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Evaluation of Knee Pain in Athletes: A Radiologist's Perspective

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Abstract

Lower limb injuries account for most of all injuries suffered by athletes and the knee joint accounts for over half of these. The etiology of knee pain is multifactorial; a good history focusing on the mechanism of injury and the chronicity of pain is extremely useful in correlating with radiologic findings and establishing a clinically meaningful diagnosis. This review article will discuss several important and common causes of acute and chronic knee pain in athletes, focusing on their mechanism of injury and site of pain as well as their salient imaging findings.

Résumé

La plupart des blessures affectant les athlètes touchent le membre inférieur et plus de la moitié d'entre elles visent l'articulation du genou. L'étiologie de la douleur au genou est multifactorielle. Une anamnèse solide axée sur le mécanisme de blessure et la chronicité de la douleur est extrêmement utile pour établir une corrélation avec les constatations radiologiques et poser un diagnostic significatif sur le plan clinique. Le présent article de synthèse aborde plusieurs causes importantes et courantes des douleurs aiguës et chroniques au genou chez les athlètes. Il met l'accent sur le mécanisme de blessure, le foyer de la douleur et les constatations radiologiques qui s'y rattachent.

Key Words: Knee; Pain; Athletes; Magnetic resonance imaging; Radiology

Lower extremity pain is extremely common in athletes, accounting for up to 90% of all injuries [1,2]. The knee joint has the largest articulating surface in the lower limb and accounts for well over half of the injuries [3]. The etiology of knee pain is multifactorial but a good history focusing on the mechanism of injury and the chronicity of pain is extremely useful in correlating with radiologic findings and establishing a clinically meaningful diagnosis. The athlete's sport in question is important, as is the acuity of the pain. Acute traumatic injuries have a different set of findings compared to chronic or overuse injuries. Although conceivably an athlete can suffer from any injury, particular sports are associated with characteristic injuries, for example, the association of classic pivot shift injury and sports such as American football and skiing is well recognized. Straightforward traumatic fractures of the bones of the knee joint have not been discussed in this article.

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Imaging

Plain radiographs are the first line imaging modality in evaluating knee pain and can reliably demonstrate fractures and may show secondary signs of soft tissue injury. Clinical evaluation of the affected joint, including a good history, can be quite accurate in identifying soft tissue injury in the knee joint, for example, the Lachman test has a sensitivity of up to 85% in identifying anterior cruciate ligament (ACL) injury [4]. However, imaging, mainly magnetic resonance imaging (MRI) remains one of the definitive methods of identifying the cause of knee pain, the other being knee arthroscopy. An understanding and knowledge of the salient internal anatomy is requisite, namely the extensor mechanism and the knee stabilizers and these will be referred to as each specific injury is discussed.

Acute Traumatic Pain

Acute knee injury is common in sports that involve rapid acceleration, deceleration, and change of direction or

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pivoting, such as American football, soccer, basketball, and skiing. ACL trauma accounts for the majority of these, over 50% in 1 cross-sectional study in a specialized sports trauma center [3]. The noncontact mechanism accounts for 70%-80% of these injuries [5,6].

Noncontact

Pivot Shift

A common noncontact injury resulting in acute knee pain is the pivot shift injury, which accounts for most of ACL tears [5,7]. This involves a valgus load applied to the knee combined with internal femoral or external tibial rotation. This results from rapid deceleration and simultaneous change of direction, a common maneuver in sports like American football and soccer. Athletes may report hearing a popping sound and rapid knee swelling. Knee instability is both reported by the patient and elicited during clinical examination.

Soft tissue

The maneuver leads to loading of the ACL, which acts to prevents anterior movement of the tibia, resulting in its disruption and anterior subluxation of the tibia in relation to the femur. Quadriceps loading at the time of injury has been implicated as the intrinsic force in noncontact ACL injuries [8]. Patient and knee positioning are important in accurately depicting and increasing the accuracy of demonstrating ACL injuries. MRI images acquired with the knee in 30°-55° of flexion, improves diagnosis of ACL trauma [9,10]. In addition to standard orthogonal plane imaging, oblique multiplanar imaging improves accuracy of demonstrating ACL injuries [11]. MRI in the oblique sagittal plane can demonstrate complete disruption of fibers or non visualization of the ACL as well as varying degrees of high signal within the ACL on T2-weighted (T2W) or fluid-sensitive sequences, a normally low signal structure on all pulse sequences. There is good correlation between MRI and arthroscopic findings, nearly 100% specificity and sensitivity in a series using a 3.0-T scanner [12]. The majority, over 80%, of ACL tears are complete [13]. Midsubstance tears are the most common site, accounting for over 70% (Figure 1), followed by tears at the femoral attachment site and least commonly in the tibial site [14]. Partial or incomplete tears account for the remainder of ACL injuries (20%) and represents a greater challenge to diagnose, although accuracy can be improved to up to 95% with 3.0T MRI [15]. Joint effusions, mostly hemarthrosis, are common as the ACL (as well as the posterior cruciate ligament [PCL]) is an intracapsular, extrasynovial structure.

Injuries and signal abnormalities are also noted within the other stabilizers and support structures including the PCL, medial collateral (MCL) and lateral collateral ligaments, the menisci and posterolateral corner. These will be discussed separately.

Bone

Anterior tibial subluxation causes impaction of the lateral aspect of the lateral femoral condyle against the posterolateral margin of the lateral tibial plateau, leading to a characteristic bone bruise pattern on T2W or short tau inversion recovery (STIR) sequences. Oedema may also be noted in the medial tibial plateau, as a result of a contrecoup injury [14]. Severe impaction can lead to osteochondral fractures, which are depicted easily by both plain radiographs and MRI.

Plain radiographs may demonstrate anterior tibial subluxation, relative to the femur, known as the anterior translation sign [16] or may demonstrate a Segond or lateral capsular attachment avulsion fracture (Figure 2), which has a classic association with ACL tears (over 70%) and other ligamentous injuries [17]. Tibial spine fractures, more common in the pediatric population, are a less common and reliable feature.

Noncontact Hyperextension

This mechanism of injury can be due a missed landing such as by a gymnast or basketball player or due to a strong kicking maneuver by a soccer or football player. The forced hyperextension leads to impaction of the anterior femur and the tibia as well as stretching the cruciate ligaments.

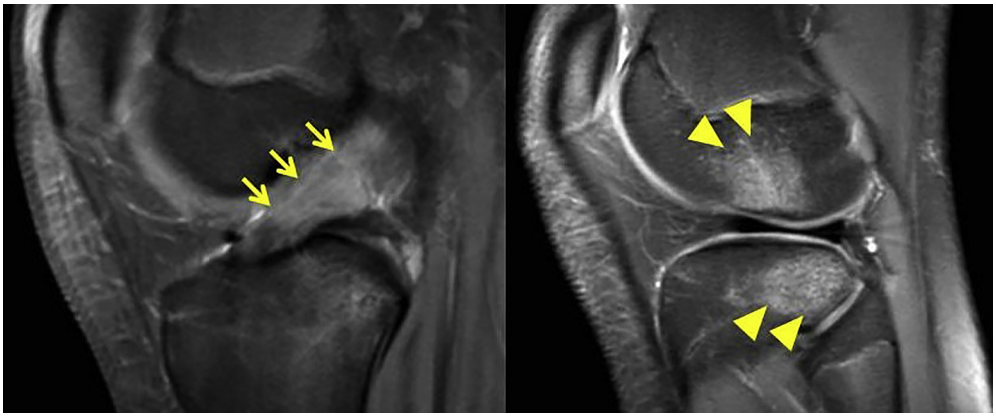

Figure 1. Sagittal fat-suppressed T2-weighted magnetic resonance imaging (T2W MRI) in a 17-year-old field hockey player demonstrates high signal and expansion in the midsubstance of the anterior cruciate ligament (arrows) consistent with a partial tear. Fat-suppressed sagittal T2W MRI depicts oedema in the lateral femoral and tibial condyles (arrowheads) indicating a pivot shift injury.