Uncommon normal variants on the knee MRI, mimicking pathologic conditions.

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Authors: D. J. Kang, I. S. Moon, Y. N. Seo, S. J. Lee; Busan/KR
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Learning objectives

With increasing availability of higher strength magnets in clinical practice, the degree of anatomical detail and resolution seen on MRI has advanced considerably. It is now possible for one to evaluate on MRI the numerous minor ligamentous and musculotendinous structures that had been difficult to identify previously.

The purpose of this exhibition is to describe uncommon normal variants on the knee MRI and to avoid the mis-diagnosis as pathologic condition.

Background

Classification into four category by structures

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**Findings and procedure details**

1. Aplasia or hypoplasia of the PCL (Fig.1)

1) Aplasia or hypoplasia of PCL

- Extremely rare
- Usually associated with other congenital abnormalities of the lower limb
- ACL agenesis, absence of on or both menisci, absence or dysplasia of patella
- Result in anteroposterior and rotatory instability of the knee

2) Radiologic signs indicate aplasia of the cruciate ligament

- Hypoplasia of the tibial eminence
- Hypoplastic lateral femoral condyle
- Narrow intercondylar notch

2. Oblique meniscomeniscal ligament (Fig.2)

1) Meniscomeniscal ligament

- Anterior transverse meniscal ligament (58%)
- Posterior transverse meniscal ligament (1 - 4%)
- Lateral & medial oblique meniscomeniscal ligament (1 - 4 %)

2) Oblique meniscomeniscal ligaments are named for their anterior attachment site

- Medial oblique meniscomeniscal ligament
- Originate from anterior horn of the medial meniscus
- Insert into posterior horn of the lateral meniscus
- Lateral oblique meniscomeniscal ligament
- Originate from anterior horn of the lateral meniscus
- Insert into posterior horn of the medial meniscus

3) Signal intensity similar to that of meniscal tissue and attaches to the menisci
- Closely resemble a displaced meniscal fragment at MR imaging and simulate a flap
tear or bucket-handle tear

3. Unilateral medial or lateral MM ligament (Fig.3)

1) The ligament which originate from the anterior horn of the meniscus and attached to
the posterior horn of the same meniscus

2) The difference between the oblique and unilateral meniscomeniscal ligament
- Differs in their attachment to the posterior horn of the contralateral or ipsilateral meniscus

3) Diagnostic MR imaging
- May mistake this variant for a displaced bucket handle meniscus tear
- Distinct structure with visible longitudinal fibers

4. Anomalous distal insertion of the ACL (Fig.4)

1) Tibial attachment site of ACL
- Broad-based, located in a fossa anterior and lateral to the medial tibial spine

2) Double bundle of ACL
- Anterior band
- Normally located beneath the transverse ligament
- Posterior band
- Posterior third of the anterior intercondylar area

3) Abnormalities at tibial insertion of the ACL
- ACL continuity with the anterior horn of the medial meniscus
- Anterior extension below the anterior tibial margin
- Anterior transverse meniscal ligament

5. Abnormal band of lateral meniscus (Fig.5)

1) Normal meniscus
- Wedge-shaped, semilunar, fibrocartilaginous structures
- Superior concave surface and flat base
- Conform to femoral condyle
- Attaches to the tibia
2) Abnormal band of lateral meniscus
- Thin, serpentine shaped, and narrower than underlying native lateral meniscus
- Peripheral attachment to the posterior horn and middle segment of underlying true lateral meniscus

6. AIMM into the ACL (Fig.6)

1) Anterior horn of the medial meniscus
- The most frequent site of variation

2) Characteristic features of AIMM into the ACL on MR imaging
- Low signal band that extends from the anterior horn of the medial meniscus
- Isointense signal intensity to the meniscus and the ACL
- Running parallel to the ACL up to the insertion site of the ACL
- High signal intensity gap between the ACL and the AIMM

3) Differential diagnosis
- Tear of the anterior horn of the medial meniscus or ACL
- Infraapatellar plicae

7. Anomalous relationship of the gastrocnemius muscle and the popliteal artery (Fig.7 & Fig.8)

1) Anomalous relationship of the gastrocnemius muscle and popliteal artery
- Abnormal embryologic development lead to various anomalous relations in the popliteal fossa
- Responsible for popliteal entrapment syndrome

2) Types of anomalous relationship
- Aberrant medial arterial course around a normal medial head of gastrocnemius muscle
- Atypical lateral location of the medial head of gastrocnemius muscle
- Medially displaces the popliteal artery
- Aberrant accessory slip of medial gastrocnemius muscle wraps around the popliteal artery
- Normal popliteal artery and hypertrophied gastrocnemius muscle

8. Accessory slip of the lateral head of gastrocnemius muscle (Fig.9)

1) Accessory slip of the lateral head of gastrocnemius muscle
- Originate from the posterior cortex of the distal femur, medial to lateral head
- Course anterolateral to the popliteal vessels
- Midline between artery and vein
- Curves around popliteal vessels
- Insert into the lateral head of the gastrocnemius muscle

2) Accessory slip of the lateral head of gastrocnemius muscle have also been implicated in popliteal entrapment syndrome
- Found in 30% of patients

9. Sesamoid bone in popliteus tendon (cyamella) or patellar tendon (Fig.10 & Fig.11)

1) Sesamoid bone
- Small, round or ovoid-shaped bones
- Within tendons or muscles
- Assist in muscle function
- Modifying pressure
- Diminishing friction
- Altering the direction of the pull

2) Cyamella
- Sesamoid bone within the popliteus muscle or tendon
- Close to head of fibula
- Less frequently than fabella

3) Differential diagnosis for cyamella and other rare sesamoid bones
- Heterotopic ossification
- Soft tissue tumors associated with bone formation
- Osteocartilaginous loose bodies

10. Dorsal defect of the patella (Fig.12 & Fig.13)

1) Well-defined lytic lesion

2) Usually located in the superolateral aspect of the patella

3) Etiology
- Uncertain
- Van Holsbeeck et al.
- Abnormal stresses applied by the vastus lateralis muscle
- Play central role in the pathophysiology of both dorsal patellar defect

3) On radiograph
- Sclerotic border and ranges in size from 4 mm to 26 mm
5) On MR imaging
- Cortical defect at the superolateral aspect of patella
- Compensated by overgrowing articular cartilage

6) Differential diagnosis
- Osteochondritis dissecans of the patella
- Brodie’s abscess
- Bone tumor

11. Distal femoral epiphyseal irregularity (Fig.14)

1) Common location of irregular margin of epiphysis
- Distal femoral epiphysis
- Trochlea of the elbow
- Tarsal navicular

2) Common observation on radiographs in children

3) On MR imaging
- Intact overlying articular cartilage
- Accessory ossification centers
- Spiculations
- Residual cartilaginous model
- Lack of bone marrow edema

4) Differential diagnosis
- Osteochondritis dissecans (stage I)

Images for this section:
Fig. 1: Hypoplasia of the PCL with Wrisberg ligament thickening in a 32-year-old man. Sagittal proton density-weighted (A and B) and coronal proton density-weighted fat supressed (C) MR images show normal appearance of ACL (black arrow) and thin bandlike structure representing hypoplastic PCL (short yellow arrow). Also evident is the hyperplastic Wrisberg ligament (long white arrows).

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Fig. 2: Medial oblique meniscomeniscal ligament. Axial (A), sagittal (B), and coronal (C) MR image show thick low signal intensity band-like structure (yellow long arrow) which courses from anterior horn of the media meniscus to the posterior horn of the lateral meniscus and passes through the intercondylar notch. And it also passes between the ACL (white arrow) and PCL (*).

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**Fig. 3:** Unilateral meniscomeniscal ligament. Coronal (A, B, and C), sagittal (D), and axial (E) MR images show thin low signal intensity linear structure originating from anterior horn to the posterior horn of medial meniscus. Arthroscopic image (F) shows the course of unilateral meniscomeniscal ligament (asterisk). Abbreviation: MFC (medial femoral condyle)

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Fig. 4: Anomalous distal insertion of the ACL in 63-year-old woman with right knee pain. Sagittal proton density weighted (A), coronal proton density weighted fat suppressed (B), and multiplanar reconstruction (C) MR images show anomalous distal insertion of the ACL (long arrows) into the anterior horn of medial meniscus (short arrows). However proximal insertion of ACL is normal appearance.

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**Fig. 5:** Abnormal band of lateral meniscus. Sagittal (A and B) and coronal (C and D) MR images show a band of tissue (long arrows) arising from the posterior horn and attaching to middle segment of the lateral meniscus, representing a distinct, separate meniscus band. And lateral meniscus (short arrow) is normal appearance. Arthroscopic image (E) shows the posterior segment of the anomalous tissue (asterisk) arose from the posterior horn of the true lateral meniscus (black arrows). The intervening segment was serpentine in shape.

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**Fig. 6**: Anomalous insertion of the medial meniscus into the ACL in 57-year-old woman with right knee pain. Sagittal proton density weighted (A and B), oblique coronal proton density weighted (C and D) MR images show low signal intensity linear band structure (white long arrows) arising from anterior horn of medial meniscus (black arrows) at the anterior aspect of ACL (white short arrows), which runs parallel to ACL.

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Fig. 7: Anomalous relationship between gastrocnemius muscle and popliteal artery in 22-year-old man with intermittent claudication during exercise. Axial angio-CT (A) image shows abnormal course of right popliteal artery (arrow) to the medial side of medial head of gastrocnemius muscle (asterisk) and normal course of left popliteal artery between medial and lateral head of gastrocnemius muscle. 3D reconstruction image shows focal segment occlusion of the right popliteal artery. Also, the right popliteal artery is displaced medially rather than left normal popliteal artery.

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Fig. 8: (Continued) Coroanl & axial proton density weighted (C, D, and E) MR images show abnormal course of right popliteal artery (white arrow) that runs medial side of medial head of gastrocnemius muscle (asterisk) and compressed right popliteal artery (yellow arrow). Abbreviation : LHGM (lateral head of gastrocnemius muscle)

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Fig. 9: Accessory slip of the lateral head of gastrocnemius in 19-year-old man with trauma. Axial (A and B) and sagittal (C) MR images demonstrate the accessory slip of the lateral head of gastrocnemius muscle (arrow), which originate from posterior cortex of distal femur and insert into the lateral head of gastrocnemius muscle (asterisk). It crosses anterolateral to the popliteal artery and vein. Abbreviation: MHGM (medial head of gastrocnemius muscle).

Fig. 10: Cyamella. Anteroposterior (A) and lateral (B) radiographs show the sesamoid bone (yellow circle) located at the posterolateral aspect of lateral femoral condyle. Sagittal (C) and coronal (D) MR images show the cyamella within the popliteus muscle (arrow) with marrow signal similar to the adjacent bones.
Fig. 11: Sesamoid bone within the patellar tendon. Lateral (A) radiographs show the well-defined and oval-shaped ossified lesion (long arrow) at the infrapatellar area. Sagittal (B and C) and axial (D) MR images show the sesamoid bone (long arrows) within the patellar tendon (short arrows), representing the similar signal intensity with the adjacent patella (asterisk).

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**Fig. 12:** Dorsal defect of the patella in a 16-year-old boy. Merchant view (A) of the left knee radiograph shows subtle radiolucent lesion (arrows) in the posterolateral aspect of the patella.

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**Fig. 13:** (Continued) Axial (B) and sagittal (C) MR images show the well-circumscribed defect (arrow) in the superolateral aspect of the patella, compensated by overgrowing articular cartilage.

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**Fig. 14:** Distal femoral epiphyseal irregularity in a 7-year-old boy. Lateral (B) radiograph shows irregularity of the lateral femoral condyle (arrows). Sagittal (B and C) MR images show normal variant irregular ossification (arrows) of the posterior aspect of the latera femoral condyle. And signal intensity of the surrounding marrow is normal and the overlying articular cartilage is intact.

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Conclusion

Due to excellent soft tissue contrast and ease of acquisition of multiple imaging plane, MRI has become the standard imaging tool for the evaluation of the knee.

Diverse uncommon normal variant are visible on the knee MRI. Awareness of imaging appearances of anatomic variants would be helpful for the accurate diagnosis and avoiding unnecessary management.

Personal information

References