“MRI of the Hip”
Wednesday, May 2nd, 2018 - 12 noon

REGISTER YOUR ATTENDANCE ON ETA

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MRI of the Hip

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Disclosures:
• Consultant: BioClinica
• Advisory Board: GE, Philips
• Book Royalties: Elsevier
• Not relevant to this talk

Note: all ultrasound images from the textbook Fundamentals of Musculoskeletal Ultrasound are copyrighted by Elsevier Inc.

Take Home Points
• Joint effusion: does not collect dependently
• Imaging for FAI is unreliable
• Bone marrow edema:
  – Is not early osteonecrosis
  – Is likely from insufficiency fracture
• Insufficiency fracture: MRI is best
• Trochanteric bursitis is uncommon

Outline:
• Hip joint
• Labrum and FAI
• Osteonecrosis
• Fractures
• Trochanteric pain syndrome

Joint Pathology
• Effusion:
  – Reactive, inflammation, hemorrhosis
• Synovial hypertrophy:
  – Inflammatory: rheumatoid, atypical infection
  – Proliferative: PVNS, synovial chondromatosis
  – Characterized: enhancement
Hip Joint: anatomy

- Distal extent: to intertrochanteric line
- Recess: between labrum and capsule
- Does not collect dependently
  - Surrounds femoral neck
- Iliopsoas bursa:
  - Normal joint communication in 15 - 20%
- Obturator externus bursa: <10%

1 Moss et al. Radiology 1998; 208:43
2 Robinson P et al. Radiology 2003; 210:499

Injection / Aspiration: fluoroscopy

- 75% direct anterior
- 24% oblique anterior
- 1% direct lateral

Shortt. Skeletal Radiol 2009; 38:377

Iliopsoas Bursa

Arthrogram

Iliopsoas Bursa: distention

- Anterior and posterior layers
  - Fibrous tissue + minute layer of synovium
  - Hyperechoic
  - Each 2 - 4 mm thick

Radiology 1999; 210:499

Hip: anterior recess
Pigmented Villonodular Synovitis

- Benign synovial proliferation
- Synovial hyperplasia
  - Multinucleated giant cells
  - Lipid-laden macrophages
  - Hemosiderin deposition
- Monoarticular: localized or diffuse

Lin et al. AJR 1999; 172:191

Synovial Chondromatosis

- Benign cartilaginous metaplasia
- Large joints: knee and hip
- May or may not ossify
- May detach: intra-articular bodies
Total Hip Arthroplasty

- Metal-on-metal articulation
- Wear debris, hypersensitivity
  - Joint effusion synovitis
  - Bursa distention
- Pseudo-tumor:
  - Soft tissue: necrosis, inflammation
  - Ultrasound: 99% sensitive\(^1\)
  - MRI: effective\(^2\)

\(^2\)Garbuz DS Clin Orthop Relat Res 2014; 472:417

Take Home Points

- Joint effusion: does not collect dependently

Labral Tear: MR arthrography

- Abnormal contrast extension into labrum
- Improved sensitivity: 50% (MRI) to 81%\(^1\)
- Anterior: most common
- Classify:
  - Degeneration: gray signal
  - Partial tear, full-thickness tear
  - Detachment

\(^1\)Sutter R et al. AJR 2014; 202:160

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Labrum: degeneration

Note hip osteophytes (white arrows)
Anterior Labrum: sagittal T1-w fat sat

Tear
Normal

Anterior Labrum: axial T1-w fat sat

Tear
Normal

Labrum Tear: full-thickness

Labral Detachment

Hip Labrum: normal variants
- Sublabral sulcus
- Posteroinferior groove
- Pectinofoveal fold
- Supra-acetabular fossa

Hip Joint: sublabral sulcus
- Smooth contrast-filled cleft: <50%
- Junction of labrum and hyaline cartilage
- No labral detachment
- No labral abnormality

Saddik. AJR 2006; 187:W507
Sublabral Sulcus

Hip Joint: posteroinferior groove
- Normal variant: 22.4%
- Posteroinferior quadrant
- Near transverse ligament: inferior

Dinauer PA et al. AJR 2004; 183:1745

Posteroinferior Groove

Hip Joint: pectinofoveal fold
- Seen at MR arthrography: 95%
- Variable appearances
- Variable attachments
  - Usually inserts onto capsule
  - May insert onto femur

Blankenbaker D et al. AJR 2009; 192:93

Hip Joint: supra-acetabular fossa
- Pseudodefect of acetabular cartilage
  - Type 1: 1.6%
    - Bony fossa filled with contrast
  - Type 2: 8.9%
    - Bony fossa filled with cartilage

Dietrich TJ et al. Radiology 2012; 263:484

Supra-acetabular Fossa: Type 1

From Dietrich TJ et al. Radiology 2012; 263:484
Supra-acetabular Fossa: Type 2 (white arrow)

Note (black arrow): supra-acetabular roof notch (another normal variant)

From Dietrich TJ et al. Radiology 2012; 263:484

Labral Tear + Paralabral Cyst

Coronal T1w

Paralabral Cyst

- Multilocular, fluid signal
- Associated with labral tear: detachment
- Fill with intra-articular contrast: 94%
- Extend extra-articular: 72%
- Remodel adjacent ilium: 50%

Magerkurth O et al. Skeletal Radiol 2012; 41:1279

Labrum Tear + Paralabral Cyst

Labral Tear: location

- Anterior: iliopsoas tendon impingement
- Anterior or anterosuperior:
  - Associated with CAM-type femoroacetabular impingement
- Posterolateral tear:
  - Pincer-type femoroacetabular impingement
  - Leveraging effect

Aly AR et al. Skeletal Radiol 2013; 42:1245

Femoroacetabular Impingement

- CAM-type
- Pincer type
- Combination of both: most common

Brian P et al. Semin Roentgenol 2010; :230
CAM-type FAI:
- Extra bone:
  - Femoral head-neck junction
- Hip flexion / internal rotation:
  - Contact between extra bone and anterior labrum
- Labral tear, cartilage injury

CAM = a mechanical linkage that translates motion

FAI: pathology
- Radiograph: femur
  - Pistol-grip deformity
  - Fibrocystic change
- MRI: alpha angle >50 degrees
- MR arthrography:
  - Improved sensitivity acetabular cartilage: 83% (MRI) to 92%¹
  - No advantage: femoral cartilage defects

¹Sutter R et al. AJR 2014; 202:160

CAM-type FAI: Pistol-grip deformity

Pitfalls
- Pseudo-bump
  - Capsular reflection
  - Low signal
- Pseudo-labral tear
  - Adjacent iliopsoas tendon
  - Low signal
  - Simulates displaced labral tissue

Alpha Angle
Abnormal: >50 degrees

Iliopsoas
Capsule
Oblique
Pincer-type FAI:
• Deep hip socket or retroverted acetabulum
• Abnormal contact between acetabular rim and labrum
• Radiograph: cross-over sign
• MRI: acetabular retroversion

Pincer-type FAI: Cross-over sign

Note: distance between sacrococcygeal junction and pubis should be between 3 and 4 cm

Pincer-type FAI: Otto Pelvis (idiopathic acetabular protrusio)

FAI: imaging findings
• Radiography: inaccurate
  – Pistol-grip and fibrocystic change
  – Cross-over sign
• Alpha angle measurements:
  – Unacceptable intra- and inter-observer variability
  – Does not correlate with physical exam findings
  – Osseous bump: not always anterior

Femoral head and acetabulum: medial to ilioischial line
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Osteonecrosis: terminology

• Involving end of a bone:
  – Avascular necrosis
  – Aseptic necrosis
• Diaphysis or metaphysis:
  – Bone infarct

Osteonecrosis: etiology

• Anemia (sickle cell)
• Steroids
• Etoh
• Pancreatitis
• Trauma
• Idiopathic
• Caisson disease or Chronic renal failure (children)

Osteonecrosis: classification

• Modified Ficat
• 1: symptoms but normal radiographs
  – 1A: abnormal MRI; 1B: abnormal bone scan
• 2: radiograph positive- mixed lucent sclerotic
• 3: subchondral lucency (crescent sign)
  – 3A: without collapse; 3B: with collapse
• 4: osteoarthrosis


Osteonecrosis

Note early flattening or collapse
**Osteonecrosis: MRI findings**

- Serpiginous, geographic low signal
  - Represents interface, not necessarily calcified
  - Bone marrow edema NOT early osteonecrosis
    - Weight-bearing aspect of femoral head
- Internal signal: variable
- Double line sign: pathognomonic
  - High signal (T2w) inside low signal line

1. Kim YM et al. JBJS 2010; 82B:837

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**Isolated Bone Marrow Edema**

- In the past, was called:
  - Transient osteoporosis of the hip
  - Transient bone marrow edema syndrome
- Now: due to insufficiency fracture
  - Look for discontinuous linear low signal
  - Subcortical, parallel to cortex
  - Subtle collapse, little femoral head abnormality
- Is NOT a early finding of osteonecrosis

**Insufficiency Fracture**

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**Femur Fractures: etiology**

- Traumatic
- Stress
  - Insufficiency-type:
    - Normal stress on abnormal bone
    - Osteopenia, bisphosphonate-related
  - Fatigue-type:
    - Abnormal stress on normal bone
- Pathologic

**Fractures: femur**

- Intra-capsular
  - Subcapital
  - Transcervical
  - Basicervical
- Extra-capsular
  - Inter-trochanteric
  - Sub-trochanteric
  - Peri-trochanteric
  - Trochanteric

**Fractures: femur**

- MRI findings:
  - Bone marrow edema
  - T1w and PDw: linear low signal fracture line
  - T2w: low or high signal fracture line
- MRI is much better than CT
  - Sensitivity (insufficiency): MRI 99%, CT 69%
- MRI most accurately shows extent of fracture

\(^1\)Cabarrus MC et al. AJR 2008; 191:995
Proximal Femur Fracture: MRI

Garden Classification
1. Incomplete, valgus impacted
2. Complete, non-displaced
3. Displaced, angulated
4. Displaced

Garden 3 or 4 = hip replacement because of osteonecrosis risk

Femoral Neck Fracture: now displaced

Intertrochanteric Fracture

Subtrochanteric Fracture
Fracture: bisphosphonate

- To treat osteoporosis: *i.e.* Fosamax
  - Inhibits osteoclasts, may slow bone turnover
- Increased risk of fracture:
  - Average treatment at fracture: 6 years
  - Femur: subtrochanteric, diaphyseal, lateral cortex
- Early sign: periosteal reaction
  - 2% are asymptomatic at early stage
  - Black line: fracture likely progresses

Chen SS et al. AJR 2010; 194:1581

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Trochanteric Pain Syndrome:

• Trochanteric bursitis: uncommon\(^1\)
  – Up to 20% of subjects\(^2\)
  – Not actually inflamed\(^3\)
  – Not associated with pain\(^4\)
• Gluteus tendinosis: 50%\(^1\)

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2Long SS et al. AJR 2013; 201:1083
3Silva F et al. Clin Rheumatol 2008; 14:52
4Blankenbaker et al. Skeletal Radiol 2008; 37:903

Greater Trochanter: gluteal tendons

Greater Trochanter

Pfirrmann et al. Radiology 2001; 221:469

Trochanteric Bursa Distention

Peritrochanteric Fluid Signal

• Tendon:
  – Gray: tendinosis; Fluid signal: tear
  – Calcific tendinosis
• Bursa
• Diffuse soft tissue: common finding
  – Doesn’t correlate with present\(^5\)
  – Likely irrelevant if symmetric

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Syllabus on line and other educational material:
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