The Knee: normal variants that may simulate disease at advanced imaging

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Learning Objectives

- At the end of the presentation, each participant should be able to:
  - Discuss the most common normal variants in the pediatric knee that may simulate pathology on MR imaging.
  - List three normal structures that may simulate meniscal tears on MR imaging.
  - Describe the four types of synovial plicae in the knee as well as their clinical significance.

The Knee: normal variants

- Bipartite patella
- Dorsal defect of the patella
- Cortical desmoid
- Distal femoral epiphyseal irregularity
- Posterior “stripe”
- Juvenile cartilage signal intensity
- Terminal sulcus cartilage “thinning”
- Semimembranosus insertions
- Lateral inferior geniculate vessels
- Meniscus fissure
- Meniscal ossicle
- Plicae
- Discoid meniscus
- Fabello-fibular ligament
- Meniscofibular ligament
- Popliteofibular ligament
- Tibial attachment of the biceps femoris
- Transverse meniscal ligament
- Meniscofemoral ligaments
- Oblique menisco-meniscal ligament
- Double barreled PCL
- Meniscal root attachments
- Patella-meniscal ligament
- Fabella
- Cyamiella
- Accessory popliteus tendon
- Bifurcated popliteus
- 3rd head of the gastrocnemius muscle
- Bifurcating sartorius tendon

Bones: Bipartite patella

- Patellar ossification
  - Primary center: 4-6 yrs
  - Secondary centers: 8-12 yrs
  - Failure of fusion

- Bipartite
  - 2-3%
  - Bilateral – 50%
  - Types (Saupé)
    - 1 – inferior pole (5%)
    - 2 – lateral margin (20%)
    - 3 – superolateral (75%)

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**Bones: bipartite patella**

- **Symptomatic**
  - acute / chronic trauma
  - fracture / avulsion
  - may be overlooked as etiology

- **MRI**
  - edema along margins

Kavanagh, Skeletal Radiol 2007
53 pts – knee pain – only MRI finding: edema along bipartite patella

**Bones: Dorsal defect of the patella**

- **Unknown etiology**

- **Incidence**
  - 0.3 – 1% / bilat - up to 30%
  - may be seen with bipartite
  - may cause symptoms

- **Appearance**
  - well circumscribed
  - round, lytic lesion
  - superolateral patella

**Bones: dorsal defect of the patella**

- **DDx: OCD**

<table>
<thead>
<tr>
<th>DDP</th>
<th>OCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>round</td>
<td>variable shape</td>
</tr>
<tr>
<td>superolateral</td>
<td>central superomedial</td>
</tr>
</tbody>
</table>

- **MRI**
  - round focus
  - superior (lat) patella
  - lack of edema
  - evaluate overlying cartilage

DDP
OCD
round variable shape
superolateral central superomedial

**Bones: cortical desmoid**

- **AKA**
  - distal femoral cortical irregularity
  - avulsive cortical irregularity
  - periosteal / juxtacortical desmoid

- **Avulsive / tug etiology**
  - reactive, fibro-osseous lesion

- **Medial supracondylar femur**
  - lytic
  - concave – medial head of gastroc
  - proliferative – adductor magnus

**Bones: cortical desmoid**

- **Radiographic DDx:**
  - FCD, distal femoral stripe
  - Neoplasm
  - Infection

- **MRI**
  - T1 - ↓ SI
  - T2 - ↑ SI
  - low SI rim
  - classic location

marrow / ST edema acute trauma
Vierra, AJR 2011
Bones: distal femoral irregularity

- Normal variation vs. OCD
- Uneven mineralization
  - 3 – 13 yrs old
  - related to rapid growth
  - usually posterior LFC
- Appearance
  - spiculation, “puzzle piece”
  - overlying cartilage intact
  - lack of marrow edema

11 yr old male

Bones: “Juvenile OCD”

- “Juvenile” OCD
  - open physes
  - mean age: 12-13 yrs
  - central 1/3 + intercondylar
  - adjacent edema common
- Vs. “Adult”
  - better prognosis (80% resolve)
  - more commonly bilateral + LFC
  - MRI signs of fragment instability
    - less predictive than in adult

Kijowski, Radiology 2008
### Bones: normal vs. OCD

<table>
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<tr>
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<th>Normal Ossification</th>
<th>OCD</th>
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</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>3-13 yrs (not seen F&gt;10 M&gt;13)</td>
<td>Avg age: 12-13 yrs [not seen F&gt;7 M&gt;13]</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>Posterior 1/3  MFC = LFC</td>
<td>Middle 1/3 Intercondylar</td>
</tr>
<tr>
<td><strong>Lesion angle</strong></td>
<td>Deeper</td>
<td>More steep</td>
</tr>
<tr>
<td><strong>Bilateral</strong></td>
<td>25%</td>
<td>11%</td>
</tr>
<tr>
<td><strong>Marrow Edema</strong></td>
<td>Uncommon</td>
<td>Common</td>
</tr>
</tbody>
</table>

[Laor, Radiology 2002]

### Bones: distal femoral stripe

- **Skeletally immature**
  - fibrovascular tissue
  - between periosteum and bone
  - disappears with age
- **MRI**
  - high signal subperiosteal tissue
  - “stripe” on sagittal images
  - “cuff” on axial images

[Laor, Radiology 2002]

### Epiphyseal Cartilage: signal intensity

- **Age related changes**
  - **Early** (< 1 yr)
    - homogeneous
  - **Wgt-bearing (1-3 yrs)**
    - SI wgt bearing surface
  - **Later** (3-5 yrs)
    - increased SI
    - stippled → well defined

[Varich, Radiology 2000]
[Laor, Radiology 2000]

### Cartilage: lateral sulcus “thinning”

- **Terminal sulcus**
  - lateral femoral condyle
  - separates trochlear from wgt-bearing cartilage
  - cartilage appears thinned
  - (esp on sagittal images)

### Cartilage: upper trochlear “defect”

- **Axial scans**
- **Fat saturation**
- **Above articular cartilage**
  - Cross ref with sagittal
Cartilage: upper trochlear “defect”

- Axial scans
- Fat saturation
- Cross-reference sagittal – above articular cartilage
- Asymmetric cartilage – lateral extends more proximally

Meniscal Tear: mimic

Posterior root pseudotear
Meniscal Tear: *mimic*

- AHLM Striations

Meniscal Tear: *mimic*

- Proton Density
  - Magic Angle Artifact
  - Proton Density

Meniscal Tear: *mimic*

- Transverse ligament

Meniscal Tear: *mimic*

- Meniscofemoral ligament

Meniscal Tear: *mimic*

- Oblique meniscomeniscal ligament
  - ant horn one meniscus
  - post horn of the other
  - courses between cruciates
  - may simulate BHT

Sanders TG, Radiology 1999

Meniscal Tear: *mimic*

- Semimembranosus
  - 5 arms
  - anterior
  - direct
  - capsular
  - inferior
  - obl popliteal ligament

- Anterior arm
  - may mimic displaced meniscal fragment

LaPrade, JBJS(Am) 2007

ANT ARM
Meniscus: meniscal ossicle

- Posterior horn MM
  - cancellous bone
- Uncertain etiology
  - vestigial?
  - post-traumatic?
    - root avulsion - PHMM
- May be symptomatic
- Imaging
  - “loose body”

Synovium: Plicae

- Embryologic remnants
  - peripheral cavitations
  - fail to coalesce
  - synovial folds
  - three compartments
- Types
  - infrapatellar
  - suprapatellar
  - mediopatellar
  - lateral (rare)
Synovium: Plicae

- Plica Syndrome?
  - mediopatellar
  - thickens
  - impinges on femur/patella
  - cartilage “impingement” lesion

- MR Findings
  - appearance does not correlate with symptoms

The Knee: normal variants

- Bone
  - Bipartite patella
  - Dorsal defect of the patella
  - Cortical desmoids
  - Irregular ossification vs. “juvenile OCD”
  - Posterior stripe

- Cartilage
  - Juvenile cartilage signal intensity
  - Terminal sulcus cartilage “thinning”
  - Upper trochlear “defect”

- Menisci
  - Meniscal roots
  - Transverse ligament
  - Meniscofemoral ligaments
  - Semimembranosus insertion
  - Lateral inferior geniculate vessels
  - Meniscal ossicle

- Plicae
  - Medial patellar
  - Suprapatellar
  - Infrapatellar

Thank you!