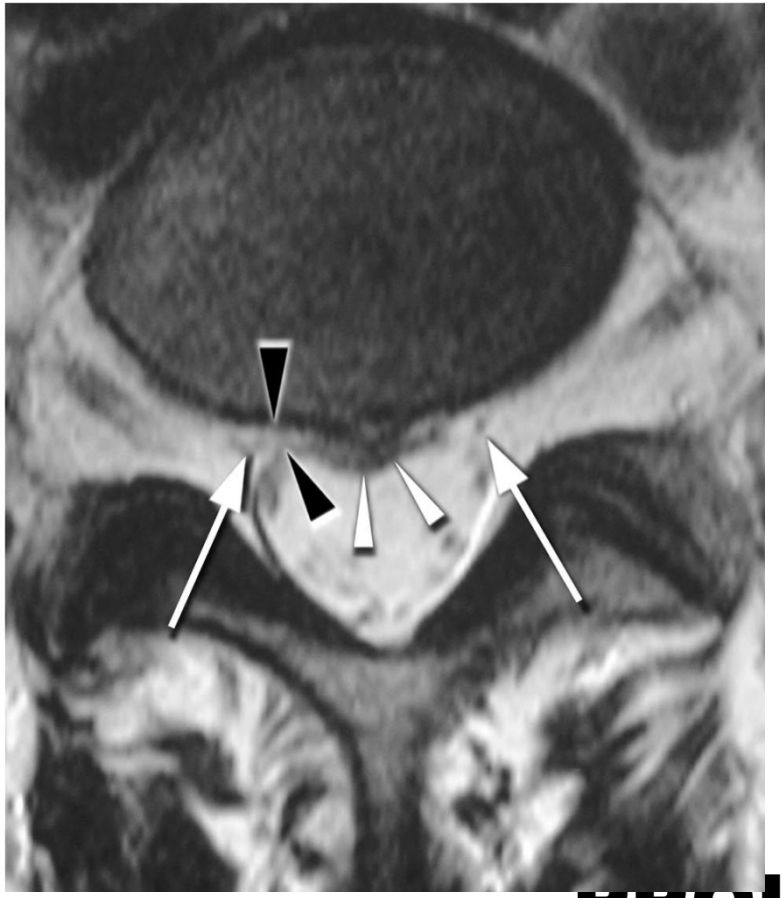
Grade 3 (sever degree of foraminal stenosis)

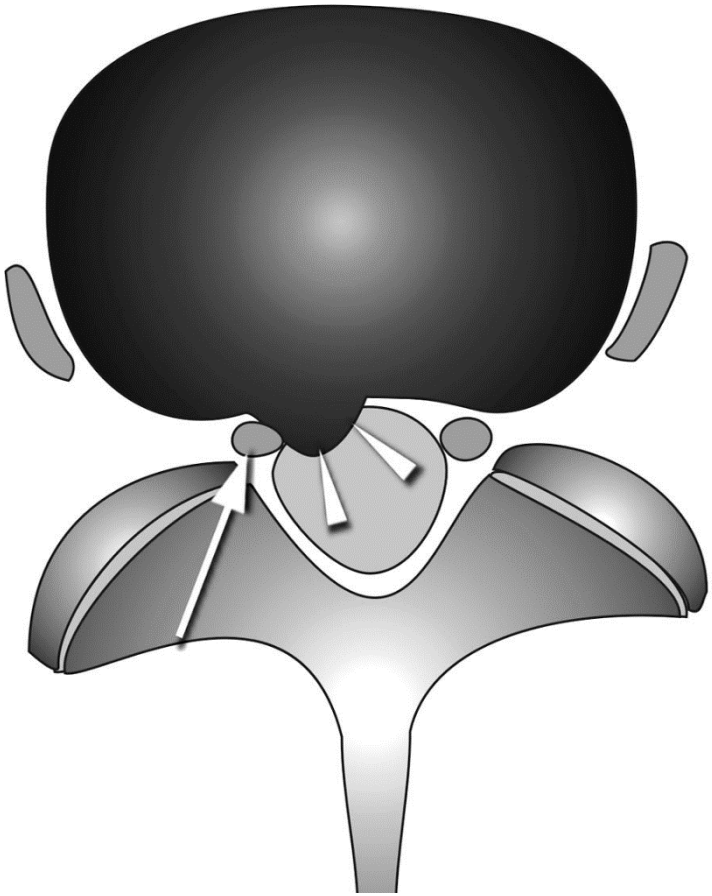
Advanced stenosis with obliteration of the epidural fat

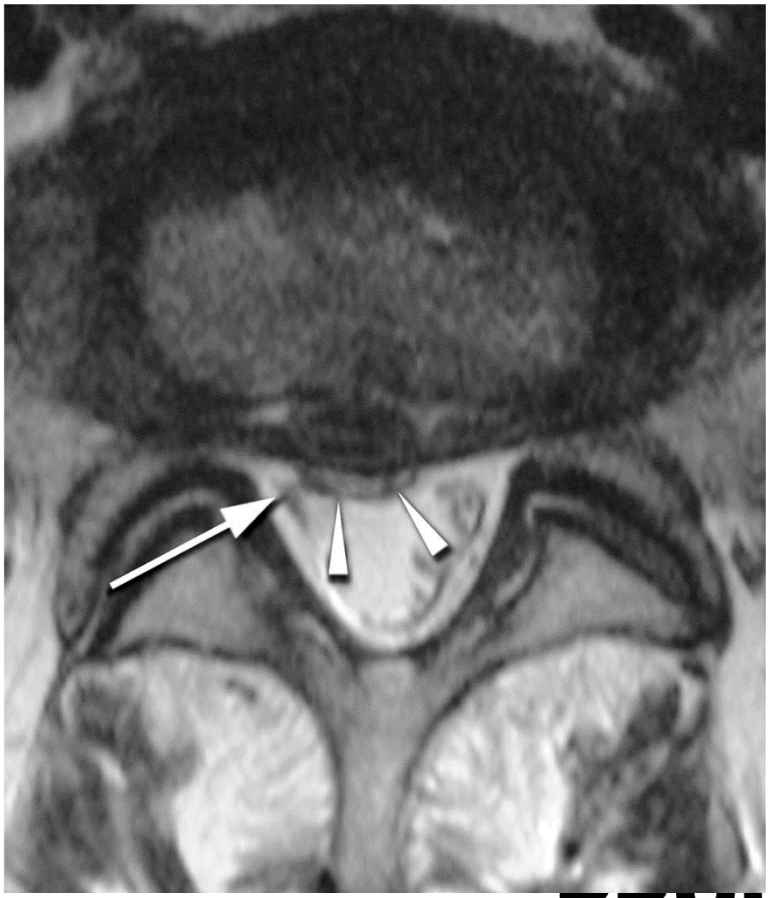


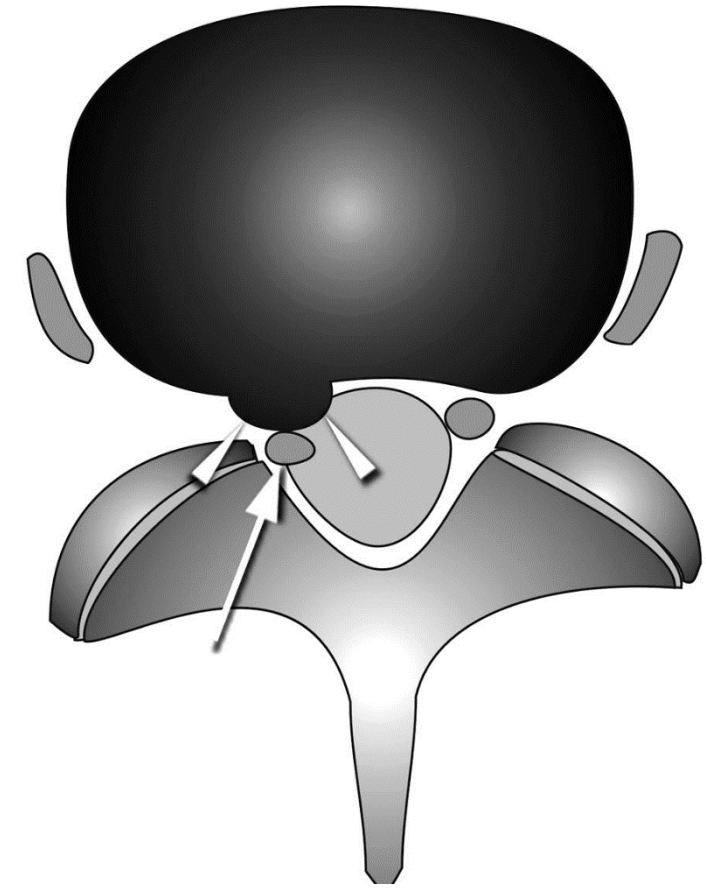
Lee et al. 2010

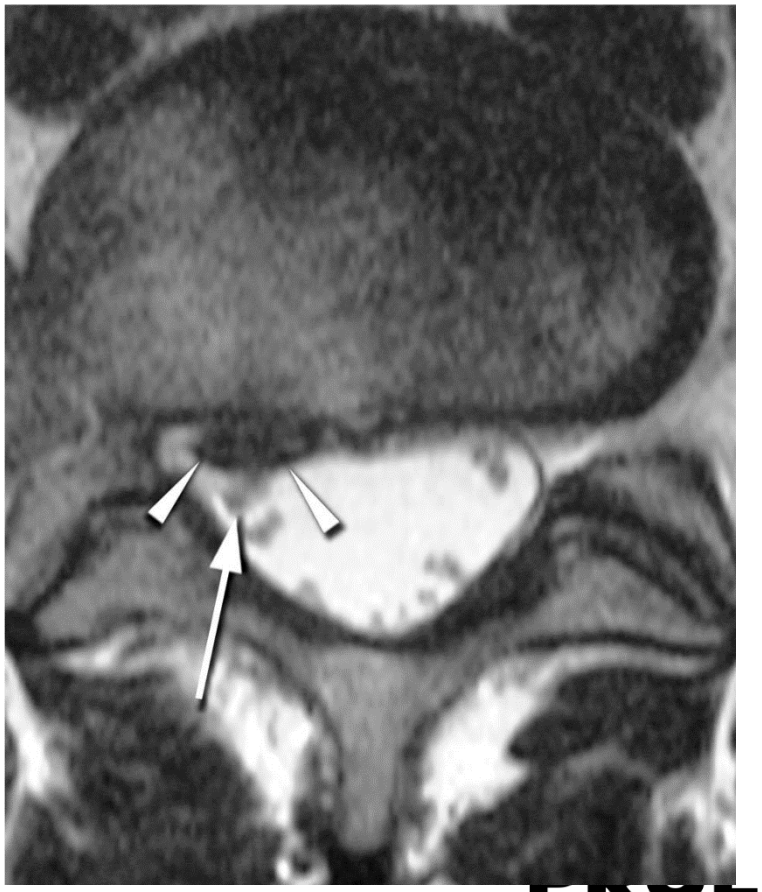


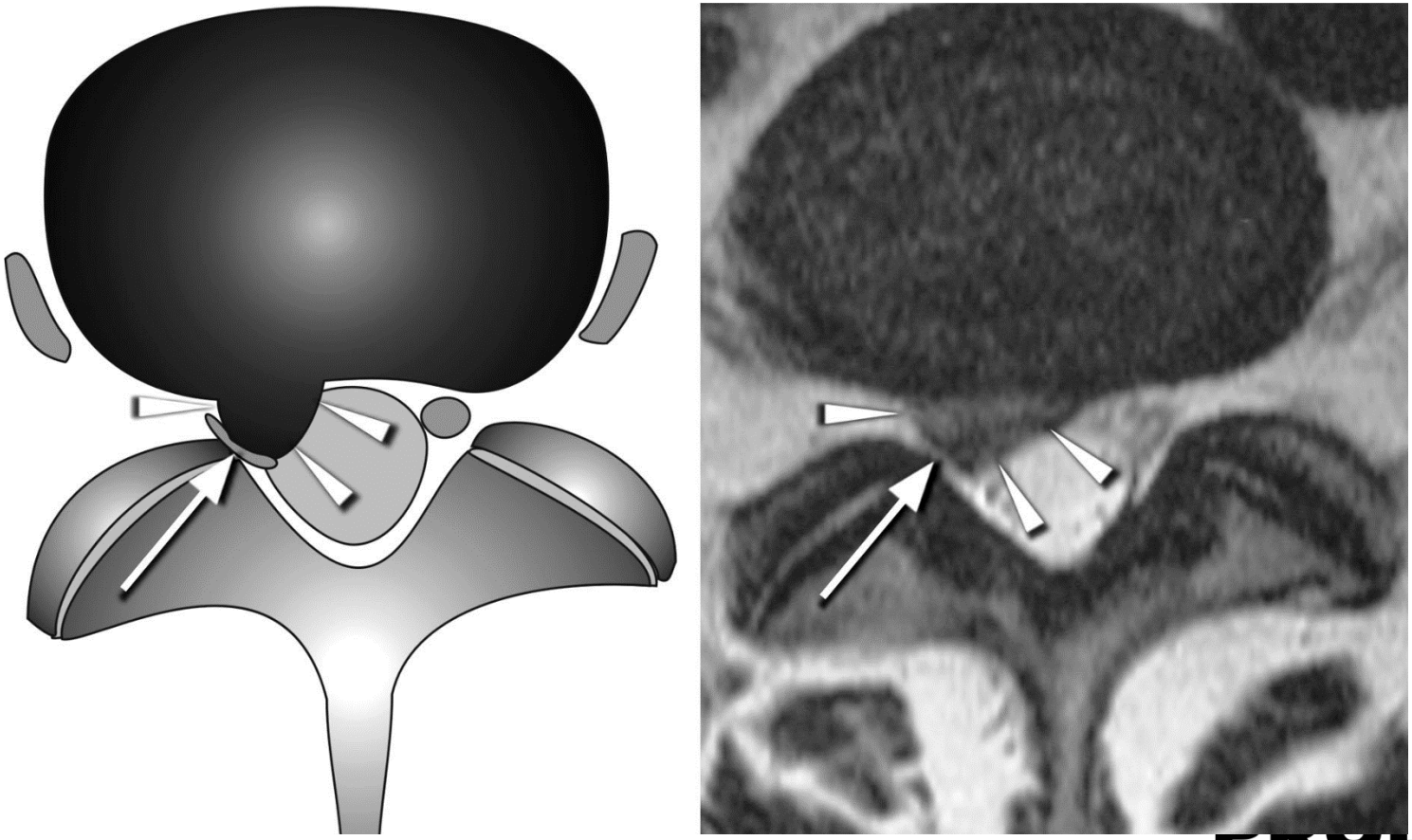


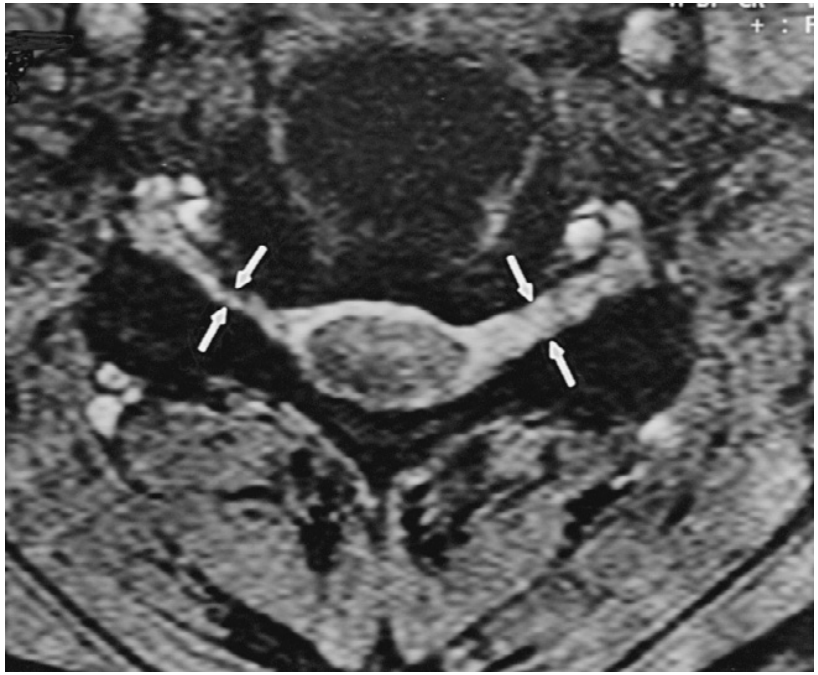












POSTOPERATIVE CHANGES

Postoperative Changes: Uncomplicated

Vertebral Marrow

- Unchanged from before surgery; no enhancement (unless Modic 1 changes are present)

Nerve Roots

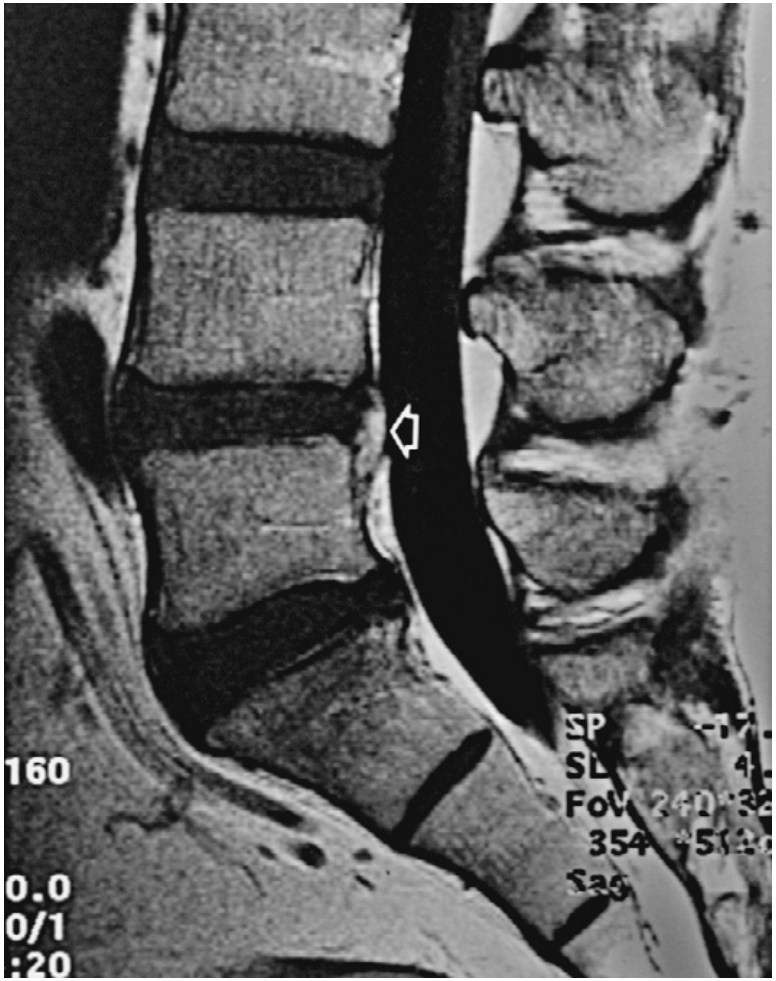
- May enhance for 6 months

Disks

- Contrast enhancement of posterior annulus, and increased signal on T2 for years

Epidural

- Scarring/fibrosis common
- Contrast enhancement of fibrosis for years
- Fibrosis is often nodular, resembling persistent or recurrent disk extrusion
  - Peripheral enhancement may mimic disk extrusion in first 6 months
  - Diffuse enhancement is typical after 6 months, allowing differentiation from disk (peripheral enhancement only)



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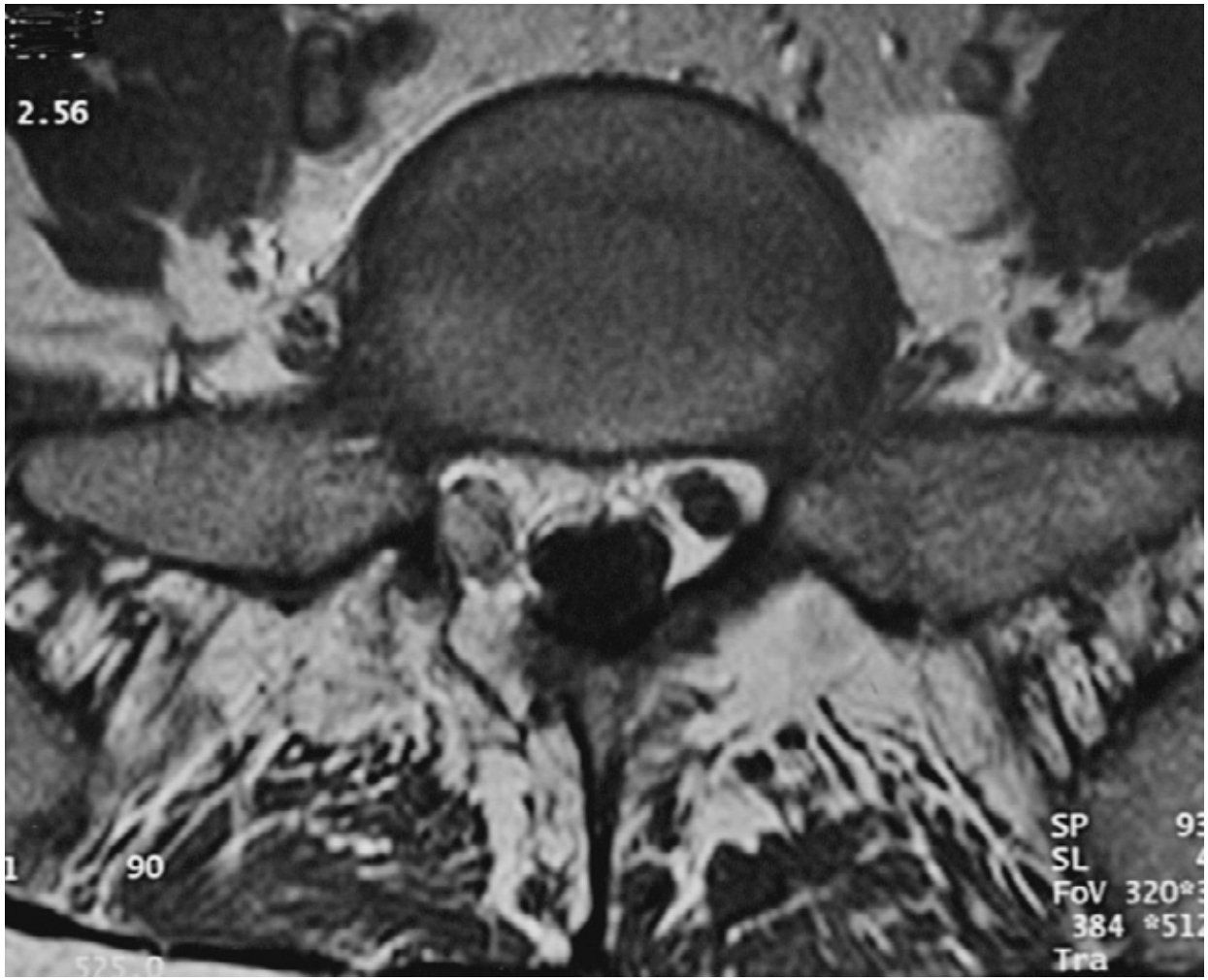
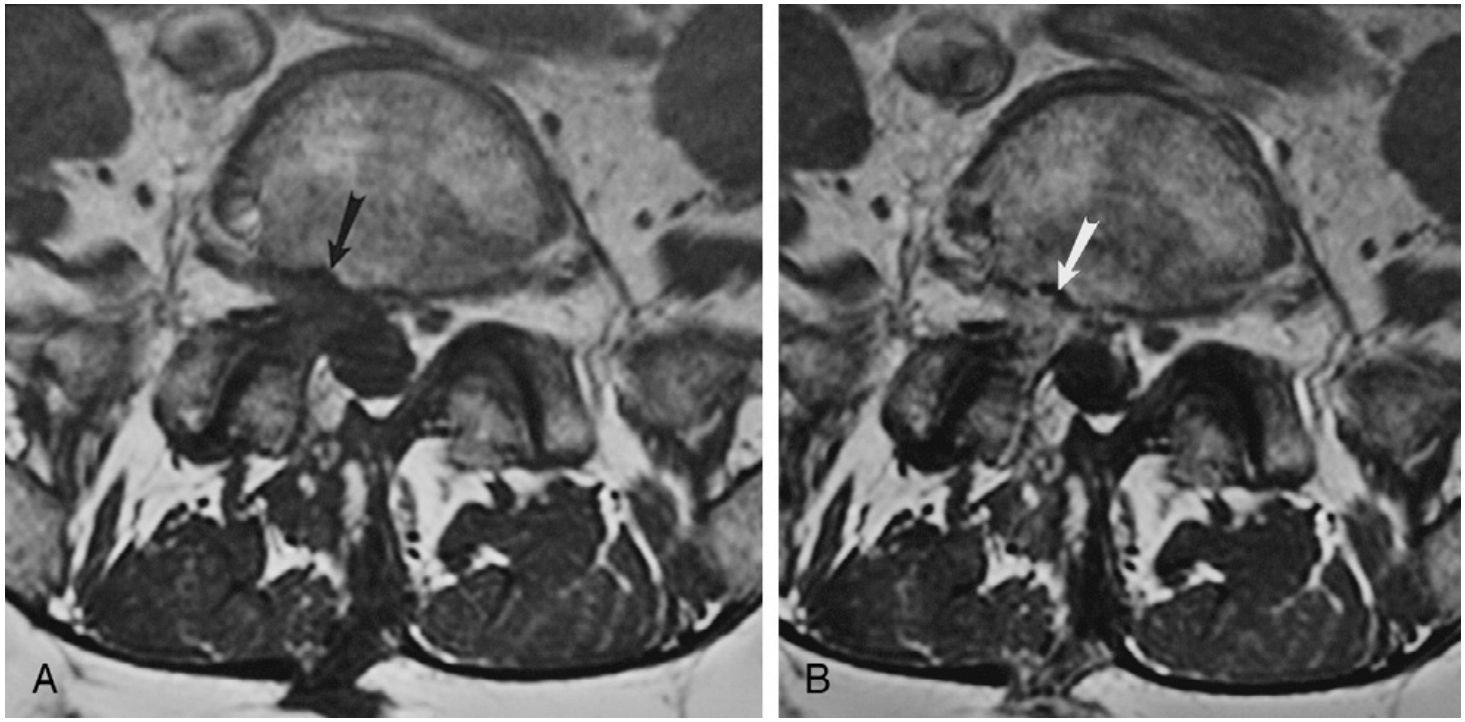
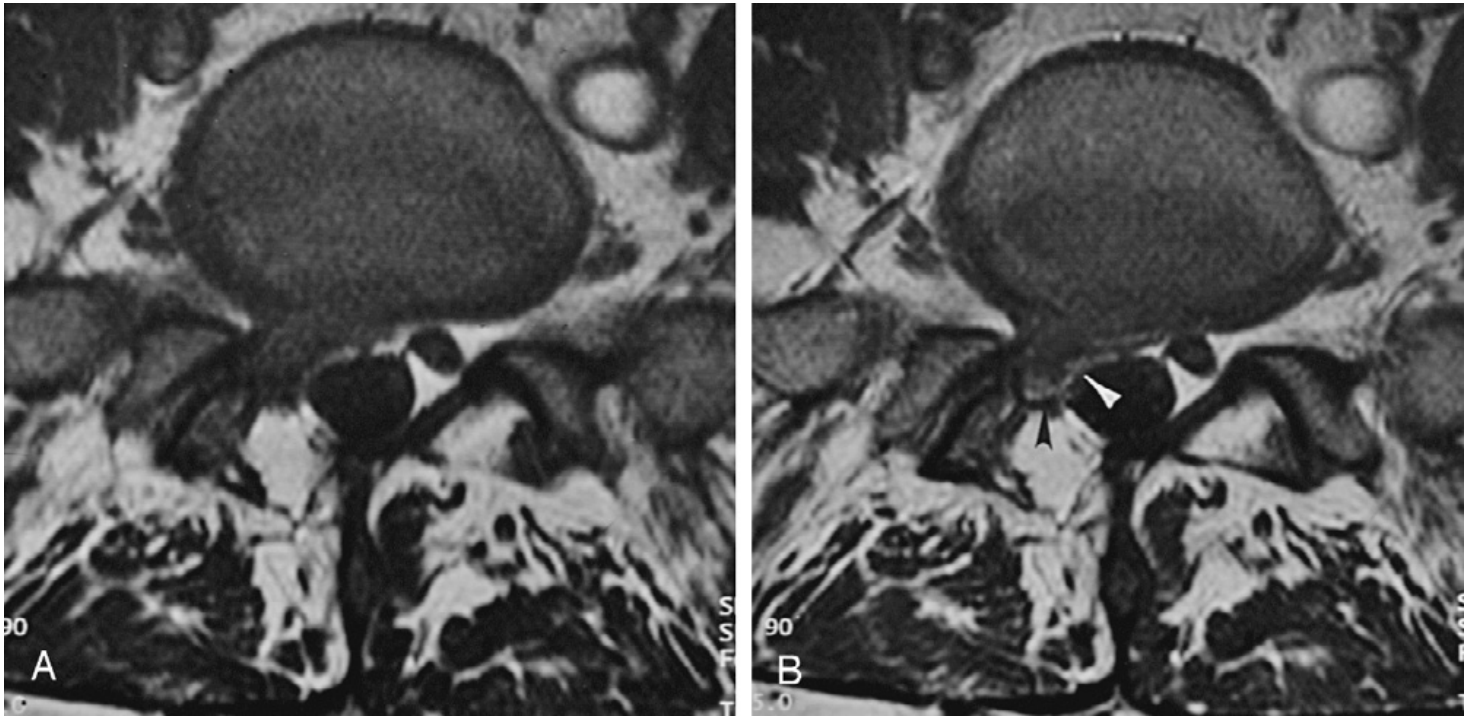






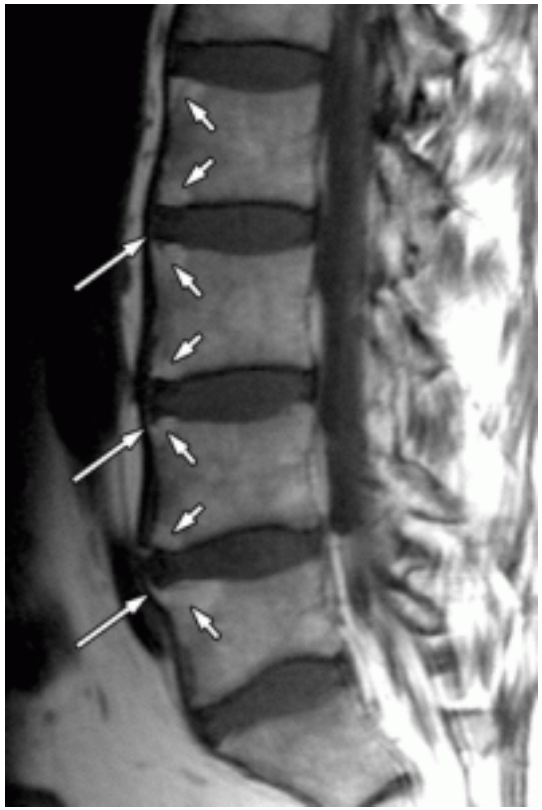
INFLAMATORY CHANGES

Spondylodiscitis

- Classic MRI Triad
  - T1: Low signal vertebral body marrow
  - T1, postcontrast: Marrow enhancement (and possibly Disc)
  - T2: High signal in Disc (and possibly marrow)

- Associated Abnormalities
  - Decreased Disc height
  - Destruction of end plate

Ankylosing Spondylitis



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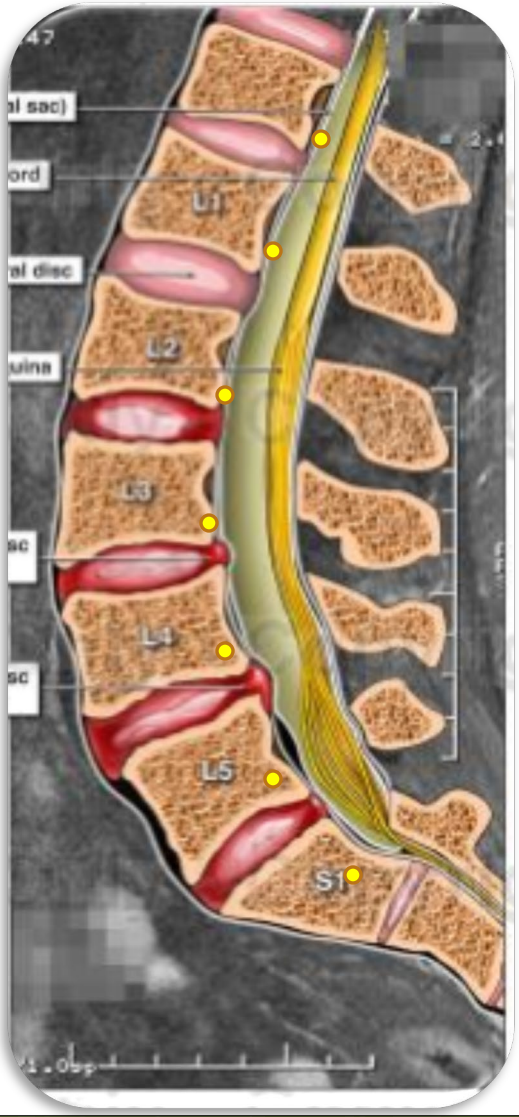
Spondylolisthesis



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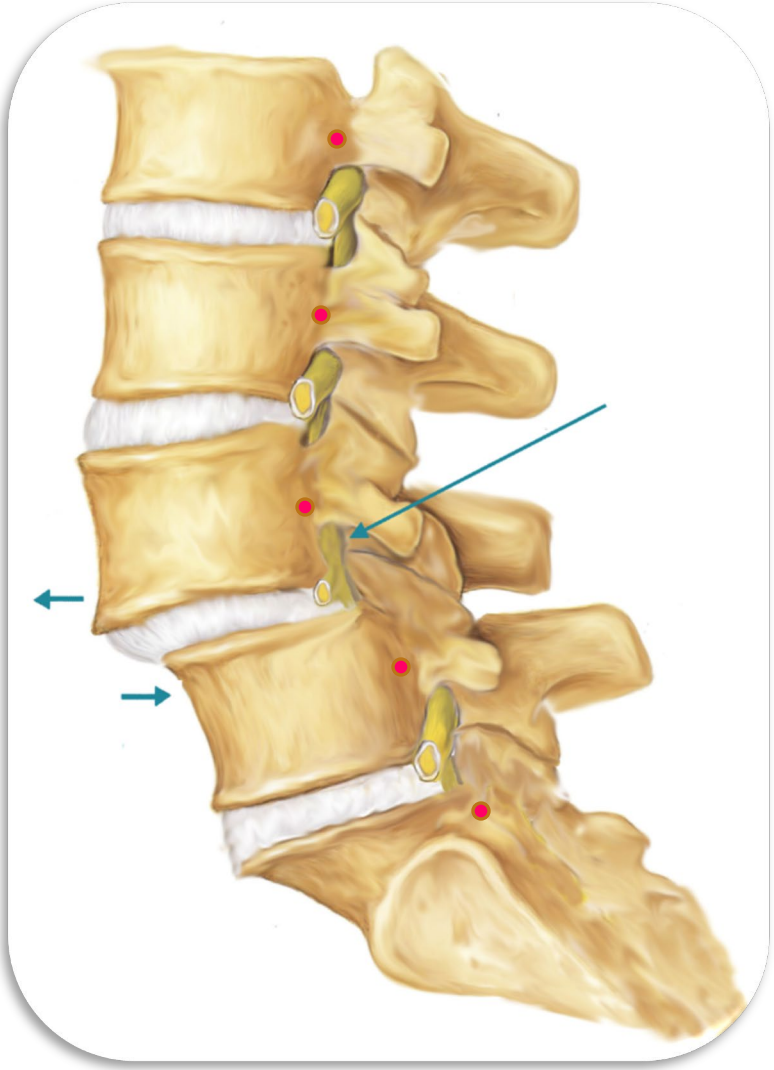

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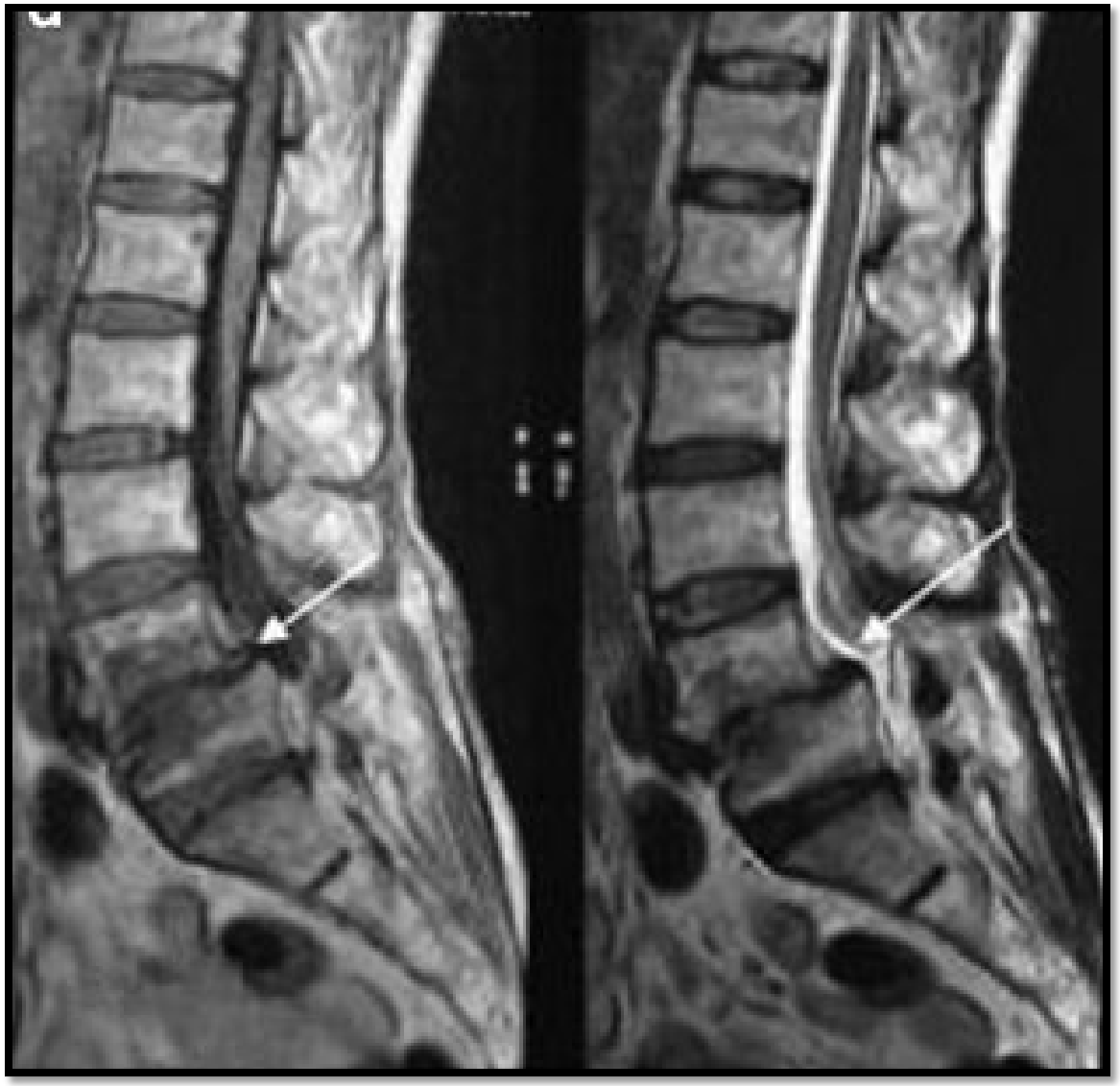

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Spondylolisthesis

1. Lytic
2. Degenerative

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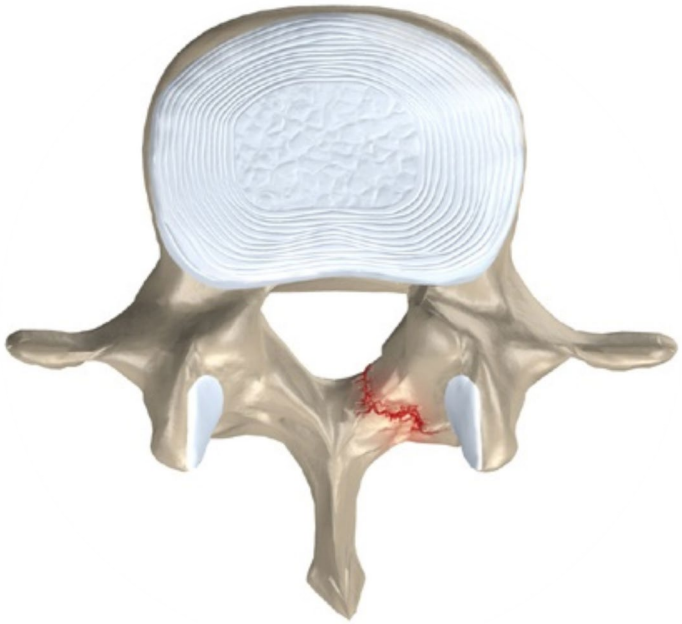
Lytic



Pars interarticularis

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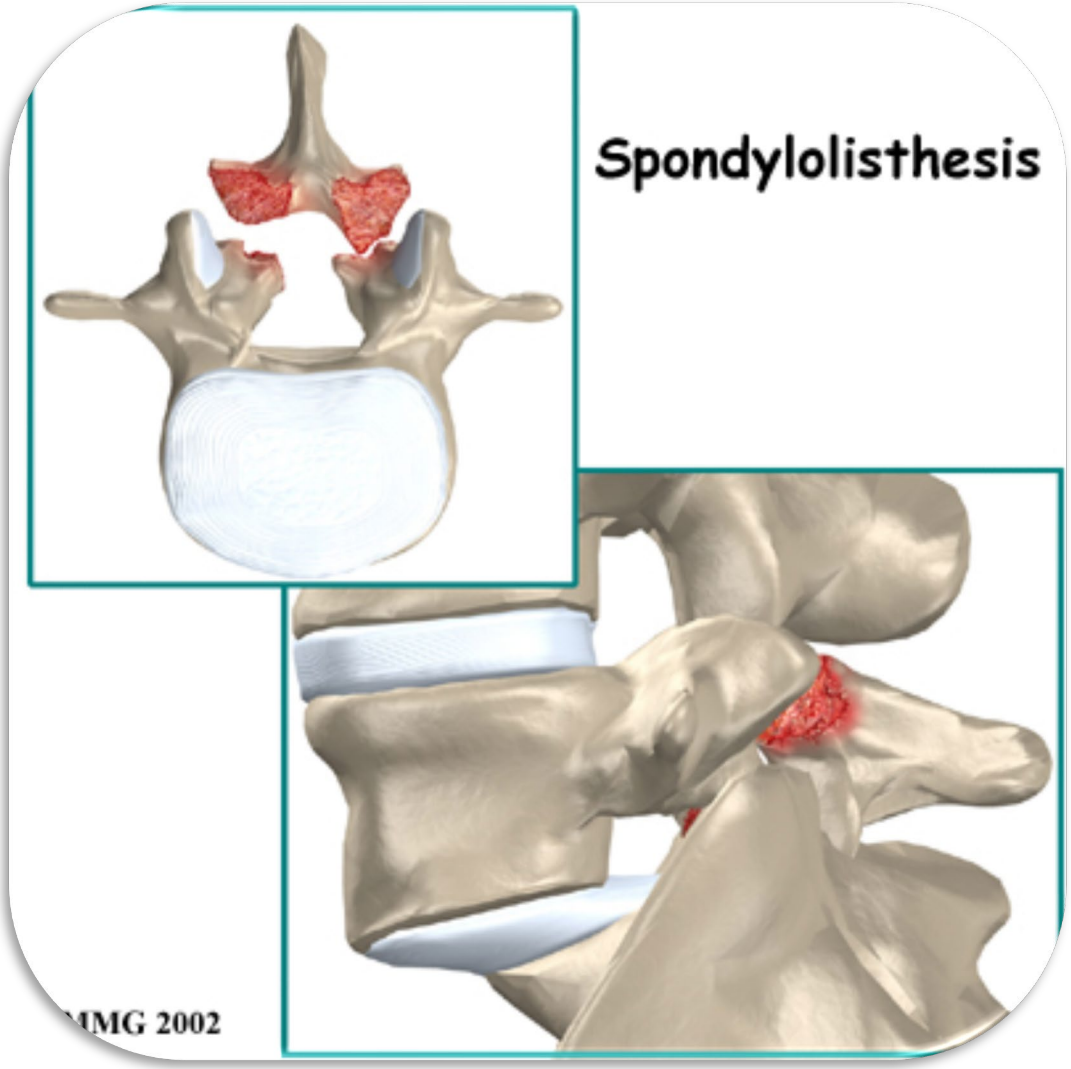
Lytic



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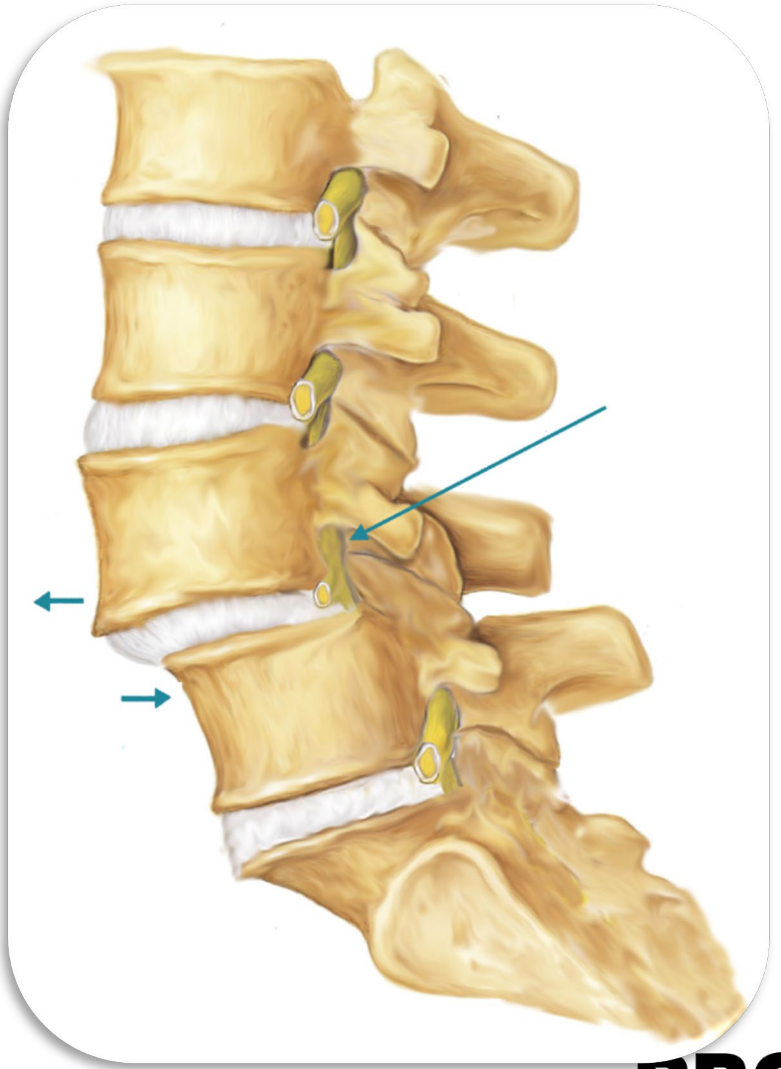
Degenerative



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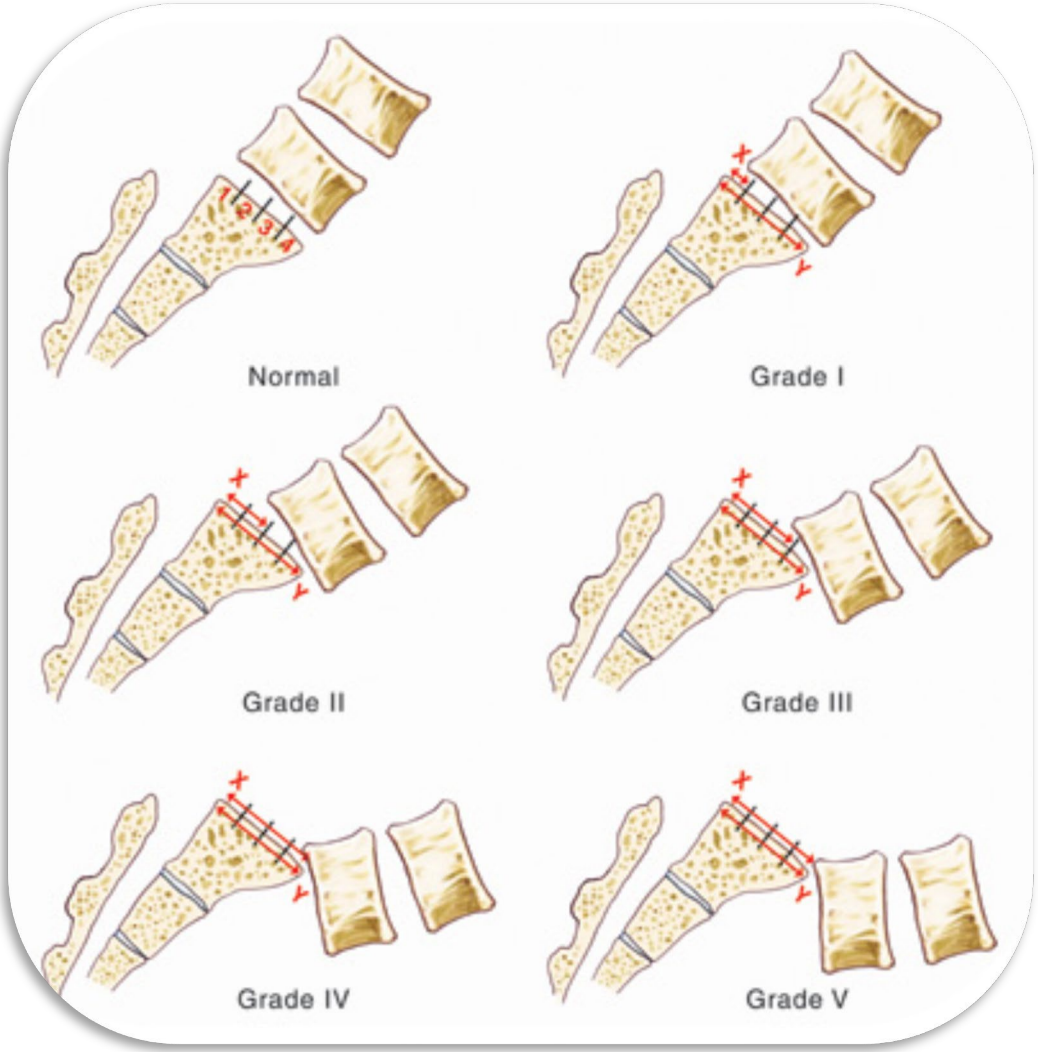

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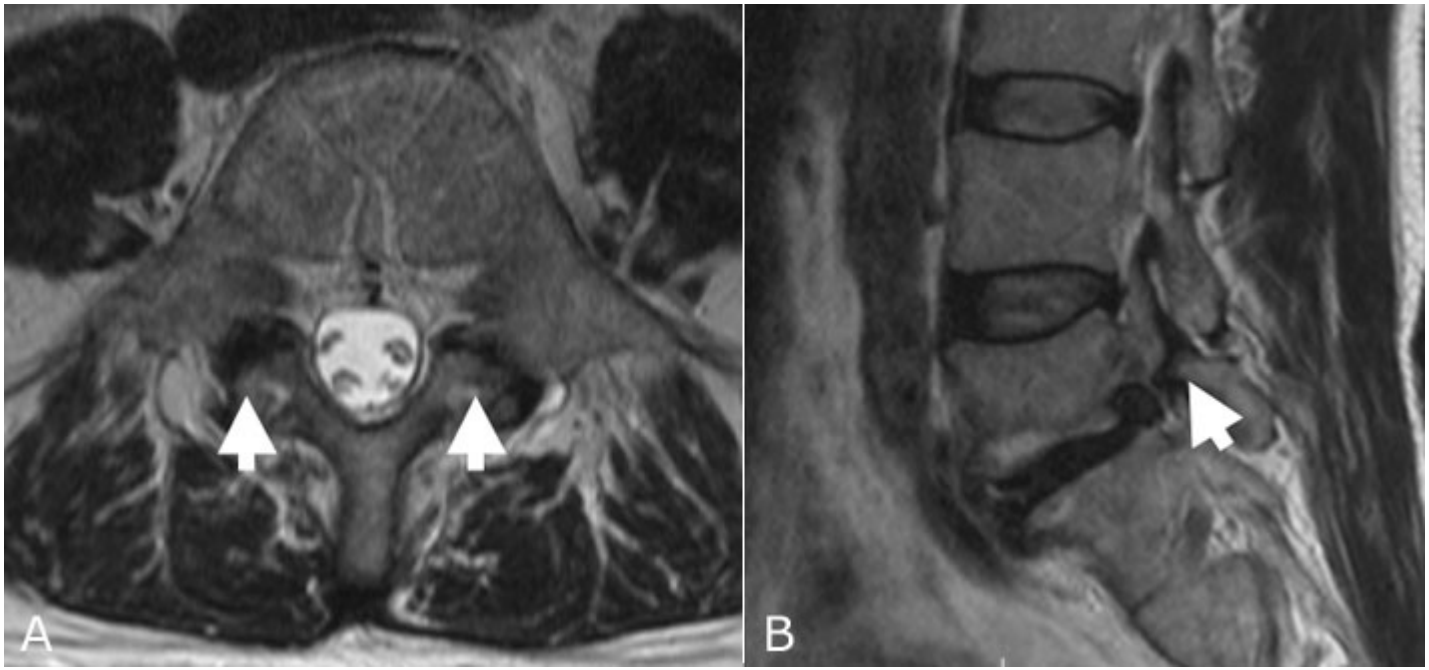
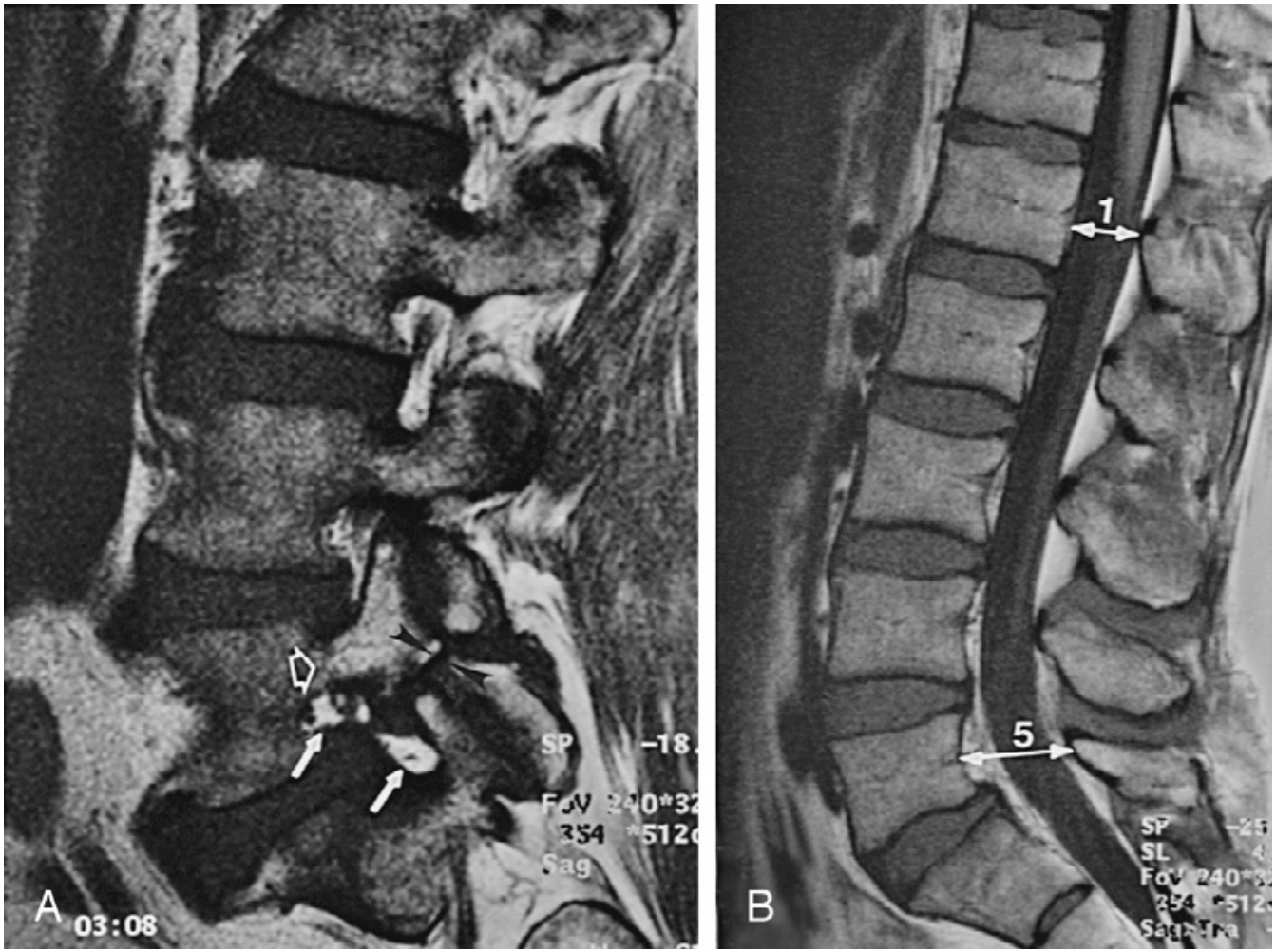
Spondylolysis & Sponylolisthesis

- Direct Evidence
  - Defect in pars interarticularis
  - Difficult diagnosis by MRI
  - Sclerotic (low signal) intact pars may mimic lysis

- Indirect Evidence
  - Neural foramen
  - Obliquely oriented figure-of-eight configuration
  - Widened canal compared with L1 level by >25% (even when no spondylolisthesis is present)

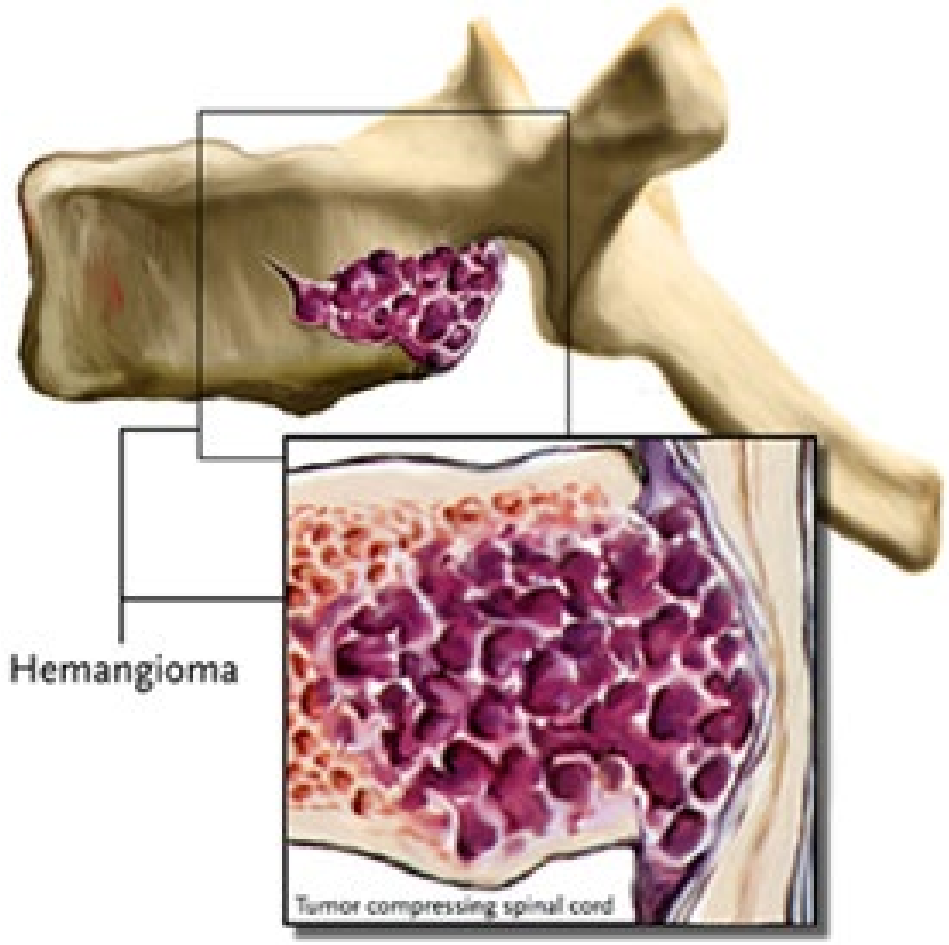


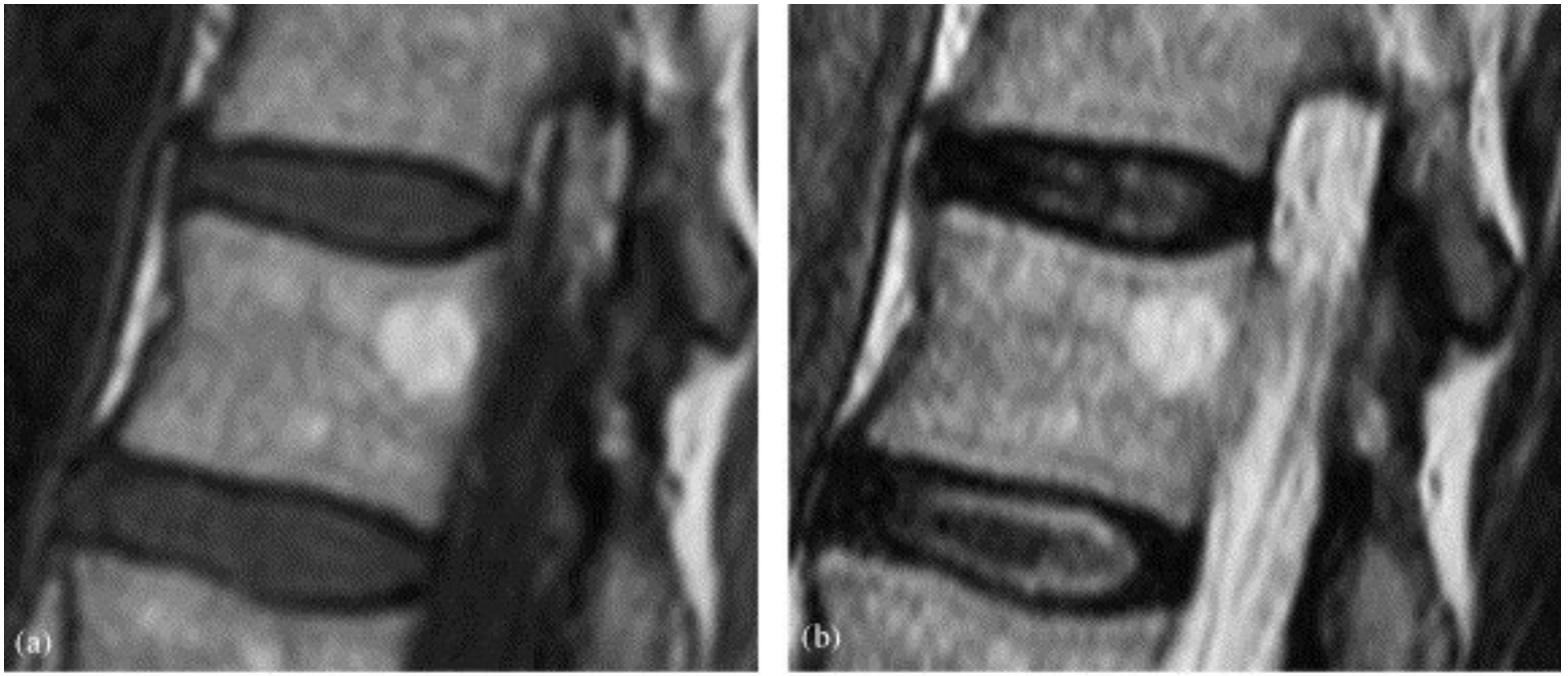


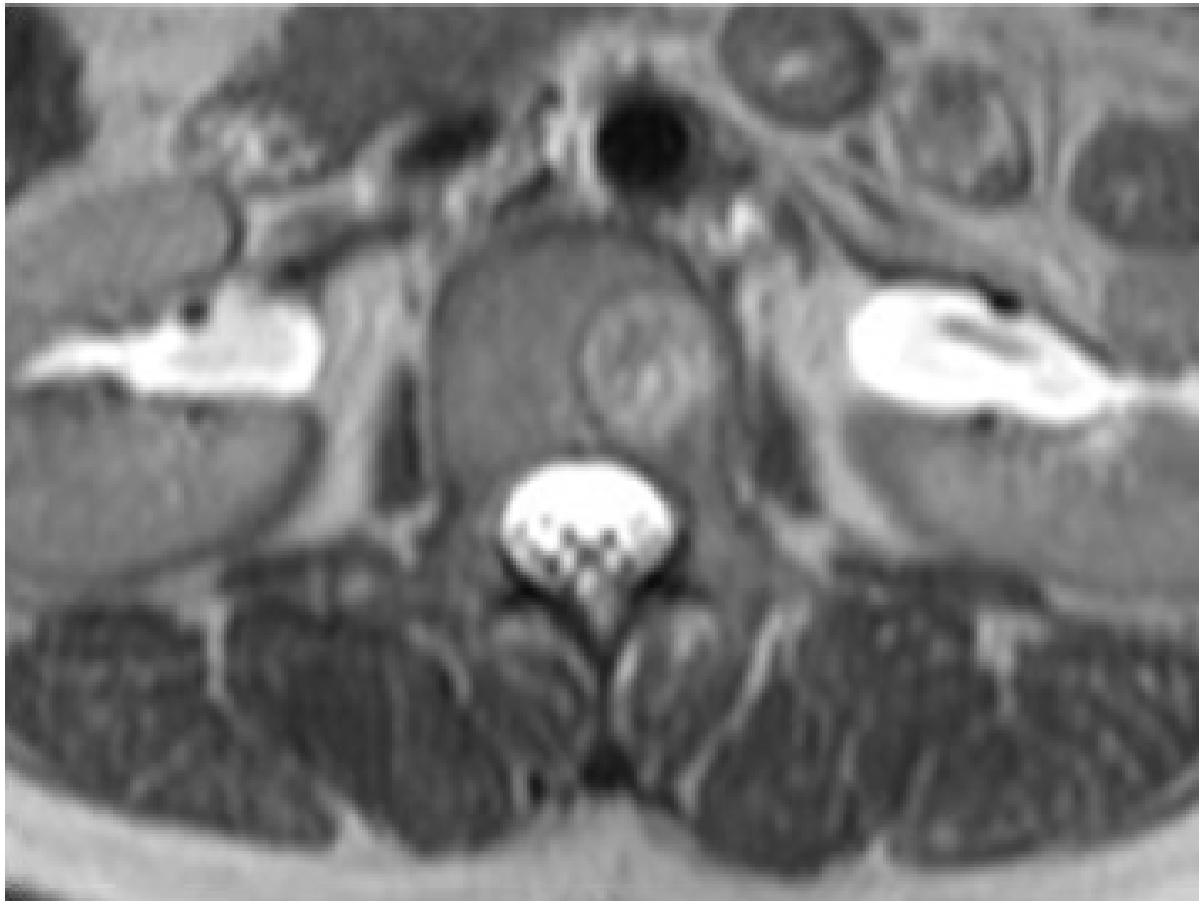
OSSEOUS SPINE TOMOURS

Hemangioma

- Spinal hemangiomas are common and frequently multiple. The vertebral bodies are more commonly affected than the posterior elements.
- On T1W images, they are round lesions of high signal intensity, caused by the large fat component of typical hemangiomas; on T2W images, they also are high signal intensity (higher than fat) because of the slow-flowing blood in the lesions.



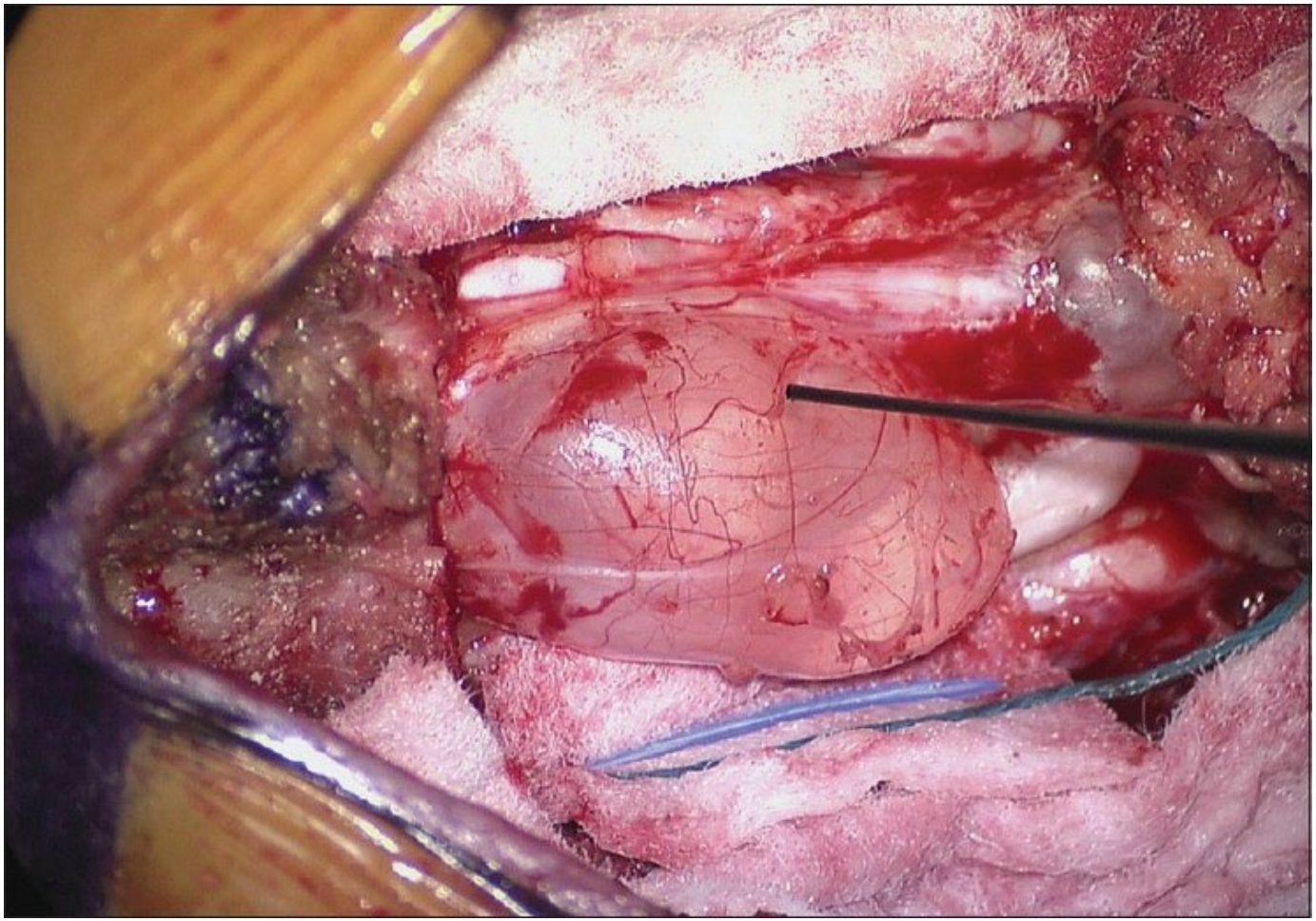


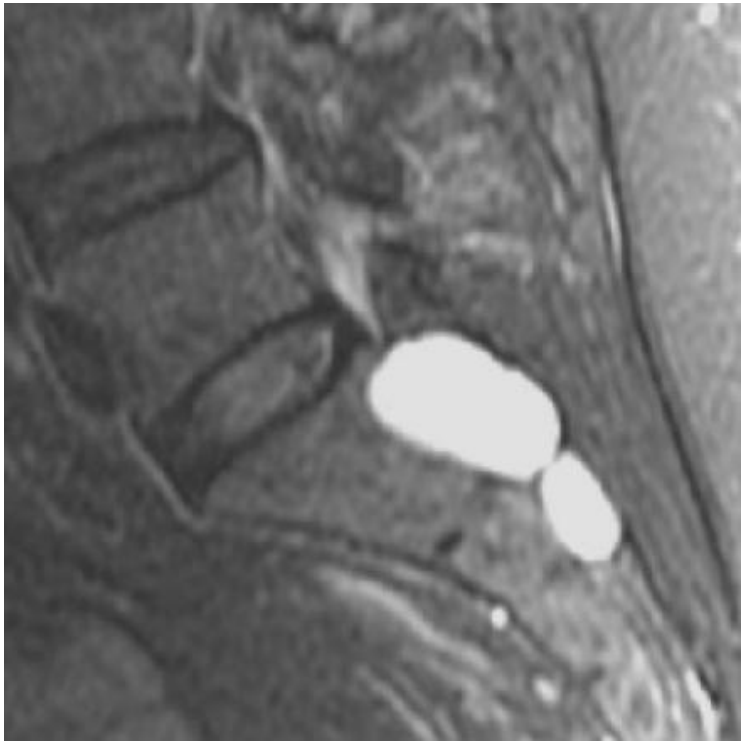


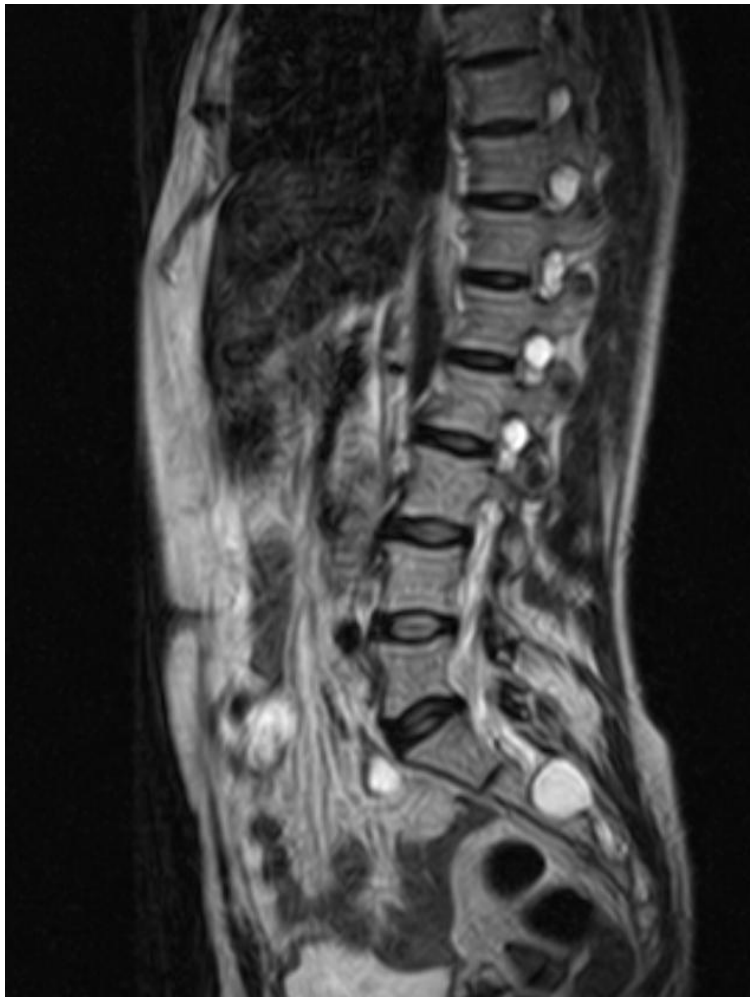

L1
L2
L3
L4
L5
S1
S2
S3
T12
L1
L2
L3
L4
L5
S1
S2
S3
S4

Perineural (Tarlov cysts)

- Dorsal nerve root fibers involved with cyst
  - Affect sacral nerve roots usually
  - Asymptomatic, or may cause nerve compression symptoms
  - Signal follows CSF, or higher than CSF on T2 (static flow)







Syrinx

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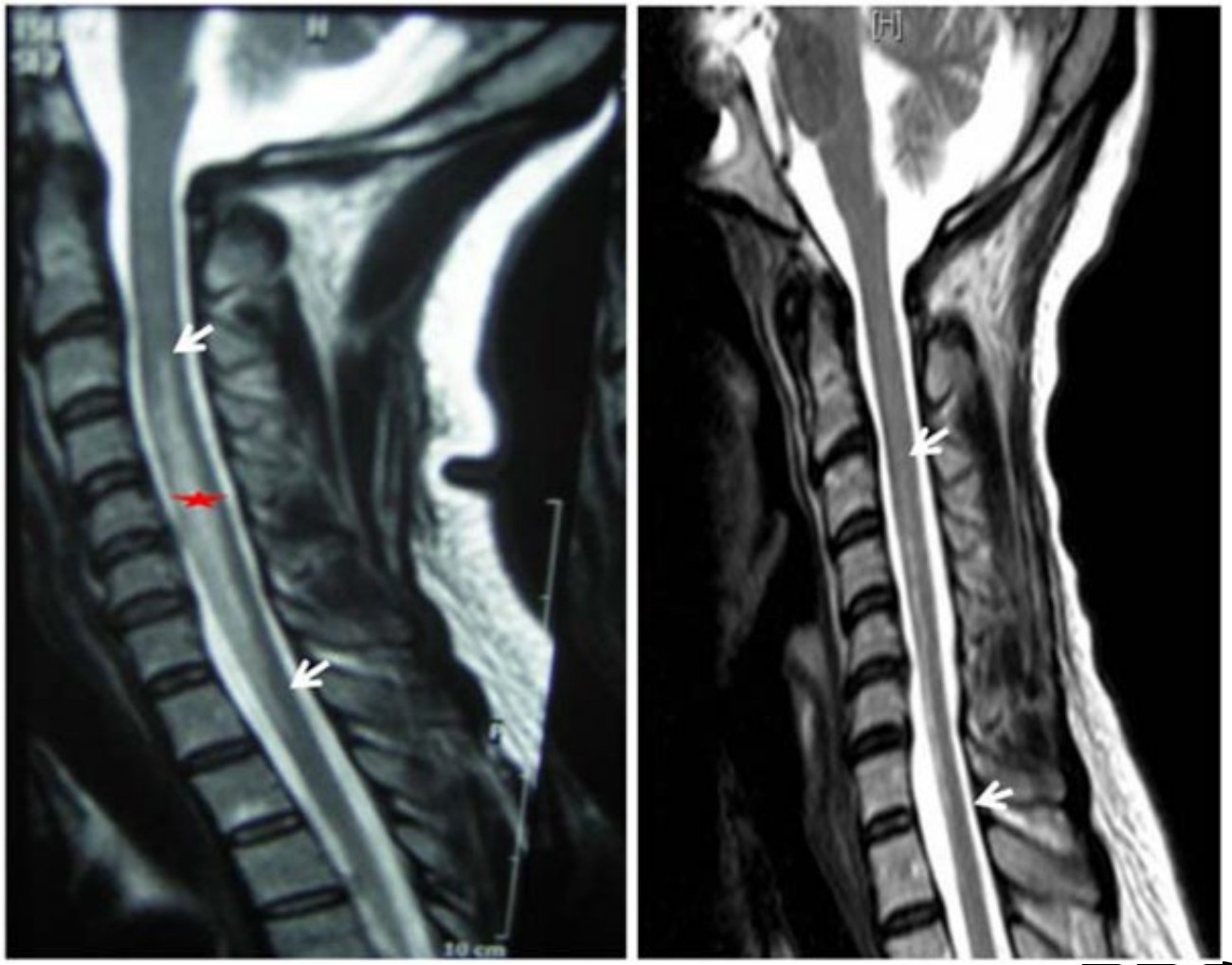
?



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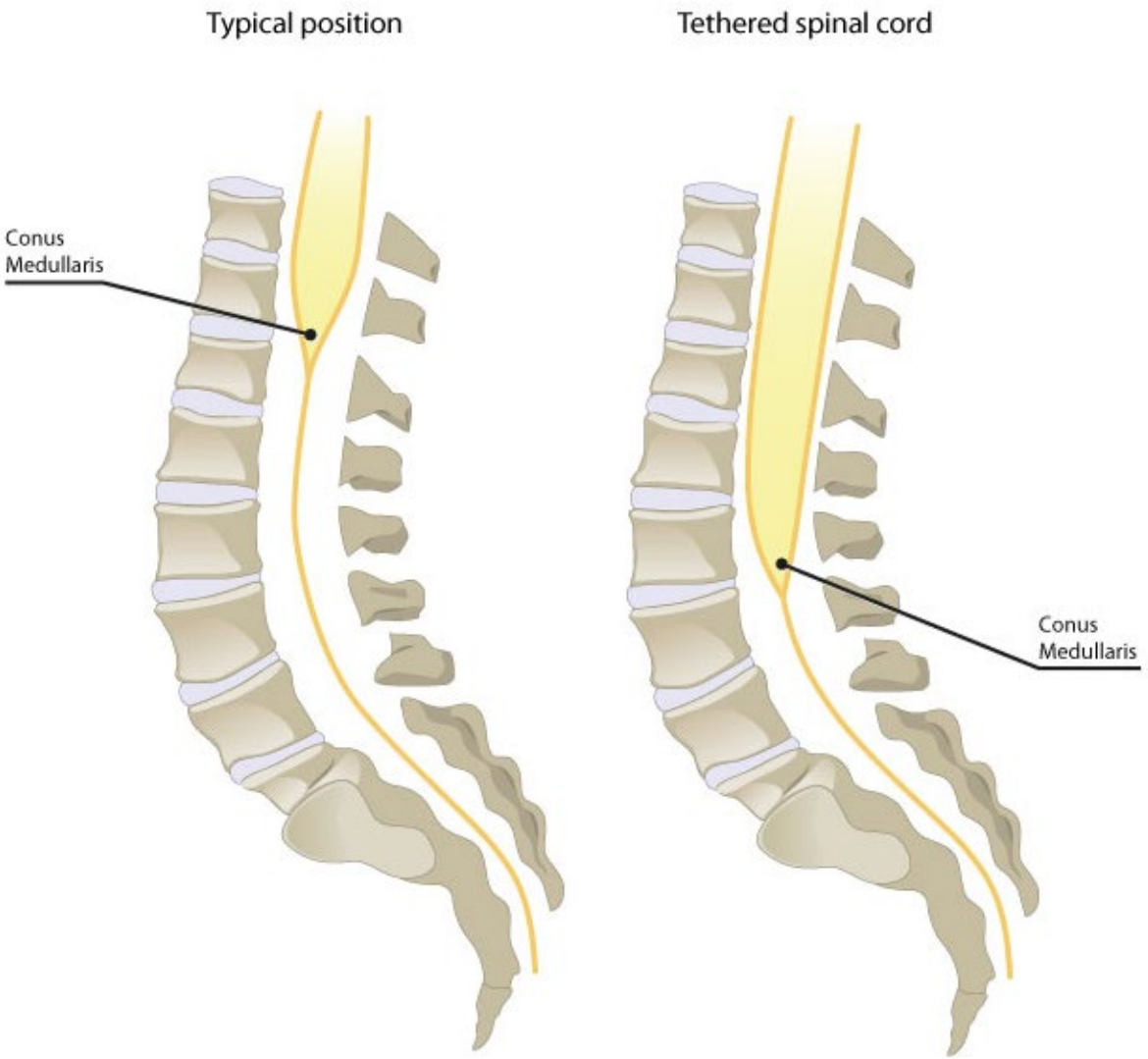
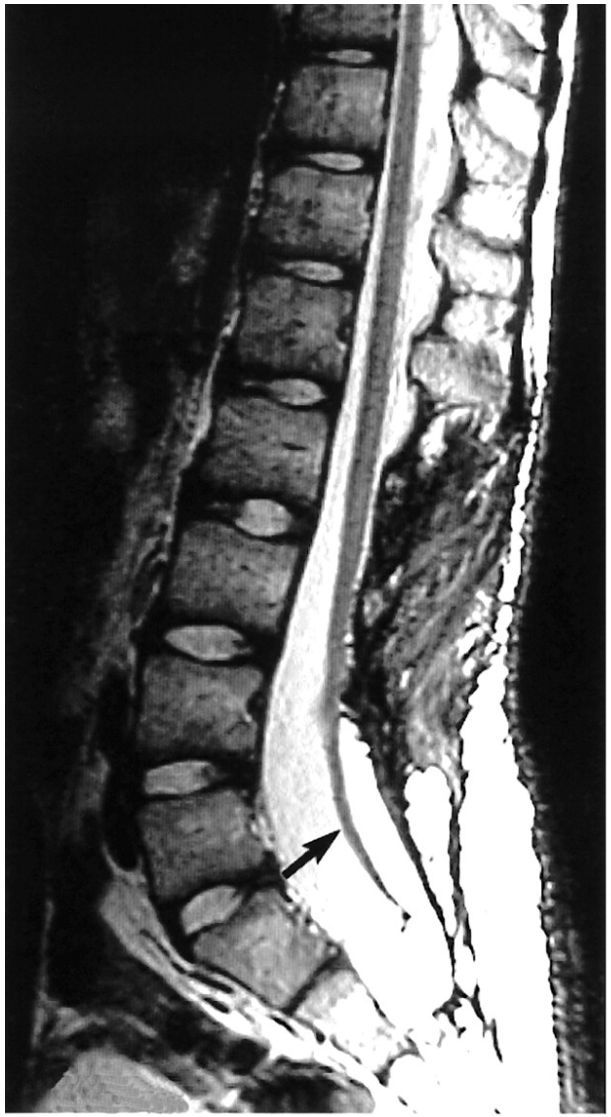
Tethered Cord

- Clinical
  - Occurs in children or adults
  - Pain, dysesthesias, spasticity, loss of bowel and bladder control

- MRI Findings
  - Conus distal to L1-2 Disc
  - No sharp transition between conus and filum (conus appears elongated)
  - *Pitfall*: Layering of cauda equina may mimic low-lying cord; must depend on axial images for diagnosis


Typical position
Tethered spinal cord
Conus
Medullaris
Conus
Medullaris

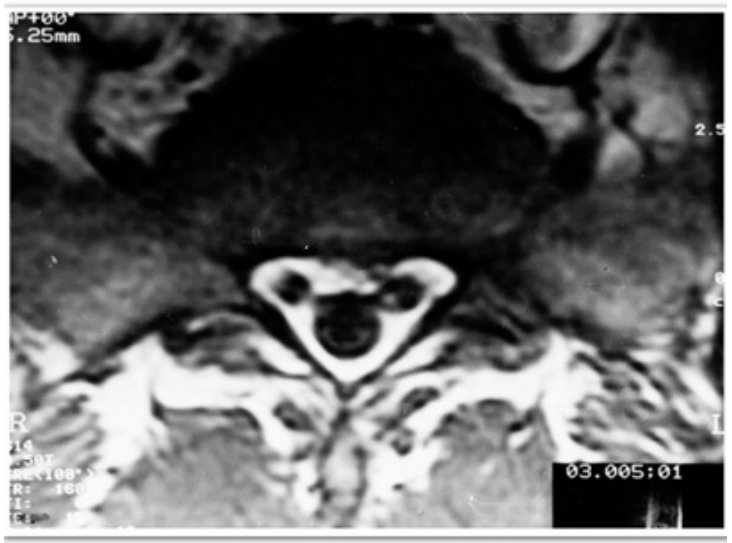

Page: 9 of 14
cm
IM:9 SE:102



A

Outcomes of Non-Surgical Treatment

Imaging Studies



Benson RT, 2010

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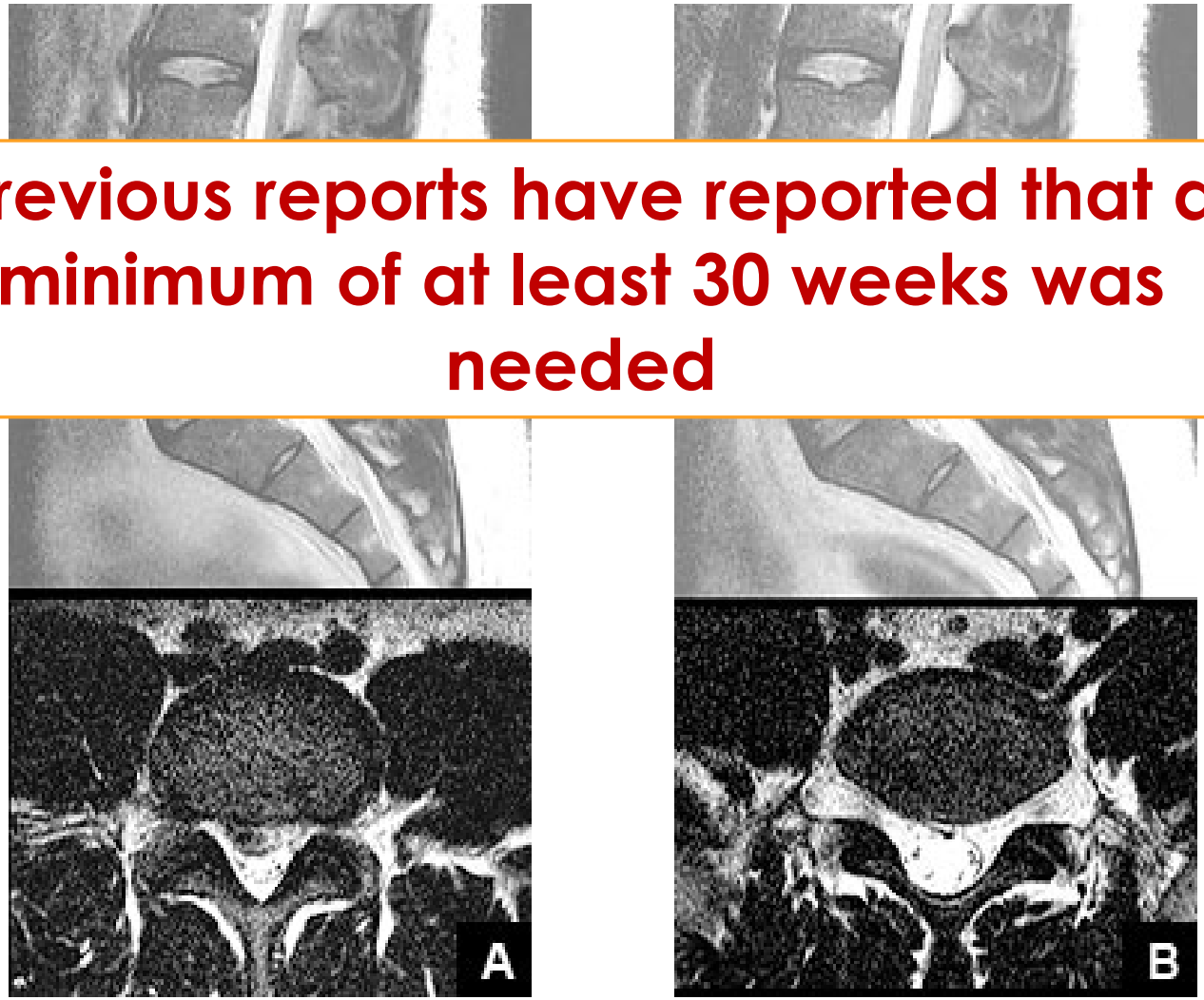
rate of spontaneous regression

- 96% for disc sequestration, 70% for disc extrusion, 41% for disc protrusion, and 13% for disc bulging
- rate of complete resolution of disc herniation was 43% for sequestrated discs and 15% for extruded discs

previous reports have reported that a minimum of at least 30 weeks was needed



Nozawa S, 2009

Follow-up MRI 3 months after the lumbar injury showed complete disappearance of the extruded disc material

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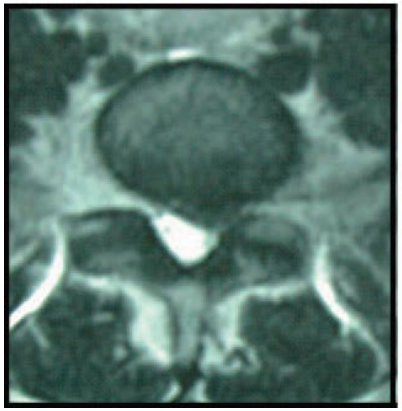
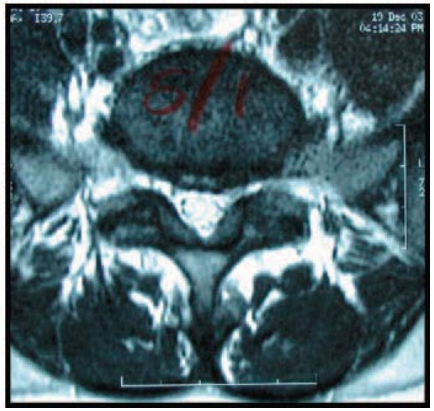
Takada et al., 2001

- **37 of 42 patients (88%) showed an effective reduction in herniated mass on MRI 3-12 months after the onset of symptoms**





26-year-old female
L5–S1 disc extrusion with associated left S1 radiculopathy
9-week FR program

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33-year-old woman with a 7-months history of low back and right leg pain

Sabuncoguolu H, 2008

44-year-old man with a 6-month history of untreated left thigh and low back pain

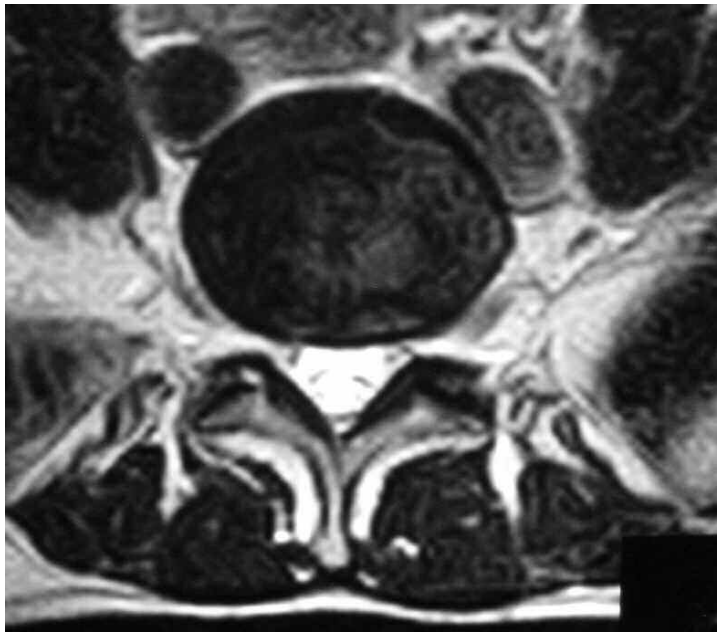
Sabuncoguolu H, 2008

Case

- A 50-year-old male presented with a chief complaint of severe lower back pain and left sided sciatica persisting for two months
- Intervention: 20 sessions of Traction

Yochum & Maola, 2007

Yochum & Maola, 2007



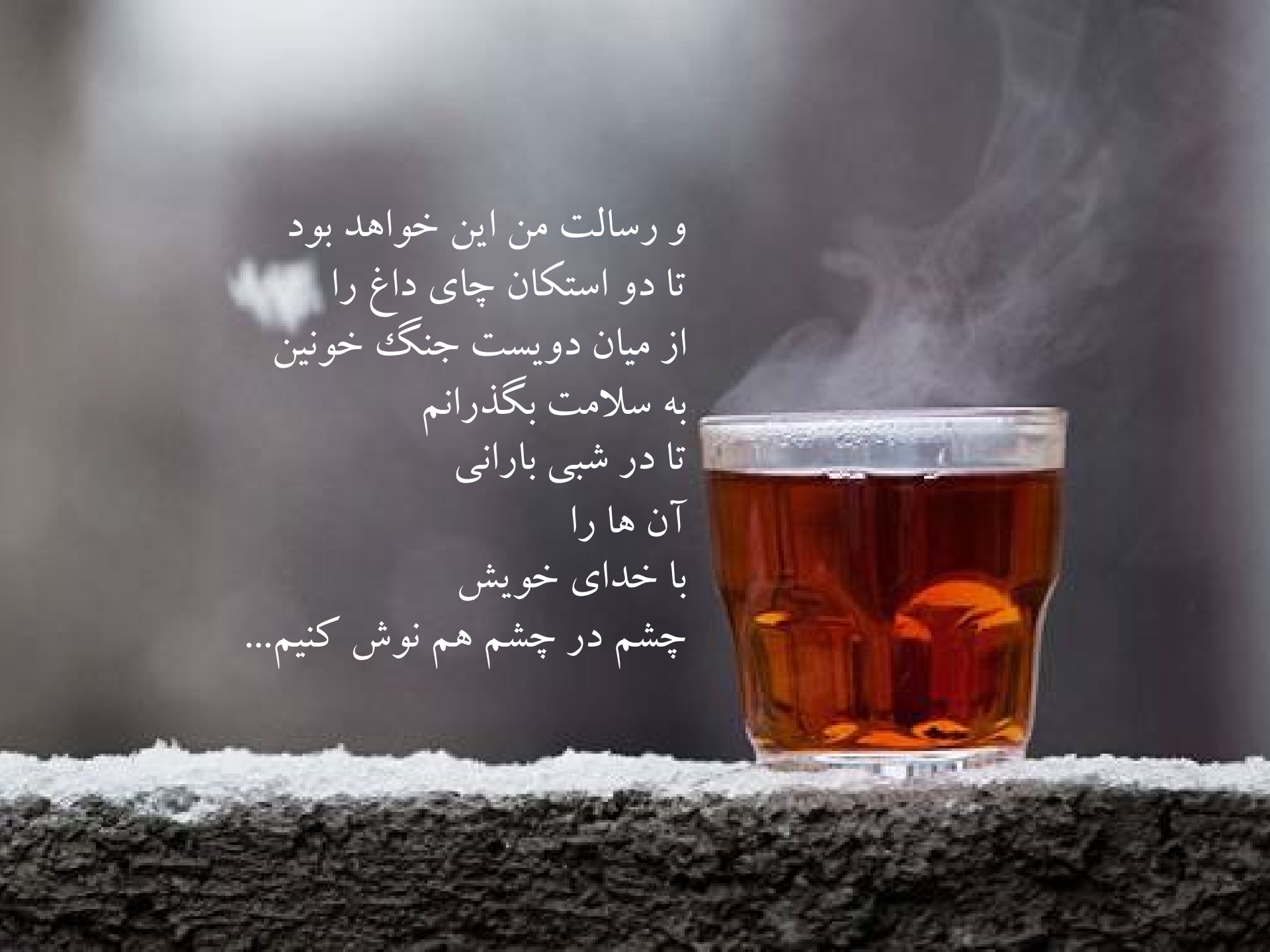
Yochum & Maola, 2007

Mechanisms of spontaneous disc regression

- herniated disc is not separated from the annulus fibrosus
- gradual dehydration and shrinkage
- enzymatic degradation and phagocytosis of cartilaginous tissue due to inflammatory reaction and neovascularization

Causes of Reduction

- Resorbtion
- Desiccation
- Phagocytosis


و رسالت من این خواهد بود
تا دو استکان چای داغ را
از میان دویست جنگ خونین
به سلامت بگذرانم
تا در شبی بارانی
آن ها را
با خدای خویش
چشم در چشم هم نوش کنیم...