

## **79. Cruciate Ligaments**

Knee MRI at high field strength and with high spatial resolution can identify tears of the anterior cruciate ligament (ACL) with accuracies approaching 100%. The normal ACL—arising from the posterior inner surface of the lateral femoral condyle and attaching anterolateral to the anterior tibial spine—is seen in Fig. 79.1A. The smooth, continuous fibers of this ligament demonstrate low SI on T1 and T2WI, due to its composition of type I collagen the rigid architecture of which limits motion of free water. This increases T2 relaxation and thus decreases SI on T2WI. Linear hyperintensity within the ligament on fluid sensitive sequences is a common finding of intact ligaments. While the anterior cruciate ligament can often be sufficiently evaluated on true sagittal MR images with 3 mm slice thickness or less, the additional acquisition of sagittal oblique images parallel to the ACL may aid in its evaluation. Optimal posterior cruciate ligament (PCL) evaluation is similarly obtained, its normal appearance seen on the T2WI of Fig. 79.1B. The low SI fibers of the PCL span from the medial condyle of the femur to the posterior intercondylar area of the tibia. An intact PCL usually displays signal hypointensity on all sequences. ACL tears may occur in the mid-portion or at its attachments, which may be accompanied by a loss of the ligament's parallel course with Blumensaat's line on sagittal PDWI. A fluid-filled gap within the ligament, appearing as high SI on T2 and PDWI, is a sign of an ACL tear which has high accuracy. If not completely visualized sagittally, additional T2 or PDWI in the coronal plane may aid in the detection of abnormal ligamentous SI. The T2WI of Fig. 79.1C demonstrates an undulating appearing ACL with high SI throughout correlating with edema. Such undulation often signifies ligamentous lengthening typical of a partial-thickness ACL tear (Grade 2). Lesions with abnormal ligamentous hyperintensity but no thickening are often classified as Grade 1. A secondary sign of an ACL tear is also present in this patient, seen in Fig. 79.1D, PCL "bowing" or "buckling". Complete ligamentous disruption is defined as a Grade 3 lesion. The absence of low SI fibers within the lateral portion intercondylar notch indicates a Grade 3 lesion. The posterior horn of the lateral meniscus may be uncovered in ACL tears, and concurrent injury to other ligaments, particularly the medial cruciate, frequently occur. Additional acute findings include joint effusions and bone contusions, both of which are seen as high SI on T2WI. Contusions occur in pivot-shift injuries from external femoral rotation with anterior tibial subluxation, involving the lateral femoral condyle and posterolateral tibia. Such injuries may angulate the PCL leading to a squared appearance, as illustrated. Segond fractures are associated with ACL tears and result from lateral capsular avulsion, seen as edema-like SI involving the location of capsular insertion on the lateral proximal tibia. The tibial tuberosity may

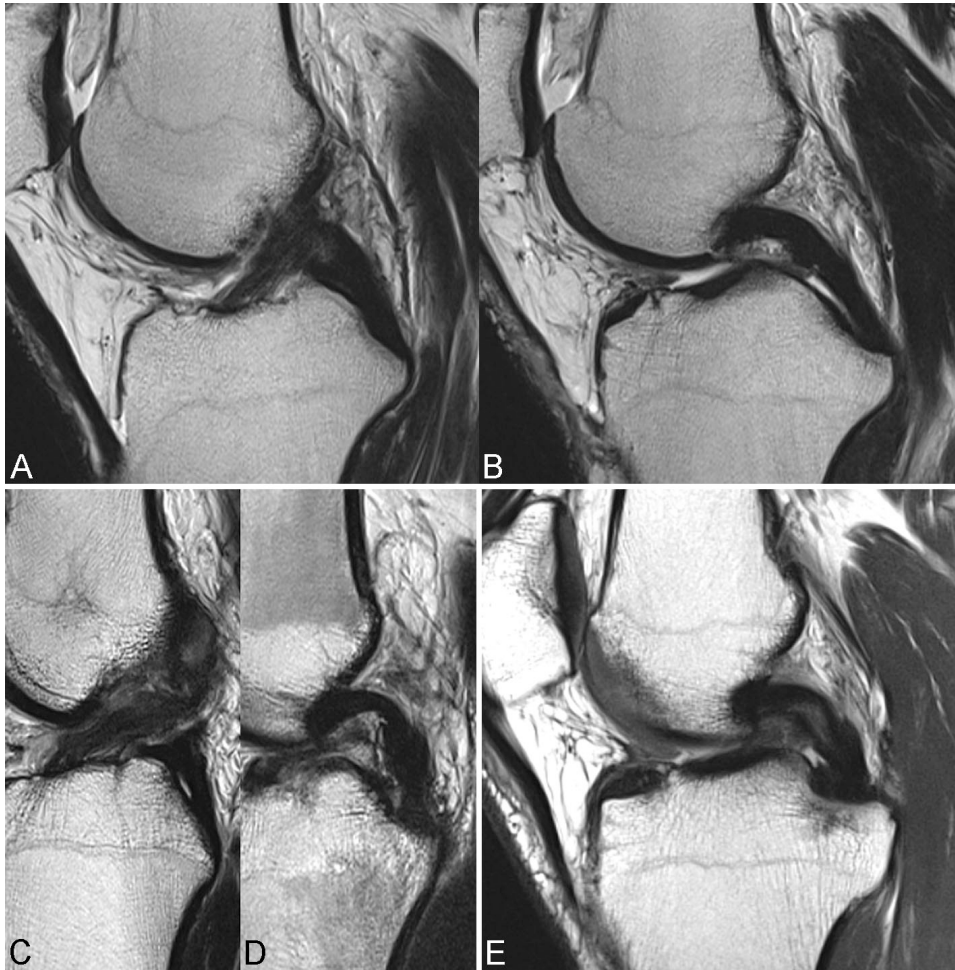


Fig. 79.1

also avulse, especially in children. Absence of joint effusion or bone contusion suggests a chronic lesion with the injured ACL adopting a horizontal orientation over time, potentially adhering to the PCL. Scarring or resorption may also occur, the latter signified by the presence of fat on T1WI often at the ligament's insertion. Chronic hyperintensity on T1WI reflects mucoid degeneration. Ganglion cysts within the tendon or intercondylar notch may mimic an ACL tear, demonstrating edema-like SI. MR arthrography is rarely required for the diagnosis of cruciate ligament tears, but the presence of gadolinium within the triangular space between the ACL and PCL or within the ACL itself are suggestive. Surgical ACL reconstruction may be performed with tendinous grafts from the patella or hamstrings which may demonstrate abnormal hyperintensity on fluid sensitive sequences within the maturation phase. Prior preference of GRE T2WI for the detection of ACL tears has been supplanted by intermediate- and T2-weighted FSE sequences, especially in the post-operative setting to minimize susceptibility artifact. Principles for imaging the PCL are similar for those of the ACL. PCL tears are similarly diagnosed by disruption along the

*Essentials of Clinical MR, 2<sup>nd</sup> edition*

ligament's course or by areas of high SI on T2WI correlating with edema. Figure 79.1E demonstrates this appearance with high SI edema involving the midportion of the otherwise low SI PCL on sagittal images. Partial, midsubstance tears, as seen here, are typical in PCL injury. Associated avulsion at the insertion of tibial component of the medial collateral ligament from off the medial tibial plateau is known as a medial or reversed Segond fracture. The arcuate sign—avulsion of the superior fibular styloid—is associated with posterolateral corner injuries and cruciate tears, especially the PCL.