What Plain Views and When to Order Advanced Imaging

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ACSM Team Physician Course – Part II
Essentials of Sports Medicine: From Sideline to the Clinic

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Learning Objectives:

1. Know the images and position of the patient to order for certain diagnoses
2. Understand when to order advanced images after plain X-Rays

I have nothing to disclose.
Menu

1. Intro
2. Hip
3. Knee
   • OA Case
   • Bone Bruise
4. Foot
   • Navicular
   • Calcaneus
   • Achilles
5. Conclusions
WORKUP
Algorithm for Evaluation and Treatment of Suspected High-Risk Stress Fractures

(Reprinted with permission from Boden BP, Osbabr DC. High-risk stress fractures: Evaluation and treatment. *J Am Acad Ortho Surg* 2000; 8(6):344-353, Fig. 1, p. 347.)
High Risk Tensile Side
Low Risk Compression Side
Plain Radiographs LE

- Standardized Views
- Create and Agree within your group/department
- Special Views
  - Marked Cone
  - Stress
  - Comparison
Imaging

- Special Studies
  - MRI scan
    - With or without gadolinium
  - CT scan
  - Ultrasound
When Should an MRI Exam Be Obtained?

- Recent Trauma
- Difficult Physical Exam
- Physical Exam that Does not Match Clinical Symptoms
- Normal Radiographs with Significant Symptoms
- Pre-Operative Planning
- Recent MRI that was Technically Suboptimal

Courtesy Martin L. Schwartz, MD
Clinical Prof. of Radiology, UAB
How Should The MRI Scan Be Performed

• Best Possible Equipment
• Dedicated Coils for the Body Part
• Contrast When Necessary
• Correct Sequences to Define Appropriate Anatomy
• Shortest Exam to Achieve Results and Keep Patient Comfortable

Courtesy Martin L. Schwartz, MD
Clinical Prof. of Radiology, UAB
Contrast Administration

- Intraarticular Contrast Gives Superior Soft Tissue Contrast and Significantly Enhances Diagnostic Capability
- Intravenous Contrast Useful for Post Operative Menisci and Tumors

Courtesy Martin L. Schwartz, MD
Clinical Prof. of Radiology, UAB
IMAGING: MRI SCAN

- Communicate with radiologist skilled in hips. Now better results if intra-articular gadolinium
- Use of intra-articular injection is helpful
  - Lidocaine – if improves symptoms confirms intra-articular process
  - Gadolinium outlines labrum better
- Low resolution studies (small magnet; open scanner)
  - Unreliable except for obvious disease (i.e., AVN)
- High resolution MRI
  - 1.5 Tesla magnet; surface coil
  - Reliability improving
  - Still up to 42% false negative
  - Indirect evidence most reliable (effusion; paralabral cyst; subchondral cyst)
- MRI helpful for:
  - Labrum tear
  - Articular cartilage defects
  - Ligamentum teres tears
  - Impingement
  - Capsule/ileofemoral injury
1.5 Tesla

Courtesy Martin L. Schwartz, MD
Clinical Prof. of Radiology, UAB
0.35 Tesla Open

Courtesy Martin L. Schwartz, MD
Clinical Prof. of Radiology, UAB
1.0 Tesla Extremity

Courtesy Martin L. Schwartz, MD
Clinical Prof. of Radiology, UAB
Thanks to Thomas Byrd M.D. for the hip images
Radiographs

- AP pelvis including both hips
  - Properly centered to assess radiographic indices
  - Allows comparison of contralateral hip for subtle variations
  - Allows assessment of surrounding areas (ilium, ischium, pubis, sacrum & SI joints)
Radiographs

- Lateral view of affected hip
  - Frog lateral (lateral of proximal femur; not a true lateral of joint)

- Consistent, reproducible study
- Cross table, False profile, Dunn, etc. for specific circumstances
IMAGING: Femoroacetabular Impingement

- Helpful identifying morphological variants predisposing to intra-articular pathology:
  - Pincer type (acetabular retroversion)
    - Cross-over sign
    - Posterior wall sign
    - Arthroscopic parameters more sensitive indicator
  - Cam-type (proximal femur)
    - SCEF; “Pistol grip” deformity (premature physeal closure)
    - CT reconstruction excellent (!) for three-dimensional architecture
Radiographs

• Helpful identifying morphological variants predisposing to intraarticular pathology
  • Femoroacetabular impingement
    • Cam-type (proximal femur)
      • CT reconstruction excellent(!) for three dimensional architecture
Low Resolution Studies

- (small magnet; open scanner)
- Unreliable except for obvious disease (i.e., AVN)
High Resolution MRI

- 1.5 Tesla magnet; surface coil
- Reliability improving
- Still up to 42% false negative
- Indirect evidence most reliable (effusion; paralabral cyst; subchondral cyst)
Radiographs

• Helpful identifying morphological variants predisposing to intraarticular pathology
  • Dysplasia (reduced CE angle)
Radiographs

- Helpful identifying morphological variants predisposing to intraarticular pathology
  - Femoroacetabular impingement
    - Cam-type (proximal femur)
      - CT reconstruction excellent(!) for three dimensional architecture
Rim Impingement

- Radiographic indices
  - Cross over sign
  - Posterior wall sign

Reynolds D et al, JBJS 81B, 281, 1999
Rim Impingement

- Radiographic indices
  - Cross over sign
  - Posterior wall sign
**KNEE Radiographs**

- Standing 45º PA, bilateral
- Patellar Views: Merchant or Sunrise Bilateral
- Lateral 45º Flexion
- Notch for Osteophytes

- Standardize Your Views for All Physicians
- Use Goniometer
- Know Your XRay Technicians
Osteoarthritis grading systems:

- Kellgren and Lawrence
- Fairbanks
- Joint space narrowing JSM – standing radiographs
- Ahlback classification

Numerous studies comparing different classifications—there is disagreement on the definition and grading of osteoarthritis, as well as poor correlation with patient symptoms and progression of osteoarthritis.
45 Degree Flexed Weight-Bearing PA View is most sensitive for detecting joint space loss


IMAGING

• Plain radiographs
  • Radiographs most important investigative tool
  • Poorly indicative of problems amenable to arthroscopic intervention
    - McCarthy & Busconi, Orthop 1995

•Insensitive indicator of early OA
  - Santori & Villar, Orthop 1999
History & PE

- 55 YO Female
- Difficulty walking due to left knee out of alignment
- Fell 10 years ago and was told she had meniscal tears
- PE: Height 5’ 5½”, weight 303: BMI 43
- Bilateral Knees:
  - Diffuse crepitus and pain
  - Mild effusion
  - No calf tenderness
Left Knee
Right Knee

What test would you do next?
MRIs

Are more tests needed?
MRI Scan in the Arthritic Knee After 50 years

• Not Helpful for Articular Cartilage
• Meniscal Signal Will Usually Be Abnormal and come to the tibial surface.
MRI Scan in the Arthritic Knee After 50 years

• Is the root of the Medial Meniscus Avulsed?
• What about my Baker’s Cyst?
• Think tree - MRI Scan
  • In a Big Forest – Arthritis
    — The Plain Xrays show us the reason for stiffness & pain: Arthritis
IMAGING THE ARTHRITIC KNEE

• Use goniometer to assure comparable Xrays year to year and for outcome studies

• Let the Orthopaedist Order the MRI Scan in the Arthritic Knee Patient.
  • May want DESS or special articular cartilage sequences.
  • In most cases MRI scans in patients over age 50 would not change treatment plan.
  • I don’t need an MRI scan to know what to do arthroscopically! I was scoping knees prior to MRI scans!
17 YO WF  Right Knee Lateral knee pain

Complete radial tear of the interval horn/body junction, with a high-grade radial tear of the posterior horn/root junction.
Bone Bruise

Does That Predict Development of OA?
Bone Bruise Patterns

- Acute patellar dislocation
- Medial patella anterolateral femoral condyle
- No OA from bone bruise, but from articular cartilage injury and mal-tracking
Bone Bruise Patterns

- In soccer, medial tibial plateau bone bruise no long term risk of OA
- In degenerative posterior horn root avulsions, medial tibial bone bruise often seen

? Long-term follow-up for bone bruises needed to determine significance for development of OA
What is the significance of Bone Bruises?

Unknown...

- Long term Bone Bruise ≠ OA
- In ACL injuries noncontact compartments:
  - Lateral / acute
  - Medial / chronic OA
- Classification systems for bone bruises need further development
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Imaging of the Foot
Secondary Center Ossifications

- Apophysis – present 22%
  Appears > 8 years
  Fusion: 12 years - females
          15 years - males

- Os peroneum
  In tendon at cuboid level

- Os versalianum – present 15%
  Insertion peroneus brevis
  Usually bilateral – present in 0.1%
Fig. 19-25. Lateral (left) and anteroposterior (right) drawings of the foot indicating the location of the commonly found accessory bones (circles with numbers) and forefoot sesamoids (shaded circles). (1) Os tibiale externum, (2) processus uncinatus, (3) os intercuneiforme, (4) pars peronea metatarsalia 1, (5) cuboides secundarium, (6) os peroneum, (7) os vesalianum, (8) os intermetatarsae, (9) os supratalare, (10) talus accessorius, (11) os sustentaculeum, (12) os trigonum, (13) calcaneus secundarium, (14) os subcalcis, (15) os supranaviculare, (16) os talotibiale. (Keats, T. E., An Atlas of Normal Roentgen Variants That May Simulate Disease, 2nd ed., p. 371. Chicago, Year Book Medical Publishers, 1979.)
19 YO basketball player Os vesalianum bilateral feet.
Os peroneum
PAINFUL OS PERONEUM

Courtesy UK Radiology
PAINFUL OS PERONEUM

Courtesy UK Radiology
18 YO Freshman
Div. I basketball athlete

- C/O mid-foot pain, L > R
- Started when she was running, playing in shoes mandated by her school
- History of “normal” periods
Navicular

- Initial x-rays
Navicular view
30° ER
Torg described

Typical orientation of navicular stress fracture
Basketball Player with Proximal Foot Pain

Courtesy Martin L. Schwartz, MD
Clinical Prof. of Radiology, UAB
Tarsal Navicular Stress Fracture

Courtesy Martin L. Schwartz, MD
Clinical Prof. of Radiology, UAB
NAVICULAR STRESS REACTION

Courtesy UK Radiology
Stress Fractures

CALCANEAL APOPHYSITIS
(Sever’s Disease)

• Repetitive microtrauma
• Normal Radiographs
• Sclerosis due to normal multicenter ossification
Calcaneal Stress Fractures
Marathon Runner Complains of Heel Pain Around Achilles Tendon 2 Weeks Post Race

Courtesy Martin L. Schwartz, MD
Clinical Prof. of Radiology, UAB
Occult Calcaneal Fracture

Courtesy Martin L. Schwartz, MD
Clinical Prof. of Radiology, UAB
20 YO Football Athlete

- Diabetic
- Heel pain
- DX: plantar fasciitis
- Xray: performed after the season
Open excision, ectopic bone
ACHILLES TEAR

Courtesy UK Radiology
57 YO WM

- College Professor
- Heel Pain for 1 Year
- PMH + for Hypertension Only
- Left Ankle
- Symptomatic Calcific Tendinitis
Physical Exam

• Pain Over Lateral Insertion, Achilles Tendon
• Symmetrical Calf Strength and Flexibility

Radiographs

• Calcific Deposits in Achilles
• Calcaneus Normal
Calcific Achilles Tendinitis

Opposite Foot for Comparison
While waiting for an appointment to see a foot and ankle specialist, a motorcycle fell on his left ankle. He complained of weakness of the calf and inability to go up on his toes.
Test and Results

- Lateral Radiograph Compared to Pre-Injury Film
- Proximal Displacement of Calcific Nodule, Mild Haglund’s Deformity
Final Working Diagnosis

• Avulsion of Calcific Achilles Tendon from Calcaneus

Operative Findings

• Complete Avulsion Achilles Tendon
• Calcific Degeneration of Tendon
Surgery
Operative Treatment

- Direct repair with metal anchors to calcaneus
- Augmentation with plantaris tendon weaved in pulvertaft fashion

1 Week Post Surgery
You Look for What You Know and You Find What You Look For
The End               Thank You!

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References

