MRI of the Hip:
Femoroacetabular Impingement (FAI)

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Contributions from Dr. Suzanne Anderson
Femoroacetabular Impingement

- Major cause of hip labral tears and cartilage damage
- Leads to OA of the hip
- Related to morphologic variants/abnormalities of the femur and/or acetabulum
Femoroacetabular Impingement

• Abnormal contact between prox femur and the acetabular rim with repetitive motion

Primary Test
Flexion, Adduction, Internal Rotation
(FAIR)

*Tannast M, et al. AJR 2007;188:1540-1552*
Femoroacetabular Impingement

- Cam - younger males
  - Femoral cause
  - Asphericity
    anterior/lateral femoral head-neck junction
- Pincer - middle aged female
  - Acetabular cause
  - Overcoverage contacts
    femoral head-neck jct
    - Retroversion
    - Coxa profunda or
      protrusio acetabulum

Femoroacetabular Impingement

• Beck et al 302 FAI analysed hips
  – 26 isolated cam
  – 16 isolated pincer
  – 14% pure FAI form
  – Remainder mixed cam-pincer FAI -86%

Beck M et al JBJS, B 2005
Femoroacetabular Impingement
Cam Type

Pistol Grip Deformity =
Lateral Femoral Waist Deficiency
or
Loss of femoral head-neck offset
Femur: Cam Impingement

Nonspherical femoral head

Changes rotary motion to linear motion
Femoroacetabular Impingement
Pincer Type

- Acetab overcoverage
  - Retroversion
    - Figure of 8-anterior overcoverage
  - Coxa profunda/protrusio
- Leads to
  - Labral tears & degeneration cartilage
  - Small rim chondral lesions posteroinferior acetabulum
Pincer Impingement
Femoral Head Defect
Femoroacetabular Impingement

Pincer Type

- Acetab overcoverage
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    - Figure of 8-anterior overcoverage
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Reynolds et al, JBJS-B 1999
Local Excessive Coverage

Normal

Retroversion
General Overcoverage
Normal Hip Jt Space Model

Normal
Femoral head
Ilioischial line
Acetabular fossa

Coxa profunda

Protrusio acetabuli

Beck M et al, Clin Orthop, 2004
Acetabular Depth
Axial Cross Section

- Abnormal
  - Can be associated with pincer FAI
- Point in center of femoral head lies medial to a line drawn between front and back of acetabulum
Pincer (protrusio acetabuli): acetabular depth deeper

Cam: acetabular depth shallower

Pfirrmann C et al Radiology 2006;240(3):778-785

Acetabular protrusion
Chen L et al Skeletal Radiol 2008
Femoroacetabular Impingement
Femoral Cause = Cam Type

• Aspherical femoral head/neck junction
  – ↓Concavity at the anterior or lateral femoral head-neck junction
• Premature contact b/t femur and acetabular rim
• Triad
  – Anterior loss of head-neck junction offset (bump)
  – Anterosuperior labral tear
  – Adjacent chondrosis
Femoroacetabular Impingement
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Femoroacetabular Impingement

Alpha Angle

- Method to quantify femoral head neck offset
- Measured on oblique axial section parallel to femoral neck and passing through narrowest portion of femoral neck
- > 55 degrees predisposes to cam impingement

*Kassarjian et al. Radiology 2005;236:588

Normal Alpha Angle <55 degrees
Femoroacetabular Impingement
Abnormal Alpha Angle

Hip Labrum

- Static stabilizer
  - Increases depth of acetabulum
  - Maintains intra-articular pressure
- Has pain receptors
- Tears do not heal
- Tears lead to cartilage stress and injury
Hip Labrum

- Fibrocartilaginous labrum rims outer acetabulum
- Triangular (66%)
  - Decreases in older population
- Heterogeneous SI
  - With aging
- Absence (1-14%) and sublabral sulcus
  - NI variant vs. degenerative
Labral Tear
MR Arthrography

- Study of 35 patients
- MR arthrography
- Surgical correlation
- Sensitivity
  - 91%-92%
- Specificity
  - 71%-100%

Czerny C et al. AJR 1999;173:345
Toomayan GA et al. AJR 2006;186:449
Labral Tears

- Four quadrants
  - Anterior
  - Anterosuperior
  - Posterosuperior
  - Posterior
- Most tears in anterior or anterosuperior portion (3-11 o’clock)
- Two types of morphology
  - Detachment or avulsion from cartilage
    - Most common
  - Intrasubstance

*Siebenrock KA, et al. JBJS 2003;85-A:278*
MR Arthrography Technique

- 20-22 g spinal needle
- Needle tip-bone contact at femoral head-neck junction
- Aspirate, then inject small amt of iodinated contrast
- 10 cc dilute gad
  - .1 cc gad
  - 5 cc Ropivacaine
  - 15 cc saline
Direct Hip MR Arthrography

Technical Considerations

Image Single Hip Protocol

- Coronal T1 + T1 FS
- Coronal FSE PD FS or STIR
- Oblique axial T1FS (parallel to long axis of femoral neck)
- Sagittal T1 FS

Cor T1 Scout For Obl Axial Plane
Hip Labrum
Coronal Plane-Ant and Post Sup

Perilabral recess

Anterosuperior
Posterosuperior
Hip Labrum
Oblique Axial Plane-Ant & Post

Anterior

Posterior
Sublabral Recess

Seen in 18% of hips

Studler U et al. Radiology 2008;249:947-954
Anterior and Posterior Labral Cleft
Sublabral Recess vs. Tear

Anterior Cleft

Posterior Cleft
Hip Labrum
Sagittal Plane

Normal

Tear
Labral Tear
MR Description

• Amount of residual labral tissue
• Orientation of intrasubstance tears
• Presence of labrocapsular detachment
• Condition of adjacent cartilage
Cartilage Damage

- Underestimated by MRI
  - Sensitivity 47-79%
  - Specificity 77-89%
- Descriptions
  - Size
  - Location
  - Defect thickness
  - Subchondral bone interface
  - Subjacent marrow signal
Other Findings with FAI

- Herniation pit
  - 1-2 cm
  - Round or oval lytic lesion
  - Anterior femoral neck
  - Some are related to acetabular impingement

- Labral ossification
  - Os acetabulum
  - Double contour sign
  - Stress fracture acet rim
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Leunig M, et al. Radiology 236;237-246
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*Ganz R et al CORR 2003*
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Paralabral Cyst

- Benign cystic lesion in acetabular roof or posterolateral soft tissues
- Association with labral tear
- May erode bone, contain gas
- More common with hip dysplasia than FAI
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Femoroacetabular Impingement Treatments

- Periacetabular osteotomy
- Labral debridement
- Cartilage debridement or repair
- Remove excessive femoral bone
  – Excision osteoplasty

Correction of acetabular retroversion

*Siebenrock KA, et al. JBJS 2003;85-A:278
Femoroacetabular Impingement
Open and Arthroscopic Surgery

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FAI Pre-Op and Post-Op
Femoral Osteoplasty

Pre-op

Post-op
Post Op FAI
Femoral Osteoplasty
Post Op FAI Complications

- Residual or recurrent labral tear or detachment
- Scarring or fibrosis
- Adhesions
- Synovitis
- Heterotopic bone
- Spurring on resected bump

Adhesions
Post Op FAI
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FAI Surgery ➔ THR
Femoroacetabular Impingement

Acetabulum (excessive coverage) = Pincer impingement

Femur (nonspherical head) = Cam Impingement

General (Coxa profunda, Protrusio acetabuli)

Focal Prominence (Anterior or Posterior)

Osseous bump (Lateral or Anterosuperior)

Femoral retroversion, Coxa vara
MRI of the Hip

Femoroacetabular Impingement

- It is important for the radiologist to be aware of the features of FAI
- FAI can cause hip pain and predisposes patients to later osteoarthritis
- FAI has certain characteristics related to the femoral head neck junction and acetabulum that are best seen on MRI
- MR arthrography aids in evaluation of the labrum and cartilage
- Open and arthroscopic surgical treatment is being widely performed in the orthopedic community