Magnetic resonance imaging in patellar tendon abnormalities: A pictorial review

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Purpose

The objective of this exhibit is to describe and illustrate the spectrum of imaging findings in patellar tendon abnormalities. The differential diagnoses are discussed.

Methods and Materials

From September 2010 through November 2011, we studied 159 knees in 150 patients with anterior knee pain in a 1.0T MRI scanner. The MRI protocol in all cases included spin-echo or fast spin-echo proton-density and T2-weighted sequences in the sagittal and coronal planes as well as gradient-echo and sometimes spin-echo T1-weighted sequences in the axial plane. STIR or fat-suppressed T1-weighted sequences were also used in some cases. We administered intravenous gadolinium contrast when necessary. All studies were interpreted by two experienced radiologists working independently.

Results

Patellar tendon abnormalities were classified into two categories: traumatic and not-traumatic.

Traumatic:

Partial tears. Many tears do not completely disrupt the soft tissue. This is similar to a rope stretched so far that some of the fibers are torn, but the rope remains in one piece. Incompletely discontinuous fibers of the patellar tendon can be detected through their hypointense signal on T1-weighted and/or T2-weighted MRI at the proximal level (Figure 1) or at the distal level (Figure 2).

Complete tears. A complete tear will disrupt the soft tissue into two pieces. Patellar tendon rupture is a rare injury, but it has great clinical importance as the patellar tendon is the terminal extension of the quadriceps muscle in the leg. The patellar tendon often tears where it attaches to the patella, and it can break a piece of the bone as it tears. When a tear is caused by a medical condition - like tendonitis - the tendon usually tears in the middle. Sports injuries can result in acute avulsions at the insertion of the patellar tendon onto the inferior patellar pole and less commonly at its tibial insertion (Figure 3).
Complete tear of the patellar tendon with interposed edema and/or hemorrhage can be seen on MRI (Figure 4).

**Surgical tendinosis.** Previous surgery around the tendon, such as a total knee replacement or allograft for anterior cruciate ligament reconstruction, might increase the risk of a tear. Thickening of the patellar tendon with signal alteration on all sequences due to collagen degeneration can be shown in MR (Figure 5).

**Non-traumatic:**

Overuse tendinopathies are common in athletes with mature skeletons, occurring in up to 20% of jumping athletes. Among others, "Jumper's knee", "patellar tendinosis", "patellar tendinopathy", or "repeated microtrauma or overuse of the patella, patellar tendon, the lower pole of the patella, or the tuberosity of the tibia" are all terms that have been used to refer to the same pathology, but the most widely accepted term is currently enthesitis.

Unlike in muscle tissue, where overuse results in strengthening, in the tendon overuse results in inflammation (acute) and degeneration (chronic) that can lead to tearing. The characteristic symptoms are a) localized pain anterior to the patella that is aggravated by activity and increases with efforts and may or may not calm with rest, b) infiltration, and c) localized crepitus.

On MRI, acute tendinitis of the patellar tendon usually manifests as focal or diffused thickening with increased signal intensity on T2-weighted or STIR of part (often the proximal third) (Figure 6) or the entire patellar tendon. Chronic tendinitis of the patellar tendon shows thickening with heterogeneous signal intensity on all (especially T1-weighted and T2-weighted) sequences (Figure 7).

The differential diagnosis includes other conditions presenting with anterior knee pain, such as intra-articular, patellofemoral, and soft-tissue pathology, which can differ in etiology, clinical traumatic onset, and clinical findings.

1. **Osgood-Schlatter disease.** This condition occurs at the level of the tibial tuberosity, where the patellar tendon inserts. This area is particularly fragile due to local growth phenomena and because the patellar tendon is subjected to multiple and repeated traumas that cause microavulsion. Osgood-Schlatter disease produces a true avulsion of cartilaginous fragments of the tuberosity, drawn up through the tendon (multiple and repeated thrusts of the tendon). Fragmentation of the tubercle and inflammatory changes in the adjacent tendon are typical findings that can
persist into adulthood. The pathology is also well-demonstrated on MRI as thickening of the distal patellar tendon with a variable increase in signal intensity on T1-weighted, T2-weighted, and gradient-echo sequences, with hypertrophy and/or fragmentation of the tibial tubercle and heterotopic ossification within the distal patellar tendon (Figure 8).

2. **Sinding-Larsen-Johansson disease.** This results from the same process as Osgood-Schlatter disease, but it occurs at the inferior pole of the patella where the proximal tip of the patellar tendon inserts (apical ossification center). This disease mainly affects children aged 10 to 13 years, who typically present mechanical pain during exercise. The imaging characteristics are similar to those in Osgood-Schlatter disease. MRI can reveal increased T2-weighted signal intensity for edema in the proximal aspect of the patellar tendon, sometimes with adjacent patella edema if reactive (Figure 9).

3. **Prepatellar bursitis.** This is a progressive condition that can manifest initially due to a variety of situations. Repeated pressure on the patella, such as kneeling, can cause inflammation and discomfort that contribute to the development of patellar bursitis. Other factors that may contribute to the development of prepatellar bursitis include the presence of a chronic arthritic (e.g., gout) or bacterial infection within the knee joint. The MRI findings include well-circumscribed prepatellar fluid seen as homogenous decreased signal intensity on T1-weighted sequences and increased signal intensity on T2-weighted sequences (Figure 10).

4. **Prepatellar edema.** Trauma or nonspecific edema involving subcutaneous cellular tissue, seen as indefinably decreased signal intensity on T1-weighted sequences and increased signal intensity on T2-weighted sequences in the area over the patellar tendon (Figure 11).

5. **Chondromalacia patellae.** This term refers to degeneration of the articular cartilage and is associated with anterior knee pain. The grading spans from softening of the cartilage to full-thickness defects. MRI can demonstrate signal alteration of the hyaline cartilage of the patella as an area of hypointensity on T1-weighted sequences or hyperintensity on T2-weighted sequences within cartilage with normal or altered contours, often accompanied by bone reactive change such as osseous edema, cyst formation, and sclerosis, depending on the stages, the latest of which is degenerative arthritis (Figure 12).

6. **Stress or trauma fractures of the patella** result from direct or indirect forces. The patella is the weakest point of the extensor mechanism of the knee. In stress fractures, MRI shows increased bone marrow signal with linear decreased signal intensity within the patella on T2-weighted and STIR sequences and sometimes surrounding soft-tissue edema (Figure 13). Variable displacement of fragments with or without hemorrhagic effusion can be seen in high energy fractures (Figure 14).

7. **Posttraumatic osteochondral lesions.** Acute or repetition injuries to the knee can cause osteochondral lesions of the patella or other sites of the knee (Figure 15).
8. **Focal masses.** Focal swellings around the knee are common but masses around the patellar tendon are rare. Gout (Figure 16), the nodular form of pigmented villonodular synovitis (Figure 17), and rheumatoid arthritis (Figure 18) are other synovial-based lesions that may present as a mass or with symptoms of patellar derangement. Metastases are the most common malignant patellar tumor (Figure 19). On MRI, masses can show a variable intermediate-to-decreased signal intensity on T1-weighted and T2-weighted sequences. The definitive diagnosis of any focal mass must be confirmed at histology.

9. **Meniscal pathology** (Figure 20) and other intra-articular pathologies such as loose bodies (Figure 21) should be ruled out by their etiology, clinical traumatic onset, and clinical and/or imaging studies.

Images for this section:

![Fig. 1: PARTIAL TEAR OF THE PROXIMAL PATELLAR TENDON. Sagittal proton-density MR image in a 41-year-old male soccer player with acute anterior knee pain after indirect trauma shows an incomplete tear with discontinuous fibers at the infrapatellar level of the patellar tendon (arrow).](image-url)
Fig. 2: PARTIAL TEAR OF THE DISTAL PATELLAR TENDON. Sagittal proton-density MR image in a 68-year-old man with persistent anterior knee pain from indirect trauma in a fall shows an incomplete tear with discontinuous fibers and intratendinous hematoma at the level of the distal patellar tendon (arrow).
Fig. 3: AVULSION FRACTURE OF THE ANTERIOR TIBIAL TUBerosity WITH PATELLAR Tendon DISINSERTION. Sagittal T2-weighted MR image in a 31-year-old man with acute anterior knee pain after direct trauma to the knee. A fragment of the anterior tibial tuberosity is displaced cranially from the tibia (arrow). Note the traumatic edema of the popliteal muscle and osteosynthesis of the femur from previous surgical.
**Fig. 4:** COMPLETE TEAR OF THE PATELLAR TENDON. Sagittal T2-weighted MR image in a 50-year-old diabetic man with a two-month history of anterior knee pain due to a spontaneous tear of the patellar tendon shows a complete tear with an intertendinous hematoma at intermediate level of the patellar tendon (arrow). Note also the prepatellar bursitis (red arrow).
Fig. 5: SURGICAL TENDINOSIS. Sagittal proton-density MR image in a 44-year-old man who had undergone surgery on the anterior tibial tuberosity 3 years before shows diffuse thickening of the patellar tendon (arrow).
Fig. 6: ACUTE PATELLAR TENDINITIS. Axial GRE MR image in an 18-year-old male basketball player with acute anterior knee pain shows focal thickening with increased signal intensity at the proximal level of the patellar tendon (arrow).
**Fig. 7:** CHRONIC PATELLAR TENDINITIS (or non-surgical tendinosis). Sagittal proton-density MR image in a 68-year-old woman with chondromalacia patellae but no history of trauma or surgery shows fusiform thickening of the patellar tendon with signal alteration (arrow).
Fig. 8: OSGOOD-SCHLATTER DISEASE. Sagittal STIR MR image in a 15-year-old boy with persistent anterior knee pain shows thickening of the distal patellar tendon with increased signal intensity with fragmentation of the tibial tubercle within the distal patellar tendon and adjacent reactive trabecular osseous (arrow).
Fig. 9: SINDING-LARSEN-JOHANSSON DISEASE. Sagittal STIR MR image in an 18-year-old man with persistent anterior knee pain shows thickening of the proximal patellar tendon with increased signal intensity with fragmentation of the distal pole of the patella and adjacent soft-tissue edema (arrow).
**Fig. 10:** PREPATELLAR BURSITIS. Sagittal T2-weighted MR image in a 51-year-old woman with a slow-growing prepatellar mass shows a high signal intensity cystic mass involving the patella and the proximal third of the patellar tendon (arrow).
**Fig. 11:** PREPATELLAR EDEMA IN SUBCUTANEOUS CELLULAR TISSUE. Sagittal proton-density MR image in 51-year-old man injured while playing soccer shows an ill-defined area of decreased signal intensity in the area over the patella tendon (arrow) and a partial tear at the distal insertion of the quadriceps muscle (red arrow).
Fig. 12: CHONCROMALACIA PATELLAE. Axial GRE MR image in a 61-year-old woman with persistent anterior knee pain shows a softening of the cartilage with reactive cyst formation at the patella (arrow). Articular synovitis is also evident.
**Fig. 13: STRESS FRACTURE.** Sagittal proton-density MR image in a 26-year-old man with a history of traumatic transient lateral patellar dislocation shows a line of decreased signal intensity without reactive edema osseous within the inferior pole of patella (arrow). The lesion was not visualized on plain-film X-rays.
**Fig. 14:** TRAUMATIC FRACTURE. Sagittal STIR MR image performed to rule out meniscal and ligamentous lesions in a 63-year-old woman after a fall shows a line of decreased signal intensity with extensive reactive bone edema within the patella and soft-tissue edema around it (arrow).
Fig. 15: POSTTRAUMATIC OSTEOCHONDRAL LESION. Sagittal proton-density MR image in a 48-year-old man with a history of trauma shows an osteochondral lesion in the distal pole of the patella with a caudally displaced loose body inside Hoffa’s fat pad (arrow).
**Fig. 16:** TOPHACEOUS GOUT. Sagittal STIR MR image in an 80-year-old man with a monoarticular inflammation crisis affecting the left knee after sporadic hyperuricemia over 23 years shows an osteolytic lesion with a polyllobulated, slightly inhomogeneous soft-tissue mass on the anterior aspect of the patella extending to the proximal patellar tendon. Biopsy revealed urate deposits surrounded by giant cells.
**Fig. 17:** PIGMENTED VILLONODULAR SYNOVITIS. Sagittal T2-weighted MR image in a 38-year-old man with anterior knee pain and knee extension block shows a heterogeneous mass occupying Hoffa's fat pad (arrow). These findings are consistent with the nodular form of pigmented villonodular synovitis and the diagnosis was confirmed at histology.
**Fig. 18:** RHEUMATOID ARTHRITIS. Coronal STIR MR image in a 47-year-old woman with a prepatellar mass with articular inflammation affecting the right knee shows a high signal intensity prepatellar polylobulated septated cystic mass at the anterior aspect of the knee corresponding to the prepatellar bursitis (arrow).
Fig. 19: METASTASIS. Sagittal proton-density MR image in a 58-year-old man with rectal cancer and persistent anterior knee pain shows a heterogeneously low intensity area at the distal extreme of the knee (arrow). Biopsy confirmed a bone metastasis and metastases were also found at other sites (right sacrum).
Fig. 20: MENISCAL PATHOLOGY. Sagittal T2-weighted MR image in a 48-year-old man with persistent anterior knee pain shows a high intensity rounded septated mass adjacent to the torn anterior horn of the lateral meniscus (arrow) consistent with a meniscal cyst.
**Fig. 21:** LOOSE BODIES. Sagittal T2-weighted MR image in a 60-year-old woman with severe chondromalacia and persistent anterior knee pain shows a free osteochondral fragment within Hoffa’s fat pad (arrow).
Conclusion

MRI is an excellent method for evaluating patellar tendon pathologies; it has proven to be the most reliable imaging technique for the diagnosis and further characterization of patellar tendon lesions.

References


Personal Information