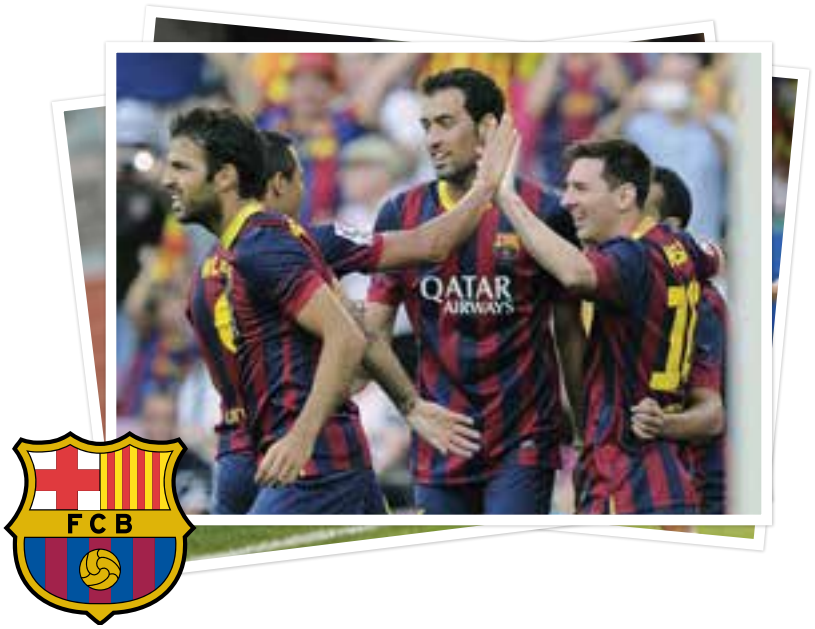
A LETTER FROM

FC BARCELONA

Hamstring Injuries In Football: Applying scientific knowledge to daily on-field practice



– Written by Luis Til et al, Spain

THE COST OF INJURY

Hamstring injuries are associated with sports that involve rapid acceleration or deceleration, jumping, cutting, pivoting, turning or kicking. A vicious cycle of re-injury is not uncommon, resulting in significant morbidity in terms of symptoms, reduced performance and time loss from sport. From an economic point of view, these time-loss injures have a very negative effect, not only due to their direct cost but also reducing squad availability and likelihood of success. As a result, sports science and medicine in football has focused on hamstring injuries in order to both decrease incidence and to reduce the impact on availability and its subsequent economic impact.

Diagnostic imaging has improved markedly in the last decade, helping our understanding of the topography of the injury, the type and amount of tissue affected as well as the correlation with structural anatomy. Detailed analysis of the 'functional impact' of the injury should, in the future, allow better monitoring of the healing process thus optimising the return to play time and minimising the risk of re-injury.

Today, multiple interventional treatments are proposed in the literature, but those should be considered as adjunctive treatment only. The primary treatment must be as functional as possible, respecting the healing/remodelling process.

The publication of the F.C. Barcelona *Clinical Practice Guide for Muscle Injuries*[1] was created out of our desire to systematically address the issues of diagnosis, treatment and return to play of muscle injuries.

EPIDEMIOLOGY AT BARCELONA

Over the last decade, the FC Barcelona football team have suffered 150 time loss injuries (missing at least one practice or game). Of these, 60 have involved hamstrings (40%) and biceps femoris accounted over 50% of these. This means that on average, we experience around six hamstring injuries per season. Football, when played by FC Barcelona, shows a higher hamstring injury rate when compared with other pro sports with similar demands such as basketball, handball, futsal and roller hockey.

These data are comparable to those obtained by other European football clubs[2]. Unfortunately, in our experience, we have not decreased the injury rate despite the implementation of an injury prevention strategy. However, as other authors remark, we believe monitoring of these programmes should be more thorough and extensive in order to clarify their validity, as they are subjected to multiple variables that impact upon their actual effectiveness. The increasing competitiveness, intensity and density of the competition calendar might be an issue to consider when evaluating an injury incidence rate.

RISK FACTORS AND MECHANISM OF INJURY

To prevent new injuries, we try to identify players at risk. Of all published risk factors for hamstring injury in football players, it seems that age and previous hamstring

injury, especially when rehabilitation is inadequate, places an athlete at increased risk of suffering an injury to the hamstring. As a result, these players follow specific prevention strategies in order to try to diminish the risk of injury or re-injury.

Studies examining whether hamstring strength, range of motion, muscle imbalances or low back pathology are a significant risk factor have produced conflicting results. However, we do assess these factors in our players and implement corrective measures. In our experience, these factors are often relevant, especially in players with new tactical roles or newcomers to the team. Training content and periodization, either in pre-season or in-season, remain unclear as a risk factor for certain injuries. FC Barcelona's training model introduces specific technical and tactical elements into training routines. This is considered to be a protective factor for articular injuries. For example, the ball is introduced as a main component of the pre-season training from the very first day.

Fatigue and decreased adaptability to training loads may also be a determinant factor. Therefore, monitoring workloads during training and competition, as well as the relationship between them, might help us to identify at-risk situations.

Recently, genetic markers have been used to try to define if there is a likelihood suffering certain injuries, as well as their correlation to the time required for recovery. In theory, players presenting certain polymorphisms, IGF2 and CCL2 (specifically its allelic form GG), might be more vulnerable to severe injuries and should be involved in specific prevention programmes[3].

DIAGNOSIS AND PROGNOSIS

Muscle injuries are diagnosed by clinical symptoms, physical examination and imaging. From an epidemiological perspective mechanism and circumstances of injury are also recorded.

MRI allows us to determine the exact anatomic location and extent of injury. However, for FC Barcelona, MRI is only utilised when a soleus muscle injury is clinically suspected, injuries affecting proximal quadriceps insertions or clinical-ultrasound discrepancy at the proximal/distal myotendineous union of hamstrings.

In daily practice ultrasound is proving to be a very useful tool in muscle injuries follow-up. We believe sports medicine physicians must be able to manage muscle injury follow-up and first diagnosis approach with US. It allows real time dynamic examination and elastography in order to monitor tissue stiffness (scar tissue also) and assessment of vascularisation by Doppler. Additionally, it is a very inexpensive and useful examination tool during follow-up. All these features are pushing US towards becoming an essential imaging technique in monitoring muscle injuries.

In terms of prognosis of hamstring injuries, biceps femoris injuries have a worse prognosis than those affecting semitendinosus or semimembranosus muscles. When reviewing a biceps femoris muscle, proximal injuries, long head injuries and those affecting both heads (long/short) at the same time seem to have the worst prognosis.

In fact, it appears that the closer to the insertion the injury is, the worse the prognosis. This observation might be explained due to the higher amount of connective tissue in these areas. We can think of it as a tree: a wound that affects the trunk or a main branch will be much more severe than one affecting a distal branch or the leaves attached to them.

To date, we classify muscle injuries by Peetrons grading scale (1 to 3)[4], the myoconnective union affected and the affected muscle affected (i.e. grade 2 injury of the myotendinous junction of the distal portion of the biceps femoris muscle) as proposed in our Clinical Practice Guideline for Muscular Injuries. All injuries must be codified following OSICS-10 coding[5].

However, two new muscle classifications have recently been proposed. This fact, in addition to our own experience, has motivated us to rethink our classifications, making a point not only in location but also in myotendinous vs myofascial affection.

TREATMENT AND REHABILITATION PROTOCOLS

To advance the successive phases of rehabilitation with increasing workloads we follow Mendiguchia[6], who recommends a criteria-based approach to rehabilitation, that includes objective and quantitative tests with potential to identify deficits and address them in a systematic progression (i.e. algorithm) during the stages of returning to sport.

> ***FC Barcelona experience on average six hamstring injuries per season***

From a practical point of view, the initial phase (3 to 7 days) starts with a short rest period to allow the first 'bridging' between the injured tissues. Ensuring only a short rest minimises the adverse effects of immobility. Making this initial phase too short or too long has been associated with a higher rate of re-injury, so it is a key point of the recovery process. We also utilise cryotherapy, elevation and compression. We recommend the use of crutches in those athletes with severe injuries in order to securely avoid stretching the injured muscle during this phase. The presence of haemorrhagic collections correlates with persistent symptoms; evacuation of haematoma by ultrasound-guided aspiration improves contact between the injured structures. Occasionally, this procedure must be repeated.

In the second phase, mobilisation must begin as soon as possible but gradually and within the limits of pain. Mobilisation

has shown to improve injured skeletal muscle regeneration. Since severe injuries involve rapid muscle deconditioning, they must be handled by progressive stretching and strengthening. We propose initially progressive unloaded isometric contractions gradually adding load. When isometric work is well-tolerated at high loads, we progress to isotonic training, without load at first and increasing progress favouring concentric and eccentric contractions. The workouts with isokinetic and iso-inertial devices offer different types of resistance that, when combined properly, enable the muscle to adapt to various types of loads. At this stage cardiovascular training should be performed with low impact, such as cycling or swimming. Since core stability programmes have been shown to improve results in terms of lower re-injury rates and enhanced return to play, they must be introduced along with the specific rehabilitation programme of the injured muscle.

The third phase involves sport specific training to return to football. At this stage tissue remodelling, anatomically and functionally, is promoted. The benchmark is the contralateral muscle. The on-field training must be co-supervised by an experienced athletic trainer, since we try to simulate specific football skills.

As a remark, it should be pointed out that all work must be preceded by a warm-up to improve the viscoelastic properties of the muscle, and to optimise neuromuscular recruitment for optimal absorption of loads. Stretching has been associated with improvement of elasticity, distending the scar and is recommended.

The use of electrotherapy is not widespread in our club, nor are we aware of any literature that supports its use. If used, make sure it doesn't interfere with other physical treatments such as cryotherapy.

Surgical treatment is reserved for total tendinous or subtotal lesions of the muscle belly. Early recognition is important since surgical repair in the first 3 weeks shows better outcomes than delayed surgical repair. Unresolved haematomas causing compression on other structures should be considered for surgical treatment as well. Painful scars and calcification should be carefully evaluated from a surgical perspective.

> ***We believe sports medicine physicians must be able to manage muscle injury follow-up and first diagnosis approach with ultrasound***

Regarding drug treatment, we recommend the use of a paracetamol/acetaminophen as an analgesic. Although there is controversy regarding the use of non-steroidal anti-inflammatories (NSAIDs) and glucocorticoids in the treatment of muscle injuries in humans, research discourages their use. As an exception, even with the lack of scientific evidence, indomethacin is used when myositis ossificans is suspected. Hyperbaric oxygen therapy has been proposed as another approach to improve the regeneration of the injury, however to our knowledge, no scientific evidence supports its use.

Regarding the use of the so-called 'regenerative therapies' such as platelet-rich plasma (PRP), we feel this is still controversial. There is lack of consensus on time of administration, dose or methodology, which makes the evidence difficult to interpret. We indicate PRP in athletes over 18 years with aspirable intramuscular haematoma, affecting major muscle groups. It seems, clinically, that PRP treatments within the first week improve outcomes. On the other hand, we've observed there seems to be inter-individual response variability. To date, we cannot yet differentiate good and bad responders to PRP treatments.

RETURN TO PLAY

The model of return to play described by Creighton[7] describes the complexity of this decision, especially in professional sports and, more precisely, in the context of muscle injuries.

What criteria do we use? Standard physical examination and ultrasound imaging (MRI is only used in specified cases). Field tests evaluating fatigability, agility, speed and power should match the results obtained prior to injury in order to decide return to play. Tolerance is shown to all individualised specific exercises; in this particular case the use of GPS devices can give us important information about how the player mimics rehabilitation requirements with training requirements. Currently, we are evaluating GPS systems in order to evaluate skills performance and analyse if it might have a role in determining the optimal moment of return to play. More data and research are needed in this field.

In the past decade we have used tensiomiography, however we have not obtained results that allow us to use these tests as reliable criteria for return to play.

The player is considered fit to re-join the team when he has been able to assimilate submaximal workloads equivalent to training with no problems. A good tolerance to normal practice with the team for at least 4 or 5 days will finally allow the return to competition.

On average, proximal myotendinous junction injuries will last up to at least 6 weeks while myofascial injuries will take 2 to 3 weeks to heal before the athlete can return to play.

Another critical aspect not to be missed when deciding on return to play is individual playing position. Less explosive players (usually defenders and midfielders) easily meet the timing described while players in more explosive positions should be introduced more carefully, allowing some extra time to fully meet the requirements.

RE-INJURY

Re-injuries have classically been attributed to unsuitable rehabilitation protocols or returning to play too soon. We believe our re-injuries are due to this second factor. Furthermore, in our specific population, re-injuries seem to be related with playing position, where more explosive players required (lateral defenders and wingers) seem to have a higher risk of re-injury.

We are cautious, but not conservative, and the management of the decision is not made in a 'perfectly controlled laboratory set up'. At times, depending on the calendar and the player, the final decision must be managed in a multidisciplinary manner.

PREVENTION

Prevention is especially relevant in players with known risk factors for hamstring injuries such as age, previous injuries and knee ligament injuries and programmes should be individualised after physical examination. We have found that the best prevention for hamstring injuries is general conditioning and the conditioning of, in particular, the thigh muscles which allows players to meet the intensity requirements of football.

To date, as primary prevention we focus on monitoring training and competition loads as well as strength training using the so-called 'tirante musculador or Russian eccentric brace' in order to include hamstring curls as part of the daily training.

Regarding secondary prevention, we focus on monitoring training and competition loads, clinical follow-up of initial muscular symptoms, active assisted stretching and Versapulley (VP) training twice a week. VP is similar in concept to YoYo technology devices, however VP features a cone instead of a flywheel. A cord is wound on a conic shaft offering a supposedly variable inertia over the range of motion, with a higher resistance offered at the narrower part of the cone.

A correct warm-up programme which focuses on strengthening (eccentric) and stretching muscle is recommended although it remains controversial. Prevention programmes should include core stability, as well as monitoring aspects as nutrition and fatigue recovery.

CONCLUSION

1. Hamstring injuries are a concerning issue for FC Barcelona since they generate the largest number of muscle injuries in professional football.
2. We're studying and analysing prevention and treatment protocols, recommended by experts. However, we're still suffering injuries.
3. Our current trend is to handle the problem individually, while we continue studying, analysing and researching.

References

1. *FC Barcelona Medical Services. Clinical practice guide for muscular injuries. Epidemiology, diagnosis, treatment and prevention. Apunts Med Esport 2009; 164:179-203.*
2. *Ekstrand, J, Hägglund, M, Waldén M. Epidemiology of muscle injuries in professional football (soccer). Am J Sports Med 2011; 39:1226-1232.*
3. *Pruna R, Artells R, Ribas J, Montoro B, Cos F, Moñoz C et al. Single nucleotide polymorphisms associated with non-contact soft tissue injuries in elite professional soccer players: influence on degree of injury and recovery time. BMC Musculoskeletal Disord 2013; 14:221.*
4. *Peetrons P. Ultrasound of muscles. Eur Radiol 2002; 12:35-43.*
5. *Rae K, Orchard J. The Orchard Sports Injury Classification System (OSICS) version 10. Clin J Sport Med 2007; 17:201-204.*
6. *Mendiguchia J, Brughelli M. A return-to-sport algorithm for acute hamstring injuries. Phys Ther Sport 2011; 12:2-14.*
7. *Creighton D, Shrier, I, Shultz R, Meeuwisse W, Matheson G. Return-to-play in sport: a decision-based model. Clin J Sport Med 2010; 20:379-385.*
8. *Chan O, Del Buono A, Best T, Maffulli N. Acute muscle strain injuries: a proposed new classification system. Knee Surg Sports Traumatol Arthrosc 2012; 20:2356-2362.*
9. *Järvinen TA, Järvinen TL, Kääriäinen M, Kalimo, Järvinen M. Muscle injuries: biology and treatment. Am J Sports Med 2005; 33:745-764.*
10. *Muller-Wohlfahrt HW, Haensel L, Mithoefer K, Ekstrand J, English B, McNally S. Terminology and classification of muscle injuries in sport: the Munich consensus statement. Br J Sports Med 2013; 47:342-350.*
11. *Sherry MA, Best TM. A comparison of 2 rehabilitation programs in the treatment of acute hamstring strains. J Orthop Sports Phys Ther 2004; 34:116-125.*
12. *Rae K, Britt H, Orchard J, Finch C. Classifying sports medicine diagnoses: a comparison of the International classification of diseases 10-Australian modification (ICD-10-AM) and the Orchard sports injury classification system (OSICS-8). Br J Sports Med 2005; 39:907-911.*

Luis Til M.D.

Orthopedic Surgeon and Sports Medicine Physician

Former FC Barcelona Team Physician (2003-2006)

Ricard Pruna M.D.

Sports Medicine Physician

FC Barcelona Team Physician (2006-)

Daniel Medina M.D.

Sports Medicine Physician

FC Barcelona Team Physician (2008-)

Gil Rodas M.D., Ph.D.

Sports Medicine Physician

Former FC Barcelona Team Physician (2004-2007)

Department of Medicine

FC Barcelona

Barcelona, Spain

Contact: daniel.medina@fcbarcelona.cat