MRI of the Knee

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Financial Disclosure

- I have no relevant financial relationships with commercial interests to disclose.

Outline

- Coils, Patient Positioning
- Acquisition Parameters, Planes and Pulse Sequences
- Knee Arthrography
- Normal Anatomy
- Abnormal Anatomy (Injury Patterns)
- High Field MRI (3.0T Magnets)
Imaging Details

- Supine Positioning
- Slight external rotation
- Dedicated knee coil
  - 8 channel
- 14 to 16 cm field of view
- 2.5 to 5 mm slice thickness
- Rarely use intravenous gadolinium
- Exam time 15 minutes

MRI Pulse Sequences

- T1 weighted Sequences
  - Fat sensitive
  - Good anatomic resolution
- Proton Density Sequences
  - Fat and fluid sensitive
  - Best anatomic resolution
- T2 Fat Saturated Sequences
  - Fluid sensitive, all else dark
  - Pathology sequence
  - Poor anatomic resolution

MRI Acquisition Planes

- Scout Image
  - Find the knee in the magnetic field
- Axial Images
  - Parallel to tibial plateau
- Coronal Images
  - Parallel to posterior margin of femoral condyles
- Sagittal Images
  - Perpendicular to sagittal plane
Axial Images

Axial MPGR  Axial T2 FS

Coronal Images

Coronal T1  Coronal T2 FS

Sagittal Images

Sagittal PD  Sagittal T2 FS

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MR Knee Arthrography

- Infrequently Performed
- Allows T1 weighted imaging for best spatial resolution
- Mainly used in cartilage and post-operative meniscus assessment
- Fluoroscopically guided
- Anterior approach with 25 g needle
- 20-30cc Dilute Gadolinium injected
- MR performed within 45 minutes after exercise

MR Arthrogram Images

- Distended joint, gadolinium fills tears in structures that line the joint
- Sequences: T1 axial, coronal, sagittal with fat saturation
  - Only bright structure is gadolinium
- Coronal T1 no fat saturation
- Sagittal T2 with fat saturation

MR Arthrogram Knee Loos Osteochondral Lesion

- Coronal T2 Fat Sat
- Coronal T1 Post Gad Fat Sat
- Sagittal T1 Post Gad Fat Sat
Normal Anatomy: Medial Collateral Ligament (MCL)

Coronal T1  Coronal T2 Fat Sat

Normal Anatomy: Lateral Collateral Ligament (LCL or FCL)

Coronal T1  Coronal T2 Fat Sat

Normal Anatomy: Anterior Cruciate Ligament (ACL)

Sagittal PD  Sagittal T2 Fat Sat
Normal Anatomy: Posterior Cruciate Ligament (PCL)

Sagittal PD  Sagittal T2 Fat Sat

Normal Anatomy: Medial Meniscus

Sagittal PD  Sagittal T2 Fat Sat

Normal Anatomy: Lateral Meniscus

Sagittal PD  Sagittal T2 Fat Sat

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Normal Anatomy: Coronal Plane Menisci

Interpreting Knee MR

- Systematic, disciplined approach is crucial
  - Don’t go for the money
- Structured Report
  - Menisci
  - Cruciates
  - Extensor Mechanism
  - Collaterals
  - Cartilage
  - Fluid
  - Bone Marrow
- Look for injury patterns
- Address the clinical question

Grade 2 MCL Sprain
Grade 3 LCL Sprain

Coronal T2 fat sat

Acute Interstitial ACL Tear

Sagittal PD

Sagittal T2 Fat Sat

Posterolateral Corner Injury

Segond Fracture
ACL Avulsion

Sagittal T2 Fat Sat
Coronal T2 Fat Sat

PCL Avulsion

Coronal T1
Coronal T2 Fat Sat

ACL Graft Tear

Intact ACL Graft
Sagittal PD

Torn ACL Graft
Sagittal PD
Chronic ACL Tear

Sagittal PD

Sagittal T2 Fat Sat

Acute PCL Tear

Sagittal PD

Sagittal T2 Fat Sat

Radial Lateral Meniscus Tear

Axial MPGR

Sagittal PD

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Complex Medial Meniscus Tear

Bucket Handle Medial Meniscus Tear

Flipped Locked Lateral Meniscus Tear
Discoid Lateral Meniscus Tear

Parameniscal Cyst presenting as mass - percutaneous aspiration and rupture

Medial and Lateral Bucket Handle Tears
Post Intervention Cartilage Assessment

Pre-Microfracture

Axial T1 Post Arthrogram

Post-Microfracture

Axial T1 Post Arthrogram

Baker's Cysts

Sagittal PD

Sagittal T2 Fat Sat
Baker's Cyst Rupture

IT Band Friction Syndrome

Transient Patellar Dislocation
Jumper’s Knee (Infrapatellar Tendonopathy)

Quadriceps Tendon Rupture

Infrapatellar Tendon Rupture
Recent Advances: High Field MRI
3.0 Tesla versus 1.5 Tesla MRI

• Twice the magnetic field strength
• Twice the signal to noise in a given pixel
  – Increase matrix / decrease pixel size (increase spatial resolution)
  – Decrease slice thickness (increase spatial resolution)

Sagittal T2 Fat Sat 3.0T  Sagittal T2 Fat Sat 1.5T

Exostotic Osteochondroma

– Decrease NEX / imaging time (decrease spatial resolution)
Fractures

Radiograph

Coronal T2 Fat Sat

Fractures

Coronal T2 Fat Sat

Coronal T1

Cartilage Mapping

• T2 mapping

Axial T2 Fat Sat 3.0T
Cartilage Mapping

MARS (metal artifact reduction sequence)

MARS prosthesis imaging
Summary

- MRI plays an indispensable role in the evaluation of knee injuries.
- Intra-articular and Intravenous gadolinium are not routinely required in the assessment of knee injuries.
- High field MR systems increase diagnostic sensitivity, particularly of cartilage lesions.
- Accept nothing less than the interpretation of a specialized musculoskeletal radiologist.
- Always correlate imaging findings with clinical examination and discuss discrepancies with your radiologist.