# IMAGING IN FOOTBALL MEDICINE

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Imaging is an important arsenal in football medicine for guiding diagnosis, monitoring and treatment of sports injuries. An accurate diagnosis is required to design appropriate treatment and to determine prognosis in football players[1]. Imaging modalities are also utilized to guide interventional procedures in the treatment of several injuries.

Imaging methods have been around for a while, but they constantly undergo technical advances, which improve lesion characterization and accuracy. The three pillars for an adequate diagnosis in high level football medicine are experience of the musculoskeletal radiologist, applicable techniques and up-to-date equipment.

Football injuries can be acute or chronic from repetitive stress (overuse). In the professional level, ultrasound (US) and magnetic resonance imaging (MRI) are the methods of choice. Table 1 shows the major indications and disadvantages for the several imaging modalities.

Return to play decision is fundamental to the practice of football and must balance a fast return to play with complete healing, recovery, and re-injury risk. Recent studies on medical imaging focus on prognostic radiologic features to support this challenging multifactorial decision[2-4].

Lower extremity injuries are more common in football. In this chapter, we will review imaging aspects of the most frequent and important injuries in football players.

## GROIN PAIN

Groin pain is a common problem in football players (10-14% of all injuries)[5,6]. The term groin pain in athletes is defined by four clinical conditions: (1) adductor, (2) pubic, (3) inguinal, and (4) iliopsoas-related groin pain (Figure 1), according to the "Doha agreement meeting on terminology and definitions in groin pain in athletes"[7]. Hip joint injuries and other conditions (sacroiliitis, nerve entrapment and intra-abdominal abnormalities) can also cause groin pain and must be referred and managed. Diagnosis is based on clinical history and examination. Imaging will help in the diagnosis and classification of which condition (s) the injury applies.

Adductor-related is the most common cause of groin pain is football players[8,9]. A combination of rectus abdominis and adductor longus strains are predominantly found. The injury can extend to the rectus-adductor aponeurosis at the symphysis pubis. US is the first-line image modality and MR gives a more detailed analysis. These methods can demonstrate adductor tendon abnormalities such as inflammation or ruptures (Figures 2, 3, 4). Cortical irregularities and calcifications are common in asymptomatic athletes (Figure 5).

There is a close anatomic relationship between adductor tendons and the pubic symphysis. On imaging, pubic-related groin pain condition is seen on MRI as pubic bone edema, which may also occur along with other groin pain conditions[9]. It is important to state that subtle pubic bone edema on MRI is also frequently seen in asymptomatic athletes. However, as the athletes become more symptomatic, bone edema increases and other features are present, such as fluid within the pubic symphysis joint and periarticular edema (Figure 6). Chronic features (pubic spurs and cortical irregularities) are commonly present in athletes with a past history of groin pain (Figure 7). It is accepted that the pubic-related groin pain entity is on a spectrum of stress changes from asymptomatic athletes to degenerative changes in chronic cases.

In the iliopsoas-related groin pain, MRI and US can demonstrate iliopsoas tendinopathy and bursitis (Figure 8).

US is the best imaging modality to evaluate inguinal-related groin pain. Although rare in athletes, dynamic US is highly accurate to diagnose inguinal and femoral herniation (Figure 9). Inguinal wall motion is present in many symptomatic and asymptomatic athletes, making clinical correlation mandatory. MRI is usually normal in the evaluation of the inguinal region.

## Table 1

| Imaging Method | Indications | Disadvantages |
|---|---|---|
| *Radiographs (XR)* | *Evaluation of bone fractures* | *Subtle fractures may be missed* |
| | | *Radiation exposure for the patient* |
| | *Post-surgical follow-up of bone fixation* | *Soft tissue injuries are not evaluated (muscle, tendon, cartilage, menisci, ligaments)* |
| *Computed tomography (CT)* | *Evaluation of bone fractures (occult and complex fractures)* | *Very initial fractures can be missed* |
| | *CT-arthrography (CT with intraarticular injection of iodinated contrast) for internal derangement of joints: When MRI is contraindicated* | *Radiation exposure for the patient* |
| | *Guidance of spine, joint and muscle injections* | *Poor soft tissue evaluation* |
| *Ultrasound (US)* | *Evaluation of tendon and muscle injuries* | *Lower accuracy for deep muscle strains* |
| | *Dynamic evaluation of musculoskeletal structures (ligaments, tendons, fasciae, muscles)* | *Operator-dependent* |
| | *Real time guidance of muscle and joint injections* | *Intraarticular structures are poorly evaluated (cartilage, labrum, ligaments, menisci)* |
| *Magnetic Resonance Imaging (MRI)* | *Evaluation of soft tissue structures (ligaments, tendons, muscles, cartilage, labrum, menisci, nerves, intervertebral discs)* | *Uncomfortable procedure (claustrophobia, long scanning times)* |
| | *Evaluation of occult fractures and apophyseal injuries* | *Contraindicated in patients with some metallic or electronic implants (pacemakers, aneurysm clips, heart valves).* |

**Table 1:** Imaging modalities in sports medicine.

### MUSCLE INJURIES

Technical advances in US technology provided some advantages in the evaluation of muscle injuries, compared to MRI: relatively cheap and widely available, comparable spatial resolution, allows portability, dynamic evaluation, serial evaluation to follow healing and real-time guidance for muscle injections. However, MRI is considered the reference imaging method to assess muscle injuries in athletes due to excellent contrast, high resolution, and the ability to evaluate soft tissue. Also, MRI provides better evaluation of deep muscle compartments and demonstrates scar tissue formation at the site of injury.

US features of muscle injuries are loss of fascicular pattern with fiber disruption, hypoechoic and/or hyperechoic focal areas within the muscle and focal or complete fiber discontinuity. Usually, fiber discontinuity occurs at the myofascial junction or around the musculotendinous junction, however it can occur at any location within the muscle (Figure 10). MRI most classic feature of muscle injury is diffuse ill-defined high signal intensity change (called "edema") on fluid-sensitive sequences. When edema is found around the musculotendinous junction, we may have the classic "feathery" appearance (Figure 11). Fiber discontinuity is seen as a focal area of well-defined high signal intensity (Figure 12). Muscle injuries may also occur far from the musculotendinous junction and at the peripheral myofascial junction[10] (Figure 13).

There are several imaging classification systems for muscle injuries (table 2)[11-14]. The classic 1-3 classification system lacks diagnostic accuracy and provides limited prognostic information. The grade 1 injury is defined as edematous pattern without muscle disruption on MRI. US can be negative or show ill-defined areas of increased echogenicity. Grade 2 is defined as an area of focal fiber disruption and grade 3, complete disruption of the musculotendinous unit with fluid (hematoma) filling the gap created by the tear[10] (Figures 14 and 15). However, the presence of intramuscular hematoma can also occur in muscle contusions and grade 2 tears. Dynamic evaluation of muscle tears on US is useful to evaluate the presence of fiber disruption.

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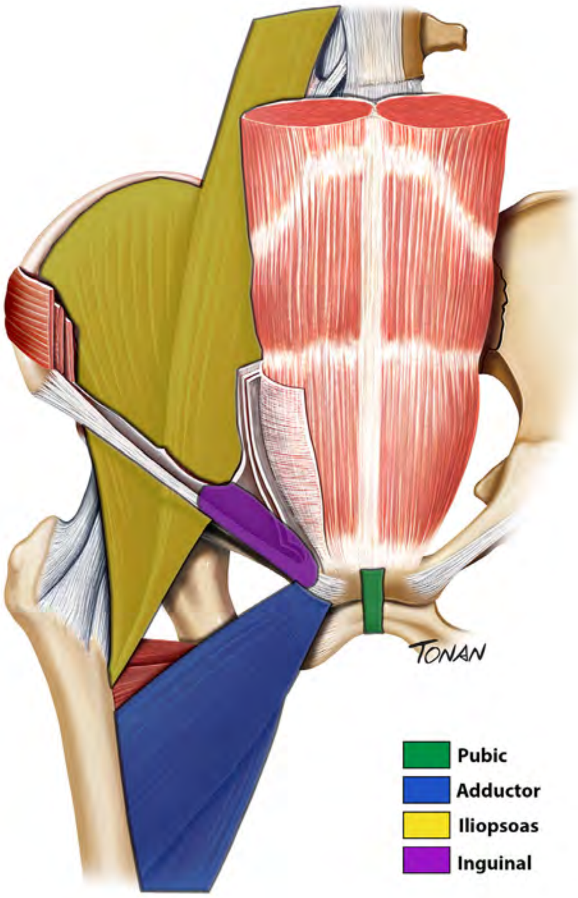
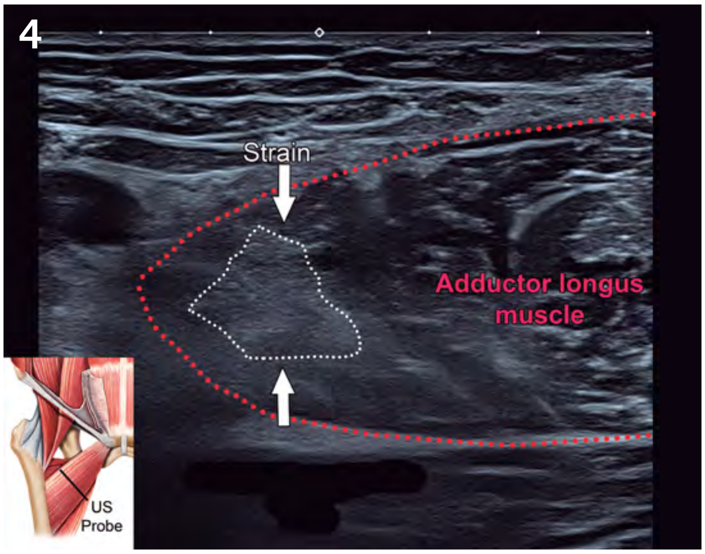
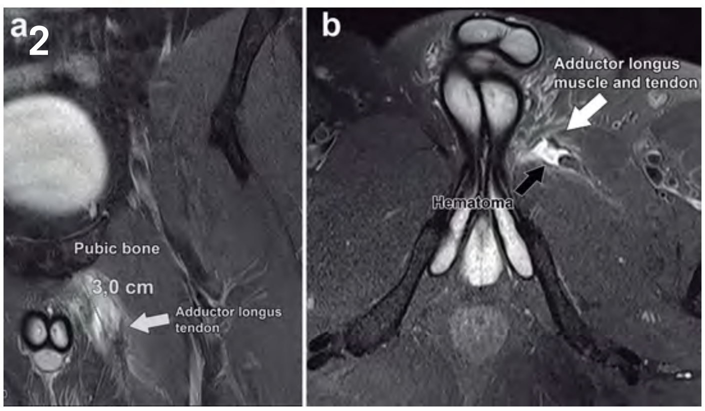


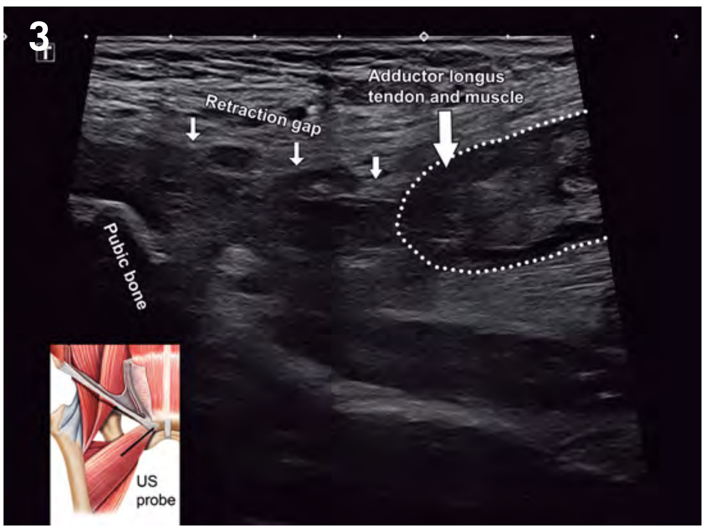




**Figure 1:** Groin-pain in athletes - Four clinical conditions and anatomic correlation: Pubic, adductor, iliopsoas and Inguinal – related groin pain (Modified from reference 7, with permission).

**Figure 2:** Adductor tendon rupture – MRI. Male football player, 22 years-old. Coronal (a) and axial (b) T2-weighted fat-suppressed magnetic resonance (MR) images of the pubic region show a complete rupture of the origin of the adductor longus tendon at the pubic bone, with a 3,0cm distal retraction of the tendon and muscle (white arrows in a and b). There is a small hematoma at the rupture site (black arrow in b).

**Figure 3:** Adductor tendon rupture – US. Male football player, 24 years-old. Longitudinal US image of the adductor longus muscle. There is a complete rupture of the origin of the adductor longus tendon with a gap of 4,0 cm and a distal retraction of the tendon and muscle.

**Figure 4:** Adductor longus muscle strain – US. Male football player, 19 years-old. Transverse US image at the middle third of the adductor longus muscle. There is a grade 2 strain, represented by the hyperechoic area within the muscle.

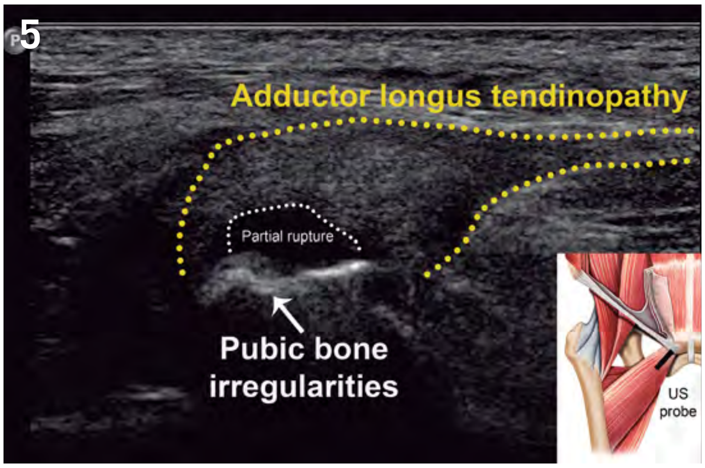
**Figure 5:** Adductor longus tendinopathy – US. Male football player, 31 years-old, asymptomatic. There is thickening and heterogeneity of the origin of the adductor longus tendon with a deep partial rupture. There are bone irregularities at the adjacent pubic bone.

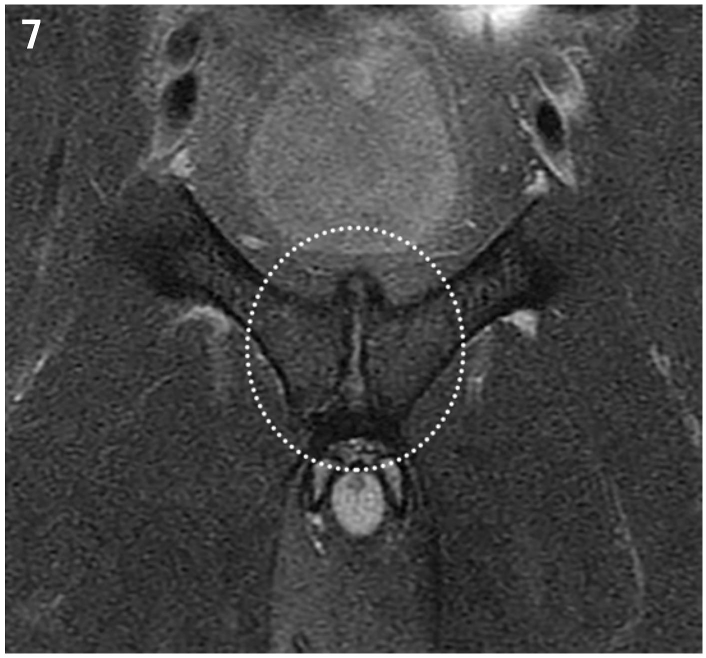
**Figure 6:** Osteitis pubis. Coronal T2-weighted fat-suppressed MR image of the pubic symphysis in a symptomatic 37 years-old football player. Pubic bone edema, fluid within the joint and a tear at the left adductor longus tendon origin (typical secondary cleft sign).

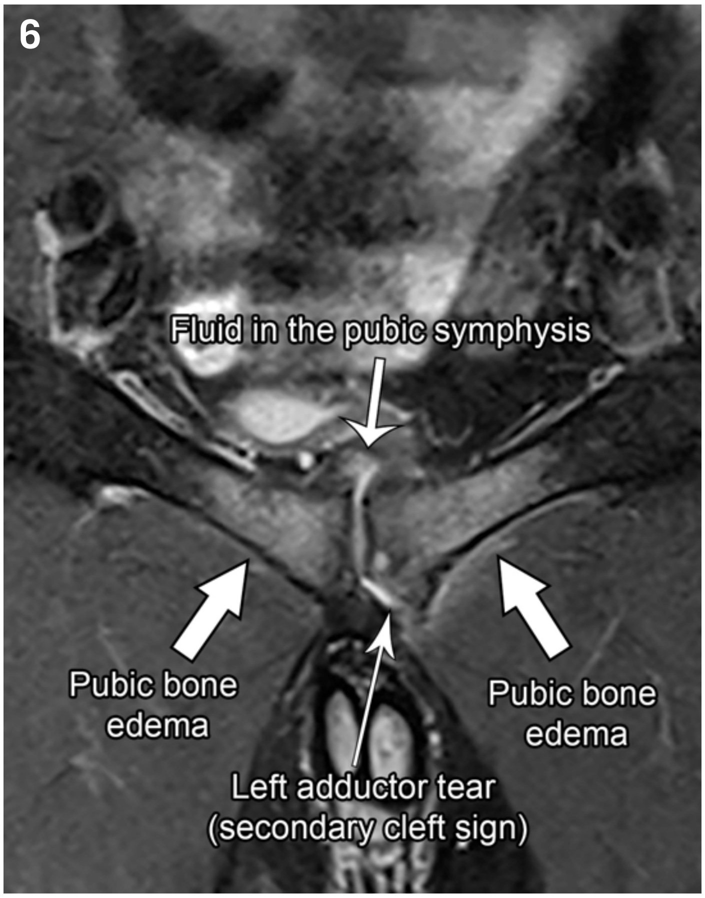
**Figure 7:** Chronic changes in the pubic symphysis. Coronal T2-weighted fat-suppressed MR image of the pubic symphysis in an asymptomatic 34 years-old football player. Osteophytes and bone irregularities in the pubic symphysis (circle).

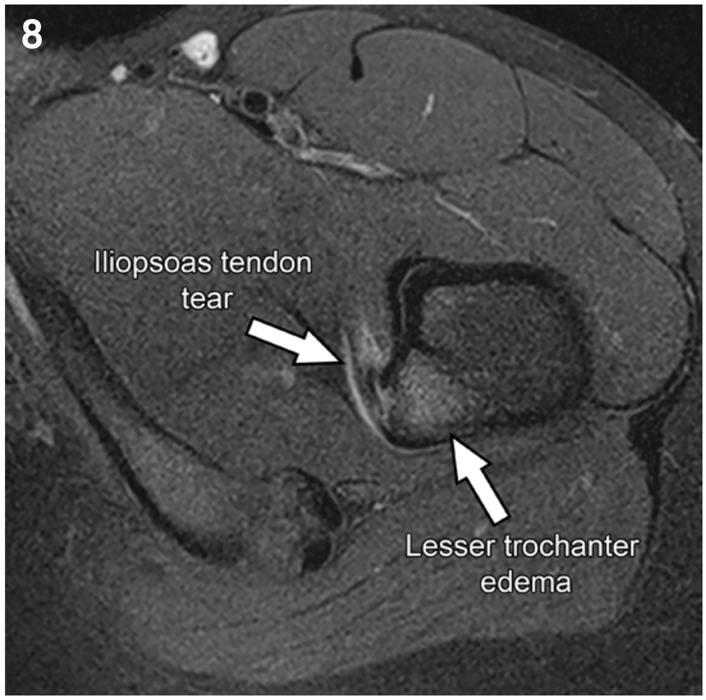
**Figure 8:** Iliopsoas tendon strain. Axial T2-weighted fat-suppressed MR image of the pelvis in a 12 year-old girl, injured during a football game. There is a tear in the iliopsoas tendon at the insertion on the lesser trochanter of the femur, with associated bone marrow edema.

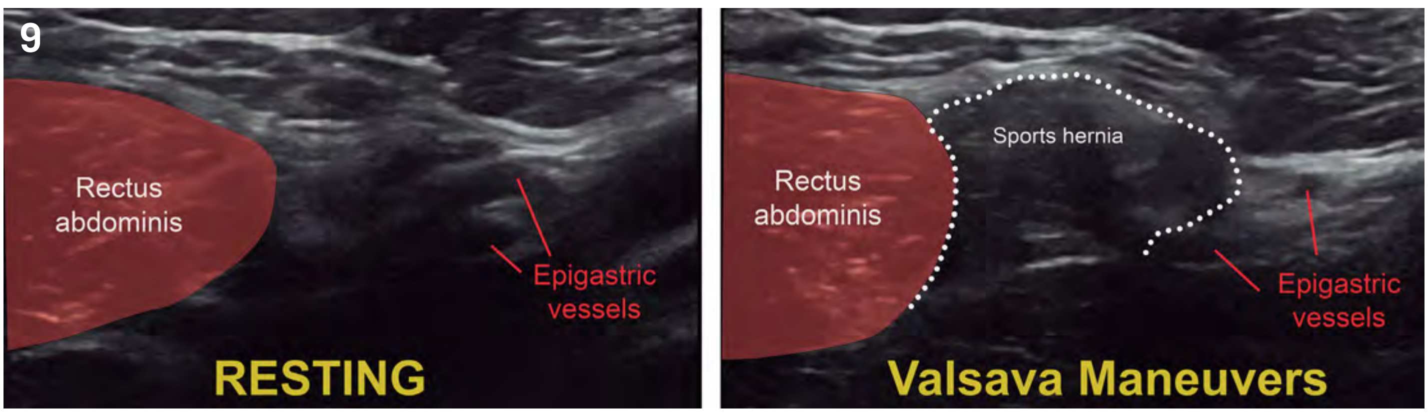
**Figure 9:** Sports hernia. US transverse images of inguinal region while resting and during Valsalva maneuvers. There is bulging of the epiploic fat between the rectus abdominal muscle and epigastric veins after Valsalva maneuvers, indicating a sports hernia.

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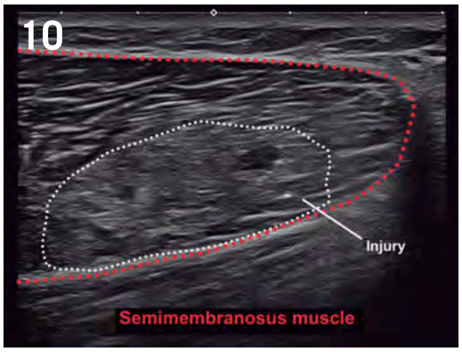
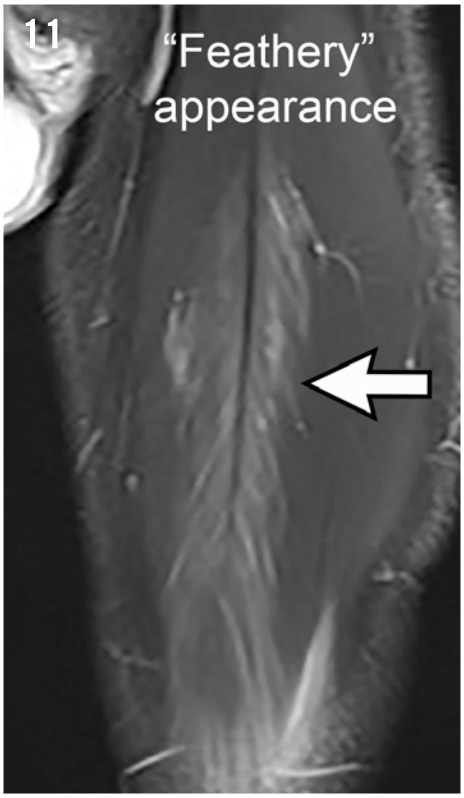
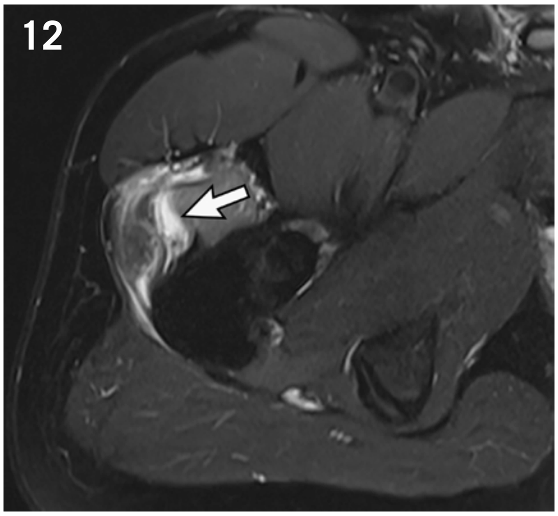


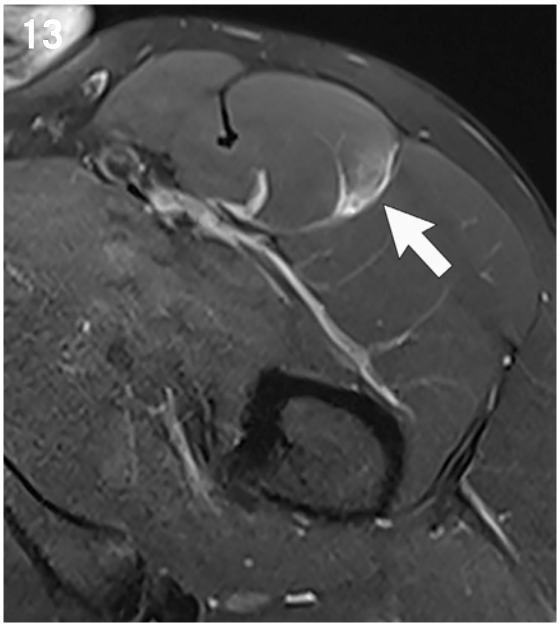




**Figure 10:** Grade 2 muscle injury. US longitudinal image of the posterior thigh. There is a hyperechoic area (white dotted area) and loss of the fibrillar pattern within the semimembranosus muscle (red dotted area), indicating an injury.

**Figure 11:** Muscle injury – "Feathery" appearance. Coronal T2-weighted fat-suppressed MR image of the thigh shows edema around the intramuscular musculotendinous junction (arrow), with the classic "feathery" appearance.

**Figure 12:** Focal fiber discontinuity on MRI. Axial T2-weighted fat-suppressed MR image of the thigh shows focal fiber discontinuity of the vastus intermedius muscle (arrow).

**Figure 13:** Myofascial muscle injury. Axial T2-weighted fat-suppressed MR image of the thigh. There is edema of the peripheral myofascial portion of the rectus femoris, indicating an injury.

The Munich consensus on classification of muscle injuries included grades according to the cause of the injury[13]. Another recent classification system is based on extent and location of injury (myofascial junction, intramuscular and tendinous)[14]. Adequate staging of the muscle injury is crucial, avoiding underestimation of the injury and consequent recurrent muscle tear because of a premature return-to-play.

Hamstring musculotendinous tears are the most common injuries in football, representing 10-37% of all injuries[6,15]. The hamstring complex is in the posterior compartment of the thigh and includes the semimembranosus, semitendinosus, and biceps femoris muscles. In football, the most injured muscle is the biceps femoris and over half of the cases involve more than one hamstring muscle. Most frequently, the proximal and distal musculotendinous junctions are injured[6,16] (Figure 16). Apophysitis and avulsion of the ischial tuberosity (the site of origin for the hamstring and hip adductor tendons) is seen most frequently in skeletally-immature players[17] (Figure 17).

Some imaging findings are associated with a longer rehabilitation time: the presence of injury at MRI, injury of the proximal or intramuscular tendon at the deep musculotendinous junction and greater longitudinal length of the muscle injury[1,4,16] (Figure 16). A negative-MRI is associated with a favorable recovery prognosis[11]. However, based on the current literature, MR and US findings alone do not provide accurate information for prediction of time to return-to-play after a muscle injury[18].

The rectus femoris is the most frequently injured muscle of the quadriceps complex. Injuries are located at the origin of the direct and indirect heads, proximal musculotendinous junction, deep musculotendinous junction of the indirect head and distal musculotendinous junction close to the knee joint[19]. More common injuries are located in the deep musculotendinous junction of the indirect head and are related to a longer return-to-play time[20,21]. The "bull's-eye" pattern is the most frequently observed finding in MRI[20,22] (Figure 18). A specific kind of lesion, the degloving injury, is seen in 9% of rectus femoris tears whereas the inner bipennate intramuscular portion of the indirect musculotendinous complex is separated from the surrounding superficial unipennate portion of the rectus femoris[23] (Figure 19). Acute avulsion fractures and chronic traction apophysitis of the origin of the direct head at the anterior inferior

## Table 2

| Classification System | Injury Grading | MR Anatomic Site of the Injury |
|---|---|---|
| *Peetrons (2002) – US* | • *Grade 0: normal appearance*<br>• *Grade 1: focal / diffuse bleeding, lesions < 5% of muscle volume or cross-sectional area*<br>• *Grade 2: partial rupture - lesions from 5 to 50% of the muscle volume or cross-sectional diameter*<br>• *Grade 3: complete muscle rupture with retraction* | |
| *Modified Peetrons (2012) – MRI* | • *Grade 0: normal MRI*<br>• *Grade 1: edema without architectural distortion*<br>• *Grade 2: Partial tear with architectural distortion*<br>• *Grade 3: Complete muscle or tendon rupture* | |
| *Munich Consensus (2013) – US / MRI* | • *Grade 1A: fatigue induced muscle disorder - normal MR/US*<br>• *Grade 1B: Delayed-onset muscle soreness (DOMS), normal US/MR or edema only*<br>• *Grade 2A: spine-related neuromuscular disorder, normal US/MR or edema only*<br>• *Grade 2B: Muscle-related neuromuscular disorder, normal US/MR or edema only*<br>• *Grade 3A: minor partial muscle tear with fiber disruption on high resolution MRI. Intramuscular hematoma*<br>• *Grade 3B: moderate partial muscle tear with fiber disruption on US/MR, probably including some retraction, with fascial injury and intermuscular hematoma*<br>• *Grade 4: (Sub)total muscle tear / tendinous avulsion with subtotal / complete discontinuity of muscle / tendon on US/MR. Possible wavy tendon morphology and retraction. With fascial injury and intermuscular hematoma*<br>• *Contusion: direct injury. US/MR show diffuse or circumscribed hematoma in varying dimensions* | |
| *British Athletics Muscle Injury Classification (2014) – MRI* | • *Grade 0: normal MRI (MRI-negative muscle injury (grade 0a) or characteristic MRI features of DOMS (grade 0b)*<br>• *Grade 1: Small muscle tear*<br>• *Grade 1a: MRI high signal change at the myofascial border with <10% extension into muscle belly, longitudinal length <5 cm*<br>• *Grade 1b: MRI high signal change < 10% of cross-sectional area of the muscle (can occur around the the musculotendinous junction), longitudinal length < 5 cm (may have fiber disruption < 1 cm)*<br>• *Grade 2: Moderate muscle tear*<br>• *Grade 2a: MRI high signal change at myofascial border extending into the muscle, 10-50% of cross-sectional area of the muscle at the maximal site, longitudinal length 5-15 cm, fiber disruption < 5 cm*<br>• *Grade 2b: MRI intramuscular high signal change (can occur around the musculotendinous junction), 10-50% of muscle cross-sectional area at the maximal site, longitudinal length 5-15 cm, fiber disruption < 5 cm*<br>• *Grade 2c: MRI high signal change extends into the tendon, <50% of maximal tendon cross sectional area, <5 cm of tendon cross-sectional area*<br>• *Grade 3: Extensive muscle tear*<br>• *Grade 3a: MRI high signal change at myofascial border extending into the muscle, >50% of cross-sectional area at the maximal site, longitudinal length >15cm, fiber disruption > 5cm*<br>• *Grade 3b: MRI high signal change >50% of cross-sectional area at the maximal site of the muscle (can occur around the musculotendinous junction), longitudinal length >15 cm, fiber disruption > 5 cm*<br>• *Grade 3c: MRI high signal change extends into the tendon, >5 cm longitudinal length of tendon, >50% of cross-sectional area of tendon, may have loss of tendon tension*<br>• *Grade 4: complete discontinuity of the muscle, with retraction*<br>• *Grade 4c: complete discontinuity of the tendon with retraction* | *a: Myofascial*<br>*b: Intramuscular*<br>*c: Intratendinous* |

**Table 2:** Imaging classification systems for muscle injuries.

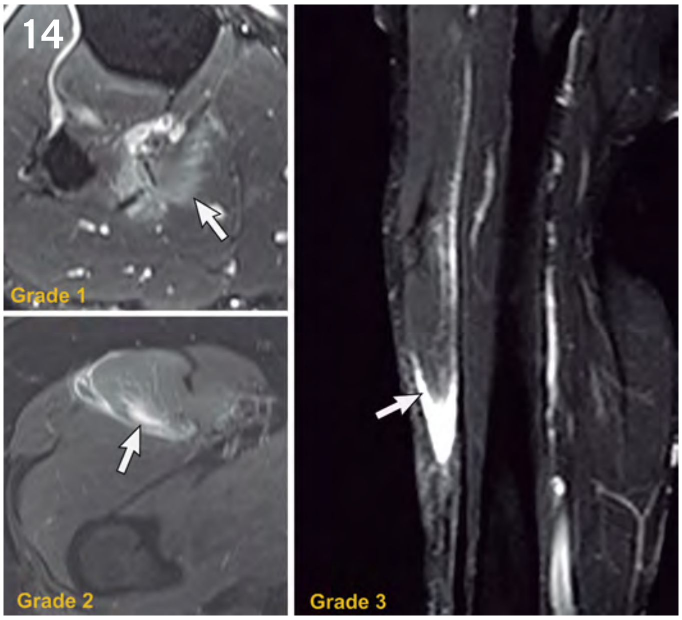
iliac spine are more common in skeletally-immature players[17,24] (Figure 20).

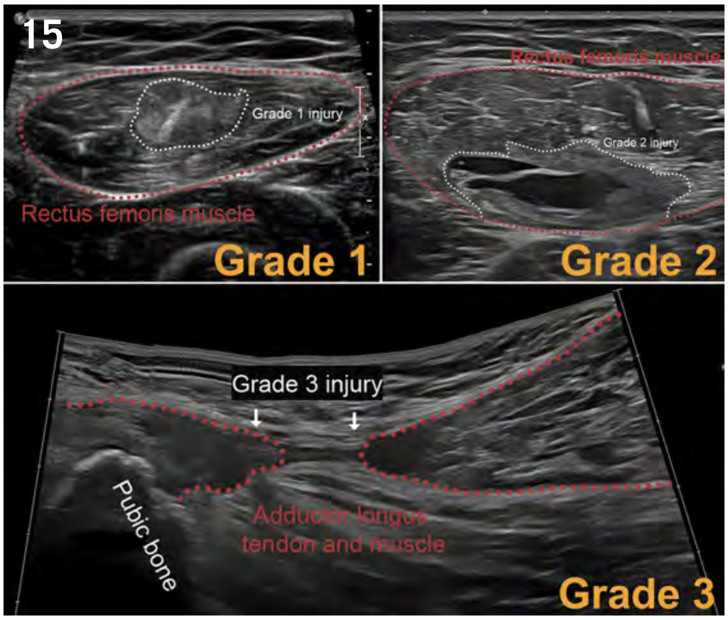
KNEE INJURIES

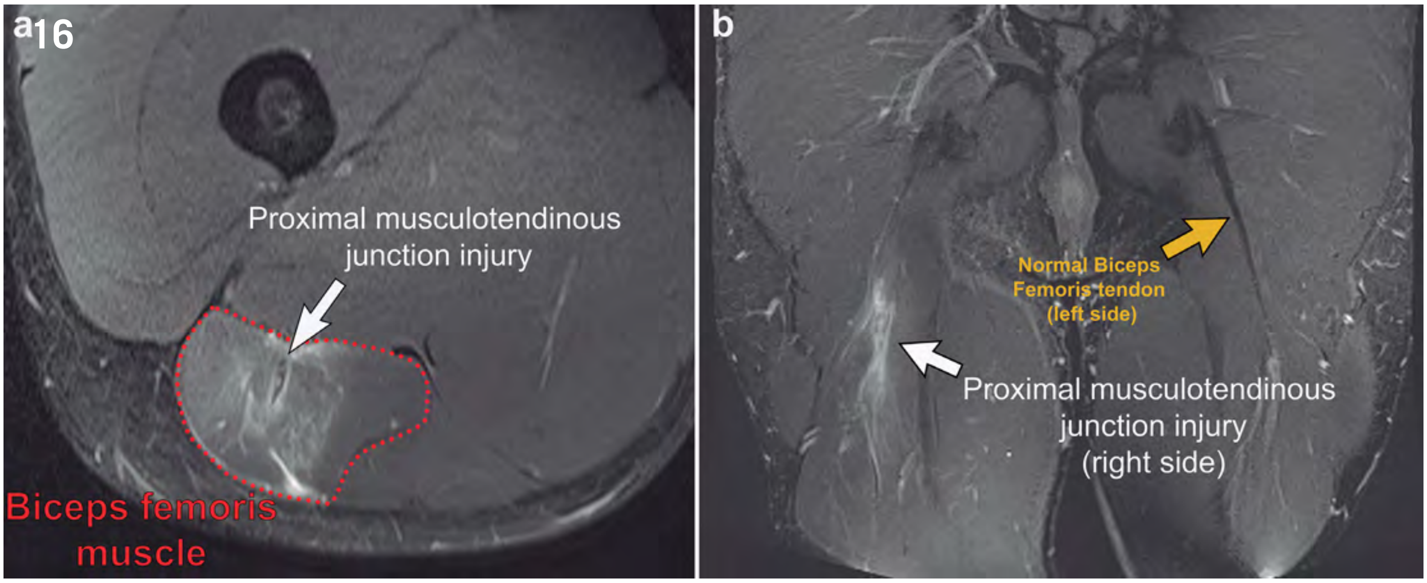
Knee is frequently injured in football (18% of all injuries)[5,6]. The knee joint is exposed to elevated risk of injury, either acute trauma or chronic overuse injuries and is subject to stress from indirect and direct forces. Usually knee injuries have a worse effect on return-to-play and accelerate development of knee osteoarthritis[25].

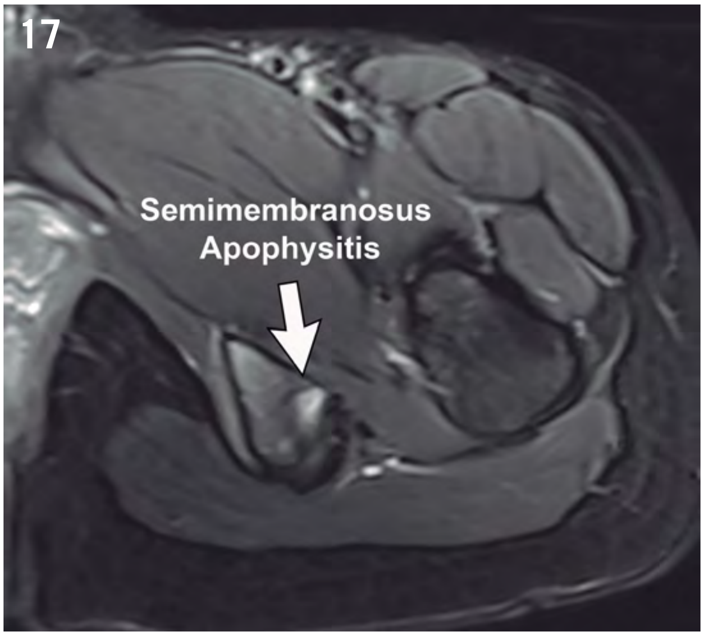
Anterior cruciate ligament (ACL) tears are prevalent in children and women and MRI is the modality of choice for its evaluation. The pivot-shift is the most common noncontact mechanism involved in ACL injury, creating the typical osseous contusions of the anterior lateral femoral condyle and posterior aspect of the lateral tibial plateau (Figure 21). On acute phase, ACL injuries typically produce hemarthrosis, focal ligament discontinuity or diffuse thickening and edema. Also, abnormal ligament fiber orientation is seen (Figure 22). Secondary MRI signs are anterior translation of the lateral femoral condyle, uncovering of the posterior horn of the lateral meniscus and PCL buckling[26].

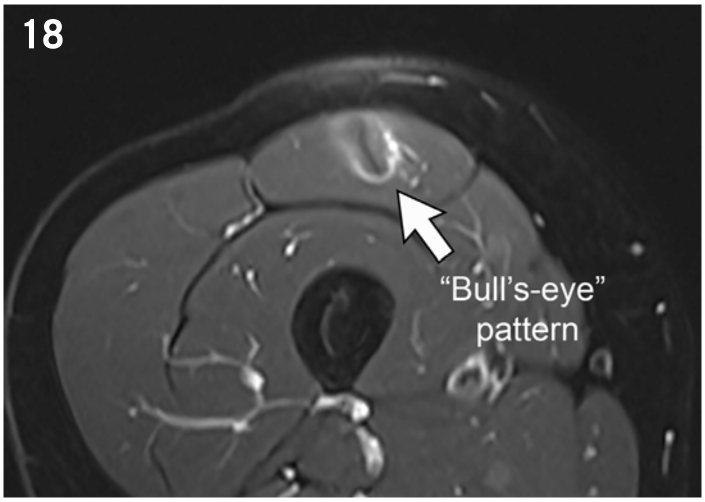
Meniscal tears in football players are usually secondary to acute trauma, isolated or associated with ACL or chondral injuries. They are most common at the posterior horn of the medial meniscus; however, in young patients with acute injuries, lateral meniscal tears are common. MRI is highly accurate for the diagnosis of a meniscal

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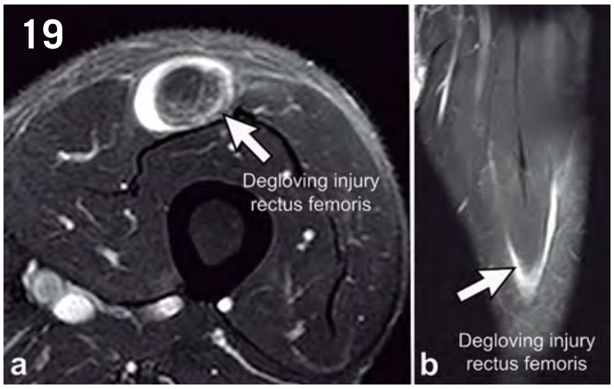
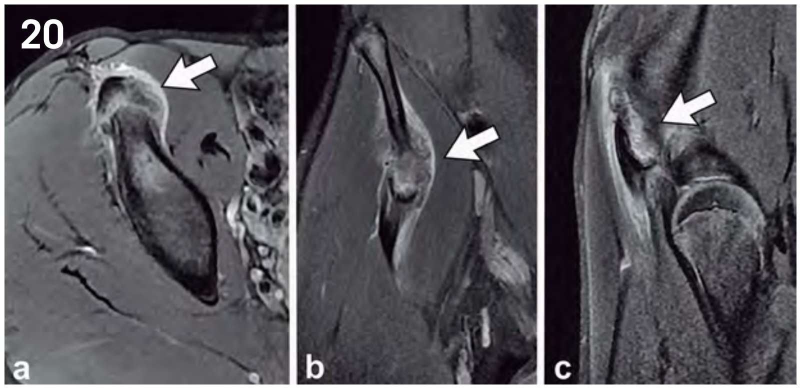
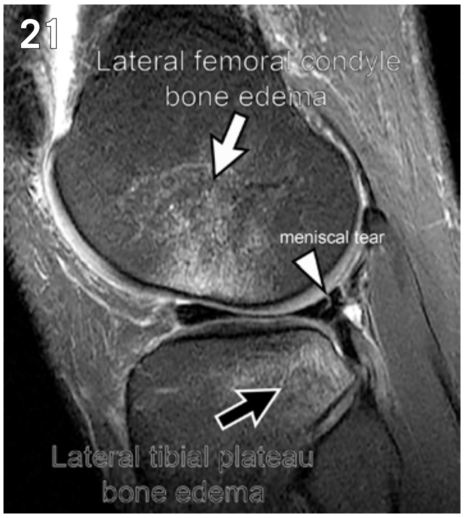




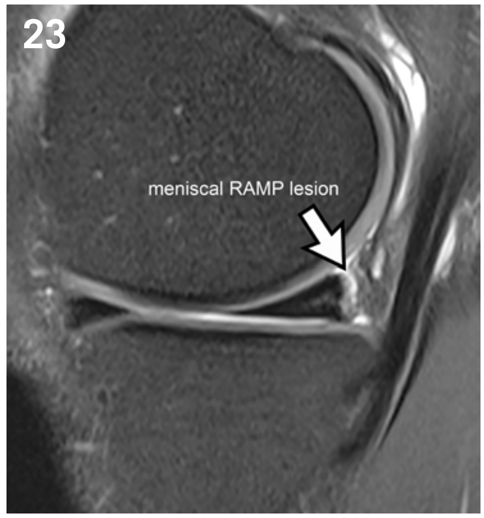



**Figure 14:** Classic muscle injury grading on MRI. Grade 1: edematous pattern without muscle disruption on MRI. Grade 2: area of focal fiber disruption (fluid-signal area within the muscle). Grade 3: complete disruption of the musculotendinous unit with fluid (hematoma) filling the gap created by the tear.

**Figure 15:** Classic muscle injury grading on US. Grade 1: ill-defined areas of increased echogenicity. Grade 2: area of focal fiber disruption (well-defined anechoic or hyperechoic areas within the muscle). Grade 3: complete disruption of the musculotendinous unit with fluid (hematoma) filling the gap created by the tear.

**Figure 16:** Biceps femoris musculotendinous junction injury. (a) Axial and (b) coronal T2-weighted fat-suppressed MR images of the thigh. There is a grade 2 injury of the proximal musculotendinous junction of the right biceps femoris with edema. Compare with the normal left biceps femoris intramuscular tendon (in b).

**Figure 17:** Hamstring apophysitis. 14 years-old female football player. Axial T2-weighted fat-suppressed MR image of the pelvis shows edema and bone irregularities at the origin of the semimembranosus tendon at the ischial tuberosity, compatible with apophysitis

**Figure 18:** "Bull's-eye" pattern injury. Axial T2-weighted fat-suppressed MR image of the left thigh shows edema surrounding the intramuscular musculotendinous junction of the rectus femoris and the typical "bull's-eye pattern

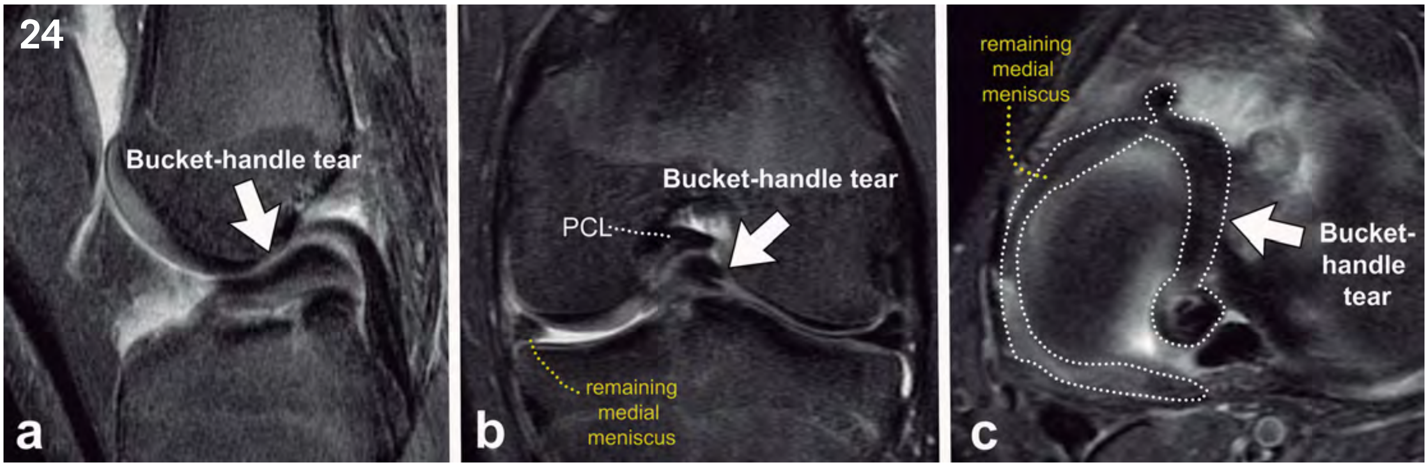
**Figure 19:** Degloving injury – rectus femoris. (a) Axial and (b) coronal T2-weighted fat-suppressed MR images of the thigh. Inner and outer muscle portions of rectus femoris are separated by fluid (arrows). The coronal image (in b) shows retraction of the inner muscle.

**Figure 20:** Rectus femoris avulsion. 13 years-old boy injured during a football game. (a) Axial, (b) coronal and (c) sagittal T2-weighted fat-suppressed MR images of the pelvis show avulsion of the anterior inferior iliac spine, at the origin of the direct head of the rectus femoris (arrows).

**Figure 21:** Typical bone contusions in ACL injury. Sagittal T2-weighted fat-suppressed MR image of the knee. Bone marrow edema in the anterior lateral femoral condyle (white arrow) and in the posterior aspect of the lateral tibial plateau (black arrow). There is a meniscal tear in the posterior horn of the lateral meniscus (arrowhead).

**Figure 22:** Complete ACL tear. Sagittal T2-weighted fat-suppressed MR image of the knee. There is a complete tear of the proximal aspect of the ACL with horizontalization of its distal fibers (arrow).

**Figure 23:** Meniscal Ramp lesion. Sagittal T2-weighted fat-suppressed MR image of the knee shows a vertical tear at the posterior meniscocapsular junction of the medial meniscus (arrow).



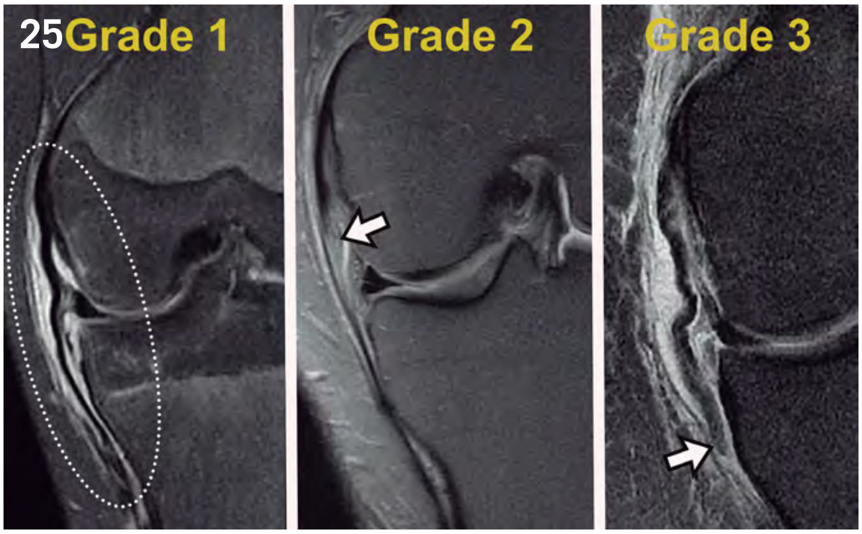





**Figure 24:** Meniscal bucket-handle tear. (a) Sagittal, (b) coronal and (c) axial T2-weighted fat-suppressed MR images of the knee. Complete vertical tear of the medial meniscus with displacement of the inner part of the meniscus to the intercondylar notch (arrows - bucket-handle tear). Note the typical "double-PCL sign" (in a), the remaining medial meniscus (in b and c) and the appearance of a bucket-handle that the displaced meniscal fragment creates with the remaining meniscus (in c). PCL: Posterior cruciate ligament.

**Figure 25:** MCL tear - grades. Grade 1: edema surrounding the ligament. Grade 2: thickening and edema within the ligament. Grade 3: complete ligament tear.

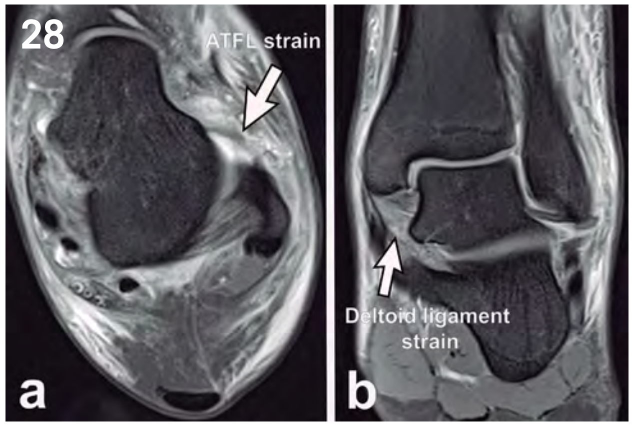
**Figure 26:** Patellar tendinopathy. 20 years-old male football player. Sagittal T2-weighted fat-suppressed MR image of the knee demonstrates thickening and edema at the origin of the patellar tendon (circle - tendinopathy).

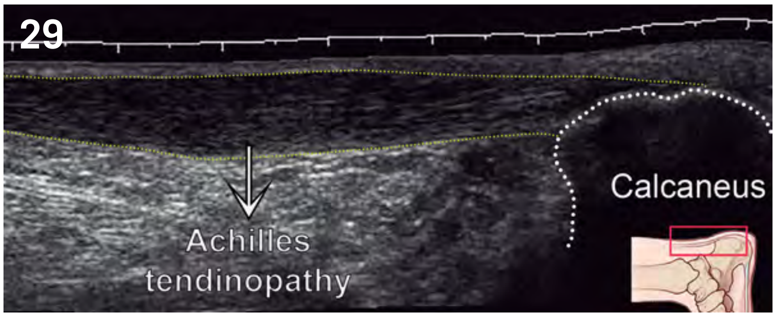
tear, which is classified according to its direction and location: longitudinal, vertical, horizontal and radial tears[27] (Figure 21). A meniscal ramp lesion is located at the meniscocapsular junction of the posterior horn of the medial meniscus and is strongly associated with ACL tears[28] (Figure 23). Identification of displaced meniscal tears on MRI is important in patient management and preoperative planning (Figure 24).

Medial collateral ligament (MCL) injury is the second more common type of injury in football, after hamstring injuries, although injury rates have decreased in the last decade. MCL injury is more commonly caused by contact than non-contact situations[29]. MRI is the imaging modality of choice to demonstrate the three types of injuries: Grade 1: peri-ligamentous edema; Grade 2: thickened and edematous MCL and Grade 3: complete MCL tear (Figure 25). Although US is not frequently ordered to assess the MCL, US features for MCL tear have been described and dynamic maneuvers with valgus stress are useful for diagnosis of grade 3 tears[30].

Patellar tendinopathy is seen in skeletally mature football players, and describes a spectrum of disorders at the proximal insertion of the patellar tendon[31]. Diagnosis can be performed by ultrasound and MRI (Figure 26).

Knee osteoarthritis is common in football players. However, studies show that this condition is less likely to cause functional disability[32]. The main predisposing factor

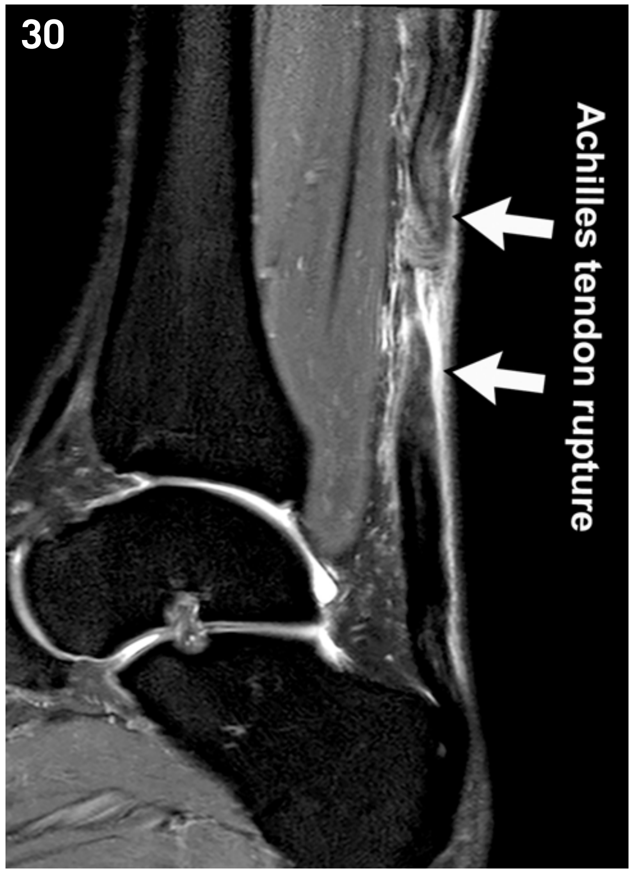




**Figure 27:** Osteoarthritis. 23 years-old asymptomatic male football player. (a) Coronal and (b) sagittal T2-weighted fat-suppressed MR images of the knee. Severe osteoarthritis in the patellofemoral and lateral femorotibial compartments, with diffuse and advanced chondral erosions, osteophytes, subchondral edema, degenerative meniscal tear with extrusion and loose bodies surrounding the popliteus muscle (arrows in b).

**Figure 28:** Ankle strain. 18 years-old male football player. Ankle strain during a game. (a) Axial and (b) coronal T2-weighted fat-suppressed MR images of the ankle. There is diffuse subcutaneous edema around the ankle, anterior talofibular ligament (ATFL) strain (arrow in a) and deltoid ligament strain (arrow in b).

**Figure 29:** Achilles tendinopathy. Longitudinal US image of the posterior ankle. There is thickening and heterogeneity of the Achilles tendon, indicating tendinopathy.

**Figure 30:** Achilles tendon rupture. Sagittal T2-weighted fat-suppressed MR image of the ankle shows complete rupture of the proximal portion of the Achilles tendon (arrows).

for development of early osteoarthritis in football players is direct trauma with potential surgical consequences[33] (Figure 27).

## ANKLE INJURIES

The ankle is commonly injured in football, corresponding to 14% of all injuries[6]. Acute injuries are common and related to inversion injury of the ankle. Imaging is performed in cases where clinical diagnosis and grading is difficult and when there is development of chronic sequelae[34]. In the ankle, MRI has the advantage over US of providing a global assessment including osseous and chondral injuries. However, for confirmation of tendon and ligament disorders of the ankle, US is very useful.

Ligament injuries from inversion sprains are common, however ankle stability is maintained by muscle recruitment and scar tissue and treatment is mainly conservative. Lateral ligament injuries are more common than medial ligament and syndesmotic injuries (Figure 28).

Achilles tendon disorders are relatively common in football, however injuries have decreased in recent years because of understanding of injury biomechanics and consequent modification of training protocols. Both methods, US and MR, are indicated for assessment of the Achilles tendon (Figures 29 and 30).

All types of ankle impingements syndromes are common in football players, especially 2-4 weeks after an acute injury. MR imaging is accurate for assessing soft tissue and osseous abnormalities involved in the impingement syndrome. US is more useful to correlate clinical symptoms with imaging findings.

## IMAGE-GUIDED INTERVENTION

Image-guided therapeutic interventions provide minimally-invasive treatments and can be performed in the acute and chronic

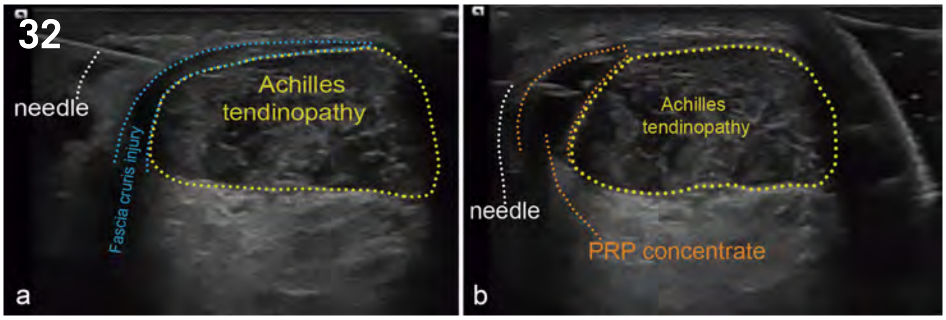




**Figure 31:** Platelet-rich plasma (PRP) injection. Images demonstrating US-guided injection of PRP technique.

**Figure 32:** Platelet-rich plasma (PRP) injection – US images. (a) Transverse image of the ankle demonstrates a chronic Achilles tendinopathy and thickening and hypoechogenecity of the fascia cruris, indicating an injury. In this image, the needle is positioned over the fascia cruris. (b) Transverse image of the ankle after the injection of the PRP concentrate.

settings. Real-time imaging guidance of interventional procedures, such as articular joint and tendon injections is advantageous over blind techniques in terms of greater accuracy and effectivity (the needle is accurately placed and medication is injected in the right place), patient safety (lesser risks of complication due to reduced risk of inadvertent injury to adjacent structures), patient comfort (less postprocedural pain, faster recovery and shorter stay) and consequent increase in treatment cost-effectivity[35]. Improvement of imaging modalities, new technologies and materials also made possible the development of new intervention techniques, such as viscosupplementation, platelet-rich plasma and stem cell therapies, that may become potential state-of-the-art treatments in the future[36] (Figures 31 and 32).

SUMMARY
Various injuries occur in football players, especially in the lower extremities. Imaging allows fast and accurate diagnosis for the athletes, facilitating treatment. Image-guided interventions are the mainstay of nonsurgical intervention in athletes and can be used to treat several injuries.

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