MANAGEMENT OF HAMSTRING AND RECTUS FEMORIS TENDON INJURY IN ELITE TRACK AND FIELD ATHLETES

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INTRODUCTION

There is little debate on the relevance of thigh muscle injury in elite sports. Their incidence, impact on athletic as well as team performance[1-4], and tendency to recur make them a daily challenge for medical staff. This applies especially to injuries involving the hamstrings and quadriceps, which are the most frequently injured muscle groups.

The majority of muscle injuries in various sports are magnetic resonance imaging (MRI)-negative injuries and partial tears at the musculotendinous junction (MTJ)[5]. In general, these injuries are successfully treated non-operatively by means of a progressive/phased rehabilitation programme.

Injuries involving the tendon, however, are regarded as a different clinical entity. These injuries can involve the 'free' and 'intramuscular' tendon (Figure 1)[6,7]. Full-thickness free tendon injuries (i.e. tendon avulsion or rupture) are characterised by complete discontinuity between muscle origin and insertion, with evident loss of function. Intramuscular tendon injuries (partial- or full-thickness) do not result in complete discontinuity between muscle origin and insertion, but have nonetheless gained notoriety in the last decade; these injuries might be associated with worse prognosis in terms of time to return to play (RTP) and reinjury rate. As a result, and depending on the context, tendon injury may warrant surgical consultation for optimal shared treatment decision-making. Therefore, recognition of these injuries is paramount.

In what follows, we will discuss recognition, expected outcomes, and treatment for tendon injury of the hamstrings and rectus femoris in track and field athletes.

RECOGNITION: CLINICAL AND RADIOLOGICAL DIAGNOSIS

Hamstrings

Recognition of a proximal hamstring tendon avulsion/rupture intuitively seems straightforward, yet there are some pitfalls that we have previously described in detail[8]. A proximal hamstring tendon injury typically occurs during forced hip hyperflexion with an extended knee. Patients report acute onset of severe posterior thigh pain, difficulty sitting/walking, severe loss of function, and

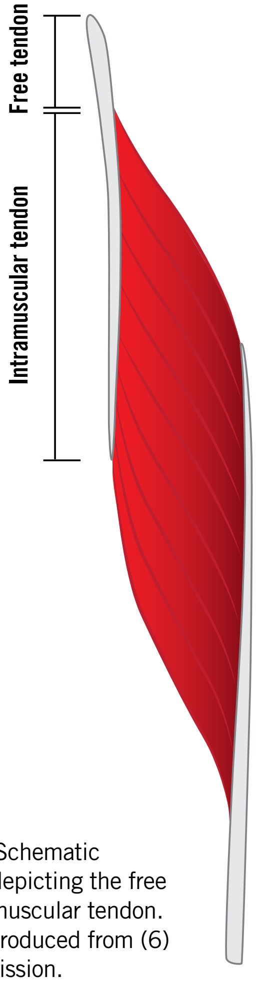

Figure 1: Schematic overview depicting the free and intramuscular tendon. Figure reproduced from (6) with permission.

bruising of the posterior thigh within days after injury. Physical examination may reveal bruising, proximal palpation pain with a palpable gap during resisted knee flexion, and loss of hamstring strength. Pitfalls that may lead to a missed diagnosis include a hip abduction injury mechanism, absent bruising or bruising at the level of the knee, incomplete loss of function due to compensating adjacent muscle groups, and increased rather than decreased range of motion in the subacute/chronic setting.

We strongly advise MRI[9] to confirm proximal tendon injury, especially if the physical examination findings do not clearly rule it out. For a reliable evaluation of proximal hamstring tendon injury on MRI, we use the 'dropped ice cream sign' (Figure 2)[10].

In case MRI is not at all available, we refer to ultrasound evaluation guides[11,12]. Caution is advised as our clinical experience indicates that ultrasound may not be as accurate as MRI to assess extent of tendon injury and tendon retraction, and published research that has led to the recommendations in this article are based on studies using MRI for assessment.

In case of adolescent/skeletally immature patients, radiographs are indicated to rule out avulsion fracture/apophyseal avulsion.

Rectus Femoris

Rectus femoris injuries predominantly occur during sprinting and kicking, although proximal free tendon injury occurs infrequently due to a sprinting injury mechanism[13,14]. Presenting symptoms are similar to those of proximal hamstring tendon injury; swelling, ecchymosis, palpation pain at the origin with loss of rectus femoris contour along with a palpable defect where the tendon is expected, and loss of strength during hip flexion and knee extension.

We argue that the diagnosis of proximal rectus femoris tendon injury has its pitfalls. Importantly, in our experience, an acute rectus injury may have an insidious rather than acute onset of symptoms. Pain/symptoms may be limited, and loss of strength may be the (only) presenting complaint in some cases.

FREE AND INTRAMUSCULAR TENDON INJURY: PROGNOSIS AND TREATMENT IN ELITE TRACK AND FIELD ATHLETES

Free Tendon

Full-thickness injury to the free tendon includes tendon avulsion and tendon rupture. Proximal injury is more common than injury to the distal tendon. This type of injury is commonly referred to either a

Figure 2: The dropped ice cream sign is used to evaluate if proximal tendon avulsion is present, and which tendons are involved. On an axial image of a left pelvic area, the ischial tuberosity (IT) resembles an ice cream cone. The two scoops represent the proximal tendons: the conjoint tendon medially (1) and the semimembranosus tendon laterally (2). Depending on whether one or both proximal hamstring tendons are avulsed there is a single (middle) or double dropped ice cream sign (right). (The ice cream flavors **c**ara**me**l (**c**onjoint **me**dial) and **s**tracciatel**la** (**s**emimembranosus **la**teral) can serve as a mnemonic for which tendon is affected by using the first letter and last syllable). Figure reproduced from (10) with permission.

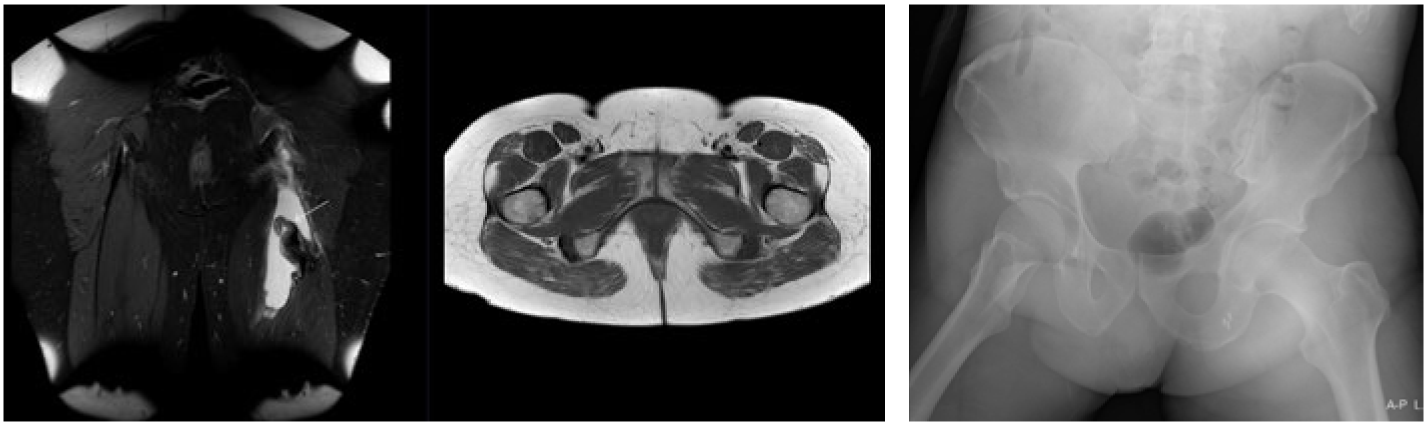

Figure 3: Coronal and axial MRI demonstrating proximal hamstring tendon avulsion on the left side (left), and radiographic evaluation of correct positioning of suture anchors follow surgical repair (right).

Peetrons grade 3 (i.e. total muscle or tendon rupture) or British Athletics Muscle Injury Classification (BAMIC) grade 4c (i.e. full-thickness tear of tendon), depending on which classification is used.

Irrespective of whether operative or non-operative treatment is chosen, surgical consultation is advised for full-thickness free tendon injury as recovery might be prolonged and muscle function/strength may be permanently affected without refixation/suturing of the tendon. We argue that this is an especially relevant factor to consider in track and field, a type of sport that does not allow for modification of 'style of play/participation' to compensate for injury sequelae. Any loss in speed/strength will expectedly lead to decreased ability to perform, and thereby decreased chances of winning. In other words, prognosis and treatment are in part dictated by the type of injury but also the type of sports the athlete engages in[15].

Proximal Hamstring Tendon Injury

There is limited evidence on hamstring tendon injury outcomes in elite track and field athletes to guide prognosis and decision-making[16,17], with a lack of evidence on (proximal) hamstring tendon avulsion/rupture. While several systematic reviews have been published[18-21], and more data on non-operative outcomes become available for comparison[22,23], these results cannot be generalised to elite athletes. Instead, expert opinion surveys and recent consensus statements are available[24-28]. These should not be regarded as strict guidelines, but rather as an aid to inform and guide (shared) decision-making. Operative treatment should be considered for an elite athlete with a full-thickness tendon avulsion/rupture of one or both proximal hamstring tendons with retraction, loss of tension/function leading to inability to engage in ADL/sports activities, sciatic involvement, and (if applicable) insufficient response to non-operative treatment.

Operative refixation of the hamstring tendons is typically achieved by means of suture anchors, followed by a phased rehabilitation programme[23].

Proximal Rectus Femoris Tendon Injury

In a similar fashion, evidence on outcomes following proximal rectus femoris tendon avulsion/rupture in track and field athletes is limited to less than a handful of cases[14,29]. Decision-making is therefore eminence-based rather than evidence-based. Approximately 80% of athletes (from various sports) with these injuries undergo operative treatment, resulting in a 100% return to sports rate after a mean 22 weeks compared to 93% after a mean 12 weeks following non-operative treatment[14]. The complication rate following operative repair was 18%, and comprised mainly neurapraxia/nerve injury (LFCN) and recurrent injury.

Similar to the hamstrings, the comparison between operative and non-operative outcomes is limited by high risk of bias due to methodological constraints (e.g. retrospective study designs, lack of blinding and randomisation, selection bias). Injuries involving only the direct or indirect head with no or limited retraction are arguably more likely to be treated non-operatively than considerably retracted injuries involving both the direct and indirect head. On the other hand, these outcomes might also illustrate that there is a subgroup of athletes with a proximal rectus femoris tendon injury that return to sports within a relatively short period without operative treatment. Future research might focus on factors predisposing to poor outcomes following non-operative treatment, leading to more evidence-based indications for operative repair. Including a comparison of strength/functional outcome measures is expected to aid that process.

In our practice, the decision-making process is similar to that of hamstring tendon injury. Operative (anatomical) repair is performed using suture anchors. Specifically for rectus femoris tendon injury, we discuss operative treatment for kicking/sprinting athletes with a full-thickness tendon injury of both heads or full-thickness injury of one head in combination with a partial-thickness injury of the other head.

Intramuscular Tendon

In the past decade, many debates have spotlighted injury to the intramuscular tendon. These injuries involve the musculotendinous junction and additionally extend along and into the intramuscular tendon (Figure 5). The debate was partly instigated by an editorial that raised awareness about the 'more severe variant' of muscle injury in athletes[30]. Since then, various studies have been published, with conflicting outcomes[31]; some studies reported large differences in time to return to play and reinjury rate between injuries with and without intramuscular tendon injury, while others found no or notably smaller differences. In addition to differences in methodology (prospective vs. retrospective design, presence vs. absence

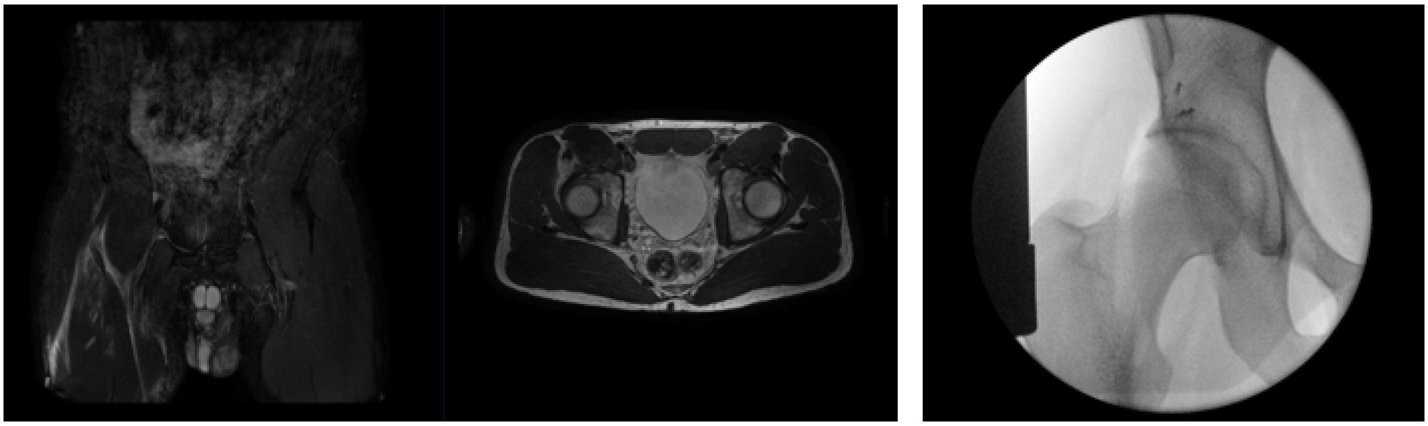

Figure 4: Coronal and axial MRI demonstrating proximal rectus femoris tendon avulsion on the right side (left), and radiographic evaluation of correct positioning of suture anchors follow surgical repair (right).

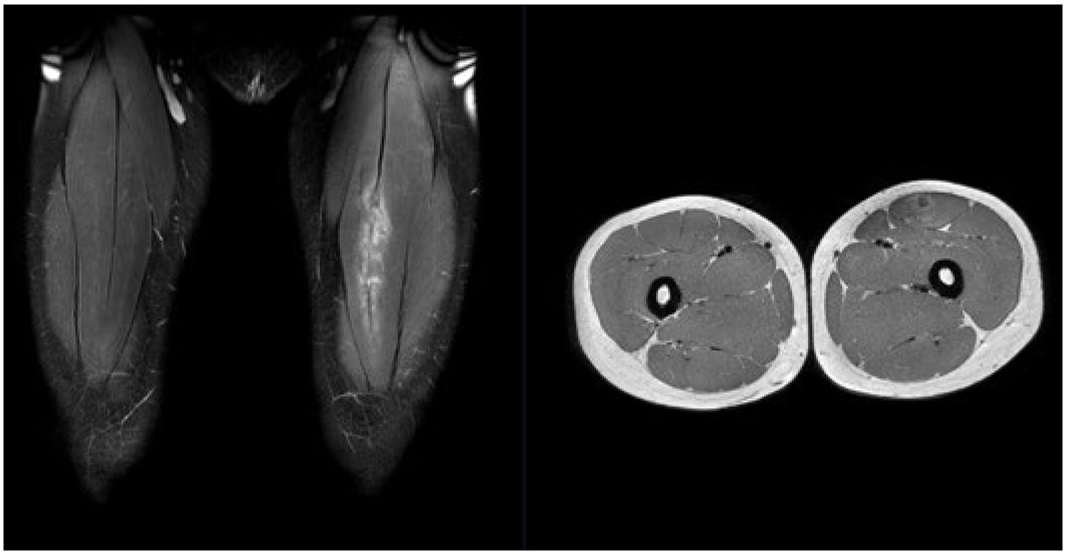

Figure 5: Coronal and axial MRI demonstrating intramuscular tendon injury of the indirect head of the rectus femoris (indirect head) on the left side.

of blinding of treating physicians to MRI findings), the type of sports in which the (injured) athletes participated may also have contributed to differences in study outcomes and conclusions. For example, running speeds are higher in track and field compared to field sports, resulting in increased biomechanical demand on the tendon. Outcomes in track and field may therefore differ from those in field sports.

In track and field, the British Athletics Muscle Injury Classification (BAMIC) group have explored time to return to full training and reinjury rate following hamstring and rectus femoris tendon injury[16,17,32]. In their classification[33], injuries are graded based on extent (grade 0-4) and anatomical location of the injury (a: myofascial, b: musculotendinous, c: intratendinous). While these studies are subject to high risk of bias due to retrospective study designs, relatively small sample sizes, and lack of blinding, they currently are the best available evidence in track and field athletes. For hamstring injuries, higher grade (i.e. grade 3) and c-injuries were associated with increase time to return to full training, and c-injuries were associated with increased reinjury rate[17]. For rectus femoris injuries, c-injuries were associated with increase time to return to full training, and grade 3 injuries were associated with increased reinjury rate[32]. Based on these findings, the BAMIC group presented a framework for rehabilitation of track and field athletes with muscle injury with specific guidelines based on injury grading[34]. A subsequent analysis several years after implementation has demonstrated favourable outcomes: there was a clear decrease in reinjury rate for c-injuries to 0%. Time to return to full training was increased for 2c injuries by approximately one week, but decreased for 3c injuries by approximately four weeks.

Operative outcomes for acute and chronic/recurrent intramuscular tendon injuries of the hamstrings and rectus femoris have also been reported[32,35-37]. Reported time to return to play ranged from 2.5 to 4.5 months. Based on reported non-operative outcomes for acute, non-chronic/-recurrent injuries, operative treatment is likely not indicated. For injuries that lead to persisting functional deficit with inability to return to performance or the tendency to recur multiple times, operative repair may be considered. Following surgery, favourable outcomes have been reported in terms of rate of rate of return to performance and rate of reinjury.

RETURN TO SPORT AND PERFORMANCE

Following injury, athletes progress through a progressive/phased rehabilitation programme. For examples of rehabilitation programmes, we refer to the cited articles in the previous sections[23,34]. Ideally, the athlete, coach, treating physiotherapist, and team physician are all included in the

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rehabilitation process and the return to play decision-making[38]. We make use of clinical criteria for progression through rehabilitation as well as the return to play decision-making. These include the unrestricted and pain-free completion of the rehabilitation programme including sport-specific phases, resolution of palpation pain, symmetrical strength (<10% side-to-side difference), and patient-reported readiness to return to play. For sport-specific training load, we aim to have the athlete perform above their normal match/competition load during the final stages of their rehabilitation.

We make use of follow-up MRI to assess progression of tendon healing, but this is eminence-based rather than evidence-based practice[39]. It should thus be taken into account as a contributing rather than a decisive factor.

Following the return to sport decision, the athlete should gradually return to training and competition load. The road to return to performance is, of course, also guided by personal goals and the upcoming competition(s) schedule of the injured athlete.

CONCLUSION

In hamstring and rectus femoris injury, tendon injury represents a distinct clinical entity.

In elite track and field athletes, surgical consultation is advised in case of full-thickness free tendon injuries. Operative repair by means of suture anchors might be indicated for retracted proximal tendon avulsions/ruptures in order to improve recovery of function, rate of return to performance, and reinjury rate.

Intramuscular tendon injuries may be associated with an extended return to play duration and increased reinjury rate, but available evidence is constrained by high risk of bias. Based on the current evidence, these injuries may potentially benefit from an adapted rehabilitation programme to improve outcomes, but high-level evidence is required for confirmation. Operative treatment is likely not indicated for acute, first-time injuries, but may be considered for chronic/recurrent intramuscular tendon injuries.

References
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