MRI of the Knee:

Part 4 - normal variants that may simulate disease

Mark Anderson, M.D.
University of Virginia
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.

• identify a cortical desmoid and describe its typical appearance and location on MR images.

• list 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 flounce
Meniscal ossicle
Plicae
Discoid meniscus
Fabello-fibular ligament
Meniscofibular ligament
Popliteofibular ligament

Tibial attachment of the biceps femoris
Transverse meniscal ligament
Meniscofemoral ligaments
Oblique meniso-meniscal ligament
Double barreled PCL
Meniscal root attachments
Patello-meniscal ligament
Fabella
Cyamella
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 (Saupe)
    • 1 – inferior pole (5%)
    • 2 – lateral margin (20%)
    • 3 – superolateral (75%)
Bones: Bipartite patella

- Patellar ossification
  - primary center: 4-6 yrs
  - secondary centers: 8-12 yrs
  - failure of fusion

- Bipartite
  - 2-3%
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  - Types (Saupe)
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    - 3 – superolateral (75%)
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

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

• **MRI**
  - lack of edema
  - evaluate overlying cartilage
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
  - $T1 - \downarrow SI$
  - $T2 - \uparrow SI$
  - low SI rim
  - classic location
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

*Gebarski, Pediatr Radiol 2005*

*Kijowski, Radiology 2008*
4 years later (14 yo)
## Bones: normal vs. OCD

<table>
<thead>
<tr>
<th></th>
<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 &lt; 8 yrs)</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 More steep</td>
<td>Elongated More shallow</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>

*Jans, Radiology 2010*
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 2009
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
Synovium: *Plicae*

- **Embryologic remnants**
  - *peripheral cavitations*
  - *fail to coalesce*
  - *synovial folds*
  - *three compartments*

- **Types**
  - *infrapatellar*
  - *suprapatellar*
  - *mediopateellar*
  - *lateral (rare)*
Synovium: Plicae

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

• MR Findings
  - appearance does not correlate with symptoms

Boles, JCAT 2004  Weckstrom, The Knee 2010
Demirag, Knee Surg Sports Traumatol Arthrosc 2006
The Knee: normal variants

**Bone**
- Bipartite patella
- Dorsal defect of the patella
- Cortical desmoid
- 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