Spine MRI interpretation: the basics

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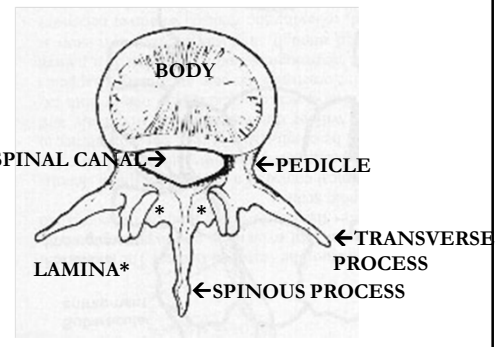
GENERAL APPROACH TO SPINE MRI

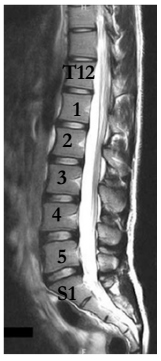
- BONES
- DISCS
- DISC SPACES
  - FORAMINA, LATERAL RECESS, SPINAL CANAL
- SPINAL CORD/CONUS MEDULLARIS
- PARAVERTEBRAL TISSUES
- CRANIOCERVICAL JUNCTION

LUMBAR VERTEBRA



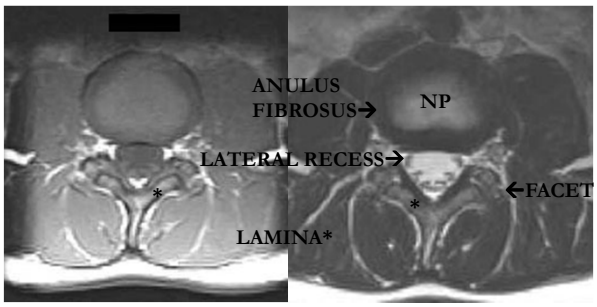
LUMBAR ANATOMY:SAGITTAL

T1

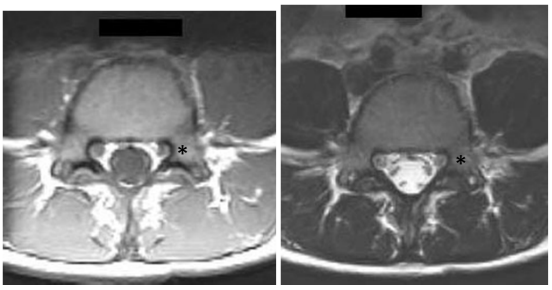


T2

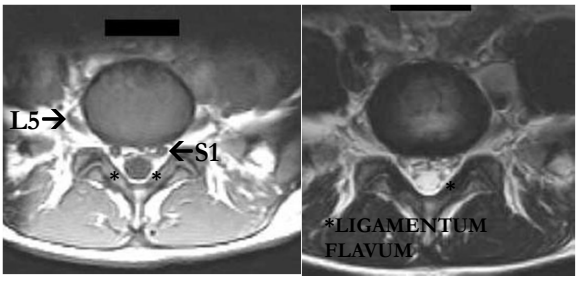
L3-4 DISC



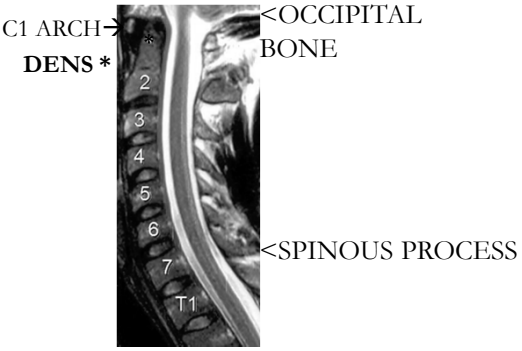
L5 PEDICLE*



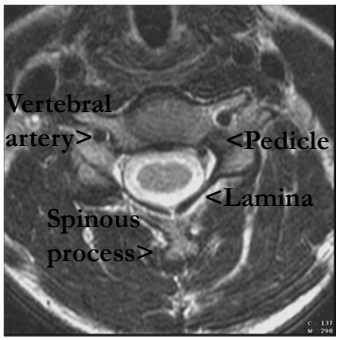
L5-S1 DISC



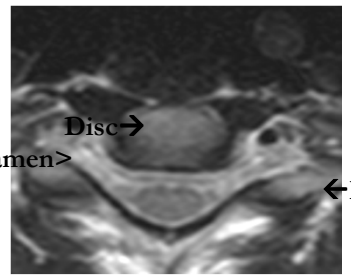
CERVICAL ANATOMY SAGITTAL T2



CERVICAL ANATOMY AXIAL T2



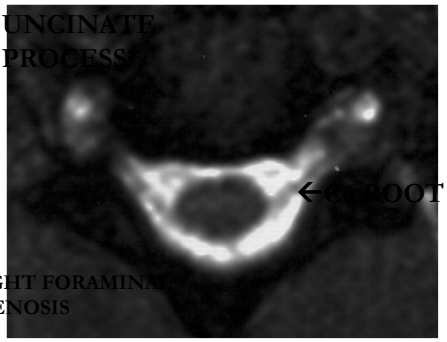
CERVICAL ANATOMY AXIAL T2



UNCINATE PROCESS

- LOWER 5 CERVICAL VERTEBRAL BODIES (C3-7)
- SUPERIOR ARTICULAR PROJECTIONS WHICH INDENT THE POSTEROLATERAL ASPECT OF DISC AND VERTEBRAL BODY ABOVE
- FORM UNCOVERTEBRAL (LUSHKA'S) JOINTS: SYNOVIAL OR LOOSE CONNECTIVE TISSUE

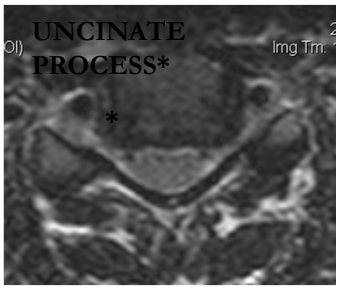
C5-6 DISC SPACE LEVEL



CERVICAL LATERAL SAGITTAL

T2

CERVICAL ANATOMY AXIAL T2



EXITING NERVE ROOTS THROUGH FORAMINA

- CERVICAL: ROOTS EXIT ABOVE NAMED VERTEBRAL BODY
  - C7 EXITS AT C6-7 LEVEL ABOVE C7 BODY
- C8 EXITS AT C7-T1 LEVEL
- THORACOLUMBAR: ROOTS EXIT DISC SPACE LEVEL BELOW VERTEBRAL PEDICLE
  - L5 EXITS AT L5-S1 LEVEL BELOW L5 PEDICLE

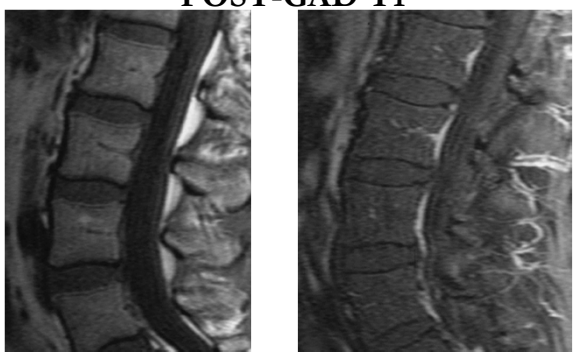
GENERAL APPROACH TO SPINE MRI

- **BONES**
- **DISCS**
- **DISC SPACES**
  - **FORAMINA, LATERAL RECESS, SPINAL CANAL**
- SPINAL CORD/CONUS MEDULLARIS
- PARAVERTEBRAL TISSUES
- CRANIOCERVICAL JUNCTION

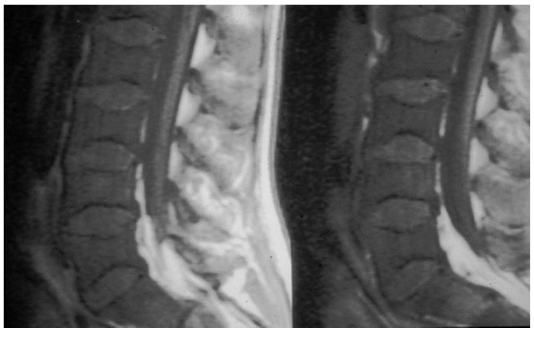
BONES AND DISCS

- VERTEBRAL BODIES
  - HEIGHT AND ALIGNMENT
    - SCOLIOSIS, STRAIGHTENING
    - SPONDYLOLISTHESIS
    - COMPRESSION FRACTURES
  - MARROW SIGNAL INTENSITY
    - DIFFUSE VS FOCAL
    - BENIGN VS PATHOLOGIC
    - ENDPLATE CHANGES
  - SPONDYLOSIS
- DISCS
  - SIGNAL INTENSITY
  - HEIGHT

NORMAL T1, AND FATSAT POST-GAD T1



DIFFUSELY ABNORMAL SAGITTAL T1



LEUKEMIA

SAGITTAL T1, NO CONTRAST

NORMAL

MYELOMA

SAGITTAL PRE AND POST-GAD T1


PRE-GAD **LYMPHOMA** POST-GAD

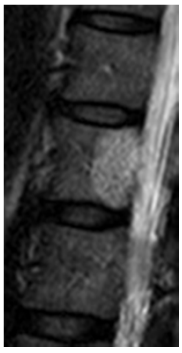
FOCAL ABNORMAL MARROW SIGNAL


EWING'S SARCOMA

VERTEBRAL HEMANGIOMA

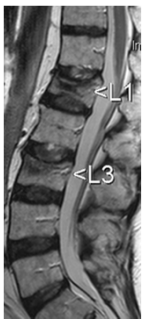
- TYPICALLY BENIGN INCIDENTAL FINDING
- HYPERINTENSE ON BOTH T1 AND T2, BUT SOME CAN BE HYPOINTENSE ON T1
- DDX: FATTY MARROW REPLACEMENT
- 10-12% OF ALL AUTOPSIES
- FAT-SAT MR OR CT CAN BE HELPFUL

VERTEBRAL HEMANGIOMA

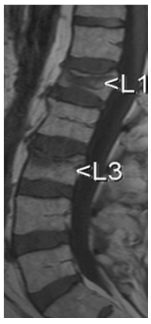



T2 T1

COMPRESSION FRACTURES



T2

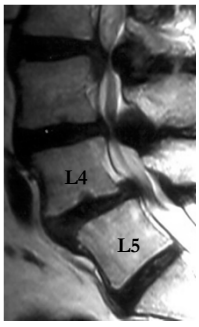


T1

SPONDYLOLISTHESIS

- CONGENITAL OR ACQUIRED DEFECTS IN THE PARS INTERARTICULARIS (part of the vertebral posterior ring between the superior and inferior articular processes)
- GRADE I: 25% OR LESS
- GRADE II: 25-50%
- GRADE III: 50-75%
- GRADE IV: 75-100%
- GRADE V: OVER 100%
- GREATER THAN 25% TYPICALLY ASSOCIATED WITH BILATERAL SPONDYLOLYSIS

L4-5 GRADE I



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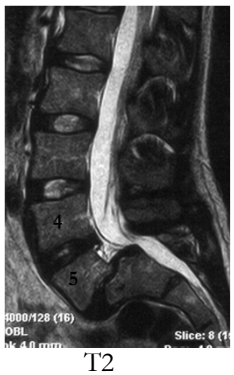
L5-S1 GRADE II



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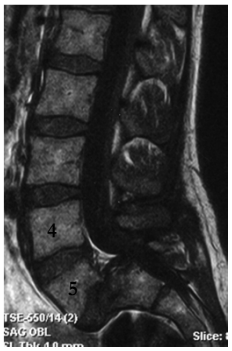


T1

GRADE II

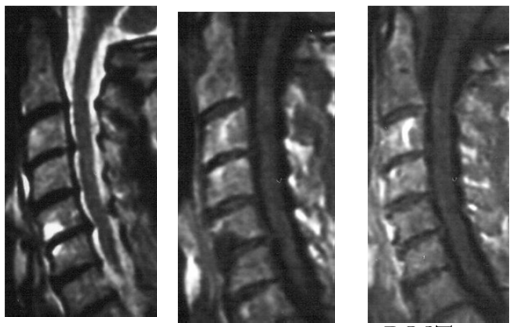
←SPONDYLOLYSIS L5

MODIC CLASSIFICATION TYPES 1, 2, 3

- ACUTE-SUBACUTE:
  - TYPE 1: BONE MARROW EDEMA ASSOCIATED WITH ACUTE-SUBACUTE INFLAMMATORY CHANGES

- HYPOINTENSE T1
- HYPERINTENSE T2
- CAN ENHANCE

TYPE 1



T2 T1 POST-GAD T1

MODIC CLASSIFICATION TYPES 1, 2, 3

- CHRONIC CHANGES:
  - TYPE 2: PROLIFERATION OF FATTY MARROW

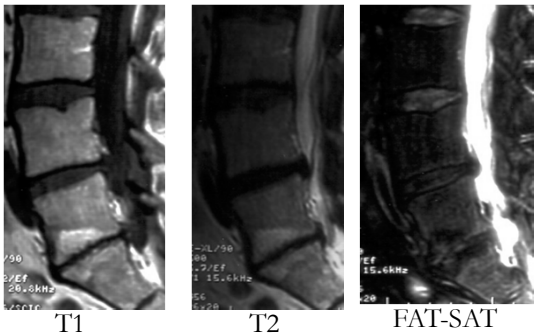
  -HYPERINTENSE ON T1

  -ISOINTENSE OR HYPERINTENSE ON T2

  -CAN ENHANCE
  - TYPE 3: REACTIVE OSTEOSCLEROSIS DEVOID OF MARROW

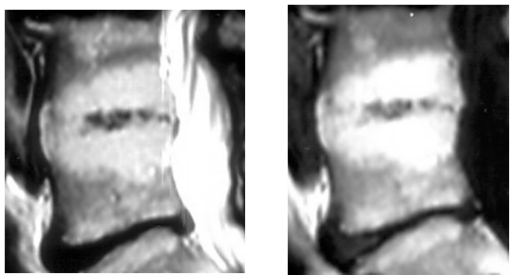
  -HYPOINTENSE ON T1 AND T2

TYPE 2



T1 T2 FAT-SAT T2

TYPE 2



T2 T1

NOMENCLATURE AND CLASSIFICATION OF DISC PATHOLOGY

- ASNR: Am. Soc. Of Neuroradiology
- ACR: Am. College of Radiology
- ASSR: Am. Society of Spine Radiology
- NASS: North American Spine Society
- CNS: Cong. of Neurological Surgeons
- AAOS: Am. Academy of Orthopaedic Surgeons
- AAPM&R: Am. Academy of Physical Medicine &Rehabilitation

General classification of disc lesions

- Normal
- Congenital/developmental variant
- Degenerative/traumatic:
  - Anular tear
  - Bulging
  - Herniation: protrusion, extrusion, intravertebral
  - Degeneration: Spondylosis deformans, Intervertebral osteochondrosis
- Inflammation/infection
- Neoplasia
- Morphologic variant of unknown significance

Source: AJNR online

NORMAL

- "YOUNG DISCS WHICH ARE MORPHOLOGICALLY NORMAL"
- EXCLUDES DEGENERATIVE, DEVELOPMENTAL, OR ADAPTIVE CHANGES (i.e. scoliosis, spondylolisthesis)

"NORMAL" SAGITTAL LUMBAR

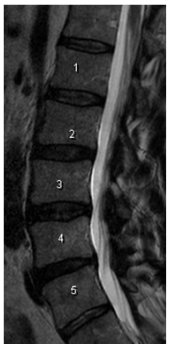
T2

T1

"NORMAL" DISC AGING

- SIGNAL INTENSITY REFLECTS WATER CONTENT: HYPERINTENSE ON T2
- WITH AGE, INCREASE IN COLLAGEN AND DECREASE IN GLYCOSAMINOGLYCANS
- LESS WATER AFFINITY, AND THUS DECREASED SIGNAL INTENSITY WITH AGING REFLECTING DESSICATION

DESSICATION



T2

NORMAL

T2

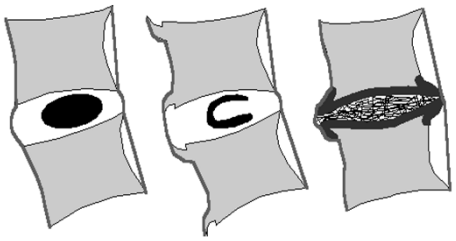
CONGENITAL-DEVELOPMENTAL VARIATION

- CONGENITALLY ABNORMAL DISCS
- ADAPTIVE CHANGES IN DISC MORPHOLOGY (i.e. in response to scoliosis, spondylolisthesis)

DISC DEGENERATION

- DECREASED T2 SIGNAL AND LOSS OF DISC HEIGHT
- SPONDYLOSIS DEFORMANS, INTERVERTEBRAL OSTEOCHONDROSIS
- ASSOCIATED MARROW SIGNAL CHANGES: TYPES 1, 2, 3
- VACUUM DISC PHENOMENON: HYPOINTENSE ON BOTH T1 AND T2

DISC DEGENERATION

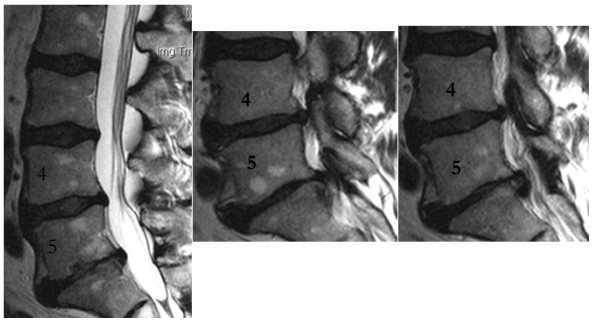


AJNR online

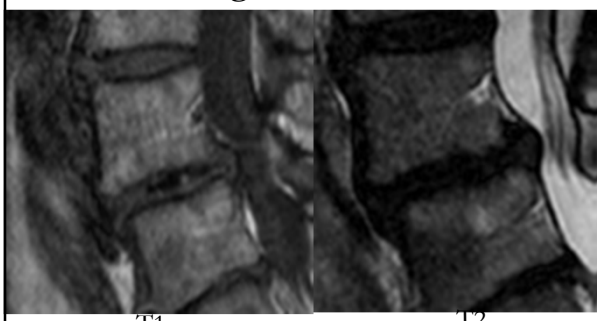
DISC DEGENERATION

- SPONDYLOSIS DEFORMANS: Degenerative process of the spine involving essentially the anulus fibrosus and characterized by anterior and lateral marginal osteophytes arising from the vertebral body apophyses, while the intervertebral **disc height is normal or only slightly decreased**
- INTERVERTEBRAL OSTEOCHONDROSIS: Degenerative process of the spine involving the vertebral body end-plates, the nucleus pulposus, and the anulus fibrosus, which is characterized by **disc space narrowing, vacuum phenomenon, and vertebral body reactive changes**

DISC DEGENERATION: T2



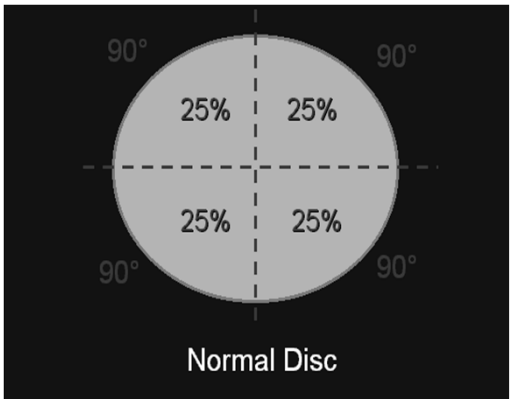
VACUUM DISC: gas deposition, with low signal on both T1 and T2



T1 T2

DISC BULGING

- "BY DEFINITION, IS NOT A HERNIATION"
- PRESENCE OF DISC TISSUE (OUTER ANULUS) EXTENDING DIFFUSELY, OR "CIRCUMFERRENTIALLY", BEYOND THE EDGES OF THE DISC SPACE
- ARBITRARILY DEFINED AS GREATER THAN 50% OF THE PERIPHERY OF THE DISC



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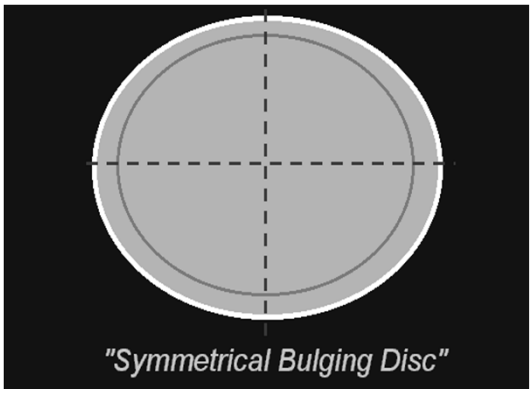

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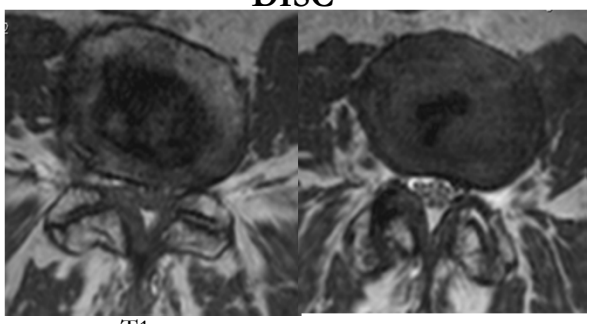
DISC BULGING WITH VACUUM DISC

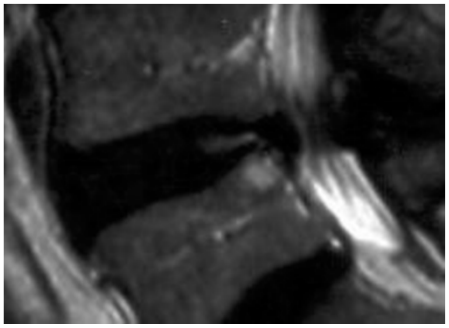


T1 T2

ANULAR TEAR, OR FISSURE

- Separations between anular fibers, avulsion of fibers from their vertebral body insertions, or breaks through fibers that extend radially, transversely, or concentrically, involving one or more layers of the anular lamellae
- HYPERINTENSE ON T2
- CAN BE HYPOINTENSE ON T1, AND CAN ENHANCE

ANULAR TEAR, OR FISSURE



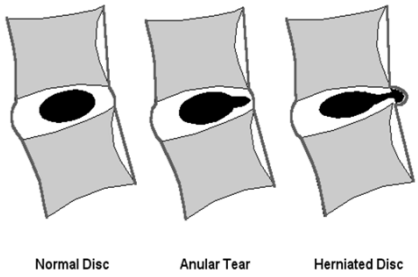
T2

HERNIATION

LOCALIZED DISPLACEMENT OF DISC MATERIAL:

- PROTRUSION (base greater than distal extension)
  - FOCAL (less than 25%)
  - BROAD BASED (less than 50% ,180 degrees, of the circumference of the disc)
- EXTRUSION (base narrower than apex)
- SEQUESTRATION

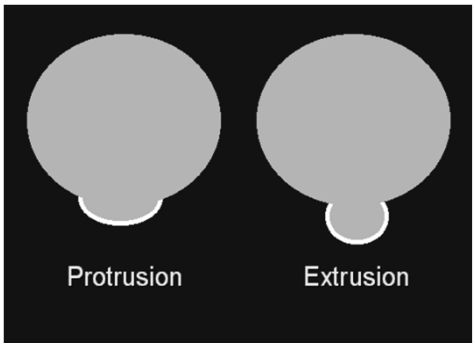
AJNR online



AJNR online

EXTRUSION

- BASE IS NARROWER THAN APEX
- SUBCLASSIFICATION:
  - BASIC EXTRUSION
  - SEQUESTRATION
- SEQUESTRATION: DISPLACED DISC MATERIAL IS NOT CONTINOUS WITH DISC



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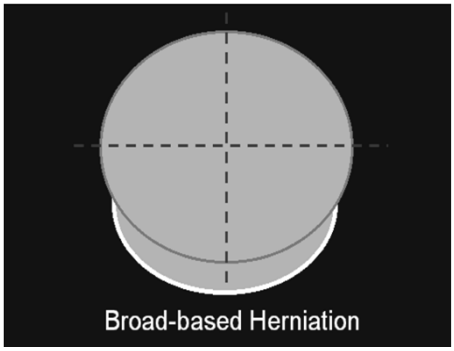

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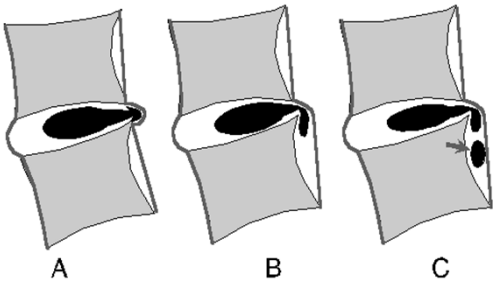

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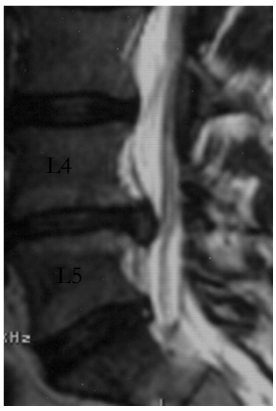
L4-5 DISC EXTRUSION T2 SAG



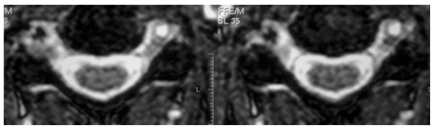
L5-S1
PROTRUSION AND
ANULAR TEAR

C6-7 DISC PROTRUSION AND ANULAR TEAR

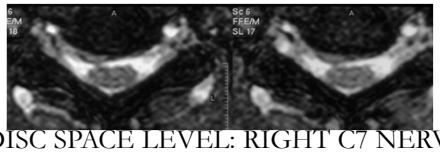
T2

T1

C6-7 DISC PROTRUSION AND ANULAR TEAR-AXIAL T2



C3-4 DISC SPACE LEVEL



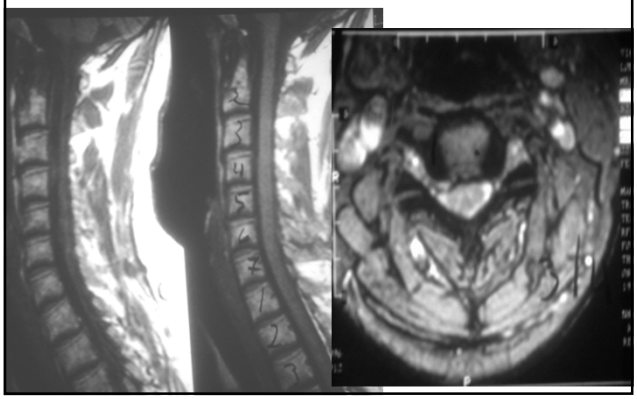
C6-7 DISC SPACE LEVEL: RIGHT C7 NERVE ROOT

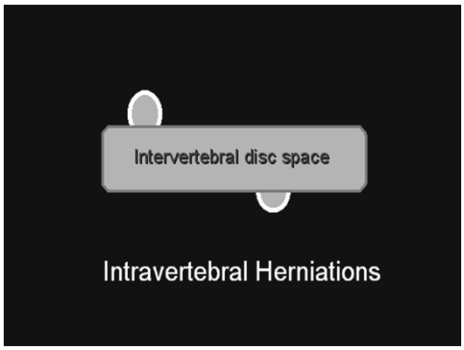
C5-6 DISC EXTRUSION WITH CORD COMPRESSION

T1

T2

FORAMINAL PROTRUSION





SCHMORL'S NODES

ASNR online

ENHANCING SCHMORL'S NODES

SCHMORL'S NODE

T1

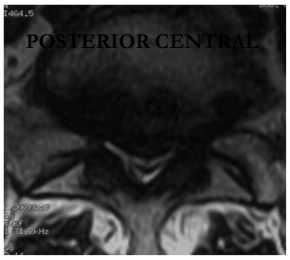
LOCATIONS OF DISC HERNIATIONS

- POSTERIOR
  - CENTRAL
  - PARACENTRAL
- POSTEROLATERAL: FORAMINAL
- LATERAL: EXTRAFORAMINAL
- ANTERIOR

EVALUATION OF EACH DISC SPACE LEVEL

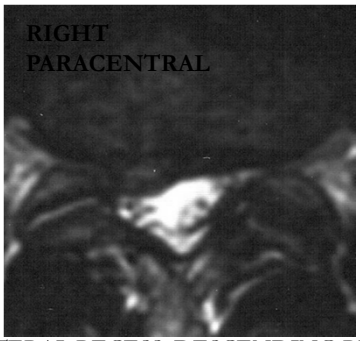
- DISC
- FACETS
- LIGAMENTUM FLAVUM
- SPONDYLOSIS/SPONDYLOLISTHESIS
- CERVICAL SPINE: UNCINATE PROCESS
- FORAMINAL, LATERAL RECESS, SPINAL CANAL STENOSIS
- EFFECT ON THE NERVE ROOTS

L5-S1 DISC HERNIATION



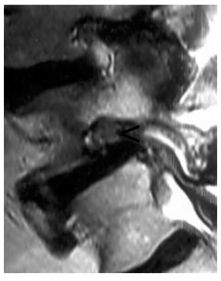
LATERAL RECESS AND SPINAL CANAL STENOSIS: BOTH S1 NERVE ROOTS

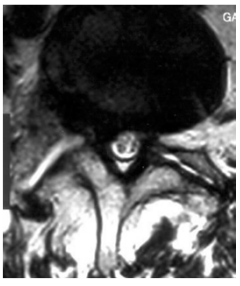
L4-5 DISC DISC HERNIATION



LATERAL RECESS: DESCENDING RIGHT L5, S1 NERVE ROOTS

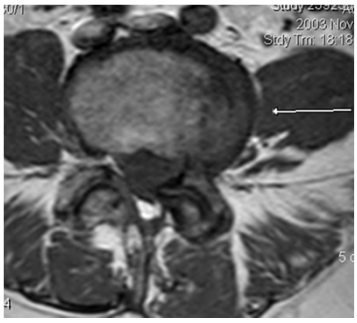
L4-5 RIGHT POSTEROLATERAL DISC HERNIATION





COMPRESSION OF RIGHT L4 NERVE ROOT

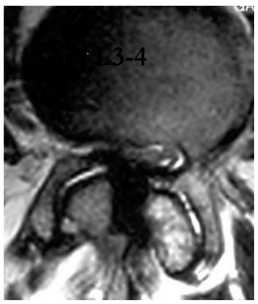
L3-4 EXTRAFORAMINAL BROAD BASED HERNIATION



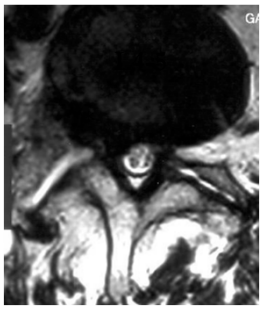
AXIAL T1

SPINAL CANAL STENOSIS

- COMPRESSION OF THE THECAL SAC, USUALLY MULTIFACTORIAL:
  - DISC DISEASE
  - FACET DISEASE
  - LIGAMENTUM FLAVUM HYPERTROPHY
  - SPONDYLOLISTHESIS
- ACQUIRED, CONGENITAL, OR COMBINATION THEREOF



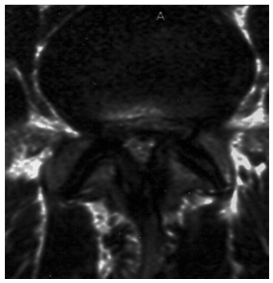
FACET ARTHROPATHY , LF HYPERTOPHY*



HERNIATION*, FACET ARTHROPATHY

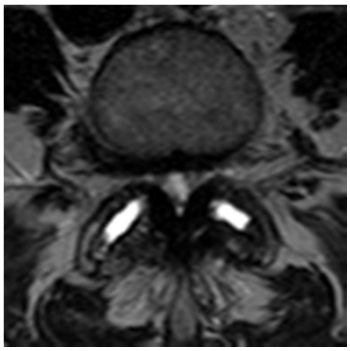
ACQUIRED SUPERIMPOSED ON CONGENITAL STENOSIS

MIDLINE SAGITTAL T2



AXIAL T2

FACET ARTHROPATHY



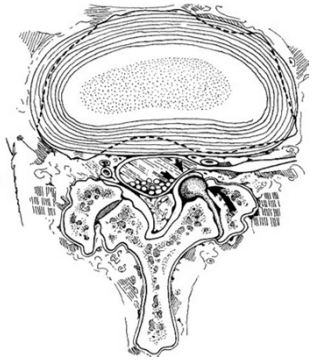
AXIAL T2

SPINAL CANAL STENOSIS

- OTHER ETIOLOGIES
  - OSSIFICATION OF PLL
  - EPIDURAL LIPOMATOSIS
- DEGREE:
  - MILD : LESS THAN 1/3
  - MODERATE: 1/3 TO 2/3
  - SEVERE: GREATER THAN 2/3
- LATERAL RECESS STENOSIS

SYNOVIAL CYST

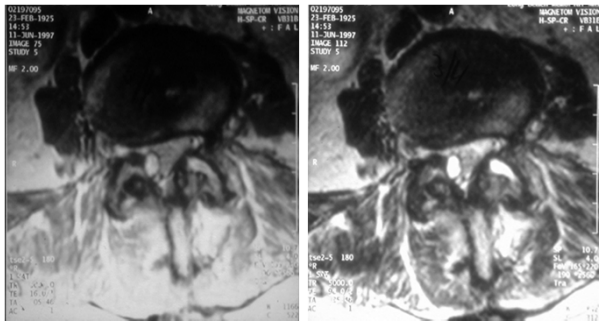
- JUXTA-ARTICULAR CYSTS
- TYPICALLY FOLLOW CSF SIGNAL BUT CAN BE VARIABLE
- RADICULOPATHY, SPINAL STENOSIS
- MOST COMMONLY LUMBAR



SYNOVIAL CYST

T2

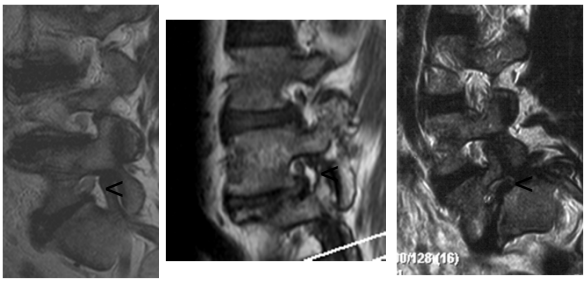
SYNOVIAL CYST



FORAMINAL STENOSIS

- MILD: NO EXITING NERVE ROOT IMPINGEMENT/COMPRESSION
- MODERATE: NERVE ROOT IMPINGEMENT
- SEVERE: NERVE ROOT COMPRESSION
- EXTRAFORAMINAL NERVE ROOT COMPRESSION

FORAMINAL STENOSIS



MILD MODERATE SEVERE

CONTRAST UTILIZATION IN SPINE MRI

- INFECTION: OSTEOMYELITIS-SPONDYLITIS, DISCITIS, FACET SYNOVITIS, MYOSITIS, ABCESS
- POST-OPERATIVE
  - SCAR VS RECURRENT/RESIDUAL DISC
  - ARACHNOIDITIS
- TUMOR VS DISC HERNIATION
- CANCER

INFECTION/INFLAMMATION

- OSTEOMYELITIS-SPONDYLITIS AND DISCITIS
- MOST COMMON PATHOGEN: S. AUREUS
- MOST COMMON MECHANISM: HEMATOGENOUS SPREAD
- AT RISK POPULATIONS: DIABETICS, ELDERLY, IV DRUG USERS, IMMUNOCOMPROMISED

OSTEOMYELITIS-DISCITIS

- VERTEBRAL BODY: IRREGULAR T2 HYPERINTENSITY WITH POORLY DEFINED ENDPLATE MARGINS, T1 HYPOINTENSITY
- DISC: T2 HYPERINTENSITY WITH LOSS OF DISC HEIGHT
- ROBUST ENHANCEMENT OF DISC AND VERTEBRAL BODY
- PARASPINAL/EPIDURAL EXTENSION

OSTEOMYELITIS-DISCITIS

T2

T1

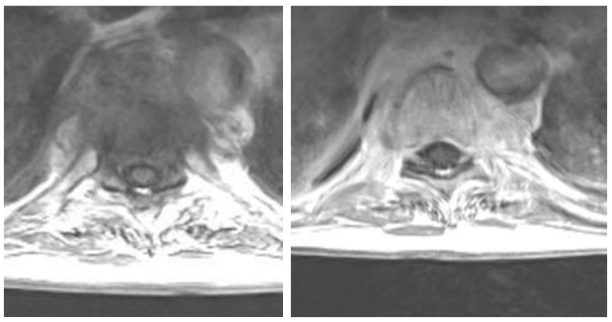
OSTEOMYELITIS-DISCITIS

T2

T1

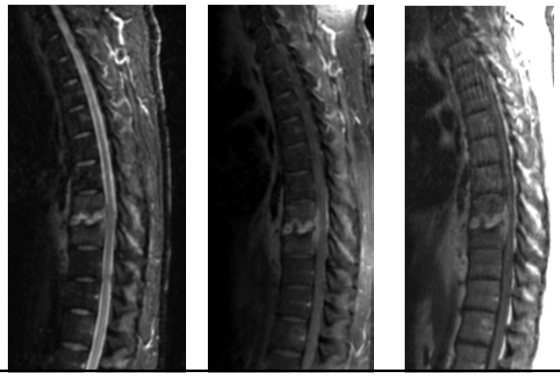
POST GAD FAT SAT T1

OSTEOMYELITIS-DISCITIS

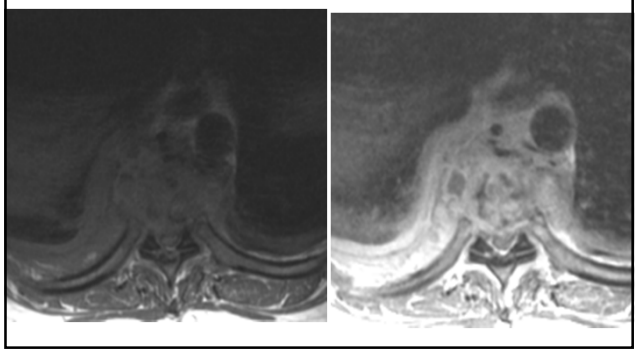


AXIAL T1 AXIAL POST-GAD T1

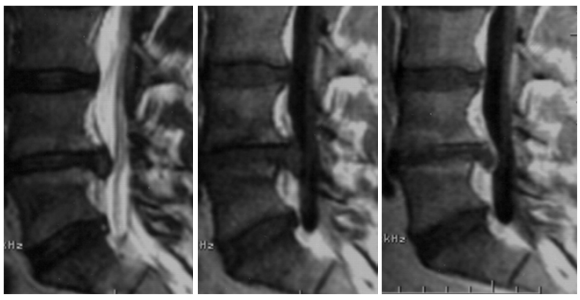
OSTEOMYELITIS-DISCITIS



OSTEOMYELITIS-DISCITIS

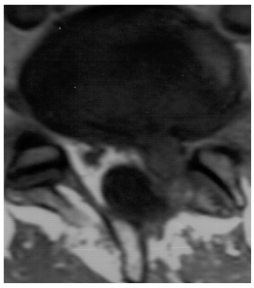


DISC VS SCAR

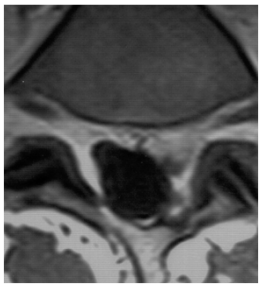


T2 T1 POST-GAD T1

SCAR VS DISC



T1

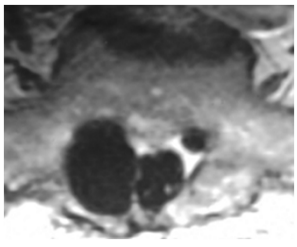


POST-GAD T1

"TARLOV", PERINEURAL, CYSTS

- OCCUR AT THE JUNCTION OF POSTERIOR NERVE ROOT AND DORSAL ROOT GANGLION (DRG)-contains neural elements
- CYSTIC NERVE ROOT DILATION-ENLARGEMENT OF SUBARACHNOID SPACE AROUND NERVE ROOT, PROXIMAL TO DRG no neural elements
- CSF SIGNAL CHARACTERISTICS: HYPOINTENSE ON T1, HYPERINTENSE ON T2
- TYPICALLY SACRAL, INCIDENTAL FINDINGS

"TARLOV", PERINEURAL, CYSTS

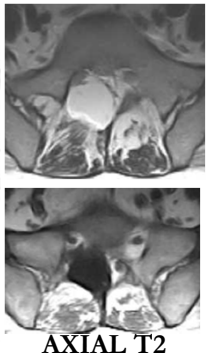


SAGITTAL AND AXIAL T1

"TARLOV", PERINEURAL, CYSTS

T2

T1



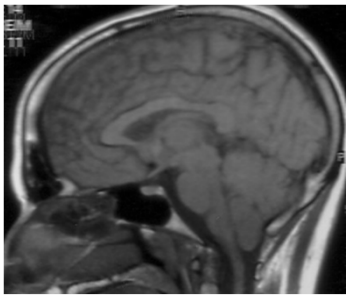
AXIAL T2 AND T1

CRANIOCERVICAL JUNCTION

T2

T1

CRANIOCERVICAL JUNCTION



CHIARI MALFORMATION, TYPE I

PANNUS WITH CORD IMPINGEMENT

ATLANTOAXIAL INSTABILITY