Differential diagnosis of anterior knee pain in Magnetic Resonance Imaging (MRI): a literature review

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Learning objectives

To understand the most frequent etiological factors and radiological features of anterior knee pain, its differential diagnosis in MRI.
Background

Anterior knee pain that originates at the front of the knee joint is a common complaint. This disorder has a profound economic and social impact as it affects approximately 15-33% of young and active people.

The role of physical examination in making differential diagnosis is rather limited since different conditions cause similar symptoms. Knee MRI is considered the gold standard in evaluating the damage to the anatomical structures of the knee, such as ligament or tendon rupture, meniscus or cartilage injury.

It is often the case that MRI findings determine the therapy, therefore radiologists have to know what to look for in knee MRI images.
Imaging findings OR Procedure Details

Ligament injury

Cruciate ligaments stabilize the knee joint. Once they rupture, a shift in ligament balance forces occurs and may lead to cartilage damage. An ACL rupture causes rotational instability and secondary changes, such as medial compartment and patellofemoral joint overload (Fig. 1). A PCL rupture causes posterior instability. When the tibia slips dorsally, mechanical load to the patella increases and speeds up wear and tear. Following an anterior cruciate ligament reconstruction, pain can be caused by postoperative complications, such as:

- **Arthrofibrosis** is a contracture of an infrapatellar fat pad and patellar tendon. A ill-defined low signal area on T1 and T2 weighted images, similar to fibrous tissue.
- **Cyclops lesion** is defined as a nodule located anteriorly to the distal end of an ACL graft (Fig. 2). Two histologic types: "hard"- composed of bone or cartilage, more often acts as obstacle and "soft"- only composed of fibrous tissue, rarely causes impingement. A low signal intensity nodule on T1WI images, anteriorly to the graft. It could show similar intensity to synovial fluid. The nodule is heterogeneous on T2WI, usually hypointense and well differentiated from fluid. Differential diagnosis should include focal pigmented villonodular synovitis, synovial chondromatosis and loose bodies.

Bipartite patella

A patella has two centers of ossification and fully ossifies until 12 years of age. In small proportion of population the ossification centers remain unfused. Three types of bipartite patella are described (Fig. 3). In the majority of cases, an accessory ossification center presents at the superolateral aspect near the attachment of vastus lateralis muscle. A bipartite patella is asymptomatic in most cases. Trauma or overuse can provoke pain in asymptomatic patients. Usually, an MRI scan is unnecessary, however, the signs of degeneration, bone marrow signal change or cartilage injury can be observed.

Patellar fracture

A direct blow or increased tension in a quadriceps and patellar tendon can cause patellar fracture. In most cases, a fracture line is transverse and passes between the middle and inferior third (Fig.4). Usually, the diagnosis is made on x-ray images. An MRI scan is useful in excluding ligamentous injury or in cases of suspected stress fracture. On MRI images stress fracture appears as low intensity line surrounded by bone marrow oedema (Fig. 4).
**Patellar dislocation**

It is one of the most common causes of anterior knee pain in young people. A high-riding patella and femoral trochlear dysplasia are the major predisposing factors. It is often the case that a dislocated patella reduces spontaneously without patient's awareness of the fact. The following MRI features of patellar dislocation are noted (Fig.6, Fig. 7):

- Medial retinaculum and medial capsule injury/tear
- Lateral femoral condyle contusion and osteochondral damage
- Medial patellar facet contusion with or without cartilaginous lesion

Medial retinaculum tears occur at the attachment site to the femur or along the medial margin of the patella and subsequently may cause avulsion injuries. Cartilaginous lesions can result in the formation of loose bodies in the joint space.

**Chondromalacia** is defined as softening and degeneration of the articular hyaline cartilage. Overuse and trauma cause damage to the cartilage which over time leads to fissuring and partial loss of cartilage thickness. Subsequently, patients with high grade osteoarthritis sustain cartilage destruction with underlying bone changes. Cartilaginous lesions are graded according to the Outerbridge classification (Fig. 8) which is based on a correlation between MRI and arthroscopic findings. Although arthroscopy is a gold standard for the evaluation of the severity of cartilage defects, new MRI sequences (T2 mapping, DW, dGEMRIC, T1rho, Fig. 9) allow early diagnosis, contribute to preoperative planning and postoperative follow-up.

**Osteochondritis dissecans** of the patellofemoral joint is an uncommon condition that may be the cause of anterior knee pain or crepitus. The osteochondral lesions involve the convex articular surfaces. The trochlear groove is the rarest location for osteochondritis dissecans. MR is the test of choice since it detects an osteochondral fragment and evaluates its stability. A high signal line demarcating the fragment from bone usually indicates an unstable lesion. Cartilaginous lesions can be classified into three main groups:

- Subchondral- intact cartilage surface
- Osteochondral fractures- disrupted articular surface with a fragment of cortical bone
- Chondral injury- underlying bone is intact

**Injuries of the extensor mechanism of the knee**

**Patellar tendinopathy** is a chronic overuse injury to the fibres of the patellar tendon. It affects adults who are involved in sports, usually demanding repeated jumping, and therefore is also known as Jumper's knee. Morphological changes do not correlate with clinical symptoms. On T1WI, T2WI and PD images the patellar tendon demonstrates an
increase in signal intensity and thickening with the inflammatory infiltration of surrounding tissues (Fig. 10). Early MRI signs of tendinopathy include the blurring of a contour with or without changes in signal intensity. Complete tendon rupture is very rare.

In adolescence repeated microtrauma to the immature patellar tendon at the insertion onto the tibial tuberosity leads to bony hypertrophy, fragmentation of a tibial tuberosity and inflammatory changes of overlying tissues—Osgood Schlatter disease (Fig. 11). Equivalent condition involving the inferior pole of the patella is called Sinding-Larsen-Johansson disease (Fig. 12).

Quadriceps tendon injury can be categorised as follows:

- Acute is described as partial or full thickness rupture, best seen on T2WI or PD images as a gap filled with hyperintensive fluid (Fig. 13).
- Chronic damage is described as increased signal intensity areas on T2WI and PD with fat suppression. Most ruptures occur at the osteotendinous junction at the upper pole of the patella. Calcification and traction osteophytes develop over time.

Fat pad syndromes

The infrapatellar (Hoffa's) fat pad is an intraarticular and yet an extrasynovial structure which has an abundant vasculature and innervation. Pathological changes are often associated with other conditions, such as patellar tendinopathy, ligament reconstruction or meniscal tear. Acute injury usually occurs in the dorsal part of the fat pad and presents as oedema or tears (Fig. 14). In chronic injury hemosiderin deposits or scarring are observed. Lateral patellofemoral impingement involves of oedema of the superolateral part of the fat pad, a shallow femoral trochlea, patellar malalignment and chondromalacia.

The inflammation of a quadriceps fat pad is rare and features are similar to that of Hoffa's fat pad.

Also, benign or malignant masses can be the cause of anterior knee pain (Fig. 15).

Pigmented villonodular synovitis is rare benign neoplastic synovial proliferation with villous and nodular projections and haemosiderin deposition. It mainly affects knee joint. On MRI images it appears as masslike lesion with well-defined low signal intensity nodule. On both T1 and T2 images it is seen low signal intensity with variable postcontrast enhancement (Fig. 16).

Iliotibial band syndrome, also known as Runner’s knee, is caused by an excessive friction between the iliotibial band and the lateral femoral epicondyle. MRI findings include the thickening of the iliotibial band and a deep bursa located over the lateral epicondyle.
Also, there is an inflammation of the surrounding soft tissues (Fig. 17). MRI is reserved to exclude other etiologies of pain such as lateral meniscal tear.

**Synovial plicae** represent remnants of embryological development. The medial patellar plica is the most common symptomatic plica which is vulnerable to friction during flexion. The affected plica appears thickened and hyperintense on MRI images (Fig. 18). Hypertrophy and fibrosis of the plica may provoke articular cartilage damage.

**Bursitis**

There are four bursae anterior to the knee joint: a suprapatellar, a subcutaneous prepatellar, a subcutaneous infrapatellar and a deep infrapatellar bursa (Fig. 19). Inflammation can be caused by acute or chronic trauma and systemic diseases such as rheumatoid arthritis or metabolic disorders.

**Patellofemoral pain syndrome** can be defined as anterior knee pain involving the patella and retinaculum that excludes other intraarticular and peripatellar pathology. It is thought due patella maltracking or patellofemoral impingement. On MRI radiologist must evaluate patellar tilt using patellofemoral angle, trochlear sulcus hypoplasia/dysplasia using trochlear sulcus angle and depth, TT-TG distance (tibial tubercle to the trochlear groove), which correlates with lateralized tibial tuberosity and patellar tendon transposition.
Fig. 1: Coronal (frontal) IR FSE (a) and sagittal T2 FSE (b) shows unevenly thinning of medial knee joint and femur trochlear groove cartilage (arrows) caused by chronic rupture of anterior cruciate ligament.

Fig. 2: Axial PDW SPIR (a) and sagittal PDW (b) shows fibrous nodule (arrows) at distal part of anterior cruciate ligament transplant.
Fig. 3: Types of bipartite patella: type I- inferior pole (a,b); type II- lateral margin (c, d); type III-superalateral portion (e, f).
Fig. 4: Inferior third of patella fracture without dislocation.

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**Fig. 5:** On MRI image the fracture line (arrows) extends across patella with bone oedema in the surrounding marrow.

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Fig. 6: Axial (a) PD FS and sagittal (b) T2 shows medial retinaculum avulsion fracture with patellar edge fragment (asterisk), medial patellar facet contusion and cartilaginous lesion (black arrows), lateral femoral condyle contusion (open arrow), loose cartilaginous body in anterio-lateral joint space

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Fig. 7: Coronal PD FS (a, b) shows lateral femoral condyle contusion and steochondral damage (white arrow), loose cartilaginous body (black arrows) in anterio-lateral joint space.

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Fig. 8: Cartilage lesions on T2 images: a- focal area of hyperintensity with normal contour; b- fragmentation of cartilage; c- partial thickness cartilage loss with focal ulceration; d- full thickness cartilage loss with underlying bone reactive changes;

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Fig. 9: Cartilage T2 mapping allows to evaluate the articular cartilage of the knee joint. Red colour shows cartilage lesion.

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**Fig. 10:** On sagittal (a) and axial (b) PD FS proximal end of patellar tendon is seen high intensity, enlarged (white arrow) surrounding by inflammatory changes (black arrow).

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**Fig. 11:** Sagittal T2 (a) and PD SPIR (b) shows tibial tuberosity bony hypertrophy (black arrow), fragmentation and inflammatory changes of overlying tissues.

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**Fig. 12:** Coronal (a) and sagittal (b) PD FS shows changes involving the inferior pole of the patella which is characteristic for Sinding-Larsen-Johansson disease.

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**Fig. 13:** Sagittal PD FS (a) and T2 (b) shows quadriceps tendon full thickness rupture as a gap filled with hyperintensive fluid.
**Fig. 14:** Sagittal (a) and axial (b) IR shows high signal intensity at infrapatellar fat pad (arrows). Sagittal image demonstrates patella alta.

**Fig. 15:** Sagittal T2 (a) and PD FS (b) shows heterointensive mass (arrows) at quadriceps fat pad which was confirmed histologically as a metastasis of renocellular carcinoma.
**Fig. 16:** A synovial nodular lesion is seen (arrows), with heterogenous signal characteristics.

**Fig. 17:** Coronal (a) and axial (b) PD FS shows thickened and oedematous iliobibial band (white arrow) and bursa (black arrow) between the band and lateral epicondyle of the femur.
**Fig. 18:** Sagittal T2 (a) and axial PD FS (b) shows thickening of medial patellar place (arrows) and insignificant Chondromalacia of femoral trochlear groove.

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**Fig. 19:** Axial PD FS (a) and sagittal GRE (b) shows hyperintensive fluid in prepatellar region (black arrows) and suprapatellar bursae (white arrows) - characteristic for prepatellar and suprapatellar bursitis.

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Conclusion

Knee MRI is a valuable imaging technique for the identification and differentiation of anterior knee pain.

Making a diagnosis might be a challenge due to a wide set of causes and nonspecific symptoms, therefore the knowledge of characteristic radiological features of major etiological factors is of fundamental importance.
References

• Andrews CL, Roberts CC. Expertddx, Musculoskeletal. Lippincott Williams & Wilkins; 2009.