Common Causes of Adult Knee Pain

• Patellofemoral dysfunction
• Past Trauma: ligamentous sprains or meniscal tear
• Osteoarthritis
• Baker cyst
• Bursitis
• Inflammatory arthritis
• Septic arthritis
• Gout, pseudogout
• Medial plica syndrome

Calmbach WL, American Family Physician. 2003 Sep 1;68(5):917-22.
Modalities Used to Evaluate Knee Pain

- Plain Film
- MRI
- CT
- Bone Scan
Plain Films Reveal Bony Abnormalities

- Osteoarthritis
  - Joint space narrowing
  - Sclerosis
  - Subchondral cysts
  - Spurring of tibial spines
  - Osteophytes
- Loose bodies
- Chondrocalcinosis
- Fracture
MRI Provides Definition of Soft Tissue

- Tendonitis or tendon tears
- Articular cartilage
- Meniscus tears
- Bone bruise/marrow edema
- Strains
- Cysts
- Bursitis
- Tumors
- Osteonecrosis
CT Provides Cortical Detail

- Occult fractures
- Fracture fragment location
- Tumors
  - Periosteal reaction
  - Small amounts of calcification
- Special uses:
  - Fulkerson study (patellar tracking)
  - CT arthrogram
Bone Scan Highlights Physiological Rather than Anatomic Processes

- Neoplasm
- Occult Fracture
- Osteonecrosis
Plain Film Patient ND: History

• 45 year old man with knee pain

• Knee pain suddenly worsened, no traumatic incident

• No prior work up

• Initial imaging for knee pain is plain film.
Plain Film: Views

AP

Lateral

Sunrise

PACS Imaging, BIDMC
Plain Film: Anatomy

Bones of the Knee

PACS Imaging, BIDMC
Plain Film: Anatomy

Articular Compartments

Medial compartment

Lateral compartment

Patellofemoral compartment
Plain Film Patient ND:
Weight bearing AP Demonstrates Degeneration

- Joint space narrowing
- Subchondral sclerosis
- Osteophytes
- Normal Alignment

PACS Imaging, BIDMC, courtesy of Jim Wu
Plain Film Patient ND:
Lateral View Shows Degeneration

Normal

Patient ND: Osteophytes, Loose Bodies

PACS Imaging, BIDMC

PACS Imaging, BIDMC, courtesy of Jim Wu
Plain Film Patient ND:
Sunrise View Shows Patellofemoral Compartment

Normal

Patient ND:
Marginal Osteophytes
Relatively preserved joint space

PACS Imaging, BIDMC

PACS Imaging, BIDMC, courtesy of Jim Wu
Plain Films Can Show Soft Tissue Abnormalities

Normal

Plain Film Companion Patient: Effusion

PACS Imaging, BIDMC, courtesy of Jim Wu
Plain Film Patient ND: Conclusion

• Plain films showed advanced arthritis in a relatively young man (age 45).

• MRI: Chronic ACL tear, anterior translation of the tibia, meniscal tears, cartilage damage, loose bodies.

• Arthroscopy: Partial meniscectomy and removal of loose bodies.

• Knee replacement at age 50
MRI Patient MJ

- 61 year old female
- Mild osteoarthritis by plain film
- Left knee pain, mostly posterior
- Pain has persisted > 4 months
- Takes Tylenol with some relief
- Physical therapy did not help
- Received non-contrast MRI of the left knee
Knee MRI: Views

Axial

Sagittal

Coronal

PACS Imaging, BIDMC
Knee MRI: Sequences
Proton Density Fat Saturation (PD FS)

- Cartilage
- Meniscus
Knee MRI: Sequences
T2 Fat Saturation (T2 FS)

- Highlights fluid
- Edema
- Cysts
- Tendon
- Ligament
Knee MRI: Sequences
Proton Density (PD)

- Cartilage
- Meniscus
- Fractures
- Fatty structures
Knee MRI: Sequences and Views

Axial PD FS

Sagittal T2 FS

PACS Imaging, BIDMC

Sagittal PD

Coronal PD FS
MRI Anatomy: Structure of Menisci

- Meniscus appears black on MRI.
- Intersection of ligaments and meniscus may mimic a tear.

MRI Anatomy: Menisci

- Lateral Meniscus
- Medial Meniscus
- Humphrey Ligament (anterior meniscofemoral)
- Wrisberg Ligament (posterior meniscofemoral)
- Transverse Ligament
- ACL
- PCL

PACS Imaging, BIDMC
MRI Patient MJ: Menisci

• Lateral meniscus tear to the tibial surface
• Lateral meniscus free edge tear
MRI Anatomy: Location of Articular Cartilage

- Black = Cortex
- Grey = Cartilage
- White = Joint fluid
MRI Anatomy: Images of Articular Cartilage

- Black = Cortex
- Grey = Cartilage
- White = Joint fluid
MRI Patient MJ: Loss of Patellar Cartilage

MRI Companion Patient #1: Normal patellar cartilage

MRI Patient MJ: Loss of patellar cartilage

PD Fat Saturation

PACS Imaging, BIDMC
MRI Anatomy: Tendons and Ligaments

- Tendons and ligaments appear black.
- Discontinuity: tear
- Increased signal: tendonopathy, tendonitis, mucinous degeneration, sprain
MRI Anatomy: Cruciate Ligaments

- Anterior Cruciate Ligament (ACL)
- Posterior Cruciate Ligament (PCL)

MRI Patient MJ: Normal

PACS Imaging, BIDMC
MRI Anatomy: Extensor Mechanism

MRI Patient MJ: Normal

MRI Companion Patient #2: Increased Signal in Quad Tendon, ACL detached

PACS Imaging, BIDMC
MRI Anatomy: Medial Collateral Ligament

MRI Patient MJ: Normal

MRI Companion Patient #3: Torn

PD Fat Saturation

PACS Imaging, BIDMC
MRI Anatomy: Ligaments and Tendons

Anterior → Posterior

IT band  LCL  Biceps Femoris  Popliteus

Lateral View

PD Fat Saturation
PACS Imaging, BIDMC
MRI Anatomy: Baker Cyst

Excess synovial fluid distends synovium posteriorly between the medial head of the gastrocnemius and the semimembranosus tendon.

MRI Companion Patient #4: 48 year old female with pain and swelling in the posterior aspect of the left knee.

PACS Imaging, BIDMC

Axial STIR
MRI Patient MJ: Baker Cyst

Baker Cyst

PD Fat Saturation

PACS Imaging, BIDMC
MRI Anatomy: Ganglion

MRI Companion Patient #5

Popliteus
Ganglion

PD FS
PACS Imaging, BIDMC
MRI Anatomy: Marrow Edema
Insufficiency Fracture

MRI Companion Patient #6

• Marrow Edema
  – Insufficiency Fracture
  – Cartilage Loss
  – Contusion (within 3 months)
  – Osteonecrosis
  – Fracture
  – Infection
  – Tumor

T2 Fat Saturation

PACS Imaging, BIDMC
Eugene Lin et al, “Chapter 129 Subchondral Bone Marrow Edema” (Chapter). Practical Differential Diagnosis for CT and MRI.
MRI Anatomy: Marrow Edema
Cartilage Loss

- Marrow Edema
  - Insufficiency Fracture
  - Cartilage Loss
  - Contusion (within 3 months)
  - Osteonecrosis
  - Fracture
  - Infection
  - Tumor

MRI Companion Patient #7

T2 Fat Saturation
PACS Imaging, BIDMC
Eugene Lin et al, “Chapter 129 Subchondral Bone Marrow Edema” (Chapter). Practical Differential Diagnosis for CT and MRI.
Marrow Edema

- Insufficiency Fracture
- Cartilage Loss
- Contusion (within 3 months)
- Osteonecrosis
- Fracture
- Infection
- Tumor

T2 Fat Saturation

PACS Imaging, BIDMC
Eugene Lin et al, “Chapter 129 Subchondral Bone Marrow Edema” (Chapter). Practical Differential Diagnosis for CT and MRI.
MRI Patient MJ: Conclusion

- 61 year old female with posterior left knee pain
- Thinned patellar cartilage
- Meniscal tears
- Small baker cyst

- Posterior knee pain could be due to tears and the baker cyst, but asymptomatic meniscal tears and cysts are common.

24 year old Female with right knee pain
History of periodic patellar dislocation, first dislocation at age 18.
Exam: anterior tenderness, patellar laxity, patellar click, J sign, and patellar apprehension, and normal alignment.
Physical therapy has not helped.
Plain film: good alignment, ossific body at the edge of the patella.
MRI: evidence of a medial retinacular tear and patellofemoral cartilage loss.
Received a Fulkerson study to evaluate patellar tracking.
Anatomy: Stabilizers of the Patella

- Vastus medialis
- Quadriceps tendon
- Patella
- Patellar tendon
- Medial patellofemoral ligament
- Retinaculum
- Tibial Tubercle

PACS Imaging, BIDMC, courtesy of Jim Wu
Anatomy: Patellar Tracking

- Patellar Facets
- Trochlear Groove

PACS Imaging, BIDMC
Conditions associated with patellofemoral pain

- Laxity
- Joint hypermobility
- Weakness of the vastus medialis
- Genu valgus
- Internal femoral torsion
- Tight lateral patellar retinaculum
- Patellar or trochlear dysplasia
- Osteoarthritis
CT Companion Patient: Fulkerson Study

Fulkerson Study Shows Patellar Engagement, Tilt, and Subluxation

Normal

0°
Patella not engaged

15°
Patella begins to engage.
Any subluxation becomes apparent.

30°
Patella is engaged

60°

Non Contrast CT
PACS Imaging, BIDMC
CT Patient PW: Fulkerson Study Confirms Abnormal Patellar tracking

Normal  Abnormal

Patella not engaged

Patella is not engaged. Trochlear groove is not well defined.

Patella is laterally positioned and tilted.

Patella is engaged.

Non Contrast CT
PACS Imaging, BIDMC
CT Companion Patient: Fulkerson Study Measures
Tibial Tubercle-Trochlear Groove distance

• Distance between the tibial tubercle and trochlear groove is shown in orange.

• Normal distance <2 cm

• Longer distance may contribute to a patellar tracking problem

Non Contrast CT
PACS Imaging, BIDMC
CT Patient PW: Conclusion

- Tibial Tubercle-Trochlear Groove distance was normal so tibial tubercle osteotomy was not offered.

- Fulkerson study revealed lateral displacement of the patella and late engagement.

- MRI showed a medial retinacular tear.

- Medial patellofemoral ligament reconstruction was recommended.
Radiological Evaluation of Knee Pain: Conclusion

- Plain film: Initial imaging

- MRI:
  - Persistent pain with non-diagnostic films
  - Clinical suspicion of soft tissue process
  - Pre-operative planning

- CT:
  - CT arthrogram if MRI contraindicated
  - Fulkerson for suspicion of tracking disorder

- Bone Scan:
  - Usually not indicated
  - May be used for tumors
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References

• Images from PACS Imaging, BIDMC unless otherwise noted.
• Calmbach WL, American Family Physician. 2003 Sep 1;68(5):917-22.
• Eugene Lin et al, “Chapter 129 Subchondral Bone Marrow Edema” (Chapter). Practical Differential Diagnosis for CT and MRI.