Sports Related Hip Disorders in Children and Adolescents

Sarah D. Bixby
Department of Radiology
Boston Children’s Hospital
Boston, MA
Imaging the Painful Hip

- Plain radiographs of pelvis and hips
  - AP and frog-leg views
  - No pelvic shield on first AP radiograph
  - Cross-table lateral radiograph (if patient unable to externally rotate)
Lateral Hip Radiographs

- Frog-leg
- Dunn
- False Profile
- Cross-table
Lateral Hip Radiographs

• **Frog-leg:** SCFE, LCP, femoral head lesions, screening

• **False Profile:** DDH, Pincer impingement

• **Cross-table:** Femoral neck lesions and fractures

• **Dunn:** Cam-type femoroacetabular impingement (FAI)
Sports (+/-) Related Hip Injuries

- Slipped Capital Femoral Epiphysis
- Traumatic Hip Dislocation
- Femoral Neck Stress Fracture
- Avulsion Fractures
- Athletic Pubalgia
- Femoroacetabular Impingement
- Mimics
14 yo male with anterior hip pain x 1 month
Slipped Capital Femoral Epiphysis

- **THE** “Don’t Miss” diagnosis!
- Most common adolescent hip disorder
- Salter I fracture
- Risk factors:
  - Obesity
  - Hypothyroidism
  - Growth spurt
Slipped Capital Femoral Epiphysis

- Radiographs may be normal in a “Pre-Slip” (especially if contralateral hip not available as a control)
  - MRI useful
    - Physeal widening
    - Metaphyseal marrow edema
    - Joint effusion
    - Synovitis

Left hip pain; Normal or Abnormal?
Slipped Capital Femoral Epiphysis
Slipped Capital Femoral Epiphysis
Epiphyseal Tubercle Radiolucency
Missed SCFE?

15 year old male with chronic hip pain
Slipped Capital Femoral Epiphysis

In situ screw fixation

Modified Dunn osteotomy
Slipped Capital Femoral Epiphysis

- 26% risk of AVN
- Technically challenging (compared to in situ pinning). Tertiary care centers
14 year old football player; left hip pain after tackle
14 year old football player; left hip pain after tackle

2 years later, persistent limp
Posterior Hip Dislocation
Posterior Hip Dislocation

- Top 3 Causes of Posterior Hip Dislocation in Children at BCH
  - Football injuries
  - Snow sports (falls while skiing)
  - MVC
Posterior Hip Dislocation with Labral Entrapment
Posterior Hip Dislocation with Labral Entrapment
Posterior Hip Dislocation with Labral Entrapment

- Presence of entrapped labrum changes management
- Surgical dislocation may be necessary to repair labrum
- If posterior dislocation clinically suspected, MRI to evaluate for both osseous and soft tissue injury
Posterior Hip Dislocation with Labral Entrapment
Complications of Posterior Hip Dislocation

• **Arthrosis**
  – Most common complication (up to 24%)
  – Related to chondrocyte damage at time of injury

• **Avascular Necrosis**
  – Increased risk with >6 hours to reduction
  – Rare in children

• **Sciatic Nerve Injury**
Femoral Neck Stress Fracture

• Uncommon location for stress injury (tibia, metatarsals)
• Female > male
  • **Female athlete triad**: low-energy availability, functional hypothalamic amenorrhea, and osteoporosis
• High risk for progression
• Radiographs usually 1st diagnostic test ordered
  • Sensitivity 10% in early stage
  • Usually only seen on AP radiograph
Femoral Neck Stress Fracture

- MRI more sensitive than radiographs
- MRI grade correlates with time to return to sport:
  - Grade 1: mild marrow edema with no fracture line
  - Grade 2: moderate edema, no fracture line
  - Grade 3: severe edema
  - Grade 4: edema + fracture
Femoral Neck Stress Fracture

- 14 year old female athlete with pain over left ASIS

Grade 1 stress fracture
Femoral Neck Stress Fracture

- 20 year old female runner with right hip pain

Grade 1 stress fracture
Femoral Neck Stress Fracture

Grade 3 stress fracture
Femoral Neck Stress Fracture

Grade 4 stress fracture
Athletic Pubalgia

- “Sports hernia”
- Strain or tear of soft tissue in the lower abdomen/groin
- Most common in sports with twisting at waist
Athletic Pubalgia

- Specific MRI protocol angled to pubic symphysis:
  - Adductor tears
  - Osteitis pubis
  - Sports hernia
18 year old male with right hip pain

Right adductor longus tendinopathy
Osteitis Pubis:
- Pubic symphysis has numerous musculotendinous connections
- Chronic repetitive shear and distraction injuries
- Sclerosis, osteolysis, physeal widening
Athletic Pubalgia

- Osteitis Pubis:
  - Pubic symphysis has numerous musculotendinous connections
  - Chronic repetitive shear and distraction injuries
  - Sclerosis, osteolysis, physeal widening
Ischial Avulsion Fracture
14 year old male with right hip pain

- Ischial growth plate open until age ~20-25 years
- Nondisplaced fractures treated conservatively
- Displacement > 2 cm require surgical fixation

Ischial apophyseal avulsion at semimembranosus attachment
Ischial Avulsion Fracture

14 year old male with right hip pain

Ischial apophyseal avulsion at semimembranosus attachment
Ischial Avulsion Fracture

16 year old male with football injury and left hip pain

Ischial apophyseal avulsion at hamstrings attachment
Ischial Avulsion Fracture
Ischial Avulsion Fracture
AIIS Avulsion → Extra-articular FAI

15 year old male with right hip pain and s/sx FAI
15 year old male with right hip pain and s/sx FAI

AIIS Avulsion → Extra-articular FAI

Extra-articular/Subspinous impingement

Post-op
AIIS Avulsion $\rightarrow$ Extra-articular FAI

13 year old female with right hip pain

Date of injury 1 year later
AIIS Avulsion → Extra-articular FAI

Arthrogram findings:
• Direct impingement of FN on AIIS
• Lever effect with hip abduction
13 year old female with right hip pain after soccer injury
Femoroacetabular Impingement (FAI)

– Repetitive “collisions” between femur and acetabular rim
  • Morphologic alterations femur and/or acetabulum
  • Extremes of hip motion/activity

Background

Cam FAI
Alpha Angle

Abnormal values

- $> 50 \, ^\circ$

- $> 50.5 \, ^\circ$
  - Hack K et al. JBJS Am 2010;92:2436-2444.

- $> 60 \, ^\circ$

- $> 63 \, ^\circ$
  - Pollard TC. Acta Orthopaedica 2010;81:134-141

- $> 83 \, ^\circ$
  - Jung KA et al. JBJS Br 2011;93:1303-1307
Cam FAI
Alpha Angle

Artwork courtesy of Andrew Phelps MD
Radial MRI Imaging

- Imaging planes rotate around a fixed central point
- Creates images orthogonal to points on the circumference of a circular surface
Radial MRI Imaging

- **Labrum:** Planes rotate around acetabulum
- **Useful in MR arthrography**
Radial MRI Imaging

- **Labrum:** Planes rotate around acetabulum
- Useful in MR arthrography

Anterior

Posterior

ACETABULUM
Radial MRI Imaging

- **Femoral head/neck morphology**: Reformatted along axis of femoral neck
Radial MRI Imaging

3D SPACE

3D True Fisp
Radial MRI

9 o’ clock
10:30
12:00
1:30
Cam FAI
Cam FAI

• Etiology:
  – Developmental?
  – Traumatic?
  – Genetic?

10 year old male with abdominal pain
AP scout image from abdominal CT
Cam FAI

10 year old male with abdominal pain
AP scout image from abdominal CT

Same patient at age 18 years
AP scout image from abdominal CT
Cam FAI

- MRI for FAI:
  - Acetabular cartilage damage
  - Labral tear

1. Cartilage delamination
2. Labral tear
What do these patients have in common?

14 year old female with left hip pain

16 year old male with left hip pain
Acetabular “rim fracture”

- May be present in both DDH and FAI
- 3.6% of FAI patients have rim fracture
- Related to abnormal acetabular development and/or stress fractures of the acetabular rim
- Can be excised in their entirety, partially excised, or left in situ
- **Treatment dilemma:** rim fracture with intact articular cartilage that contributes to joint stability
Rim Fragment – Fracture vs. Ossicle?

Unfused ossicle

Different patient, asymptomatic
Healed “fracture” after correcting the dysplasia with PAO
Rim Fragment - DDH

Articular cartilage spans fragment

Healed “fracture” s/p PAO
Rim Fragment - FAI

- Os acetabuli/rim fractures described in 3.6% of patients with FAI
- May be excised in their entirety, partial resection, or internal fixation (versus left alone).
Rim Fracture - FAI

Corrected LCE angle <<< 20 degrees
Rim Fracture - FAI
Rim Fragments - FAI

- CE angles should be measured with and without rim fragment*
- Complete resection of fragments may lead to iatrogenic instability*
- Preoperative CT or MRI can help define the fragments and associated articular cartilage

Rim Fracture - FAI

14 year old male competitive soccer player with progressive hip pain
Rim Fracture - FAI

17 year old male soccer and lacrosse player with right hip pain
Rim Fracture - FAI
17 year old male soccer and lacrosse player with right hip pain

s/p Head/neck osteoplasty
Healed Rim Fracture
Think Outside the Cam

18 year old male track athlete with right hip pain, “most likely FAI”
Think Outside the Cam

18 year old male track athlete with right hip pain, “most likely FAI”
Think Outside the Cam
Spondyloarthritis
15 year old male with left hip pain c/w FAI
15 year old male with left hip pain c/w FAI
15 year old male with left hip pain c/w FAI
Think Outside the Cam

Patient went to surgery for head/neck arthroscopy
Think Outside the Cam

Patient went to surgery for head/neck arthroscopy

Osteoid osteoma
13 year old female with right hip pain
13 year old female with right hip pain
Osteoid Osteoma

- Radiolucent nidus
- Central calcification

- Geographic marrow edema
- Thickened medial retinaculum
- Joint effusion
Osteoid Osteoma

Klontzas ME et al.

*Osteoid osteoma of the femoral neck: use of the half-moon sign in MRI diagnosis.*

Companion Case:
14 year old female with left hip pain
Osteoid Osteoma
Osteoid Osteoma—Example 1

Initial MR Diagnosis: Stress Fracture
Osteoid Osteoma-Example 2

Initial PE and radiographs c/w FAI
Osteoid Osteoma- Example 3
Conclusion

• No single imaging algorithm for sports-related pediatric hip pain
  – history guides imaging
• Radiographs nearly always useful (even when negative); MRI is useful when radiographs “normal”
  – Optimize protocols for indication
• Growth disturbances resulting from injury may be more problematic than original trauma (e.g. SCFE, avulsion fractures, FAI, etc.)
• FAI common; overdiagnosis may mask other disease
• Patients with sports injuries may have unrelated diagnosis (e.g. osteoid osteoma)