Imaging degenerative disk disease in the lumbar spine

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Learning Objectives

- Anatomy review
- Pathophysiology of degenerative disc disease
- Common sequelae of disk disease
  - Herniation
  - Stenosis
  - Instability
- Imaging modalities
- Clinical Outcomes
Anatomy of the three joint complex

- Degenerative disk disease is a poorly defined term.
- Often misused, but generally agreed to refer to pathology associated with repetitive traumatic injury to the “three-joint-complex” of the spine
  - Endplate-disc-endplate
  - 2 facet joints

Image courtesy of Dr. Rafael Rojas
Anatomy of the three joint complex

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Image courtesy of Dr. Rafael Rojas
Pathophysiology of disk injury

- Failure of disks most common in regions with highest mechanical stress, especially lower lumbar region.

- Disc nutrition dependent on diffusion from marrow of bone or from blood vessels through annulus.

- Whether primary pathology is usually metabolic or mechanical is not known.

Image courtesy of Dr. Rafael Rojas
Pathophysiology of disk injury continued

- Deformation of endplate and loss of water in the nucleus can lead to abnormal forces on annulus.

- Small contribution from various environmental factors like exercise, trauma.

- Twin studies suggest large role for genetic predisposition.
  - Collagen
  - Cytokines (IL-2)

Image courtesy of Dr. Rafael Rojas
Common features

- Common sequelae of disk disease
  - Herniation
  - Stenosis
  - Instability
Common features

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  - Herniation
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49 year-old woman presents for evaluation of low back pain that radiates down to her lower legs.

Do you image her?
When to image for low back pain

- 85% of people with LBP are never given a precise pathoanatomical diagnosis, even with imaging

- Imaging findings and symptoms do not correlate precisely

- Indications of a more complicated status, often termed "red flags," include the following:
  - Recent significant trauma, or milder trauma, age >50
  - Unexplained weight loss
  - Unexplained fever
  - Immunosuppression
  - History of cancer
  - Intravenous (IV) drug use
  - Prolonged use of corticosteroids, osteoporosis
  - Age >70
  - Focal neurologic deficit with progressive or disabling symptoms
  - Duration longer than 6 weeks
49 year-old woman presents for evaluation of low back pain that radiates down to her lower legs.

Do you image her?

Initially, no.

However, she returns with continuing pain after 6 weeks.
Imaging Modalities

- Plain film
- MRI – Most accurate modality for assessing intervertebral disk disease.
- CT – CT myelogram
Imaging Modalities: Plain Film

- **Plain film**
  - **Pros**
    - Fast
    - Low Cost
    - Good for bony abnormalities
  - **Cons**
    - Poor visualization of disks
    - Radiation exposure
    - Most abnormalities seen on x-ray can be better characterized on CT or MRI.
Imaging Modalities: MRI

- MRI
  - Pros:
    - Most accurate modality for assessing intervertebral disk disease.
    - Excellent for soft tissue abnormalities
    - No radiation exposure
  - Cons
    - Less useful for bony abnormalities
    - Higher cost
    - Contraindicated in patients with ferromagnetic objects in their bodies, or patients with implanted electronic devices.
    - Claustrophobia or inability to hold still for long periods of time may prevent patients from completing the MRI.
Imaging Modalities: CT

- **CT**
  - Only indicated for imaging of disk disease in patients who have contraindications to MRI.
  - **Pros:**
    - Faster than MRI
    - Good for abnormalities of bony cortex
  - **Cons:**
    - Radiation exposure
    - Poor soft tissue differentiation
- **CT myelogram**
  - CT plus injection of intrathecal contrast
  - **Pros:**
    - Much better imaging of disk pathology
  - **Cons:**
    - Invasive
    - Many contraindications, including all contraindications for lumbar puncture and those for IV contrast.
49 year-old woman presents for evaluation of low back pain that radiates down to her lower legs.

Disc bulges seen at all lumbar levels.

Classic history is pain that increases with flexion.

Pain with straight leg raise seen on exam.
Index Patient MRI and Normal Comparison

Normal C- T2 Sagittal MRI

Image courtesy of Dr. Rafael Rojas

Disk herniations seen at all lumbar levels
Index Patient: Osteophytes and Marrow Changes on MRI

Osteophytes noted at multiple spinal levels.

Abnormal stresses on bone
Ligamentous laxity

Marrow changes seen at L3/L4
Abnormal stresses on the vertebrae

Edema from vascular congestion
Companion Patient: Annular Tear on MRI

35 yo male with history of LBP and R sided radiculopathy and groin pain.

Radial annular tear seen as hyperintensity at L5/S1

Image courtesy of Dr. Rafael Rojas
76-year-old female with a longstanding history of low back pain, and a more recent history of radiating left leg pain provoked by walking.

- Note signs of disk disease:
  - Decreased intervertebral height
  - Endplate sclerosis
  - Osteophyte formation
Common features

- Common sequelae of disk disease
  - Herniation
  - Stenosis
  - Instability
Index Patient: Spinal stenosis on MRI

Spinal stenosis:
- Constriction of canal and foramina commonly caused by:
  - Anteriorly
    - herniated disks
  - Posteriorly
    - enlarged ligamentum flavum
    - Facet hypertrophy
- Symptoms improve with flexion and worsen with activity (“neurogenic claudication”).
Index Patient: Spinal stenosis on MRI with normal comparison

Image provided by Dr. Rafael Rojas
Common features

- Common sequelae of disk disease
  - Herniation
  - Stenosis
  - Instability
Companion Patient: spondylolysis on plain film

- Spondylolyses are fractures through the pars interarticularis
  - Most commonly caused by repetitive mechanical injury.
  - Results in spinal instability, often with anterior displacement of superior vertebral body

Spondylolysis at L5/S1
Companion Patient: the Scotty dog sign on plain film
Companion Patient: Spondylolisthesis on Plain Film

- **Subtypes**
  - **Degenerative**
    - Subluxation at facet joints
    - Normal or narrow canal
  - **Isthmic**
    - Due to spondylolysis (seen in 6% of adults)
    - Widened canal

Anterior displacement of L5 on S1
Companion Patient: Spondylolisthesis on CT

68 year old man with LBP after a fall

- Reasons to order CT:
  - Better for bony cortex
  - Osteophytes
  - Trauma
  - MRI contraindications

Anterior displacement of L5 on S1
Index Patient: Instability on plain film

- Leftward listhesis
- Disk space narrowing
- Due to ligament laxity and degenerative joint disease
Clinical Outcomes

- So you see degenerative disk disease on imaging...now what?

  - Studies have found 25-64% of asymptomatic patients have disk herniations

  - 2/3 of patients with symptomatic disc herniation have significant resolution of symptoms at 6 months.

  - Radiologic findings do not correlate well with surgical outcomes

  - Surgery may be useful in symptomatic patients with signs of nerve root compression or severe canal narrowing if conservative therapy has failed
Take Home Points

- Imaging not indicated for LBP unless more than 6 weeks have past or a **red flag** is present in the history

- Imaging of choice for DDD is **non-contrast MRI**

- Common complications of DDD include disk herniation, spinal stenosis, and joint instability

- Imaging findings do **not** correlate well with symptom severity or surgical outcome

- In the majority of cases, conservative management will lead to significant resolution of symptoms


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