Rehabilitation of Rectus Femoris Injuries in Kicking Athletes

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Rehabilitation | Case study | Rectus Femoris

Headline

The Rectus Femoris (RF) is one of the most important muscles in sports which require repetitive kicking; this would include any of the football codes including Rugby, Australian Rules Football (AFL) and in particular Soccer where it has consistently presented as one of the most injured muscles since epidemiological data started to be collected. Quadriceps injuries typically make up 7% of the total injuries sustained by an elite soccer team during the course of a season with RF injuries making up the vast majority of those injuries (1).

During a recent season our shared club sustained an unusually high number of RF (Eight) injuries whilst simultaneously sustaining a historical low number of Hamstring injuries (Five) which goes against the published data of Hamstring > Quadriceps.(1)

It is beyond the scope of this paper to present reasons as to why there would be such a switch in the number of Hamstring and Quadriceps injuries within a season and there is nothing to suggest that the events are related. Whilst there are some similarities in terms of injury mechanism when comparing Hamstring and RF injuries which occur during high speed running or deceleration the majority of RF injuries occur during kicking and occasionally when sprinting whereas the majority of Hamstring injuries occur during sprinting and occasionally during stretching or kicking.

The purpose of this paper is to re-visit the RF in terms of its unique anatomy and suggest reasons as to why the structure of the muscle contributes to its susceptibility to injury, to sub-group RF injuries into those which typically take longer to rehabilitate and finally to present a complete rehabilitation process for this particular type of injury with a particular emphasis on ‘kicking progressions’ for use in the those sports for which a return to a full strike or “shot” will ultimately be the final mechanical criteria to allow a return to sport (RTS) (figure 1).

As part of this kicking progression we will introduce the use of an eccentric progression carried out on the Isokinetic Dynamometer (IKD) which we feel is unique and show how this can be integrated into functional loading and strengthening of the injured tissue to allow isolation of the injured tissue within a full strength program.

Anatomy and Action

RF is a bi-articular muscle located within the anterior aspect of the quadriceps muscle group; it works to extend the knee, flex the hip and stabilise the pelvis on the femur in weight-bearing.(2)

It is an extremely long muscle, is innervated by the Femoral nerve and has two proximal heads of origin. The direct head originates from the anterior inferior iliac spine and the indirect head arises from the superior acetabular ridge running parallel to the direct tendon; these origins then converge down to form the proximal aspect of the RF muscle with the indirect tendon situated medially within the proximal part of the muscle and is cord like in appearance.(3,4)

This interaction of direct and indirect heads results in the so-called “muscle within a muscle” configuration in which an outer unipennate muscle surrounds an inner bipennate muscle.

This unique anatomical variation was best described in a paper by (5) “A unipennate muscle is one in which the muscle fibres originate from one side of the tendon and that tendon remains on one side of the muscle, sometimes blending with an aponeurosis on the surface of the muscle, as is the case for the direct portion of the RF. A bipennate muscle is one in which the muscle fibres originate from two sides of a tendon, as is the case of the indirect portion of the RF, and form an intramuscular central tendon or central aponeurosis .

Because of the complex “muscle within a muscle” anatomy, injuries to the RF may not always fit into the traditional grading system of describing muscle injuries.

Types of Injury

As with all muscle injury it is important that an accurate diagnosis and prognosis is made at the time of injury. This is particularly important in the RF due to the complex nature of the anatomy as described above. There is obviously a clear clinical difference between players who present with a gradual onset of tightness with maintenance of power and a slight loss of range versus those who have acute sudden onset pain and immediately display the typical clinical signs of a more significant muscle injury such as pain, loss of strength and reduced range.
The use of imaging can give specific details of which area of the muscle is injured and this can certainly help when diagnosing and prognosticating but it is also vital to be guided by the clinical signs; this is particularly important with the lower grade injuries (clinically and radiologically) to reduce the risk of injury extension.

The RF isn’t a muscle that athletes are typically able to continue with if they still have clinical signs of a problem - even if these signs are fairly minor. Its vital that athletes are clear from a clinical perspective “on the bed”, are confident in the muscle and are also able to reproduce pre-injury objective scores of strength and length before they are exposed to any sort of explosive activity, if not there is a significant risk of the injury extending.

Bails et al (6) investigated central aponeurosis tears of the RF in 35 players, they concluded that RF central tendon injury at the proximal level (injury located above the intersection created between the lateral edge of the sartorial muscle and the medical edge of the RF) is associated with a greater RTS time than at the distal level, that players with a grade II injury have an RTS time longer than those with a grade I injury whether the injury is located proximal or distal and that greater injury length corresponds to longer RTS time. (Proximal = RTP of 45.1 when injury length is 4cm - RTS increases by 5.3 days with each 1cm increase. Distal injury = RTS of 32.9 when injury length is 3.9cm - RTS increases with each 1cm increase.

Recently attempts have been made to further sub-classify the grade of muscle injuries by including information on location within the muscle. Pollock et al (7) classified injuries as myofascial, musculotendinous junction (MTJ) and intratendinous, they described 4 grades of muscular damage according to image findings based on cross-sectional area (CSA) and length of injury within the muscle or tendon. Although this work was based on Hamstring injuries it is likely that this grading system can be extrapolated to include the RF.

This is important as intratendinous tears have been shown to take longer to recover and have a higher recurrence rate meaning that accurate initial diagnosis of tendon involvement would impact upon prognostication and early management.

Brukner and Connell (8) warned of the “difficult thigh muscle strains” related to intrasubstance quadriceps strains resulting from a tear of those fibres originating on the tendon of the indirect head of the muscle, other variations include those tears which disrupt the myobirls from the central tendon but the tendon itself remains intact whilst the central tendon itself can fail to create a fluid filled defect. They describe a clinical experience of athletes initially recovering fairly quickly only to sustain a re-injury, this time with failure of the intramuscular tendon.

Hughes et al (9) postulated that the indirect (central tendon) and direct heads of the proximal tendon begin to act independently, creating a shearing phenomenon in contrast to what occurs in the normal RF. This hypothesis was then used as a potential explanation for the longer rehabilitation associated with acute injuries involving the central (intramuscular) tendon.

Pollock et al (10) gave a possible explanation for the longer recovery time required for tendon injury. Tendon healing occurs in a very different way to muscle repair. Muscle injury induces a satellite cell response and early scaffold on which muscle regeneration can occur enabling early return of muscular function whereas Tendon repair initiates an inflammatory response characterised by extracellular matrix deposition and a functionally limited scar that requires collagen synthesis and remodelling for return of tensile strength.

The tendon remodelling phase, which occurs from around 6 weeks after injury, replaces the early type III collagen and extracellular matrix with longitudinally orientated type I collagen. This is necessary to restore the tendon stiffness and function required for athletic activity such as sprinting or kicking function.

With this in mind and similar to our clinical experience it is suggested that RF injuries which include Tendon involvement are likely to require a recovery period of 8-12 weeks depending on the length and degree of damage.

**Mechanism of Injury**

3 distinct types of injury mechanism are recognised when dealing with injuries to the RF; they are Acceleration, Deceleration and Kicking.

During acceleration the RF reaches its maximum length during early swing phase when the hip-flexor muscles generate force at the same time as the knee-extensor muscles absorb energy through an eccentric muscle action. During deceleration mechanisms of injury the body adopts a more up-right posture and a large eccentric force is passed through the quadriceps muscle group with the biarticular nature of the RF placing it under the most stress.

As muscle injury will typically happen during a lengthened state it has been proposed that the injury mechanism during “kicking” actually occurs during the cocking phase of the action when the hip flexors work to decelerate the femur as it approaches terminal hip extension and at the same time the RF has to work eccentrically distally to decelerate the flexing tibia - essentially both ends of the RF are working eccentrically to control the end of the cocking phase of kicking before the leg is then accelerated forward to strike the ball - in practice however the player will typically feel that the injury has occurred at the moment of ball strike.

**Degloving injury**

The muscle within a muscle anatomy described above also results in a type of “degloving” injury which is unique to the RF and is described by Kassarjian (11) whereby the inner bipinnate intramuscular portion of the indirect myotendinous complex is separated from the surrounding outer unipennate portion of the muscle, this results in dissociation of the inner muscle belly from the outer belly and in some cases retraction of the inner muscle belly and a palpable dip in the normal anatomy. These type of injuries have a mean RTS of 39 days although they can take up to 8 weeks.

The myotendinous junction (MTJ) of the indirect head of the RF appears susceptible to a longitudinally orientated injury giving rise to the separation of the inner bipennate component of the muscle from the surrounding unipennate muscle. This appears to occur in the periphery of the fibres of the inner bipennate muscle belly.

**Bulls eye sign**

Another commonly found injury to the indirect component of the RF is an MTJ injury centred along the indirect intramuscular tendon which is referred to as a Bullseye sign (9) due to the distinctive MRI appearance (Fig.2A). In these cases increased signal seen around the RF tendon is likely to represent evolving stages of injury with early oedema and haemorrhage followed by later increased vascularity and scarring, whereas
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Common image findings

There are a number of common image findings which can help guide the clinician in terms of diagnosis and prognosis when marrying them together with clinical findings, these are shown in the following section.

Fig. 2 – Axial image Fig.2A shows a cross section through the intramuscular haematoma (large arrows) formed by retraction of the central bipennate portion of the muscle due to a tear at the distal end of the central intramuscular tendon. This produces a characteristic appearance sometimes referred to as a “bulls eye lesion”. Linear interfascicular haemorrhage and minor partial tears are present surrounding the haematoma within the peripheral unipennate portion of the muscle belly (small arrows). The sagittal image in Fig.2B of the same injury shows the degree of retraction (large arrow) of the central bipennate muscle belly that surrounds the central tendon. Note the minor partial tears in the deeper unipennate portion of the muscle extending distally to contact the deep aponeurosis (small arrows). The coronal in Fig.2C illustrates the “muscle within a muscle” morphology of the torn, retracted central bipennate portion of the muscle and the minor partial tears outlining the interface with the peripheral unipennate portion of the muscle.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

A Bulls eye sign with secondary atrophy and fatty infiltration of the muscle around the tendon reflects an old injury (12).
Fig. 3 – Axial image showing a longitudinal tear of the anterior aponeurosis with associated loss of tension and buckling, with minor partial tearing of the muscle belly at the myotendinous junction. The anterior aponeurosis arises from the direct head tendon contribution to the muscle-tendon unit. Note that the central intramuscular tendon is intact.

Fig. 4 – In contrast to Fig. 3, this axial images shows a moderate partial tear of the deep aspect of the RF that involves the deep aponeurosis (large arrow). The aponeurotic tear involvement also produces loss of tension and buckling of the normally taught aponeurosis (small arrow).

Fig. 5 – The axial image in Fig. 5A shows a high grade partial tear involving the central and deep fibres of the central tendon (large arrows) within the mid third of the tendon. The accompanying coronal image of the same injury in Fig. 5B demonstrates the high grade nature of the injury with a long craniocaudal extent of the central tendon tear and laxity of the central tendon distal to the tear site (small arrows), both of which are adverse imaging prognostic features.

Fig. 6 – The axial image in Fig. 6A shows complete non-visualization of RF muscle or tendon with high signal haematoma (large arrows) replacing the expected space of the muscle indicating a complete rupture of the muscle-tendon unit in a goal keeper following a place kicking drill. The coronal image in Fig. 6B shows the rupture has occurred on a background of extensive chronic scarring of the central tendon (small arrows) which show laxity with muscle retraction.

Fig. 7 – The axial image in Fig. 7A illustrates an acute avulsion of the origin of the indirect (reflected) head tendon of RF from its insertion on the supero-lateral acetabular rim following an injury sustained during kicking (large arrow). The sagittal image in Fig. 7B demonstrates the intact direct head tendon inserting on the anterior inferior iliac spine (large arrow) and the thickened, retracted indirect head tendon (small arrow). The 3D CT reconstruction in figure 7C performed 8 weeks following the original injury shows heterotopic bone formation (large arrows) at the site of tendon avulsion and at the end of the retracted tendon reflecting the associated acetalbar periosteal disruption.

Fig. 8 – The axial MR image in Fig. 8 shows an acute tear of the deep free edge of the central tendon with associated moderate partial tearing of the surrounding muscle fibres of the myotendinous junction (large arrow). Note the low signal thickening of the central tendon indicating that the acute tear has occurred in a region of mature scar tissue (small arrows) following earlier tendon injury.

Fig. 9 – The images in figure 9 illustrate the locations and patterns of scar tissue that may form following RF tears. The axial image in Fig. 9A shows thick, mature low signal scar tissue (large arrows) throughout the anterior aponeurosis and the direct head tendon contribution to the more anterior fibres of the central intramuscular tendon located in the proximal third of the muscle. Note the central tendon is poorly defined as it has become retracted towards the mass of scar tissue (small arrows). Fig. 9B shows thick mature scarring following tear involvement of the deep aponeurosis (large arrows). Intermuscular haematoma commonly forms between the RF and the vastus intermedius following deep aponeurotic tears, which may further contribute to scar formation. The sagittal image in Fig. 9C demonstrates the anatomical relationship of the proximal anterior aponeurotic scarring (large arrows) and the more distal deep aponeurotic scarring (small arrows), relative to the longitudinal extent of the muscle-tendon unit.

Fig. 10 – This figure shows acute avulsion of both proximal tendon origins of the RF. The axial image in Fig. 10A shows the avulsed and retracted direct head tendon (large arrow) and the deeper more laterally located indirect or reflected head tendon (small arrow). The sagittal image in Fig. 10B illustrates the retracted direct head tendon, avulsed from the anterior inferior iliac spine, with the retracted indirect head tendon in Fig. 10C avulsed from the lateral acetalbar rim. Note both retracted tendon footprints are closely related as they merge to form the superficial and deep components of the central intramuscular tendon.

Management of Injury

The early treatment following RF injury would follow the principles of soft tissue injury management and be guided by the healing continuum of inflammation, proliferation and remodelling. The use of NSAID’s would be contraindicated in the first 5 days due to its negative effect on inflammation and thus the trigger to efficient healing. An emphasis would be placed on allowing the injured tissue to rest and settle employing passive modalities such as Crutches, Ice, compression, PSWD and Muscle stimulation.

Within elite sport this early management phase would be incorporated into a complete “return to performance” program aimed at reducing the effects of both relative immobilisation and time out of training by incorporating fitness and condition elements away from the site of injury from as early as Day 1 (the only stipulation being that the program should not result in the aggravation of any symptoms).

The key variable in allowing a kicking athlete to RTS following injury to the RF is the ability to kick and in order to do this full range, strength and power will need to be achieved. Within the rehabilitation setting progression is criteria driven rather than stipulated by time - essentially once they have achieved certain objective markers they are clear to progress to the next stage.

Whilst keeping the key variables of “reducing pain, increasing length, increasing strength and maximising function” in mind with every intervention applied to the athlete the aim is to impact positively upon each of these elements as soon as possible within the rehabilitation process.

In the early phases this is likely to include pain relieving modalities, gentle ROM exercises (painfree), functional movement patterns (initially in a pool if accessible) and as soon as the athlete is able to withstand force through the muscle (assessed manually) then loading of the muscle can begin; initially this is likely to be isometric contractions but as soon as possible light eccentric work (in various position of hip and knee flexion) can and should be started.

The achievement of full ROM and the ability to withstand eccentric force in a prone (hip extended position) then be...
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comes the key objective criteria to trigger eccentric loading on the IKD and the unique kicking progression we introduced. Alongside this OKC progression the athlete will also be progressing functional strength, closed chain strength, proprioception and multi directional movement patterns and those progressions will run alongside the kicking rehabilitation. Collectively this phase could be considered the mid-stage of the rehabilitation and is based on the principles of protecting the healing scar whilst exposing it to length and strength challenges which will positively impact upon its maturation to a functional and repaired tissue ready to withstand the powerful actions expected of it at the time of RTS.

**Eccentric Training**

Eccentric muscle contraction potentially offers a number of advantages during RF rehabilitation, in particular: fascicle lengthening; optimising improvements in muscle strength; and increasing collagen synthesis.

Retrospective evidence suggests that individuals with a history of hamstring strain injury possess shorter fascicles (13). A subsequent prospective cohort study concluded that short biceps femoris fascicles and low eccentric hamstring muscle strength significantly increased the risk of future hamstring injury (14). Although there are no studies investigating the association of fascicle length and RF injury there is compelling evidence to suggest a similar concept applies.

Concentric muscle training has been shown to reduce muscle fascicle length in vastus lateralis (15). Conversely, eccentric muscle training using an isokinetic dynamometer revealed significant increases in fascicle length for vastus lateralis and RF (16). Brughelli et al (17) performed a RCT to assess the outcome of a 4-week eccentric strength training intervention for RF using 28 professional football players. The experimental group (EG) had an increase in optimum length – likely due to fascicle lengthening - compared with the control group and also incurred no RF injuries that season – the control group suffered 2 RF injuries.

There is a paucity of evidence related to eccentric strength and RF injury. Research on hamstring injuries lends support to inclusion of eccentric strength work within muscle rehabilitation. Eccentric hamstring conditioning is arguably the most effective means of preventing hamstring injury (18,19,20,21).

Three large-scale prospective studies have shown that high levels of eccentric strength offsets the inherently greater risk of injury associated with low levels of eccentric hamstring strength (22,23,13). Recently, eccentric overload training has been shown to accelerate or optimise quadriceps endurance, isokinetic and isometric strength (24) – justification for inclusion in RF rehabilitation irrespective of associated injury data.

Takagi et al (25) investigated the repeated bout effect of eccentric contractions in the gastrocnemius muscle of rats. The CG completed one bout of eccentric contractions (EC’s) at week 4 whilst the EG completed a bout of EC’s at week 1 and week 4. The initial bout caused the muscle in the EG to become resistant to the injurious effects of the second bout. Type I collagen was increased in the EG prior to the second...
Eccentric exercise may enhance muscle rehabilitation via increased collagen synthesis.

This isokinetic dynamometer (IKD) provides a unique mode of eccentric contraction during RF rehabilitation. The athlete can complete the EC in prone (Fig. 11), which permits eccentric muscle activity throughout a large range of motion, which may optimise fascicle lengthening.

Isolating knee flexion range allows good RF excursion and EC in comparison to combined hip and knee flexion (e.g. squatting) whereby the muscle remains fairly isometric during contraction. The angular velocity of isokinetic contraction can be controlled at a slow velocity – we incorporate 10°/s. This not only provides reassurance for the athlete rehabilitating an injured muscle but may also delay short-term anoxia associated with isokinetic exercise at faster angular velocities, and improve muscle metabolism (26). A tablet computer provides the athlete with live torque data throughout each repetition.

Strength training that is externally paced and replicates a skilled movement task has been shown to increase corticospinal excitability and reduce cortico-spinal muscle inhibition compared to self-paced strength training. (27). Tendon involvement is common in RF injuries and modulation of muscle activity in this manner potentially restores corticospinal control of the muscle-tendon complex. (28)

Our IKD protocol is shown below (fig.12 and fig.13) and commenced at the earliest clinical opportunity alongside traditional gym-based loading. The athlete is educated that this is a component of their strength work rather than an isolated rehabilitation intervention and it will be completed alongside other CKC strength exercises including squat, step-up and split-squat variations before progression into plyometric work.

Kicking Progressions

Typically muscles incur strain injury in relatively lengthened states; however it is our experience that RF is commonly injured during ball contact phase. Although the RF is in a shortened position during ball contact there is huge variation potential for ball-contact forces and kicking technique.

We propose a model whereby kicking is initially compartmentalised from bi-articular to uni-articular motion at the hip and knee using knee drives (fig.14) and seated IKD concentric knee extensions respectively (fig.15). The kicking protocol evolves to include bi-articular kicking biomechanics, which is...
commenced in the pool utilising the resistive properties of the water (fig.16) and progressed to incorporate pneumatic pulley resistance on dry land. Progression of the velocity component is vital - the thigh can reach speeds of 500 degrees/second during kicking (29).

When the athlete is clear to commence pitch-based kicking progressions we recommend a graduated velocity-based interval kicking progression. A recent study found a velocity-based approach to be more reflective of the true demands of soccer compared to a distance-based approach (30).

The authors examined match analysis data from the US Major League soccer during the 2012 season. The number and type of kicks were allocated to three discreet velocity bands (0-6m.s⁻¹; 6-12m.s⁻¹; >12m.s⁻¹) and shown to vary dependent on playing position. This data acts as a reference enabling practitioners to grade the volume, intensity and type of kicking within rehab to be reflective of the demands of a particular playing position.

We describe the velocity bands as low, medium and high when explaining kicking intensity to athletes. It is acknowledged that there will be kicking variability associated with playing styles, game situations, formations and leagues.

**Pre-Activation**

The premise of this phase of training must be individualised to the athlete. For the purpose of this article a general overview of elements specific to RF injury will be discussed. Recently, it has been established that gluteal activation exercises re-
duce cortico-spinal inhibition, increase cortico-spinal excitation and improve gluteal muscle efficiency (31).

One can surmise that similar neuro-physiological processes occur following activation of alternative muscle groups.

RF does not play a significant role in generating positive work during running rather it acts to facilitate energy transfer from the hip to the ground during the braking component of stance phase (32).

During the first half of swing phase the RF is designed to absorb energy (eccentric contraction), however computational modelling has demonstrated that these forces are low relative to iliopsoas (33).

The ‘leaning tower wall series’ is a selection of exercises that replicate the stance phase function for RF (fig.17). Emphasis is placed on strong activation of the RF as it plays a critical role in absorbing energy during the braking component of stance phase.

One of the common RF injury mechanisms via eccentric loading is deceleration. This is due to the horizontal braking forces and eccentric load that the RF is subject to. ‘Drop jumps’, ‘alternating split-squat jumps’ and ‘side-step deceleration steps’ are useful exercises to prepare for the eccentric demands associated with deceleration (fig.18).

During swing phase iliopsoas produces approximately 4x the muscle forces of rectus femoris when normalised for bodyweight. Iliopsoas muscle forces increase relative to increments in running speed (33).

Insufficiency of the iliopsoas may increase the demands on RF to produce concentric hip flexion force, in particular areas derived from the direct head. At the end of swing phase the rectus femoris muscle-tendon unit is at its maximal length and thus susceptible to injury (34).

Lewis et al (35) used computational modelling to demonstrate that a 50% reduction in iliopsoas force during hip flexion resulted in increased anterior hip joint forces - RF force increased to compensate.

In addition, a lack of iliopsoas flexibility will compromise hip extension and potentially the efficacy of the stretch-shortening cycle (SSC) which contributes to iliopsoas force development. A lack of hip extension during running gait could also lead
to a compensatory increase in lumbar lordosis and potential femoral nerve root compression. Knee drives serve to replicate and enhance the efficacy of the iliopsoas SSC. Varying speed of contraction as well as resistance is recommended in order to replicate the biomechanical demands of running. The ‘leaning tower step-to-box series’ encourages hip extension in the stance leg whilst also supplementing RF activation work (fig.19).

Decreased gluteus activity in hip extension increases anterior hip joint forces. During running Gluteus Maximus extends the hip with high force and speed during flight and stance phases. Gluteus Medius stabilises the SIJ by enhancing force closure and also contributes to preventing Trendelenburg’s sign (36).

In order to reduce anterior hip joint forces in the early phases of rehab, gluteal activation and strength exercises are advocated in hip flexion initially (fig.20). Gluteal exercises should subsequently be progressed into more extended hip positions (fig.21). The rectus abdominis and oblique muscles prevent excessive anterior pelvic tilt at toe-off during running. Amongst the many negative effects associated with insufficient control of pelvic tilt, the length-tension range of iliopsoas is sub-optimal. As previously highlighted, this will increase anterior hip joint loading and subsequent RF forces. Strong abdominal contraction should be coached in all activation exercises and specific high volume lower abdominal sessions should be included to train this aerobic muscle group (fig.22).

Pitch based rehabilitation with special reference to the RF Exercise selection, volume and intensity will have a significant impact on the success of any rehabilitation program; players will only overcome the anxieties of injury once they have completed a significant volume of unique rehabilitation tasks associated with performance (37).

Before commencing pitch based rehabilitation the players training and match outputs for external loading were analysed. This information provides targeted loads for RTS with a gradual increase in volume (duration and total distance) and intensity (velocity) throughout the rehabilitation period.

Figure 24 provides a graphical representation of volume and intensity progressions achieved. The acute tolerance of the player, reflected by his maximum completed session, resulted in 77% of game total distance, 81% of high speed running and a maximum speed reached equivalent to 95% of recorded maximum speed whilst working at match intensity for metres per minute.

This information provides the practitioner with the confidence that the tissue can withstand significant stresses reflective of competition whilst conditioning them to a level which will reduce the likelihood of an acute:chronic loading spike at the time of return to competition.

### RTS

The RTS criteria used at the end stage of rehabilitation is a unique challenge to the clinician working in the kicking sports; its bi-articular nature, length and ability to generate huge torque whilst performing movements which make up a critical component of performance within these sports mean effective rehabilitation has to incorporate both open and closed chain rehabilitation variations.

Accurate diagnosis and prognosis as a result of detailed clinical assessment and the recognition of specific image findings which will impact upon the time scales imposed upon recovery whilst following a task based criteria driven progression make up a vital component of the assessment phase of the injury.

We have presented a kicking progression which utilises early eccentric training delivered on the IKD before incorporating more functional strength and movement tasks and believe this to be a unique way of combining the benefits of eccentric strength training of injured tissue on the IKD within a generic lower limb anterior biased strength and power rehabilitation program and pitch based kicking progression.

Injuries to the RF central tendon present a particularly difficult clinical challenge but the use of objective data in terms

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### Summary

Injuries to the RF present a unique challenge to the clinician working in the kicking sports; its bi-articular nature, length and ability to generate huge torque whilst performing movements which make up a critical component of performance within these sports mean effective rehabilitation has to incorporate both open and closed chain rehabilitation variations.

Accurate diagnosis and prognosis as a result of detailed clinical assessment and the recognition of specific image findings which will impact upon the time scales imposed upon recovery whilst following a task based criteria driven progression make up a vital component of the assessment phase of the injury.

We have presented a kicking progression which utilises early eccentric training delivered on the IKD before incorporating more functional strength and movement tasks and believe this to be a unique way of combining the benefits of eccentric strength training of injured tissue on the IKD within a generic lower limb anterior biased strength and power rehabilitation program and pitch based kicking progression.

Injuries to the RF central tendon present a particularly difficult clinical challenge but the use of objective data in terms
of both strength and pitch based loading markers give the clinician the best chance to return these injuries back to full competition and pre-injury levels of performance whilst minimising the risk of re-injury.

References


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