Pediatric MR Imaging of the Hip in the Age of FAI

Jerry R. Dwek MD
Rady Children’s Hospital and Health Center
San Diego Imaging
University of California at San Diego
Disclosures

• None
Femoral Acetabular Impingement

- Impingements
  - Pincer
    - Acetabular sided
  - Cam
    - Femoral sided
- Most are mixed!
• If acetabulum is too deep or not shaped correctly the acetabular rims will pinch the femoral necks.
If femoral neck is too thick, femur will knock against superolateral acetabulum.
Pincer Impingement
Acetabular Assessment

• Assess film
  – Posterior wall
  – Anterior wall
  – pelvic inclination
• Crossover sign?
• Posterior wall sign?
• Ischial spine too prominent?
• Coxa profunda and protrusio?
Crossover Sign

- Trace anterior wall
- Trace posterior wall
Pelvic Inclination

- Cranial or caudal angulation of pelvis
- Normal tilt is 60 degrees
  - Line from sacral promontory to top of symphysis relative to horizontal
Pelvic Inclination

• Increasing pelvic inclination (front goes down) increases crossover sign
• Decreasing pelvic inclination decreases crossover sign
Pelvic Inclination Radiograph

- Distance between sacroccocygeal joint and upper border of symphysis
- Sex dependent
  - Males 3.2 cm
  - Females 4.7 cm
Crossover Sign

- Must use AP pelvis
- AP hip changes angle of beam to acetabular rims and same rules do not apply

Tannast M et al. AJR 2007;188:1540-1552
Posterior Wall Sign

- Posterior wall usually intersects center of femoral head
- If it is medial, sign is positive and associated with crossover
- If lateral, may indicate overcoverage too
• Coxa profunda
  – Medial acetabular wall projects medial to ilioischial line
Protrusio Acetabuli

- Acetabular protrusio
  - Femoral head projects medial to the ilioischial line
Protrusio And Profunda

- Uncommon in pediatrics
  - Marfan's syndrome
  - Osteomalacia
• Anterosuperior labral tear occurs first, followed by progressive posteroinferior chondral (contre-coup) injury
Pincer by Cross-sectional Imaging

- Overall acetabular depth
- Acetabular version
Overall Depth
• Anterior lip must lie medial to posterior lip Everywhere!
Cam Impingement

- During abduction, femoral neck must have enough concavity to accommodate protruding superolateral acetabulum
- Femoral waist deficiency
FAL: Causes

- Slipped capital femoral epiphysis, Perthes
  - Pistol grip deformity
FAI: Causes

• Inferior physeal extension
  – Greater trochanter and femoral head have one physis till age 5-6 yo
  – Effect of delayed separation?
  – If neck physis remains, neck thickens
FAI: Causes

- Supernormal motion?

Could repetitive trauma cause hyperostotic response along femoral neck?
Cam Impingement: Radiography

- To assess anterior femoral neck a lateral view is needed
  - Cross-table lateral
  - Dunn Rippstein
- Anterior femoral neck must be concave

Tannast M et al. AJR 2007;188:1540-1552
• Cavitary change at anterior femoral neck described by Michael Pitt (1982)
• Commented that it as associated with degenerative change
• Occurs in large percentage of people with FAI
Fibrocystic Change
Cam Impingement: Imaging

- Standard post arthrographic sequences:
  - T1
  - T1 fat saturated
  - T2 fat saturated
    - Include true sagittal
- Radial sequences
  - Direct vs. reconstructed
• Femoral neck is undeniably concave on every image
Radial Imaging

- Direct vs. reconstructed
- Interleaved to reduce crosstalk
Radial Imaging

- Allows not only dx of tears
- Also allows characterization of contour of femoral neck circumferentially
Alpha Angle

- Make best fit circle around femoral head
- Line down femoral neck
- Line to point at which the femoral neck lies outside the circle
- Measure angle
Alpha Angle

- Not so fast there!
  - Difficult to measure accurately
  - Alpha angle varies along different aspects of femoral neck
  - Many normals have alpha angles in range of abnormal
    - Especially anterosuperiorly
What Is Normal
Radial Hip Imaging

- Controversial amongst radiologists
- NOT controversial amongst orthopedic surgeons
- Standard imaging in Bern
Labrum is a smooth triangular structure which is black
Rules

- Contrast passing completely through labrum is always a tear
Rules

- A paralabral cyst almost always indicates a tear
Normal Labral Clefts

- An incomplete incursion of contrast into the labrum
- Descriptions vary in literature
- Most described in posterosuperior or anteroinferior area
Cleft vs Tear

- All agree anterosuperior clefts are rare
- Anterosuperior usually tears
- Patients with abnormal morphology and signal abnormality in labrum should not be diagnosed with cleft
Osteoarthritis is a disease which begins in adolescence.

Pediatric radiologists need to pay attention to early articular cartilage changes in the young.
• Understanding articular cartilage and processes that destroy are of overarching importance

• It is our job to predict the future not purely describe the past
Articular Cartilage

- Unfortunately difficult to see cartilage injury well in hip
- Examine closely tear at chondrolabral junction
  - Labral tear may extend into articular cartilage
• Delamination tears run along intermediate and deep zones like a carpet burn
  – Deep bright signal along delamination, low signal superficially
All sequences use a multiphase acquisition in which TE or is kept stable while the other parameter varies

- T1 mapping = dGEMRIC
- T2 mapping
- T1 rho
Marfan’s Disease

• Clinical problem:
  Protrusio: What is state of cartilage
  – medial aspect of femoral head protrudes beyond ilioischial line
Abnormal Signal on Both Sides of Joint
Multiple Images with Increasing TE’s
T1 Mapping

- IV contrast and delayed imaging: dGEMRIC
- Multiple T1 sequences with rising TR
- No need for IV if contrast already in joint
T1 rho examines the dephasing of macromolecules (proteoglycans) while locking the spins of smaller entities.
Conclusions

- Assess morphology
- Be very critical of labrum
- Concentrate on articular cartilage