Non-traumatic Lesions of the Anterior Cruciate Ligament on MRI: an Updated Review

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Learning objectives

To describe the MRI findings for non-traumatic lesions of the anterior cruciate ligament (ACL) and their relevance in distinguishing among pathological entities.

Background

We studied 150 patients (aged 25-75 y) with positive findings for non-traumatic ACL lesions on MRI examination done for knee pain or restricted movements in the last 3 years.

All patients had previously undergone X-ray and some had undergone US and/or CT as well. MRI examination consisted of sagittal T2-weighted sequences commonly used in the evaluation of the ACL, together with axial gradient-echo and coronal T2-weighted sequences. Sagittal or coronal STIR or fat-suppressed T1-weighted sequences were also used in almost all cases.

Imaging findings OR Procedure Details

Non-traumatic ACL lesions are infrequent. The causes include mucoid degeneration, ganglion cyst, and, more rarely, infiltrative or compressive lesions, such as gout, synovial chondromatosis, diffuse pigmented villonodular synovitis, and chronic granulomatous disease. We discuss this differential diagnosis.

MUCOID DEGENERATION

Mucoid degeneration of the ACL, usually discovered incidentally, is by far the most common non-traumatic lesion of the ACL observed on MRI.
Mucoid degeneration of the ACL most often appears as fusiform cystic lesions extending along and interspersed within the fibers of the ligament, which might be confused with ganglia or with ligamentous tear.

MRI shows characteristically diffuse thickening of the ACL with abnormal hyperintense signal and intervening normal hypointense fibers on sagittal T2-weighted (Fig. 1 on page 6), fat-suppressed T1-weighted, or axial gradient-echo (Fig. 2 on page 7) sequences.

The lesion may also manifest as an elongated cyst along the long axis of the ACL or as an enlarged ACL with ill-defined areas of mildly increased signal interspersed among visibly intact ACL fibers ("celery stalk" appearance). The former presentation could be misdiagnosed as a chronic tear, the latter as an acute interstitial tear. Radiologists should consider cystic or mucinous degeneration of an intact ACL when cystic enlargement of the ACL or enlargement with ill-defined areas of increased signal are identified in a patient with a clinically intact ligament.

Mucoid degeneration, however, must be confirmed by pathologic examination (Fig. 3 on page 8) whenever pain or instability are present, because its MRI appearance may be non-specific. Patients may have a variety of generally mild symptoms or be totally asymptomatic. The knee is usually stable, with a negative Lachman test.

GANGLION CYST

Ganglion cysts or ganglia are cystic lesions most often found near or attached to tendon sheaths and joint capsules. The cysts are typically filled with a viscous gelatinous material and have a continuous or discontinuous fibrous (not synovial) lining. Knee pain, the most common complaint (present in all our cases), is usually attributable to other pathology. Though intraarticular ganglion cysts arising from the ACL are uncommon, there were xx cases in this study.

On MRI, ACL ganglia have a fusiform appearance. The lesions may be enclosed within the ligament or may be seen as well-defined masses anterior to the ligament that extend toward the Hoffa fat pad. ACL ganglia exhibit a homogeneously hyperintense signal on T2-weighted images that is nearly pathognomic (Fig. 4 on page 9).

GOUT
Tophaceous gout refers to the stage of established disease in which urate, protein matrix, inflammatory cells, and foreign body giant cells are deposited in the tissues. The deposits may be seen in bone, cartilage, tendons, ligaments, and other soft tissues, including bursae and other synovial spaces, being para-articular in the subcutaneous tissues.

A gouty tophus can affect any joint. When the knee is involved, radiologic examination may show tophi deposited around the prepatellar bursa, and the bursa may be inflamed with erosions of the medial or lateral tibial and femoral condyles or of the anterior tibial tubercle. Small bony cysts owing to intraosseous deposits of tophi may be seen in the patella or in the condyles of the tibia and femur. Before our case report in 2004, neither MRI or arthroscopy images of ACL involvement and infiltration by tophaceous gout had been reported in the literature.

In the present study, one patient had a gout-related lesion of the ACL. He had known antecedents of osteoarthritis and presented unspecific pain in the knee arousing clinical suspicion of medial meniscal disease. As previous X-ray studies had been negative, MRI was performed directly. MRI showed an irregular mass with intensity similar to the muscle at T1 and slightly heterogeneous signal intensity at T2* (Fig. 5 on page 10) involving and infiltrating the base of the ACL. Other masses were also discovered, one at the proximal and another at the distal portion of the medial collateral ligament. Because of the absence of calcifications in the mass, characteristic of gout, tophaceous gout was not strongly suspected in our case. Calcification within tophi is reported to be rare.

On arthroscopy, almost all synovial and cartilage components of the knee were covered with uric acid crystals. The discovery of uric acid "tapestry" enabled the main diagnosis of tophaceous gout for the lesions in the knee. Both the mass involving the ACL and the lytic lesion of the patella reported at MRI were biopsied, and tophaceous gout was confirmed at pathologic examination (Fig. 6 on page 11).

SYNOVIAL CHONDROMATOSIS

Synovial chondromatosis is characterized by cartilage nodules arising from the metaplastic transformation of synovial membrane. These nodules are made up of hyaline cartilage; they break from the synovium to form free bodies (2 mm-10 mm) that are loose inside the joint, mainly in the joint space, but also in the tendon sheaths and synovial bursa.
The knee is the most frequently affected joint, accounting for more than two-thirds of cases. Synovial chondromatosis can also appear in the hip and elbow; less common locations are the shoulder, ankle, carpus, and tarsus. It can affect patients of any age, but most cases occur in the fifth decade of life and males are affected twice as often as females. The symptoms are related to the mechanical effect exerted by the free bodies on the articular surface and generally involve the progressive onset of pain, crepitus, joint stiffness, and joint blockage, as occurred in our patient (described below).

We studied one case of synovial chondromatosis that directly involved the ACL. On MRI examination, a thick loose body was seen against the ACL, which had altered morphology and signal intensity on all sequences (Fig. 7 on page 12). MRI confirms the diagnosis in most cases and allows us to assess the degree of joint deterioration.

The treatment of choice is surgical removal of the loose bodies with partial synovectomy. It can be done either by arthrotomy or by arthroscopy, and the diagnosis of synovial chondromatosis can be confirmed by histologic study (Fig. 8 on page 13). Arthroscopy using a limited approach allows faster recovery and less surgical morbidity, so this technique is often the first choice.

**PIGMENTED VILLONODULAR SYNOVITIS (PVS)**

PVS is a locally aggressive synovial tumor. There are two forms of PVS: diffuse and nodular. The nodular form is more common in the hands and the diffuse form is more common in the knee. Its prevalence peaks during the third and fourth decades, and it affects men and women equally. PVS presents as a painless or slightly painful joint with swelling.

In this study several patients had PVS, both nodular and diffuse. Physical examination showed no bone pathology or unstable knee, and conventional X-ray studies provide no relevant data. PVS usually occurs in young adults in the form of recurrent joint effusion, slowly progressing to chronic monoarthritis with impaired and painfully movements of the knee, especially in diffuse PVS.

MRI shows mild-to-moderate effusion with characteristic hemarthrosis, without masses, cysts, or other pathological findings in the joint, which do not substantiate the suspected diagnosis of PVS. Joint effusion is common, particularly in large joints such as the knee.
and ankle. The lesion can be localized or diffuse, as occurred in one of our patients (Fig. 9 on page 14). The signal is low to intermediate in T1-weighted sequences and predominantly low in T2-weighted gradient echo sequences due to magnetic susceptibility artifacts from hemosiderin. This finding is almost pathognomonic of intra-articular PVS and allows us to differentiate it from other entities such as chondromatosis.

Although a benign condition, PVS may result in significant morbidity if left untreated. Pain, loss of function, and eventual joint destruction may result. The primary treatment options include radiation therapy or surgical resection via synovectomy. The imaging diagnosis may be later confirmed by biopsy (Fig. 10 on page 15). Recurrence is reduced with complete resection, which is achieved more often in cases with localized disease.

CHRONIC GRANULOMATOUS DISEASE

Chronic granulomatous disease (CGD) develops when the immune system's phagocytes are unable to kill some types of bacteria and fungi, resulting in recurring and chronic infections. CGD is often discovered early in childhood, though milder forms may not be diagnosed until adolescence or even adulthood, as in the exceptional case found in this study.

The patient underwent surgical synovectomy and arthrotomy of the right knee, with the diagnosis of diffuse PVS. Two years later, increased discomfort with pain in knee led to suspicion of recurrence. MRI demonstrated worsening of bone lesions and increased synovial proliferations respect to the previous imaging study done before the surgical intervention. Sagittal T2-weighted images showed the ACL totally surrounded by the proliferative synovial lesion (Fig. 11 on page 16). The affected osseous and synovial structures of the knee were biopsied; histologic study found CGD (Fig. 12 on page 17) and immunohistochemistry found alcohol-acid resistant bacilli. He is currently scheduled for re-intervention.

Images for this section:
**Fig. 1:** 58-year-old woman. Sagittal T2-weighted sequence shows celery stalk sign (arrow) with characteristic diffuse thickening of the ACL with an abnormally hyperintense signal and intervening normal hypointense fibers.
Fig. 2: Axial echo-gradient image shows diffuse thickening of the ACL (arrow) with an abnormally hyperintense signal and intervening normal hypointense fibers.
Fig. 3: Histologic evaluation (x 40) revealing distorted collagen fibers, multifocal mucoid degeneration (star), and a multilocular fibrous-walled cyst.
**Fig. 4:** 49-year-old man. Sagittal T2-weighted sequence shows fusiform mass (arrow) that is almost homogeneously hyperintense in the ACL (arrow).
**Fig. 5:** 64-year-old man. Sagittal T2*-weighted image shows a mass at the base of the ACL (long arrow) and an osteolytic lesion with expansive soft tissue within the patella (short arrow).
Fig. 6: Histologic evaluation (x 40) revealing urate deposits surrounded by giant cells.
Fig. 7: 53-year-old man. Sagittal T2*-weighted sequence shows a loose body adjacent to the thickened ACL (arrow).
**Fig. 8:** Histologic evaluation (x 40) revealing mature hyaline cartilage in a nodular pattern.
**Fig. 9:** 42-year-old man. Sagittal T2-weighted sequence shows a diffuse hypodense infiltrate that affects ACL (arrow) and other soft tissues.
**Fig. 10:** Histologic evaluation (x 40) revealing mononuclear proliferation in the presence of foamy histiocytes and pigment.
Fig. 11: 49-year-old man. Sagittal T2-weighted sequence shows the ACL totally surrounded by the proliferative synovial lesion (arrows).
Fig. 12: Histologic evaluation (x 40) revealing granulomatous infiltration in the intertrabecular space.
Conclusion

MRI is the best imaging technique for diagnosing and characterizing non-traumatic ACL lesions, often providing clues to the cause of the condition. Careful attention to clinical details and interpretation of MRI can establish the diagnosis and avoid unnecessary arthroscopic intervention in most cases.

References


Personal Information