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Current concepts in MRI of rectus femoris musculotendinous (myotendinous) and myofascial injuries in elite athletes

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ABSTRACT

Rectus femoris injuries are extremely common in athletes, particularly in soccer players, rugby player, and sprinters. Magnetic resonance imaging (MRI) plays a key role in diagnosis, prognosis, and rehabilitation of these injuries. The current article discusses current concepts in the diagnosis and treatment of rectus femoris injuries in elite athletes, including a discussion of the less well known myofascial injuries and key prognostic factors as seen at MR imaging.

1. Introduction

Injuries to the quadriceps muscles, and specifically the rectus femoris, are extremely common in athletes and are reported to represent the second most common lower extremity muscular injury after hamstring injuries. In our experience, in soccer players, quadriceps injuries, and specifically rectus femoris injuries, are more common than hamstring injuries. Although hamstring strains often have a clear clinical presentation, rectus femoris injuries in elite athletes may present with either acute or insidious symptoms owing to the complex anatomy of the rectus femoris. This article will describe the imaging strategies, risk factors, and the role of MR imaging in determining prognosis and appropriate rehabilitation of rectus femoris injuries in elite athletes with a focus on MR imaging of myotendinous and myofascial injuries.

2. MR imaging technique

As with the evaluation of any athletic injury, the MR protocol must be tailored to the specific clinical scenario. In imaging injuries of the rectus femoris, appropriate planes and fields of views must be employed. (Although there is wide range of acceptable sequences and planes of imaging, imaging of elite athlete justifies using a slightly more extensive imaging protocol since acute, sub-acute, and chronic injuries may all be present (and possibly inter-related) therefore requiring appropriate imaging of all lesions present.) Although there is wide range of acceptable sequences, imaging rectus femoris injuries in elite players should be tailored using appropriate planes and slightly extended protocol.

Our current protocol consists of initial wide field of view images that include both hips and thigh and consists of: axial T1, axial STIR, and axial gradient echo sequences all of which extend from the anterior inferior iliac spine to the distal myotendinous junction of the rectus femoris. These images are not meant to be of high resolution but serve to accurately localize both acute and chronic injuries and allow evaluation of the contra-lateral hip and thigh both for comparison (e.g. of muscle bulk) and to assess for occult additional injuries. Subsequently, higher resolution images with a smaller field of view are obtained of the symptomatic rectus femoris. This includes T2 weighted sequences with fat suppression

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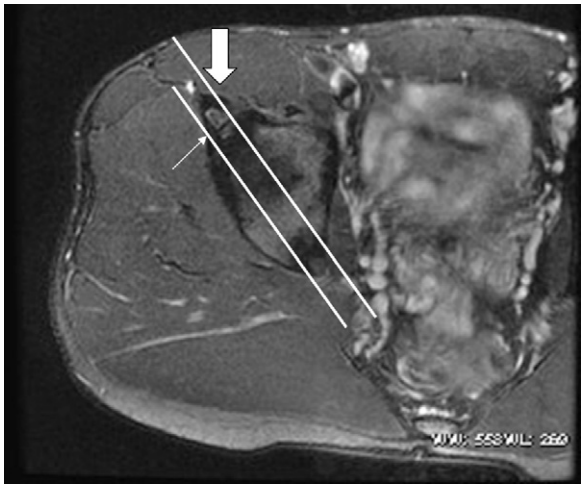

Fig. 1. Lines showing orientation of parasagittal images that will subsequently help better demonstrate the origins of the direct (wide arrow) and indirect (thin arrow) heads of the rectus femoris.

in the following planes: axial images in all cases, sagittal oblique images (paralleling the anterior inferior iliac spine) when proximal tendinous injuries are suspected, sagittal images when myotendinous injuries of the direct (superficial) component are suspected or when myofascial injuries are suspected, and coronal images when myotendinous injuries to the indirect (deep) component are suspected (Fig. 1).

3. MR imaging anatomy

The rectus femoris has somewhat complex anatomy that can be elegantly demonstrated with MR imaging [1–3]. Proximally, there are two origins to the rectus femoris which consist of the direct and indirect (reflected) tendons or heads (Fig. 2). The direct tendon arises from the anterior inferior iliac spine (AIIS) and the indirect tendon arises from the later margin of the supra-acetabular surface and the lateral acetabular rim. These short tendons give rise to a complex set of myotendinous transitions. The direct head and indirect head join just below and anterior to the AIIS with the direct head contributing to the anterior and slightly medial aspect of the proximal rectus femoris while the indirect head contributes to the posterior and slightly lateral aspect of the rectus femoris. The myotendinous junction of the direct head actually is very proximal, thin, and broad based with the tendinous fibers comprising the anterior surface of the proximal rectus femoris muscle where they imperceptively blend with the anterior fascia of the proximal rectus femoris muscle. Although according to anatomical studies the tendinous contribution from the direct head of the rectus femoris can extend down the proximal third of the muscle belly, at MR imaging, in the absence of edema or fluid, the tendon of the direct head is only typically visualized as a distinct entity to the level of the hip joint [1–3]. In contrast, the tendon of the indirect head initially has a somewhat rounded, coma shaped or ovoid configuration, propagates into the substance of the muscle where, as it descends inferiorly, rotates into an essentially sagittal orientation and acquires a flattened or linear configuration, extending along the rectus femoris muscle till the distal third of the muscle [1].

4. Risk factors and clinical presentation

There has been extensive study into the risk factors for rectus femoris injuries in elite athletes, particularly Australian rugby and soccer players [4,5]. Multiple factors may contribute to a specific injury, certain patterns have emerged in the study of rectus femoris injuries. Both extrinsic and intrinsic factors seem to play a role. The factors can be divided into four major categories: muscle, player, venue, and match.

The rectus femoris is a bi-articular muscle in that it crosses two joints (hip and knee). In addition, it has a high proportion of fast twitch (type II) muscle fibers thereby also increasing the risk of injury. Finally, during running and kicking, it is exposed to significant and often extreme stresses in the form of stretching, powerful eccentric contraction, and power concentric contraction [4]. All of these factors place the rectus femoris at risk for injuries, in particular myotendinous, myofascial, and tendinous injuries.

Players of shorter stature are at higher risk for rectus femoris injuries. Also, injuries appear to be more common during preseason training and when there has been either improper warm-up or overtraining. According to prior publications, a prior rectus femoris injury or recent hamstring injury also increases the risk of a new rectus femoris injury although the new rectus femoris injury may not be in the same location as the previous rectus femoris injury [4,5].

Environmental/pitch factors also seem to play a role. Rectus femoris injuries are more common in cold humid conditions when there has been no significant rainfall in the previous week. Thus, fields with a harder ground and thus increased ground traction are associated with rectus femoris injuries.

During actual training or a match, injuries are more common when there is a fast run-up to a kick possibly related to understriding which results in the player leaning back and the leg moving further behind the body. This places extra stress on the rectus femoris. The injury is more common in the kicking leg. There is some debate as to exactly when the injury occurs as some believe it occurs during the late backswing while others believe it occurs during the under-striding while trying to slow down. Even with video analysis, debate is ongoing [5].

The presentation of a rectus femoris injury typically takes one of two forms. Acute injuries such as acute tendon tears, acute myotendinous injuries, or acute myofascial injuries may present with an acute onset of pain immediately after the inciting event. Depending on the severity of injury, there may or may not be associated loss of muscle strength. However, certain acute injuries, such as myotendinous strains of the indirect head of the rectus femoris and some myofascial injuries, may have a more insidious onset and begin as a mild discomfort along the anterior thigh. These myotendinous injuries of the indirect head may present as increased tone and mild spasm/contraction of the muscle, particularly when the injury has associated soft tissue fluid. This may initially be thought to represent a mild overuse injury or very mild strain with the player only noticing mild discomfort while kicking the ball. They may be able to withstand the discomfort and thus keep playing for days. However, as they do so, the pain and discomfort increase to the point that it finally warrants imaging at which point MRI (or ultrasound) demonstrates the true nature and extent of the injury. Unless, there has been a direct impact such as getting kicked in the thigh, rectus femoris injuries do not typically present with a focal hematoma or mass.

5. MR appearance of rectus femoris injuries

The MR appearance of injuries to different portions of the rectus femoris varies depending on the location of the injury. In general, a three point grading system may be used for myotendinous injuries (strains) with a grade I lesion presenting as peritendinous edema without a focal or discrete tear, a grade II lesion presenting as a partial tear of the myotendinous junction with a partial thickness defect visible, and a grade III lesion presenting as a complete tear at the myotendinous junction. However, such three point grading