True pathology versus anatomical variants of the knee on MRI: pearls and pitfalls.

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Learning objectives

1. To directly compare normal anatomical variants and similar pathological MRI findings of the ligaments, tendons and fibrocartilaginous structures of the knee, thus minimising diagnostic error.
2. To illustrate other unusual anatomical variants of the knee on MRI.
Background

• MRI of the knee is one of the commonest musculoskeletal investigations in radiology.
• It enables a detailed and comprehensive evaluation of the soft tissues which plain radiography and CT cannot provide.
• Common pathology and normal variants of the knee have a variety of appearances which can occasionally mimic one another.
• Knowledge of their differences will reduce the likelihood of misdiagnosis.
Imaging findings OR Procedure details

We will compare the following anatomical variants with their pathological counterparts in a pictorial review.

1. The double PCL sign of a bucket handle tear and a prominent anterior meniscofemoral ligament.
   - On midline sagittal MRI image, a hypointense band is seen parallel and anteroinferior to the true posterior cruciate ligament (PCL). This is called the double PCL sign which usually represents a bucket handle tear of the medial meniscus (Fig. 1 on page 7). However, a prominent anterior meniscofemoral ligament (ligament of Humphrey) may also mimic a bucket handle tear (Fig. 2 on page 7 & Fig. 3 on page 8). The anterior meniscofemoral ligament connects the posterior horn of the lateral meniscus to the lateral aspect of the medial femoral condyle. It lies anterior to the PCL. A buckle handle tear is usually more irregular in outline and associated with visible meniscal abnormality.

2. Cortical desmoids and fibrous cortical defect
   - A cortical desmoid is a fibro-osseous lesion of the posteromedial aspect of distal femoral metaphysis (Fig. 4 on page 9 & Fig. 5 on page 10). The cause is thought to be repetitive traction at the femoral insertion of the medial head of the gastrocnemius or adductor magnus aponeurosis. It is usually asymptomatic and found incidentally. It appears similar to a fibrous cortical defect which is a benign lucent bone lesion frequently seen in the distal femoral metaphysis (Fig. 6 on page 11). Both will usually appear T1 hypointense with variable T2 signal intensity: MR signal is of limited help in distinguishing the two lesions. However, cortical desmoids have a typical location in the posteromedial distal femoral metaphysis, whereas fibrous cortical defects may occur at a variety of locations, most commonly the metaphyses of the proximal tibia, distal tibia and distal femur.

3. Meniscal flounce and meniscal tear.
   - Meniscal flounce is a wavy inner edge of the medial meniscus. It tends to be seen in patients with ligamentous laxity and thought to be a transient physiological distortion. It is best seen as a wavy structure in the sagittal plane (Fig. 7 on page 12) with uniform signal intensity. This can be differentiated from a meniscal tear, which will have disrupted signal intensity (Fig. 8 on page 12). Meniscal tears are more frequently associated with articular cartilage loss and thinning.
4. Speckled anterior horn of the lateral meniscus and tear of the anterior horn.

- A speckled anterior horn of the lateral meniscus is spotty or speckled at its central attachment. This is best seen on T1 and proton density weighted imaging (Fig. 9 on page 13 & Fig. 10 on page 14). The appearance is likely due to its location at the junction of the lateral meniscus and tibial attachment of the ACL. This should be considered when diagnosing a tear of the anterior horn of the lateral meniscus (Fig. 11 on page 15). In the latter scenario, MRI should demonstrate a tear in multiple planes.

5. Meniscal ossicles and osteochondral loose bodies.

- Meniscal ossicles are typically located in the posterior horn of the medial meniscus (Fig. 12 on page 16). The ossicles consist of bone marrow and cancellous bone covered by cortical bone and hyaline cartilage. They have signal characteristics of normal bone marrow (hyperintense on T1 and hypointense on T2 fat-suppressed weighted images). Osteochondral loose bodies will be of T1 hypointense signal (Fig. 13 on page 17) and may occur anywhere within the knee joint.


- The popliteus tendon inserts into the lateral femoral condyle. The multipartite popliteus is one of the musculotendinous insertion variants. The bundles of tendon appear as parallel structures on sagittal plane (Fig. 14 on page 18). They follow the normal course of the popliteus tendon. A popliteus tendon tear may appear similar but will have other features such as oedema and truncated appearance (Fig. 15 on page 18 & Fig. 16 on page 19).

We will also discuss the following unusual normal anatomical variants.

1. Suprapatellar and infrapatellar plicae

- Synovial plicae are thin folds of vascularized synovial tissue found within the lining of the knee joint. Suprapatellar and infrapatellar plicae are the commonest types.
- The suprapatellar plica is typically located at the border between the suprapatellar bursa and the knee joint cavity. It appears as a thin hypointense band posterior to the patella on both T2 and proton density weighted images (Fig. 17 on page 20).
- The infrapatellar plica originates anteriorly within the intercondylar notch, coursing through the infrapatellar fat pad and inserts into the inferior pole of the patella (Fig. 18 on page 21). It appears as a hypointense structure, best seen in the sagittal plane. This can be mistaken as a loose body (Fig. 13 on page 17).
2. Ring meniscus

   - This is a rare entity with only a few reported published cases. It is usually found on the lateral meniscus. It appears as a continuous structure in the coronal and sagittal planes (Fig. 19 on page 21). This can be mistaken for a bucket-handle meniscal tear within the intercondylar notch (Fig. 20 on page 22).

3. Oblique menisco-meniscal ligament (OMML)

   - This ligament originates from the anterior meniscal horn and inserts on the contralateral posterior meniscal horn. Medial and lateral OMMLs are named according to their anterior origin. Fig. 21 on page 23, Fig. 22 on page 23 and Fig. 23 on page 24 (video) demonstrate the medial OMML arising from the anterior horn of the medial meniscus and inserting into the posterior horn of the lateral meniscus. It is a hypointense linear structure on imaging. It can be occasionally mistaken for a bucket handle tear especially in the sagittal plane (Fig. 1 on page 7).
Fig. 1: The Double PCL sign - Bucket handle tear of the medial meniscus

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Fig. 2: The anterior meniscofemoral ligament, connecting the posterior horn of the lateral meniscus to the lateral aspect of the medial femoral condyle.

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Fig. 3: Pseudo Double PCL sign (Prominent anterior meniscofemoral ligament)

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**Fig. 4:** Lateral plain radiograph of the right knee. This demonstrates an area of ill-defined cortex in the posterior aspect of distal femur in keeping with a cortical desmoid.

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**Fig. 5:** An area of T2 hyperintensity in the posteromedial aspect of the distal femur at the origin of the medial head of gastrocnemius muscle. Appearances are in keeping with a cortical desmoid.

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Fig. 6: Coronal and sagittal MR of the knee showing a T1 hypointense lesion/defect in the posterior distal femoral meta-diaphysis. This is a fibrous cortical defect (FCD). It is slightly superior to the normal location of a cortical desmoid.

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Fig. 7: Meniscal flounce

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**Fig. 8:** Lateral meniscal tear. Note there is surrounding cartilage thinning which is associated with a meniscal tear. In meniscal flounce, the cartilage is preserved, as demonstrated on previous image.

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Fig. 9: Speckled anterior horn of the lateral meniscus

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Fig. 10: Sagittal MR images of the knee showing a speckled appearance of the inner edge of the anterior horn of the lateral meniscus at its central attachment where it is closely related to the ACL.

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**Fig. 11:** A tear of the anterior horn of the lateral meniscus. This can be differentiated from speckled anterior horn by the presence of a horizontal cleavage tear and parameniscal cysts.

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Fig. 12: Meniscal ossicles

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Fig. 13: An intra-articular hypointense lesion (yellow arrow) in keeping with a loose body.

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Fig. 14: Multipartite popliteus tendon

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Fig. 15: Sagittal T2 of the knee showing a torn popliteus tendon.

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**Fig. 16:** Sagittal T2 fat saturated sequence of the same knee from previous image showing a torn popliteus tension with surrounding oedema.

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**Fig. 17:** A suprapatellar plica is usually located at the border between the suprapatellar bursa and the knee joint cavity. It is a thin hypointense band posterior to the patella on T2 and proton density weighted sequences.

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**Fig. 18:** An infrapatellar plica originates anteriorly within the intercondylar notch, coursing through the infrapatellar fat pad, inserting into the inferior pole of the patella.

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**Fig. 19:** Coronal and sagittal images demonstrate a ring meniscus which appears as a continuous structure in two planes.

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**Fig. 20:** Coronal MR images showing a bucket handle tear of the medial meniscus with a centrally displaced meniscal fragment in the intercondylar notch.
**Fig. 21:** Oblique meniscomeniscal ligaments (OMML)

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**Fig. 22:** MiniMIP (minimum intensity projection) sagittal MR of the knee. This demonstrates the medial OMML (yellow arrow) as a hypointense band arising from the anterior horn of the medial meniscus inserting into the posterior horn of the lateral meniscus.

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Fig. 23: Sagittal MR of the knee demonstrating the medial OMML as a hypointense band arising from the anterior horn of the medial meniscus and inserts into the posterior horn of the lateral meniscus.

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Conclusion

• The ability to differentiate between anatomical variants on knee MRI and pathology with similar imaging characteristics is important and will lead to increased diagnostic accuracy.
References


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