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INJURIES AND TEAM SPORTS

MUSCLE INJURIES IN SPORTS

Muscle Injuries in Sports

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Introduction

Muscle injuries, especially those located in the thigh, are a frequent consequence of contusions and repeated actions with sprints and maximum accelerations/decelerations. Since sports combine maximal sprints with frequent player-on-player contact, it is not surprising that up to 30% of injuries occur in the thighs. In fact, elite European competition results show that the most common type of injury in male sports are hamstring muscle injuries, accounting for between 13% and 17% of the total number of injuries. Other studies have shown that injuries due to thigh muscle contusion account for up to 16% of all injuries in elite team sports. A clear example would be: on average, a male soccer team with 25 players can expect around 18 muscle injuries per season. Of these, seven will affect the hamstrings and three will affect the quadriceps (Hagglund M, Walden M, Ekstrand J., 2013).

According to observations made on young players (FC Barcelona, unpublished data), the most common muscle injury is the rupture of the rectus femoris, while hamstring injuries are the most common among professional soccer players. Due to the magnitude of the problem, the need for a better understanding of muscle injuries and their prevention has become an emerging challenge in the world of sports. In-depth knowledge of muscle injuries as well as all their implications will be the mark of success for the overall decision-making management process.

Injury Mechanisms

Hamstring injuries occur more often during maximal sprints. It is believed that injuries of the biceps femoris muscle occur more often in the final balancing phase, just before the ankle hits the ground, but it has been suggested that the ankle blow (support phase) is also a high-risk position. This injury mechanism is called the high-speed running mechanism. A second type of injury has been described, known as stretching-type injury. This happens during the movements that lead to an extensive elongation of the hamstrings, such as high kicks and sliding actions; the semimembranosus muscle is affected in this type of injury. This distinction is important, as an injury by stretching may have a longer recovery time, especially due to the proximity of the sciatic nerve (Askling CM, Malliaropoulos N, Karlsson J., 2012).

Injuries to the rectus femoris have been less studied, but most of them are the result of striking the ball, although they can also be caused by abrupt accelerations and decelerations. In both situations, athletes describe a sudden onset of localized and significant pain. The quadriceps is also a common site for contusions or injury by a direct blow.

Although most thigh injuries are handled in a conservative way, one the goals the medical record and the examination is to differentiate between athletes with severe injuries, those whose performance will be affected, and those who will benefit from surgery. During this process, diagnosis is key and must begin with a sound anamnesis.

An appropriate medical record must include the following elements:

Regarding the athlete's general medical history:

- Has the player suffered similar injuries in the past? (Some muscle injuries have a high rate of recurrence).
- Is she susceptible to injury?
- Is the patient currently taking any medication?

Regarding the injury mechanism:

- What was the injury mechanism? (Direct trauma? Maximal sprint? Kicking the ball?).
- Did the injury occur during training or competition?
- When did it start? Date and relation to the athletic session (start, middle or end of the session).
- How did it start? (Suddenly, gradually, progressively).
- Any audible sound or click at the onset of pain must be taken into account.

Regarding the initial progress:

- Was the player able to continue the activity or was she forced to stop?
- How was the patient treated immediately after the injury?
- How has the pain progressed over time?

Risk factors

Several risk factors for muscle injury have been suggested. The most convincing risk factor is the existence of prior injuries. In soccer in particular, players with a previous hamstring injury are seven times more likely to suffer a new injury compared to players who have no history of injury (Arnason A., et al 2004). On average, repeated injuries also

result in a lower readiness, which can be up to 30% higher (Ekstrand J, Hagglund M, Walden M., 2011a).

Age is also a significant risk factor for injury. Players under 22 were observed to have a significantly lower incidence of injury than players between 22 and 30, as well as those over 30 (Ekstrand J, Hagglund M, Walden M., 2011b). In athletes who are still growing, we must consider the differences between chronological and biological age. The latter is more appropriate when it comes to setting and adjusting training loads in order to avoid injury, especially overload injuries, such as apophysitis, as well as muscle tears.

Different factors have been identified and published in the literature, such as the lack of strength, imbalances between hamstrings and quadriceps, lack of flexibility (Stojanovic MD, Ostojic SM., 2011), fatigue, intense training periods, mechanical and anthropometric factors, and even competition against opponents of a higher caliber (Freckleton G, Pizzari T., 2013).

The detailed study of all the risk factors as well as the rise of technology have led us to a change of paradigm. Nowadays, knowledge is directed towards customizing and individualizing the injured athlete, and thanks to this, genetic markers that may play a large role in muscle injury have been identified. Certain individuals may be more prone to injury and may even take longer to recover. Players with specific polymorphisms, insulin-like growth factor 2 (IGF2) and C-C Motif Chemokine Ligand 2 (CCL2) (specifically its dominant-allele form (GG), may be more prone to severe injury (Pruna R, Artells R, Ribas J, 2013). It is possible that in the future, genetic testing could be used to identify individuals at a higher risk of injury and to focus on programs for preventing specific injuries.

Clinical exploration

Clinical examination provides diagnostic information and an important prognosis regarding the injury. It is essential to compare the findings from the examination of the injured area with the non-injured area.

Important considerations include:

- Checking for bruises or deformities in the muscle belly profile. Palpating to identify the specific injured region or muscle, as well as the presence or absence of a palpable defect.
- Assessing strength through manual resistance applied distally to the site of the injury.
- It is important to take into consideration that the triggering of pain through this assessment is as relevant as the alteration of functionality.
- Range of motion.

- Pain and discomfort or unease during examination are key considerations to be assessed.

An example for how to clinically assess an athlete would be as follows:

If an athlete suffers from a quadriceps contusion, a knee joint flexion higher than 90° indicates a minor injury with a shorter rehabilitation period; flexion between 45° and 90° indicates a moderate injury; and flexion under 90° is a severe injury with a long healing period.

Additional tests

Even if the diagnosis is clear in clinical terms, ultrasound and MRI (magnetic resonance imaging) examination may help to confirm the diagnosis. Plain x-rays are generally not useful, unless an avulsion fracture or an apophysis fracture is suspected in a skeletally immature individual. A musculoskeletal ultrasound scan is significantly cheaper than an MRI examination, but is highly dependent on the operator. Although it is a more costly examination, MRI shows the muscles at a deeper level with greater accuracy and is more sensitive (Harmon KG., 2010).

Ultrasounds are to be performed immediately after the injury, depending on the experience of the team sports physicians, although it is not recommended to perform one up to 48 hours following the injury if a clear diagnosis of the injury is desired. Performing an ultrasound immediately after the injury does not constitute the most accurate time to obtain a detailed image, although we sincerely believe that magnetic resonance can be performed at any moment, as it provides us with important data for diagnosis due to the current development of the technology.

MRI findings that must be assessed include:

- impact on the connective tissue;
- anatomical location of the injury;
- distance between the origin (ischial tuberosity in the case of the hamstring or the anteroinferior iliac spine/acetabulum rim in the case of the rectus femoris) and the distal end of the torn muscle;
- area of the transversal section of the affected muscle (Rogan S, Wust D, Schwitter T, Schmidtbleicher D., 2013).

In general, a larger (or longer) injury is associated with an extended return to play period, although the key factor in prognosis is the impact on connective tissue.

Treatment

The goals of treatment and rehabilitation are: first, to eliminate bleeding and bruising, restoring the range of motion without pain; second, to reach a level of functionality that allows for the third phase, a rehabilitation program on the playing field that reproduces sport-specific movements and actions.

A) Acute phase

The main goal in this initial phase is to restore movement without pain. This is done through rest, compression bandaging if needed and physiotherapy. The main initial objectives are to start working on the optimal range of motion (ORM) and isometric exercises. Massage is contraindicated during this period. In the case of minor injuries, rehabilitation must begin two or three days after the injury, as this provides the opportunity to work with the athlete's cognitive abilities, which will have repercussions on the final process of performance adjustment.

There is also a range of other treatments that are commonly used in the initial phases of the injury. These include:

- Non-steroidal anti-inflammatory drugs (NSAIDs): the use of NSAIDs during the acute phase is debatable due to their correlation with suboptimal regeneration of myofibrils and the related increase in scar tissue deposits. As a general rule, simple analgesics (paracetamol or acetaminophen) are a better option during the acute phase.
- Injection of corticosteroids: injections of corticosteroids are contraindicated during the acute phase. Although they may present certain benefits in the short term by reducing pain, they may make the player more susceptible to a new injury in the long term. Intramuscular steroid injections are also prohibited in the World Anti-Doping Agency (WADA) list.
- Platelet-rich plasma (PRP): the use of PRP for muscle injuries in elite athletes seems to be increasingly common. The theory behind this treatment is that it provides growth factors that will then help muscle regeneration. However, there is still no convincing data that shows that this improves recovery in terms of time to return to the sport (Petersen J, Thorborg K, Nielsen MB, Budtz-Jorgensen E, Holmich P., 2011; Mendiguchia J, Garrues MA, Cronin JB, 2013).

B) Sub-acute phase

During this phase, exercises can be useful to eliminate bleeding residues and avoid the formation of scar tissue in the injured area. Massages and various types of electrotherapy can be prescribed. The program must include various stretching, strength, core stability, neuromuscular and functional exercises, including on the field as soon as possible. Progress is individual and controlled by pain and functionality. In

general, a high number of repetitions and low loads are emphasized early in this phase; later, the load is gradually increased and the number of reps decreased. The use of a stationary bicycle or exercises in a pool are a gentle and efficient method to increase mobility. Light training, with a shorter stride length, may begin as soon as pain allows.

C) Functional phase

The development of strength training programs, the increase of core stability exercises and sport-specific tasks on the field are key in this third phase. The relationship with the trainer or sports therapist is very important, as it is the step prior to inclusion with the rest of the team.

Surgical handling of muscle injuries

Surgical treatment is rarely considered in treating muscle injuries; however, certain very specific indications exist in which surgical intervention may be beneficial for severe muscle injuries, even in the absence of an evidence-based treatment protocol.

Certain surgeons believe that surgical treatments with a postoperative rehabilitation protocol must be considered if a patient complains of chronic pain (duration: 4 to 6 months) in a previously-injured muscle, especially if the pain is accompanied by a clear extension deficit. In these chronic cases, the formation of scar tissue and adhesions that limit movement must be suspected, and surgical removal of these must be considered. Furthermore, and in general terms, all significant avulsions of the proximal hamstring tendon must be treated by means of surgical reinsertion.

Criteria for return to play

Return to play (RTP) is defined as the multidisciplinary decision-making process to return an injured or ill athlete to competition.

To aid and corroborate in this decision-making process, high-tech tools are increasingly used to monitor loads applied in every moment of the readaptation process, and provide the basic principles until the athlete is free of symptoms and progressively increasing loads are able to be applied until the complete resolution of the injury.

Factors that must be taken into account in terms of decision-making for RTP:

- The hamstrings are a heterogeneous muscle group, and it is therefore necessary to create injured muscle subgroups that allow for different resting and recovery times.
- To ensure an accurate diagnosis, the clinical diagnosis must be considered first, followed by the MRI and ultrasound data.
- RTP can be personalized, based not only on the type and location of the injury, but also on the player's field position and their individual anatomical characteristics.

We suggest the following criteria for guiding the time necessary for return to play.

1) With regards to the type and anatomical location of the injury, it is mandatory to follow the biological development time.
2) In order to return to soccer, no clinical symptoms must be present, and static and dynamic ultrasound tests are required, showing adequate scarring of the tissue.
3) Eccentric explosive strength must be shown in a manner that is sport-specific and relevant to the injury. It is suggested, for example, that the Askling H-Test 18 is appropriate in the case of stretching-type injuries (semimembranosus), while comfort during high-speed running with no sign of symptoms is appropriate for a sprint-type injury, generally located on the biceps femoris.
4) Core and proprioception exercises must be worked on during recovery, until relevant objective abilities are achieved. In general, this makes up at least 70% of the rehabilitation time.
5) Ordinarily, a GPS assessment is performed (i.e., a global positioning system that quantifies metrics such as maximum sprint speed, accelerations, decelerations and step balance). This must show sport-specific parameters comparable to the athlete's previous performance profile and must be accompanied by the absence of symptoms. For instance, an athlete must be able to run faster than 21 km/h without symptoms, accelerate to 3-4 m/s and have full braking/deceleration tolerance.

Prevention

There is growing amount of evidence that shows that it is possible to reduce the risk of suffering a hamstring muscle injury. Although there is less data related to the risk of injury to the rectus femoris, it is likely that similar principles are applicable to prevent injuries. The proposed strategies include different types of stretching activities, eccentric strength training, core stability and multi-intervention combinations of the above.

Stretching

Although most trainers and athletes generally believe that stretching is effective, it is not clear whether it prevents injuries (McHugh MP, Cosgrave CH., 2010; Rogan S, Wust D, Schwitter T, Schmidtbleicher D., 2013). No adequate studies on this issue have been carried out on elite athletes. Although it is possible that stretching plays a role in injury prevention, it is likely to be substantially less effective than eccentric training.

Eccentric strength

Several studies show that eccentric training, for instance through exercises such as the Nordic Hamstring (NH; Fig. 1) reduce the incidence of hamstring injuries in different athlete populations. The best evidence for the preventive effect of eccentric strengthening is a randomized, controlled study carried out in Denmark comparing the effect of NH exercise with the rate of acute-phase hamstring injuries in male soccer players. This study showed that the injury rate was 71% lower with NH exercise in players with a history of hamstring injuries. The effect was even larger with a 86% reduction in injury rate (Petersen J, Thorborg K, Nielsen MB, Budtz-Jorgensen E, Holmich P., 2011).

Intensities and repetitions are classified according the recovery phase of the sports injury.

- Beginner: 1 set (3-5 reps).
- Intermediate: 1 set (7-10 reps).
- Advanced: 1 set (12-15 reps minimum)

Similar types of eccentric protocols have also been proposed to prevent quadriceps injuries (inverted Nordic) associated with a gradual increase in the shot training volume in athletes during critical periods to help reduce the rate of injury. The optimal intensity for eccentric training programs is not yet clear.

Figure 1. Nordic Hamstring exercise

Source: Retrieved from goo.gl/uT2AP4

CORE

Many of the hamstring muscle injuries were produced by trunk flexion during runs, in the position typically assumed during sprint and acceleration. Motor control of the lumbar spine and pelvis is essential in the preparation and execution of the different athletic movements. The inclusion of core exercises in training sessions can also reduce the risk of injuries to the rectus femoris of the quadriceps (Mendiguchia J, Garrues MA, Cronin JB, et al., 2013).

Multi-intervention

Injury prevention training programs implementing various components (proprioception, core, stretching and strength) have been effective in reducing the number of muscle injuries. A successful example combining preventive strategies is the FIFA 11+ program. It has been shown that completing the FIFA 11+ injury prevention warm-up (Fig. 2) on a regular basis reduces the risk of hamstring and quadriceps injuries in males and females by 30-50% (Soligard T, Myklebust G, Steffen K, et al., 2008).

Currently, these strategies are used as the basis for supplementary training or even incorporated within training to reduce the number of injuries. Furthermore, these

strategies increase the ORM, muscle strength levels and proprioception, all of which are essential to the athlete's performance.

Notwithstanding, through customization and personalization of the programs and actions, the concept of prevention increasingly tends to be substituted by adaptation. Technology provides us with tools to monitor loads and obtain optimal profiles for each athlete in order to specifically guide their adaptation to effort while trying to prevent injuries.

Figure 2. FIFA 11+ warm-up protocol

Source: Retrieved from goo.gl/nr9wGK

Conclusions

Thigh muscle injuries frequently occur in sports as a result of contusions and through repeated maximal sprints and accelerations/decelerations.

Examination of the injured muscle must take into account: inspection, palpation, and an assessment of strength and range of motion. Even if the diagnosis is clear in clinical terms, ultrasound and magnetic resonance examinations may help to confirm the diagnosis.

Most muscle injuries can be treated with conservative methods: firstly, restoring the range of motion without pain (acute phase); secondly, achieving a performance level (sub-acute phase) that allows for the third phase, a functional rehabilitation program (functional phase). However, certain specific indications exist in which surgical intervention might be beneficial in treating severe muscle injuries.

Preventive strategies for reducing the incidence of muscle injuries have been proposed. The most important primary prevention strategy is proper training programming in terms of volume and intensity in order to achieve the appropriate physical condition for competition. Secondary prevention must be customized to modify risk factors in athletes with a history of injury. Injury prevention training programs implementing various components (with proprioception and eccentric force) have been effective in reducing the number of muscle injuries. A successful example combining preventive strategies is the FIFA 11+ program.

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