

Clinical Practice Guide for muscular injuries. Epidemiology, diagnosis, treatment and prevention

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INTRODUCTION

Muscular injuries are very frequent in the world of sport, especially in football. The most recent epidemiological studies show that muscular injuries represent more than 30% of all injuries (1.8-2.2/1,000 hours of exposure), which means that a professional football team suffers an average of 12 muscular injuries per season, equivalent to more than 300 lost sporting days¹⁻⁴. In other professional sports like basketball and handball the incidence is also high, although not reaching the figures shown in football.

Despite their high frequency and the interest in finding solutions, there is little scientific evidence on aspects as important as prevention and treatment. We will outline some weak points below:

- The diagnosis of muscular injuries is based on clinical medicine, fundamentally on symptomatology and especially on the anamnesis of the injury mechanism and physical examination. Imaging studies through the musculoskeletal echography and magnetic resonance are complementary studies, despite the fact that they could be increasingly more useful when confirming a diagnosis or especially when giving a prognosis⁵⁻⁷. There is no sufficiently specific biochemical marker available that could help with the diagnosis of the seriousness and the definitive prognosis of each of the different muscular injuries^{8,9}.
- Treatment guidelines for muscular injuries do not follow a unique model, despite the fact that the different alternatives have been modified very little¹⁰⁻¹². Finally, new expectations have been raised thanks to research within the field of biological repair and regeneration¹³⁻¹⁵.
- Certain primary and secondary prevention programmes can reduce the incidence of suffering muscular injuries, but

scientific evidence is still limited and it has only been possible to verify them in certain groups of sportsmen¹⁶⁻²⁰.

The objective of this document is to record the diagnostic, therapeutic and preventative approaches that should be taken when faced with the various muscular injuries suffered by the football players of Barcelona FC. This is not intended as an exhaustive review of muscular pathology in sport, but rather a working document that is clear, practical and comprehensive. The protocols are based on current knowledge from recent years in the daily work of dealing with these types of injuries.

CLASSIFICATION

Muscular injuries are traditionally classified, according to their injury mechanism, as either extrinsic (direct) or intrinsic (indirect).

- Extrinsic injuries, due to a contusion with an opposing player or with an object, are classified according to their severity, into light or benign injuries (grade I), moderate (grade II) or serious (grade III). These injuries may present lacerations or not.
- Intrinsic injuries, due to stretching, are produced by the application of a tensional force higher than tissue resistance, when it is in active contraction (eccentric contraction). The force and speed with which the tension is applied are variables that change the viscoelastic properties of the tissue, changing its susceptibility to breaking. Local fatigue and cellular temperature may also have an influence. Players notice a sudden pain, in the form of a pull or a sharp pain and this is normally related to sprinting, a change in speed or taking a shot. The classification of intrinsic injuries is more complex.

Table I

Classification of muscular injuries using histopathological criteria. (We understand grade 0 injuries to be injuries in which very little muscular tissue is affected. In the event that the injury were more extensive, they could present as more serious injuries and therefore with a worse prognosis)

Nomenclature	States	Characteristics	Prognosis
Contraction and/or DOMS	Grade 0	Functional alteration, elevation of proteins and enzymes. Although there is a slight break down of the muscular parenchyma, this is considered to be more an adaption mechanism than a real injury	1-3 days
Small fibrillar strain and/or muscular elongation	Grade I	Alterations of few fibres and light injury to connective tissue	3-15 days
Fibrillar strain	Grade II	More affected fibres and more connective tissue injuries, with the appearance of a haematoma	3 to 8 weeks
Muscular strain	Grade III	Major strain or complete displacement. The functionality of the unharmed fibres is completely insufficient	8 to 12 weeks

DOMS (Delayed Onset Muscular Soreness) is given to stiffness — not very scientific terms.

Table II

Classification of muscular injuries according to imaging criteria

Nomenclature	States	Musculoskeletal echography	Magnetic resonance
Contraction and DOMS	Grade 0	Inconsistent signs. Oedema between fibres and myofascial and increase in local vascularisation	Interstitial and intermuscular oedema. Increase of the signal in T2 and fat suppression sequences
Small fibrillar break and/or muscular elongation	Grade I	Minimum solution of discontinuity, oedema between interfascial fibres and fluid (indirect sign)	Increase in the interstitial signal and slightly intermuscular
Fibrillar strain	Grade II	Clear muscular defect, interfascial fluid and haematoma	Strong interstitial signal, focal muscular defect, increase in the signal surrounding the tendon
Muscular strain	Grade III	Complete muscular disruption and/or of the tendon, with retraction of the displaced part of the muscle (visible stump)	Complete muscular and/or tendon strain, with retraction

DOMS (Delayed Onset Muscular Soreness) is given to stiffness — not very scientific terms.

Following the most up-to-date concepts we propose the following classification tables for muscular injuries, according to various criteria (tables I and II)^{21,22}:

Regarding the prognosis, the days lost are for guidance only and vary in accordance with the injured muscle, its topography and the demands made on it afterwards.

Both the musculoskeletal echography and magnetic resonance enable precise information to be obtained about the muscular injury in relation to the affected connective tissue. Although almost all the injuries settle on the myoconnective junction, according to the type of myotendinous or interaponeurotic involvement, as well as the topographic area of each kind of injury, the prognosis may vary and therefore this must be borne in mind to give the all-clear to play for return to competitive matches. In this

respect, several studies are beginning to produce clear evidence about this question, and what appears clear is that the more involved the connective part and the injury area are, the worse the prognosis⁵⁻⁷.

A good clinical history and physical examination, together with the classifications proposed above must enable the achievement of a diagnosis. With the objective of being able to be clearer, we propose the compliance with the following guideline in order to label each muscular injury.

First, we give the *name* of the kind of muscular injury according to anatomopathological criteria. After that, the *first surname*, where we give the specific localisation where the injury is settled and specifically whether there is a relation with the connective part. Finally, the *second surname*, where we list the specific affected muscular group.

- Name: *Muscular strain grade II*
- First surname: *of the musculotendinous proximal area*
- Second surname: *of the biceps femoris*

EPIDEMIOLOGICAL STUDIES

We have studied the incidence of injuries of the first football team for four years (2003-2007), using the methodology that various international groups of experts have agreed upon and which is regulated and governed by the medical committee of UEFA for the various teams that play in the Champions League^{23,24}. This is a prospective study, controlling all injuries that take place as well as training and competitive hours in order to discover the risk of suffering the different kinds of injuries.

The calculation for injury risk will be performed using the following formula:

$$\text{Number of injuries/Hours of exposure to training and/or competition per 1,000 hours}$$

Nowadays this is considered as the universal framework that enables teams, clubs, sports etc, to be compared. The risk of suffering any kind of professional football injury is between 6 and 9 injuries per 1,000 hours of exposure, which explains what this occupational risk would represent in a company of 25 workers that each month had 9 workers off work. The risk of getting injured during competitive play is between 4 and 6 times more frequent than during training^{1,2}.

In table III we present the description of the various parameters regarding injury incidence regarding the muscular injuries of the first team of Barcelona FC for four seasons. These are data reviewed by the medical committee of UEFA and which are published here for the first time.

According to references in the literature, it is estimated that a professional team of 25 players will have an average of 40-45 injuries per season, of which between 16 and 20 are minor (of less than one week); between 16 and 20 are moderate (between 1 and 4 weeks), and between 8 and 10 will be serious (more than one month's absence). Muscular injuries, 30-40% of all injuries, the risk of injury is nearly 2 per 1,000 hours of exposure, each team may have between 10 and 14 muscle injuries per season.

Table III Description of the main parameters regarding injury incidence of the first team of Barcelona FC in 4 consecutive seasons. In the table almost all the decimals have been eliminated for practical reasons

Seasons	2003/04	2004/05	2005/06	2006/07
Total number of injuries	63	44	31	37
Injuries/1,000 hours of exposure to training	7	3	3	3
Injuries/1,000 hours of exposure to competitive play	34	25	15	15
Muscular injuries	22	6	14	14
Minor muscular injuries (<1 week)	8	2	2	3
Moderate muscular injuries (1-4 weeks)	11	4	10	8
Serious muscular injuries (>1 month)	3	0	2	3
% muscular injuries/total injuries	35	14	45	33
Total hours of exposure of the team	5,655	6,458	5,719	7,561
Muscular injuries/1,000 hours of exposure	4	1	2	2
Muscular injuries/1,000 hours of competitive play	16	5	9	12
Muscular injuries/1,000 hours of training	1,7	0,2	0,7	2,2
Total days injured	952	1,404	657	685
Days injured due to muscular injury	317	84	264	324
Training sessions missed due to muscular injury	203	46	173	186
Matches missed due to muscular injury	58	17	59	51

Table IV Description of the number and percentage relating to all communicated injuries in the UEFA study in the 2003-04; 2004-5; 2005-06; 2006-07 seasons

Type of injury	Number	Percentage
1 Posterior femoral (hamstring) muscles	396	14
2 Adductor muscles	260	9
3 LL Ankle Sprains/strains	203	7
4 Quadriceps muscles	160	6
5 LL Knee Sprains/strains	153	5
6 Triceps surae muscles	124	4
7 Lumbar pain	100	4
8 Achilles tendinopathy	82	3
9 Muscular bruising	82	3
10 Foot	74	3

Table V Description of the number and percentage relating to muscular injuries of the UEFA study in the 2003-04; 2004-5; 2005-06; 2006-07 seasons

Type of injury	Total (n = 55)	Percentage
1 Injury to biceps femoris muscle	16	30
2 Injury to adductor medium muscle	10	18
3 Injury to triceps surae muscle	9	16
4 Injury to quadriceps muscle	7	12
5 Injury to semitendinosus muscle	3	5
6 Others	10	19

In tables IV and V we present data on the overall study of incidence of injury that UEFA has carried out with the majority of the teams in the Champions League during a period of four seasons (2003/04/05/06). As can be seen the most frequent injury is muscular and, more specifically, injuries to the posterior femoral (hamstring) muscles, of which the biceps femoris muscle is the most affected.

These data are important because they define very well the main injuries that occur in professional football and therefore, where efforts should be directed to plan preventative strategies. What is measurable is more susceptible to improvement. The

Table VI Anamnesis

Anamnesis	Yes	No	Observations
Prior injury of the same structure			
Other susceptibility to muscle injury			
Training			Start/half-way/end
Game			Start/half-way/end
Do you remember the moment of injury?			Shot/sprint/jump/ other
Were you able to continue?			
Have you improved?			

collection of these and other new data will provide us with the results of preventative measures adopted in reducing the number of injuries.

DIAGNOSIS

The diagnosis of muscular injuries is mainly clinical, that is, based on clinical history and physical examination.

In the anamnesis (table VI) it is necessary:

- *To collect local and general history:* Has the player suffered similar injuries before?, Does he know of a susceptibility to suffer injuries?, What pharmacological background does he have?,...
- *To describe the moment of injury:* What had the trigger been?, During work, training or competition?, Was it at the beginning, the middle or the end of the session?
- *To collect the immediate progress:* Was the player able to continue the work session or did he have to abandon it?, How is the pain progressing?

In the physical examination (table VII) you have to perform the following:

- *Inspection:* Is ecchymosis or deformities of the profile of the muscle mass present?
- *Feeling:* find points of pain or muscle spasms.
- *To request active contraction of the affected muscle, first with the muscle with stretching, more sensitive in minor injuries, and afterwards against manual resistance:* Is it possible? Is it painful? What type of contraction (concentric, isometric or eccentric)?

- *To assess the analytical flexibility of the muscle:* whether or not there is pain with passive stretching.

We have already mentioned that complementary tests such as musculoskeletal ultrasound and MRI are very helpful in finding out as soon as possible the degree of injury and, above all, the prognosis for days off. The MRI is very sensitive and is precise in identifying the affected structure but on the other hand the musculoskeletal ultrasound is a dynamic study that complements the clinical examination, enabling progress monitoring, the guided evacuation of cavities and is complemented by the painful echopalpation of a given muscle, already identified by the ultrasound, a great help with the topographic diagnosis.

Table VII Examination

Examination	Yes	No	Observations
Time of progress:			
Is ecchymosis present?			
Are muscular deformities present?			
Pain points			Topography:
Muscular spasms			Which:
Is contraction possible against manual?			Isometric/ concentric/ eccentric
Is the active contraction painful?			Isometric/ concentric/ eccentric
Is the capability of passive stretching greater?			
Is passive stretching painful?			

Table VIII Timeline for carrying out complementary tests in the muscular injury

	Clinical history	Physical examination	Ultrasound	MRI	Biochemical markers
Immediate	X	X			
12 h		X	X		X
24 h		X	X	X	X
48 h		X	X		

The table VIII presents when it is chronologically most appropriate to carry out the different complementary tests, which will be more or less extensive depending on the criteria of the physician and the availability of resources.

What steps do we follow once a muscle injury is produced?

- **Immediately.** Once the injury is produced, through a survey addressed to the player (What have you noticed?, When?, How?, Where?, What have you done?) and with a structured physical examination: inspection, feeling, which movements cause pain, passive and active, we will be able to make an initial diagnostic orientation. When the injury is not a major strain early diagnosis is not easy. It is important and necessary to know and to wait a few hours to see it develop, as well as carrying out the appropriate complementary tests.
- **At 12 hours.** The ultrasound study at this early stage does not allow for an accurate diagnosis of minor muscular injuries, but does from grade II injuries. Only highly trained and specialised personnel in ultrasound analysis are capable of making a certain diagnostic on the extent of the injury. Therefore, at 12 hours only a certain diagnosis in injuries of grade II or higher can be made.
If the injury is very minor and we are not sure if it is grade 0 or I, the resolution in serum of the protein myosin allows us to make an early diagnosis of a grade I injury. This intramuscular contractile protein has a large molecular weight and does not have to be present in the blood. Its presence determines fibrillar injury. For kinetic studies it appears to be that between 12 and 24 hours is the optimum time to determine this. It is not a test that we can routinely ask for and its evidence is based on the experience of the working group that has recently published a primary work that we believe could be of great interest and in the future, open the way to new tools in defining muscular injuries²⁵.

- **At 24 hours.** This is the time agreed upon by most specialists in magnetic resonance imaging to establish an appropriate diagnosis and prognosis. As always, it is necessary that the personnel who interpret the MRI have extensive experience in this type of injury. Today, especially in injuries to the posterior femoral (hamstring) muscles, and specifically, injury to the proximal muscle tendinous junction of the biceps femoris muscle, have postulated that the total length of the injury, the relationship between the ischiatic tuberosity and the proximal beginning of the injury, and the total affected area, are the prognosis factors of the time necessary for the return to competition and the risk of reinjury^{7,26}.

- **At 48 hours.** This is the optimum time to establish a more appropriate diagnosis and prognosis using ultrasound analysis.

Finally, a technique has been proposed for assessing the “muscle tone” called Tensiomyography²⁷. While so far there is little scientific evidence from this methodology, perhaps, in the future, it will be useful to monitor the functional recovery of the muscle and for it to be a complement to the progress monitoring of muscular injuries together with musculoskeletal ultrasound.

TREATMENT

The basic principle that most authors support is that muscular injuries should have an early mobilisation and functionality. Especially after the third day, since it has been demonstrated that this:

- Rapidly increases vascularisation of compromised muscle tissue.
- Increases the regeneration of muscular fibres.
- Improves the final reparative phase avoiding fibrous scars.
- Recovers the viscoelastic and contractile characteristics of the muscles faster, ultimately, the overall functionality of the muscle²⁸⁻³¹.

Only with regard to the first phase of the treatment of muscular injuries, between the first and fifth day of the injury, is there an international consensus thanks to the few clinical trials that have been able to demonstrate a degree of scientific evidence¹⁰⁻¹⁵. There is a wide disparity of viewpoints and proposals by different authors and schools.

In this guide we will give an account of the immediate standard treatment of muscular injuries. Next, we will explain what alternatives have been proposed and, finally, we will present the specific protocols for various muscular injuries that are underway at Barcelona FC, based on the experience of its professionals and on the experience of various authors.

First Phase: immediate treatment post injury

Consisting of what is called *RICE* which in English means:

- Rest.
- Ice.

Compression.

Elevation.

This is the most agreed upon treatment for the first three days³²⁻³⁴. The immobilisation in the first phase could prevent future retractions of the strain and make a smaller haematoma. It has also been shown that the use of cryotherapy has made a significantly smaller haematoma, reducing inflammation and accelerating repair. Compression, while reducing the intramuscular blood flow, appears to have a very potent anti-inflammatory effect. What is of most interest is to combine the compression and the cryotherapy at repeated intervals of 15 to 20 minutes approximately every 3 or 4 hours. Regarding this point it should be explained that:

- This time could be higher depending on the muscular mass of the muscle involved, for example, a quadriceps muscle of an adult could require up to 30 to 40 minutes.
- That in muscular injuries by direct contusion (“sandwich”) the gel will be put in the position “of bearable stretching”.
- Care must be taken with the application of cryotherapy, with respect to the proposed intervals, and controlling individual susceptibility, to avoid skin lesions.

Second phase: of the third to the fifth day

- **Muscular activation.** Early and progressive mobilisation is very important. If the first phase has passed correctly and without complications, the following exercises can be started gradually, taking into account the degree of tolerance to the pain:

– *Isometric exercises:* Progressively, and taking into account that they have to be of maximum intensity until the onset of pain. The pain we are looking for is the bearable discomfort considered optimum between 5-10% of the visual analogue scale (VAS). Also it will be important to use progressively different ranges and to carry them out in different positions and angles. The protocol we propose in this guide is to perform isometric exercises on 3 different ranges and with a guideline of time that can start with 6 seconds of contraction and 2 seconds of relaxation.

- **Complementary work.** In this phase several matters must be taken into account:

– *Work on stability and movement of the lumbopelvic region,* which is increasingly defined as exercise programmes aimed at

improving the “core stability” in order to improve and prevent muscular injuries of the locomotor apparatus³⁵⁻³⁷.

– *Physical therapy*: this section has always been a controversial issue. Used worldwide but there is no, or very little scientific evidence. The physical therapy most commonly used is:

- a) Electrotherapy of analgesic effect and muscle decontraction to promote muscular refunctionalisation.
- b) Temperature: ultrasound (this is advisable to be performed with stretching without passing the point of pain), hyperthermy (taking into account the depth of the injury and therefore very important to study the prior ultrasound), or diathermy. Currently, the physical therapy we are advising and proposing is diathermy, and we hope in the next version to have a protocol that has demonstrated its scientific and clinical evidence.

– *Stretching*. Stretching of the muscle in this phase has to be *pain free*, following the premise of bearable discomfort. We advise starting with 12 seconds of stretching and 12 seconds of rest. The advisable and lesser risk stretching is active stretching by the method of active contraction of antagonistic muscles in axial rotation, to stretch the injured muscle and improve the viscoelastic conditions and reduce the risk of fibrous scarring and reinjury.

– *Cardiovascular maintenance*, this is another important aspect to improve muscular recovery and means:

- a) Continuing to work on the uninjured structure. Different types of exercises can be used whether swimming pool, static bicycle, as permitted by the injured muscle.
- b) And with regard to the really injured structure, we must always respect the principle of reaching the pain or tolerable discomfort limit, walking to be allowed from the third day for 30 minutes and to be gradually increased daily by 10 minutes until being able to be added to the run in the following phase.

Here we wish to make a comment with regard to the latest fashionable use of “kinesiotape” (neuromuscular bandage) with the idea of reducing muscle tension by its effect on the fasciae and having an analgesic effect. This technique requires rigorous study to verify its effectiveness.

From the fourth-fifth day again to make a clinical and radiological (musculoskeletal ultrasound) assessment to evaluate the muscular defect and whether or not there is an intramuscular haematoma, which is normally the time it takes in forming.

The presence of a haematoma could recommend the carrying out of an aspiration puncture through ultrasound control, to maintain two days of compression and again to start the phase 2 protocol.

After about the seventh day, as we have explained, we have not found an agreed standard treatment and each group or author is progressively incorporating more intensity and complexity to the exercises both to increase the continual running, the stretching, such as strengthening of the muscles (isometric, concentric and eccentric). We propose in this guide that once the athlete can walk 1 hour with “bearable discomfort” he can then move on to continuous running; initially recommending a submaximal rhythm of 8-10 km/h, which is precisely the phase higher than fast walking. “The pain” will return to be the marker that we use to go beyond this phase.

In the next chapter of this guide we will detail the different recovery programmes for diagnosed muscular injuries from the first day until return to competition.

OTHER TREATMENTS

Medication

Precisely at the instant a muscular injury occurs, a sequence of phases is launched that consists of degeneration, inflammation, myofibrillar regeneration and finally, the formation of fibrous tissue^{15,34}.

The use of analgesics or anti-inflammatories during the first hours has been a subject of debate since their use would favour the reduction of the inflammatory phase, when it seems that thanks to the reactions that occur therein trigger all of the subsequent mechanisms of the regenerative phase. There are no control studies to clearly assess the benefit-risk relation of using non-steroid anti-inflammatory drugs (NSAID's) nor glucocorticosteroids, but in any case, it seems that the use of NSAID's during the first 48-72 hours is not harmful and does not interfere with the regeneration phase if its use is not continued^{38,39}. Equally, we must remember that some authors are sure that the indiscriminate use of analgesia in the first phases of muscular injuries can have a masking effect of the pain, hindering diagnosis and encouraging a relapse^{40,41}.

Moreover, the use of antifibrotic medication such as the range of interferon, suramin and decorin, which are still in the clinical trials phase, may in the future be a good complementary treatment in the treatment of muscular injury^{42,43}. Finally, a

diuretic, losartan, has also shown to have antifibrotic properties⁴⁴.

The hyperoxygenation of the injured tissue by means of instruments that facilitate the spreading of oxygen such as hyperbaric are under research. It seems that they are effective but difficult to implement⁴⁵.

Infiltration and use of PRP

Some schools have used the infiltrations on the focus of the injury with different products, such as corticosteroids and the combination of homeopathic products (Traumeel) or others of dubious origin (Actovegin)⁴⁶⁻⁴⁹. In recent years, moreover, what has become popular in Spain is the use of Platelet-Rich Plasma (PRP), also known as “growth factors”. It seems useful that if in each phase of muscular repair: first, destruction and inflammation; second repair and regeneration, and third, final restructuring, we were capable of adding most appropriate growth factor we would be able to get better results. This is a highly topical clinical and scientific debate⁵⁰. There is a lack of rigorous clinical trials showing that this type of treatment improves recovery time of muscular injuries and reduces the risk of relapse. In the absence of such studies, the medical service of Barcelona FC has agreed that the indication of infiltration of PRP will be made when complying with criterion 1 together with criterion 2 or 3.

1. Athletes over 18 years old suffering an injury in a high demand muscle by the sport that is practiced.
2. Recurring intramuscular or myofascial cavity injuries such as the rupture of the distal myotendinous of the anterior rectal muscle or that of the Gastrocnemius muscle (so-called “tennis leg”).
3. Progress of complex and chronic injuries.

In this sense, we can now use PRP thanks to the clinical trial that we conducted on muscular injuries that affect the musculature of the leg (triceps, biceps, sural) known as “tennis leg” (*FIS_ research project awarded by the “Instituto de Salud Carlos III” of the Ministry of Science and Innovation*).

SURGICAL TREATMENT

Muscular injuries should be treated conservatively, but there are some consensual general surgical indications^{10,34}.

- Muscular injury of grade III, total strain.
- Muscular injury with partial (>50 %) or total tendinous retraction.
- Muscular injury of grade II, with more than 50% of the abdominal muscle affected.
- When there is a very large intramuscular haematoma that does not respond to repeated aspiration puncture.

Likewise, different specificities should be taken into account, and the surgical option could be prescribed in the case of recurrent muscular injuries that form significant fibrous scars and that generate adhesions with neural involvement. Moreover, in contrast, in some type of muscles such as the long adductor muscle, in a grade II-III injury, surgical treatment may not be needed as it has already been seen progressing favourably with conservative treatment.

It is not the reason for this guide, but we must remember that after this type of surgery a very careful, programmed and long rehabilitation is required. It is estimated that the return to sport could take, depending on the muscle, from a few months up to a year.

SPECIFIC RECOVERY PROTOCOLS FOR MUSCULAR INJURIES

In this section we present, comprehensively, the various protocols that we recommend for the more common muscles in our environment.

Protocol I. Grade I injury to the MTJ of the proximal portion of the biceps femoris muscle (table IX)

This is the injury that affects the shared tendon of the hamstrings m., also known in our field as the “upper rack”. This is a complex injury that occurs between the biceps femoris muscle and in a close link with the semitendinosus muscle and this has a worse prognosis, as we commented previously, the longer the injury is, the larger the area occupied and the closer to the ischial tuberosity^{6,7,26}. It is in this injury where the rule “so many centimetres long, so many weeks laid off” has empirical evidence and as we have commented on certain scientific evidence. So here we propose in protocol 1 a grade 1 type injury that could be an injury of 1 to 2 cm. long of the biceps femoris muscle, and in the next protocol we will see the protocol to follow with a more extensive injury.

In both cases clinical progress monitoring and by ultrasound will have to be made to pass to the next phase and in order not to give a premature all-clear, as it is an injury that relapses easily.

Table IX

<i>From 0 to 3 days</i>
• RICE.
• Electrotherapy.
• Massage/Drainage.
<i>From 3 to 7 days</i>
• Ultrasounds daily or Hyperthermy alternate days, or diathermy daily.
• Assessment and begin working with lumbo-pelvic stabilisation exercises.
• Beginning of manual isometric exercises (4 series of 10 repetitions in 3 different ranges and with times of progressive contraction, e.g.: 6 seconds of contraction and 2 seconds of relaxation).
• Active stretching from work with the antagonistic muscles in axial rotation following a guide of 12 seconds maintaining the stretching and 12 seconds rest.
• Proprioceptive work.
• Begin physiotherapy work in the swimming pool.
• Physiotherapy work in the field (walking forward and backward, active stretching exercises, lateral movements, etc.).
<i>From 7 to 14 days</i>
• Start of the manual strength work by means of the eccentric submaximum method (of low intensity) of 4 to 6 series and of 8 to 10 repetitions.
• Isometric reinforcement, concentric and eccentric carried out by the athlete (Russian belt...).
• Continue with field work (introduce the ball).
• Continue with guidance in the gym (lumbar-pelvic strengthening...).
• Continue with field work and, as appropriate, transfer to rehabilitation.
• Start partial work with the group and specifically with fitness trainers.
<i>Day 15 approx.</i>
• All-clear

Protocol 2. Grade II injury to the MTJ of the proximal portion of the biceps femoris muscle (table X)

The protocol in a second grade injury, with a recovery prognosis of some 6-8 weeks approximately. The protocol we propose is very similar to that proposed by various authors¹⁰⁻¹².

Comments

We do isometric exercise from the third day and the number of series, the time of contraction and the work of at least three ranges of reference will be done according to the pain. This isometric exercise and the active stretching will help to reduce the oedema, enable the injury to heal correctly and improve the functionality and viscoelastic capacity of the muscle. In injuries of the hamstring musculature we give more importance to the work of eccentric reinforcement due to its etiology. One author¹⁰ proposes that at 4 weeks to conduct an analytical study of the strength and/or muscular power to analyse possible strength deficits. Finally, personalised work has to be set out for each type of player in the last phase depending on their characteristics.

Protocol 3. Grade II injury to the MTJ of the distal portion of the femoris biceps muscle (table XI)

The protocol of recovery is very similar to protocol 2. This injury is known in our field as “distal rack”, with a recovery prognosis of approximately 4-6 weeks.

Comments

In general the prognosis of this type of injury is better than that of the proximal 1/3. Often the long and short portions of the biceps femoris muscle are affected, causing the “rack” effect as we have commented previously. At times it could leave a residual myofascial haematoma that does not necessarily affect return to competition, providing that its functionality is complete.

For the purpose of the double innervation of the two heads of the biceps femoris, it is interesting to note that it is necessary to work with internal and external rotation of the leg to selectively activate the two heads.

Protocol 4. Grade II injury to the adductor medium muscle (table XII)

It is important to distinguish this type of injury from the injury to the periostic tendon junction, of a chronic nature. This is an acute injury that creates an immediate functional impotence, which usually creates a rapid haematoma. Sonographically, a laminar defect can be seen below the fascial expansion of the adductor medium muscle. It progresses well, but if the injury is extensive, of more than 3

Table X

<i>From 0 to 3 days</i>
• RICE.
• Electrotherapy.
• Massage/Drainage.
<i>From 4 to 7 days</i>
• Ultrasounds daily or hyperthermy alternate days, or diathermy daily.
• Assessment and lumbo-pelvic stabilisation exercises.
• Beginning of manual isometric exercises of 4 series and 10 repetitions with 3 different ranges and with times of progressive contraction starting by 6 seconds of contraction and 2 seconds of relaxation.
• Active stretching using the antagonist muscle with a time of contraction relaxation 12 seconds: 12 seconds.
• Start swimming pool work.
• Guidelines in the gym using non-injurious structures and prevention planning.
<i>From 7 to 14 days</i>
• Daily ultrasound with stretching or diathermy daily.
• Follow-up manual isometric reinforcement.
• Begin work with bicycle, or elliptical machine or to walk approximately 30 minutes.
• Follow-up with active stretching.
• Lumbar-pelvic stability guidelines
• Proprioceptive work.
• Gym work (for injury and healthy structures).
<i>From 14 to 21 days</i>
• Follow-up with manual isometric reinforcement, stretching and proprioceptive work.
• Begin manual strength work by concentric submaximum method of 4 to 6 series and of 8 to 10 repetitions.
• Start progressive continual running.
• Follow-up lumbar-pelvic stability guidelines.
• Start field work with ball
• Massage therapy
<i>From 21 to 30 days</i>
• Follow-up with manual concentric reinforcement.
• Begin manual strength work by eccentric submaximum method. From 4 to 6 series and of 6 to 8 repetitions.
• Intensify stretching exercises.
• Progressive running in different rhythms without sprinting.

Table X (continuation)

• Dynamic proprioceptive exercises.
• Massage therapy post exercise when necessary.
• Transfer to physical therapists to meet sporting movement needs.
<i>From 30 to 45 days</i>
• Follow-up with combined isometric/concentric and eccentric reinforcement, especially eccentric work of the hamstring muscles.
• Correction of possible deficiencies of flexibility and strength.
• Field work to improve the conditional capacities, coordinated with physical trainers.
• Partial progressive work with the group (without explosive exercises....) and specifically with fitness trainers.
• Massage therapy all-clear.
• Full work with the group.
<i>45 days</i>
• All-clear
• Pass on to work on injury prevention.

cm, the football player must wait for a recovery of between 4 and 6 weeks.

Comments

With this type of injury it is very important to make a proper assessment of the lumbar-pelvic stability in relation to the frequent pubis problems, and more specifically with dynamic osteopathy of pubis (DOP). Therefore it is necessary to assess by ultrasound or MRI the pubis symphysis, as if affected, this may delay the return to normal training. It is not uncommon to find players who, after suffering an injury of this type begin a pubalgia that is probably a consequence of stopping training, which destabilises the symphysis and the entire lumbar-pelvic ring, therefore it will be very important to be alert to this fact. So it will be very important to influence the active stretching exercises and avoid excessive strengthening of the adductor medium muscle that will cause an imbalance at the level of pubis symphysis with the consequent risk of the appearance of a DOP.

Moreover, we must remember that this muscle allows for many exercises without discomfort, but on the other hand,

Table XI

<i>From 0 to 3 days</i>
• RICE.
• Electrotherapy.
• Massage/Drainage.
<i>From 4 to 7 days</i>
• Ultrasound daily or Hyperthermy on alternate days or diathermy daily.
• Assessment and lumbar-pelvic stabilisation exercises.
• Beginning of manual isometric exercises of 4 series and 10 repetitions with 3 different ranges and with times of progressive contraction by starting 6 seconds of contraction and 2 seconds of rest.
• Active stretching exercises (12 seconds contraction and 12 seconds relaxation).
• Start of physiotherapy work in the swimming pool.
• Post work drainage.
• Guidance in the gym with non-injurious structures and prevention planning.
<i>From 7 to 14 days</i>
• Ultrasound with stretching or diathermy daily.
• Continue manual isometric reinforcement of 4 series and 10 repetitions in 3 ranges.
• Begin work in the field (walking, active stretching...).
• Bicycle, elliptical machine or 30 minutes walking approximately.
• Proprioceptive work..
• Continue lumbar-pelvic stability guidance work.
• Continue with swimming pool work.
• Continue with reinforcement (isometric). Continue with guidance in the gym for injured and healthy structures.
<i>From 14 to 21 days</i>
• Continue with manual isometric reinforcement.
• Begin manual strength work by concentric submaximum method of 4 to 6 series and of 8 to 10 repetitions.
• Begin progressive continual running.
• Begin field work with ball.
• Massage therapy.
<i>From 21 to 30 days</i>
• Continue with combined isometric/concentric reinforcement.
• Begin manual strength work by eccentric submaximum method of 4 to 6 series and of 6 to 8 repetitions.
• Intensify stretching exercises.

Table XI (continuation)

• Progressive running with different rhythms without sprinting.
• Proprioceptive exercises.
• Post exercise massage therapy when necessary.
• Transfer to physical therapists to meet sporting movement needs.
<i>From 30 to 45 days</i>
• Continue with general and specific reinforcement, especially eccentric work of the hamstring muscles.
• Correction of possible flexibility and strength deficits.
• Massage therapy all-clear when necessary.
• Field work for improvement of the conditional capacities, coordinated with the fitness trainers.
• Partial progressive work with the group (without explosive exercises...) and specifically with fitness trainers.
• Full work with the group.

such as actively taking part in specific moves of football such as the shot, changes of direction, etc. it will be necessary to lengthen the phase of functional rehabilitation to sporting movement before allowing return to competition.

Protocol 5. Grade I injury to the soleus muscle (table XIII)

In this type of injury a small puncture in the calf is typical, but the player can usually continue doing submaximum exercise, which sometimes delays the final diagnosis. It is important to make differential diagnosis with all injuries called "tennis leg". The diagnosis must be confirmed by MRI more than by ultrasound.

Comments

In this type of injury and from the point of view of the physiotherapist, we understand that it is very important to work progressively, extensively and for a long period with isometric exercises. We need to ensure good tissue repair and a complete lack of discomfort to the making of any movement or exercise by the player. Reinjury is very frequent.

We need to ensure a guideline of concentric and eccentric exercises daily and although there is a significant clinical improvement the first few days, we should not accelerate the

Table XII

<i>From 0 to 3 days</i>
• RICE.
• Electrotherapy.
• Massage/Drainage.
<i>From 4 to 7 days</i>
• Ultrasound daily or Hyperthermy alternate days or diathermy daily.
• Assessment and lumbar-pelvic stability exercises.
• Begin manual isometric exercises of 4 series and 10 repetitions with 3 different ranges and with times of progressive contraction starting by 6 seconds of contraction and 2 seconds of rest.
• Active stretching exercises (12 seconds of contraction and 12 seconds of relaxation).
• Begin physiotherapy exercise in the swimming pool.
• Post exercise drainage.
• Guidance in the gym for uninjured structures and prevention guidelines.
<i>From 7 to 14 days</i>
• Ultrasound with stretching or diathermy daily.
• Continue strengthening manual isometric exercises of 4 series and 10 repetitions in 3 ranges.
• Begin field work (walk approximately 30 minutes).
• Continue with active stretching exercises.
• Proprioceptive work.
• Continue with guidance in the gym for injured and healthy structure.
• To start pubis guidelines (pelvic stabilisers, lumbar and abdominal flexibility exercises, as well as the gluteus).
• Continue with swimming pool exercises.
<i>From 14 to 21 days</i>
• Continue with reinforcement (gym and manual).
• Begin manual strength work by concentric submaximum method of 4 to 6 series and of 8 to 10 repetitions.
• Continue with active stretching exercises.
• Begin progressive continual running.
• Continue proprioceptive work and lumbar-pelvic stabilisation.
• Begin field work with ball.
<i>From 21 to 30 days</i>
• Continue with concentric strengthening work.
• Begin manual strength work by eccentric submaximum method of 4 to 6 series and of 8 to 10 repetitions.

Table XII (continuation)

• Intensify stretching work.
• Dynamic proprioceptive exercises.
• Post exercise massage therapy when necessary.
• Transfer to physical therapists to meet sporting movement needs.
• Can start work with physical fitness trainers in any conditional and/or coordinated capacity.
<i>From 30 to 45 days</i>
• Intensify eccentric exercise.
• Continue working for improvement of the conditional capacities, coordinated with the physical fitness trainers.
• Progressive partial work with the group (without aggressive changes of direction, specific repetitive shots except with trainers.
• Massage therapy post exercise when necessary.
• Complete work with the group.
<i>45 days</i>
• All-clear.
• Passing to work on injury prevention.

phases nor the return to competition, as the muscle is not yet ready to make fully guaranteed explosive activities for up to three weeks. And remember that if it is a Grade II injury return to competition could be extended by up to 6 weeks.

Osteopathic work on the correct position and mobility of the foot, ankle and knee joints, and assessment by a podiatrist, can help (taking into account changes in the athlete's footwear, changes of surface, etc.).

Protocol 6. Grade II injury to the inner calf muscle (table XIV)

This injury consists of the partial sprain of the medial head of the inner calf muscle along with tendinous muscle, and is popularly known as "tennis leg". Care must be taken with this type of injury and it will be very important to perform periodic ultrasound monitoring to control the repair with a laminar scar or if there is a myofascial haematoma (or even myoaponeurotic) between the inner calf and the soleus muscle, because if this haematoma appears, progress will be slower and will extend the deadline for returning to training by at least 8 to 10 weeks.

Table XIII

<i>From 0 to 3 days</i>
• RICE.
• Electrotherapy.
• Massage/Drainage.
<i>From 3 to 7 days</i>
• Ultrasound daily or diathermy daily.
• Assessment and lumbar-pelvic stability exercises.
• Beginning of manual isometric exercises of 4 series and 10 repetitions with 3 different ranges and with times of progressive contraction, of 6 seconds of contraction and 2 seconds of rest.
• Active stretching exercise (12 seconds of contraction and 12 seconds of relaxation) having a lot of respect to the threshold of “bearable pain”.
• Start physiotherapy exercise in the swimming pool.
• Post exercise drainage.
• Guidance in the gym for uninjured structures and prevention guidelines.
<i>From 7 to 14 days</i>
• Ultrasound with stretching or diathermy daily.
• Continue manual isometric strengthening work and active stretching exercises.
• Begin manual strength exercises by eccentric submaximum method of 4 to 6 series and of 8 to 10 repetitions.
• Assessment when starting continual running, in a very progressive manner.
• Guidance on proprioceptive and lumbar-pelvic stabilisation exercises.
• Can start work in the field with ball.
<i>From 14 to 21 days</i>
• Begin manual strength exercises by eccentric submaximum method of 6 to 8 series and of 12 to 15 repetitions.
• Continue with isometric strengthening combined with concentric and start working with eccentric exercises.
• Increase intensity of continual running and adding changes of direction and rhythm.
• Continue proprioceptive and lumbar-pelvic stabilisation exercises.
• Massage therapy drainage/post exercise all-clear.
• Progressive work with physical fitness trainers in conditional and coordinated capacity.
<i>From day 21</i>
• Long period of increased intensity of all physical exercises, general and specific. It is difficult to give an all-clear date as this type of injury is very special with a large variability between individuals in terms of the return to competition.

Comments

In this type of injury we recommend, as well as RICE during the first days, a bandage to prevent the possible haematoma that occurs between inner calf muscle and the soleus muscle⁵¹. The presence of an interfacial haematoma counter-indicates hyperthermy. In cases where progress is not good and there is a myofascial haematoma we recommend a treatment based on aspiration puncture of the haematoma and in difficult cases a puncture may be recommended together with the introduction of platelet-rich plasma, as discussed previously.

Another aspect to consider in this type of injury is, when performing the ultrasound, to rule out deep vein thrombosis that is sometimes associated with it⁵².

Protocol 7. Grade II injury to the intermuscular septum of the anterior rectus muscle (table XV)

The injuries from the anterior rectus muscle are classified as injuries from the intramuscular septum, from the direct and superficial musculotendinous and from the deep MTD junction. The injury of the septum is a typical football injury suffered during a shot with the ball, and has a high risk of relapse and of becoming chronic. The prognosis of an extensive injury of the septum should not be less than 6 weeks.

Comments

The most important recommendations are:

- Monitoring progress of the injury using a periodic ultrasound study. The proximal injuries and in relation to the sartorius muscle are of a worse prognosis⁵³.
- Be careful with the beginning of eccentric exercises. Until we have an image of formation of fibrous or connective tissue we do not begin the phase of strengthening with eccentric exercises. These could cause a “whipping” on the muscular structure that surrounds the septum and causes mechanical friction that does not allow muscle tissue repair.
- This action can generate a “soft” scar that facilitates relapses.
- Also be very careful when it is time to add field work, jumping type exercises and repetitive shots.
- It is very useful, from the start, to monitor the mechanics of shots and exercises in braking on the pitch.
- As always, there is additional work to strengthen and stabilise the lumbar pelvic and rotator muscles of the hip.

Table XIV

<i>From 0 from 3 days</i>
• RICE.
• Electrotherapy.
• Massage/drainage.
<i>From 4 to 7 days</i>
• Ultrasound daily or hyperthermy alternate days or diathermy daily.
• Assessment and lumbar-pelvic stability exercises.
• Start of manual isometric exercises of 4 series and 10 repetitions with 3 different ranges and with times of progressive contraction, beginning with 6 seconds of contraction and 2 seconds of rest.
• Active stretching exercises (12 seconds of contraction and 12 seconds of relaxation).
• Begin physiotherapy exercise in the swimming pool.
• Guidance in the gym for uninjured structures and prevention guidelines.
<i>From 7 to 14 days</i>
• Ultrasound with stretching exercises or diathermy daily.
• Continue with swimming pool exercises.
• Continue with the progressive strengthening of isometric exercises.
• Continue proprioceptive exercise guidelines, active stretching and lumbar-pelvic stabilisation exercises.
• Walking 30 minutes, bicycle and elliptical machine.
• Continue with lumbar-pelvic stabilisation exercises.
<i>From 14 to 21 days</i>
• Ultrasound with stretching or diathermy daily.
• Begin manual strength exercises by concentric submaximum method of 6 to 8 series and of 12 to 15 repetitions.
• Begin continuous running from 7-8 km/h.
• Start field exercises with the ball.
• Continue proprioceptive exercise guidance, active stretching and lumbar-pelvic stabilisation exercises.
<i>From 21 to 30 days</i>
• Continue with the strengthening of combined isometric/concentric exercises.
• Begin manual strength exercises by eccentric submaximum method of 4 to 6 series and of 8 to 10 repetitions.
• Increase of intensity of continuous running at different rhythms.
• Transfer to physical therapists to meet sporting movement needs.
• Start work with physical fitness trainers adding exercises to improve conditional and coordinated capacity.

Table XIV (continuation)

• Continue proprioceptive exercise guidelines, active stretching and lumbar-pelvic stabilisation exercises.
<i>From 30 to 45 days</i>
• Intensify eccentric exercise.
• Intensified work with physical fitness trainers adding exercises to improve conditional and coordinated capacity.
• Massage therapy all-clear when necessary.
• Progressive partial work with the group (without aggressive changes of direction, specific repetitive shots except with trainers).
• Full work with the group.
<i>45 days</i>
• Medical all-clear.
• Passing to work on prevention of injuries.

SEQUENTIAL MANAGEMENT MODEL OF THE TREATMENT OF MUSCULAR INJURIES (fig. 1)

In this section we present our model of sequential treatment of muscular injuries. This model is very important to understand how different professionals are progressively included in the recovery of each muscular injury.

It is important that the muscle injury of a player is checked and treated by few professionals, but with professional equipment, where a multidisciplinary team with specific skills, where it is even more important to be very rigorous in the inclusion of and transfer of the player to each of the professionals involved.

Normally, the team doctor must be the principal manager and coordinate the other professionals such as physiotherapists, physical fitness trainers and rehabilitation trainers. The rehabilitation professionals are very common in professional football teams that have specialised in optimising the transfer of players "from the stretcher to the pitch", so that then the physical fitness trainers are able to work the conditional and coordinated capacities with maximum safety.

Initially, the multidisciplinary team agrees to carry out a recovery programme, taking into account the basic protocols described previously. Usually a series of assessment checks and a possible date for a medical all-clear and the all-clear to play. (A planning model is attached at the end of this document).

Table XV

<i>From 0 to 3 days</i>
• RICE.
• Electrotherapy.
• Massage/Drainage.
<i>From 4 to 7 days</i>
• Ultrasound daily or Hyperthermy alternate days or diathermy daily.
• Assessment and lumbar-pelvic stability exercises.
• Start of manual isometric exercises of 4 series and 10 repetitions with 3 different ranges and with times of progressive contraction, beginning with 6 seconds of contraction and 2 seconds of rest.
• Active stretching exercises, very progressive (12 seconds of contraction and 12 seconds of relaxation).
• Begin physiotherapy exercise in the swimming pool.
• Post exercise drainage.
• Guidance in the gym for uninjured structures and prevention guidelines.
<i>From 7 to 14 days</i>
• Ultrasound with stretching or diathermy daily.
• Continue with manual isometric strengthening exercises of 4 series and 10 repetitions in 3 ranges.
• Start field work (approximately 30 minutes walking).
• Continue with active stretching exercise.
• Proprioceptive exercises.
• Continue with guidance in the gym for injured and healthy structures.
• Continue with swimming pool exercises.
<i>From 14 to 21 days</i>
• Continue with strengthening (gym and manual).
• Begin manual strength exercises by concentric submaximum method of 4 to 6 series and of 8 to 10 repetitions.
• Continue with active stretching exercise.
• Start progressive continual running.
• Continue proprioceptive and lumbar-pelvic stabilisation exercises.
• Start field work with the ball.
<i>From 21 to 30 days</i>
• Continue with concentric strengthening exercises.
• Begin manual strength exercises by eccentric submaximum method of 4 to 6 series and of 8 to 10 repetitions.
• Intensify stretching exercise.
• Dynamic proprioceptive exercises.

Table XV (continuation)

• Post exercise massage therapy when necessary.
• Transfer to physical therapists to meet sporting movement needs.
• Able to start work with physical fitness trainers in any conditional and/or coordinated capacity.
<i>From 30 to 45 days</i>
• Intensify eccentric exercise.
• Continue working for improvement of the conditional and coordinated capacities with the physical fitness trainers.
• Progressive partial work with the group (without aggressive changes of direction, specific repetitive shots except with trainers).
• Massage therapy all-clear when necessary.
• Full work with the group.
<i>45 days</i>
• Medical all-clear.
• Passing to work on prevention of injuries.

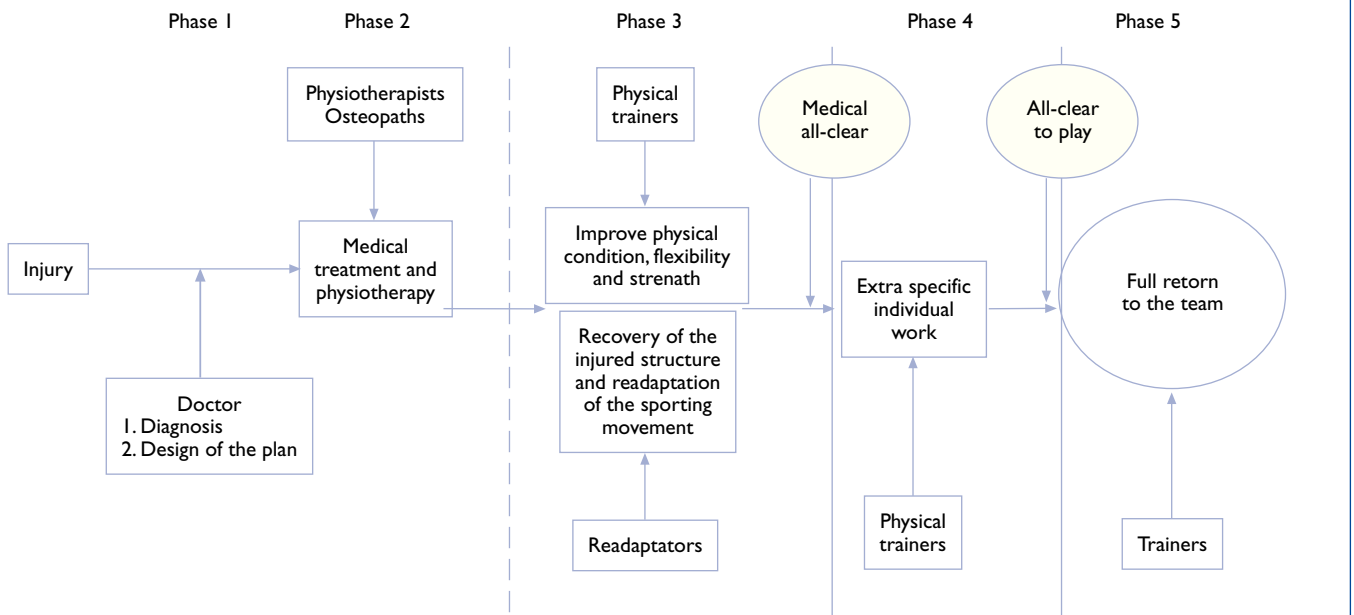
The protocol must always be personalised and must check that the objectives of each phase have been achieved. In this way the perception of the player is good, since there is good coordination.

We understand that the concepts of medical all-clear and all-clear to play are clear, but in reality they are confused. Normally, when we give the medical all-clear we also give the all-clear to play, in which the player is now working with the group with absolute normality. He therefore trains for a few days, and if all goes well, he is fit again to play in matches.

CRITERIA IN ORDER TO GIVE THE ALL-CLEAR TO PLAY

When the injured player has completed the process of rehabilitation and regaining fitness, he will start training with the team. We will have to take a decision on when he can return to play with absolute assurance that he is not going to return to injury. The risk of a reinjury in the same place is very high in muscular injuries, 14 -16% over the two months after being given the all-clear³¹.

The decision is usually taken based on experience, both of the player and of the trainer, physician and physiotherapist, and the carrying out of a test of strength, or on the field, and some imaging evidence, such as an ultrasound or an MRI.

Figure 1 Recovery Program.

We have not found studies that show a clear scientific evidence regarding the following of certain strategies in the literature reviewed.

We recommend to continue, obviously, with the experience of everyone, but we have some criteria that could be very useful in taking the best decision. This is shown in the tables XVI and XVII, modified from Orchard³¹.

With respect to this table XVII some things need to be clarified:

The criteria of an image as a marker to give the all-clear to play, has to be qualified and is not normally determinant. Many times, and above all in myofascial injuries, we may give the all-clear to play although images remain of interaponeurotic haematomas.

However, what is of great importance is strength and flexibility. When these two conditional capacities are the same as before the appearance of the injury, we can be very unworried. Obviously, there are other factors that do not appear in the tables XVI and XVII and usually have to be taken into account. They are very hard to specify but carry the experience of the professionals we have around the player. We mention this so that each person can reflect and assess each situation in which they find themselves:

- Contractual labour situation.
- Psycho-emotional state: anxious, hyper motivation, fears.

- Veteran or novice status with the team.
- Sport, and in this sense various factors are involved, from the characteristics of the player, his own game, the sporting movement, the pitch, etc., as an example a second grade injury to the biceps femoris muscle could have a return to competition that could range from 3 weeks in a basketball player up to 6 weeks in a footballer.

Then, finally it must be decided when it is best to return to play: Home game or away? Start in the first half or the second? Etc.

As final objective criteria to allow incorporation into the sport, we propose the following points:

- Clinical criteria: clinical and physical examination
- Imaging criteria: ultrasound
- Functional criteria:
 - Test of strength (isokinetic study, lab muscle etc.).
 - General physical test.
 - Specific physical test.

Also, we will never be 100% certain that a player will not return to reinjury and the risks must be considered according to specific circumstances.

As always in our environment (professional sport) we are unable to be conservative but we can be sensible, and the more

Table XVI Conservative criteria for optimum return to competition

Factors indicative of more conservative attitude before reinstatement
There remains a lack of strength in comparison with the uninjured leg
There remains a lack of flexibility with respect to the injured leg
Inability to complete training without pain or limited to carrying out certain movements
Persistence in the Ultrasound or MRI study of abnormal signal
Features of sprinters, forwards
Veteran player
At the beginning and the middle of the season
Injuries in high risk areas such as: biceps femoris muscle, intermuscular septum of the anterior rectus muscle, inner calf muscle and soleus muscle and adductor medium muscle
Prior injury (3 months)

Table XVII Positive and negative criteria for optimum return to competition

Positive factors for rapid reinstatement
No lack of strength in comparison with the uninjured leg
No lack of flexibility in comparison with the uninjured leg
No problem in doing more than one training session with the team
Ultrasound and/or MRI are normal
Player of low risk, few muscular injuries
Young player with experience of managing injuries
Good prognosis of the injured area, such as the semimembranosus muscle, medial and lateral, gluteal muscle, external calf muscle

MRI: magnetic resonance imaging.

knowledge and experience we have, the better we are able to take the final decision.

PREVENTION STRATEGIES (FIG. 2)

Recent years have seen a qualitative step forward in the field of prevention of sports injuries by incorporating scientific methods, with the objective of evaluating if the different strategies being made to reduce the incidence of injury are effective or not. In this regard, we present the Van Mechelen

scheme that synthesises this model⁵⁴, the first and most straightforward, although current researchers in this environment have taken into account many more factors that have to be borne in mind for the future^{55,56}.

It is clear that the first thing to do is a proper epidemiological injury study to know what the real scale of the problem is. Then, assessing the most obvious risk factors and taking into account the mechanisms of each injury, an adequate prevention protocol must be designed for each injury type. This protocol should have well-defined objectives and each one of the exercises that must be done, duration, number of repetitions per week, etc. Once designed, it should be applicable to a particular population and checked to see if it is sufficiently sensitive and effective to introduce positive changes in the incidence of injury.

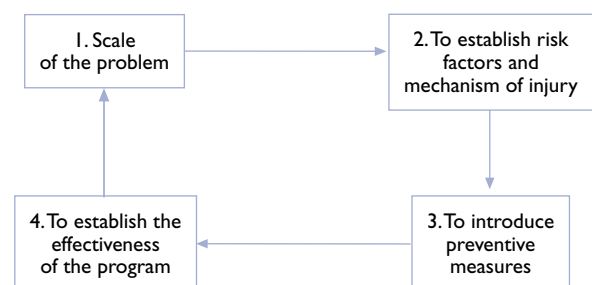
Until now, and if we focus on muscular injuries, there are very few scientific studies that demonstrate that a determined preventative protocol has been effective and that, therefore, has caused a statistically significant decrease in muscular injuries.

To give an example, even today we have no scientific evidence to recommend passive stretching exercises as the standard preventative method of muscular injuries.

In the case of prevention of injuries to the hamstring muscles, for example, there is very little research based on evidence. Only a few protocols combine certain types of stretching exercises to improve flexibility and some protocols with types of eccentric exercises have demonstrated a clear decline in the incidence of injuries in hamstring muscles.

Therefore, based on the few studies published to date, and taking into account our experience, we propose a protocol for the prevention of the most common muscle injuries in football, although we have been able to adapt it to other sports such as basketball with high expectations for the time being.

Figure 2 Causal model of prevention by Van Mechelen⁵⁴.



We will not go into a discussion about measures of a general type such as hygienic-dietetics, type of warm-up, etc, that we consider basic and essential and that we understand are carried out correctly.

The protocol we propose (fig. 3) is based on the programme we know as “F-MARC 11”, created by the medical centre of assessment and investigation of FIFA (F-MARC) in cooperation with a group of international experts³. They are currently conducting various prospective longitudinal studies in different sports to verify its effectiveness⁵⁷. For example, Arnason 2008⁵⁸ has published the results of a study using part of this programme, where he found a lower incidence of injuries of the hamstring muscles in professional footballers. It is a simple preventative programme, which is attractive, very effective and requires no special equipment except one ball and can be done in 15 minutes. The main objectives of this programme of exercises are, basically, the lumbopelvic stabilisation, neuromuscular control, polymetrics and agility.

This programme will be completed at each training session, after warm-up and stretching exercises of the main muscular groups. It is very important that the exercises are performed as they are designed. They are described as follows:

1st exercise: Supporting oneself on the forearm (fig. 4)

Initial position: We are in ventral position and with the upper part of the body with arms at right angles. The feet must be vertical to the ground as shown in the photo.

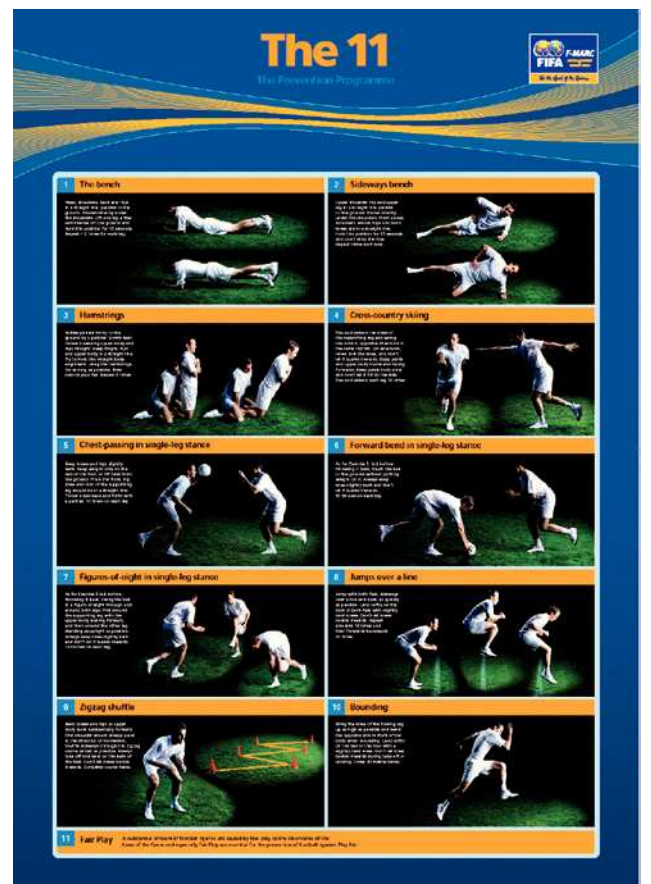
Action: Lift abdomen, hips and the knees so that the body forms a straight line, from shoulders to heels. Elbows should be positioned vertically, below the shoulders. Contract abdominal and gluteal muscles. Shoulder blades pressed inward. Lift right leg a few centimetres off the ground and maintain the position for about 15 seconds. Return to the initial position, relax and repeat the exercise with other leg. Repeat the exercise 3 times.

2nd exercise: Supporting oneself on the forearm in a lateral position (fig. 5)

Initial position: Place yourself sideways, position torso and one arm in such a way that elbow is in a vertical position at the same height as shoulder and with the forearm in contact with the ground. Bend lower knee around 90°.

Action: Raise upper leg and hips until they are at the same height as the shoulders, forming a straight line and parallel to

Figure 3 Poster F-MARC program of FIFA.



the ground. Maintain the position for 15 seconds. Return to the initial position, relax and repeat the exercise 3 times.

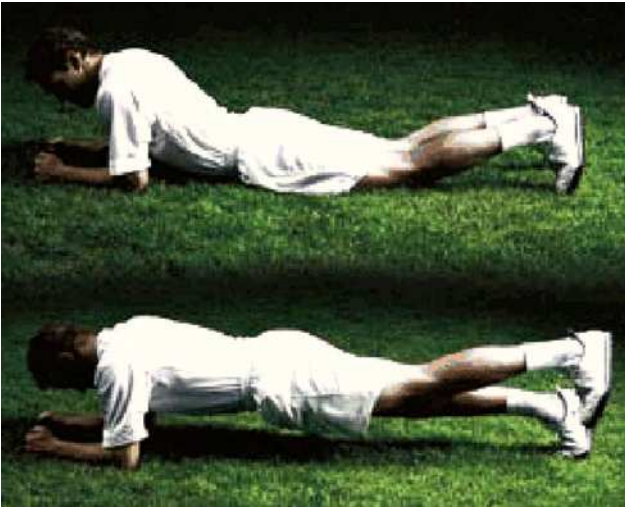
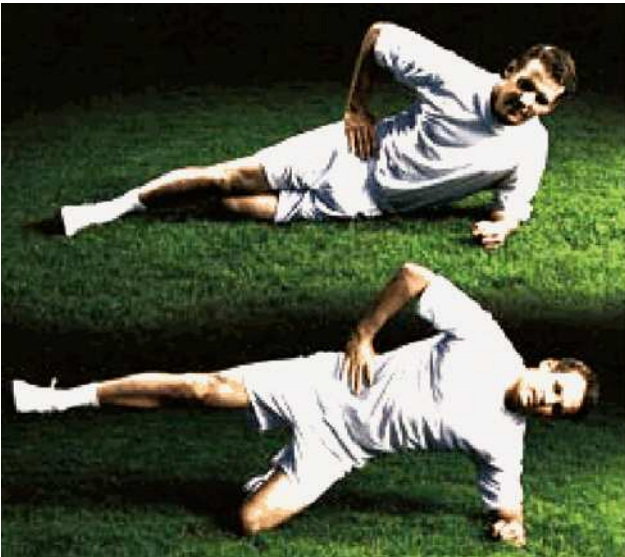
3rd exercise: Hamstring muscles (fig. 6)

Initial position: Place knees on the ground, keeping body straight. The space between knees must be the same as the width of hips. Cross arms in front of the chest. A team-mate will have to take hold of the ankles behind and hold against the ground with two hands.

Action: Lean slightly forward with torso straight and hips vertical. Legs, hips and torso form a single block. Maintain body in this straight position as long as you can while falling forward until stopped by your hands. Repeat the exercise 5 times.

4th exercise: Cross-country skiing (fig. 7)

Initial position: Stand on one leg, the right, and relax the other without it touching the ground. Slightly bend knee and

Figure 4 Supporting oneself on the forearm.**Figure 5** Supporting oneself on the forearm in a lateral position.

hips so that the torso is tilted forward. If seen from the front, the hip, knee and foot of the supporting leg have to be in a straight line.

Action: Make movements with the supported leg, while alternatively swinging the arms. Flex knee to the maximum. Weight to be distributed across the sole of the foot. While the leg is extended you must not keep the knee stiff. The pelvis and the torso must be in balance and inclined slightly forward. Repeat 15 times.

Figure 6 Hamstring muscles.**Figure 7** Cross-country skiing.**Figure 8** Standing on one leg with throwing.

5th exercise: Standing on one leg with throwing (fig. 8)

Initial position: Position yourselves face to face with a team-mate at a distance of approximately 3 metres, both standing on the right leg. Knees and hips slightly bent. Maintain body weight over the centre of the foot. If seen from the front, the hip, knee and foot of the supported leg must form a straight line.

Action: Throw the ball backwards and forwards. If supported by the right leg, throw the ball with the left arm and vice versa. Catch the ball with two hands and return it with only one. The faster the ball is passed the more effective the exercise will be. Repeat 10 times with each leg.

6th exercise: Standing on one leg and flexing the torso (fig. 9)

Initial position: The same as in exercise 5, face to face with a team-mate at a distance of 3 metres, both on the right leg.

Action: The same as in exercise 5, throw the ball backwards and forwards, but before returning it touch the ground with the ball without using force. Repeat 10 times with each leg.

7th exercise: Standing on one leg making "figure of eight" movements (fig. 10)

Initial position: The same as in exercise 5, face to face with a team-mate at a distance of 3 metres, both on the right leg.

Action: The same as in exercise 5, throw the ball backwards and forwards, but before returning it make "figure of eights" between the legs, first round the supporting leg, inclining the torso forward, and then around the driving leg, keeping it as stiff as possible. Repeat 10 times with each leg.

8th exercise: Jump with both legs (fig. 11)

Initial position: Stop, taking into account that the separation between the knees and lower leg has to be the same as the width of the hips, at approximately 20 centimetres to the side of a line. Slightly bending knees and hips so that the torso leans forward a little. If seen from the front, the hip, knee and the foot of the supporting leg should form a straight line. Arms should be slightly bent and close to the body.

Action: Jump with both legs together, sideways, above the line and returning to the original site as straight as possible. Land gently on the tips of the toes with knees slightly bent. Repeat 10 times.

Figure 9 Standing on one leg and flexing the torso.



Figure 10 Standing on one leg making "figure of eight" movements.



Figure 11 Jump with both legs.



Figure 12 Zigzag jump.



9th exercise: Zigzag jump (fig. 12)

Initial position: Stand at the beginning of the zigzag path (6 markers at a distance of 10×20 metres), with legs separated at the same distance as the width of the hips. Bend knees and hips so that the torso leans forward during the exercise. One shoulder should be in the same direction as the movement.

Action: Zigzag sideways until the next marker, turn so that shoulder is in the direction of the following marker and continue the distance in zigzag as quickly as possible. Always jumping and landing on toes. Repeat the whole distance twice..

Figure 13 Long and high jumps.



10th exercise: Long and high jumps (fig. 13)

Initial position: Stand on the driving leg with the torso stiff. The arm on the same side as the driving leg should be in front of the body. Seen from the front, the hip, knee and the foot of the supporting leg should form a straight line.

Action: Jump as high as possible with the driving leg and also lifting the knee of the rear leg as high as possible, bending the opposite arm at the same time and passing it in front of the body. With the knee slightly bent, land gently on the front part of the foot. Cover this distance of approximately 30 metres twice.

Table XVIII Grading system in the recommendations of guides of scientific evidence⁵⁹

Level of scientific evidence		Level of recommendation
I++	Meta-analysis or systematic revisions of RCS of high quality or RCS with a very low risk of subjectivity	A
I+	Meta-analysis or systematic revisions of RCS of a good level or RCS with a low risk of subjectivity	A
I-	Meta-analysis or systematic revisions of RCS, or RCS with a high risk of subjectivity	None
2++	Systematic revisions of studies of cohorts or control cases of high quality or Cohort studies or control cases with a very low risk of subjectivity or a possibility that the relationship is casual	B
2+	Cohort studies or control cases, with a low risk of subjectivity and moderate possibility that the relationship is casual	C
2-	Cohort studies or control cases, with a high risk of subjectivity and that the relationship is not casual	None
3	Non-analytical studies (clinical cases, series, etc.)	D
4	Expert/s opinion	D

20. Sherry MA, Best TM. A comparison of 2 rehabilitation programs in the treatment of acute hamstring strains. *J Orthop Sports Phys Ther.* 2004;34:116-25. C
21. Balius R. *Patologia muscular en el deporte.* Barcelona: Masson; 2005. D
22. Balius R, Rius M, Combalia A. *Ecografia muscular de la extremitat inferior.* Barcelona: Masson; 2005. D
23. Fuller CW, Ekstrand J, Junge A, Andersen TE, Bahr R, Dvorak J, et al. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *Scand J Med Sci Sports.* 2006;16:83-92. B
24. Hägglund M, Waldén M, Bahr R, Ekstrand J. Methods for epidemiological study of injuries to professional football players: developing the UEFA model. *Br J Sports Med.* 2005;39:340-6. B
25. Guerrero M, Guiu-Comadevall M, Cadefau JA, Parra J, Balius R, Estruch A, et al. Fast and slow myosins as markers of muscle injury. *Br J Sports Med.* 2008;42:581-4. B
26. Verrall GM, Slavotinek JP, Barnes FG, Fon GT, Esterman A. Assessment of physical examination and magnetic resonance imaging findings of hamstring injuries as predictors of recurrent injury. *J Orthop Sports Pyhs Ther.* 2006;36:215-24. D
27. Pisot R, Kersevan K, Djordjevic S, Medved V, Završnik J, Simunic B. Differentiation of skeletal muscles in 9-year-old children. *Kinesiology: International Journal of Fundamental and Applied Kinesiology.* 2004;36:90-7. C
28. Huard J, Li Y, Fu FH. Muscle injuries and repair: current trends in research. *J Bone Joint Surg Am.* 2002;84-A:822-32. B
29. Chargé SB, Rudnicki MA. Cellular and molecular regulation of muscle regeneration. *Physiol Rev.* 2004;84:209-38. B
30. Nagasaka M, Kohzuki M, Fujii T, et al. Effect of low-voltage electrical stimulation on angiogenic growth factors in ischemic rat skeletal muscle. *Clin Exp Pharmacol Physiol.* 2006;33:623-7. C
31. Orchard J, Best TM, Verrall GM. Return to play following muscle strains. *Clin J Sport Med.* 2005;15:436-41. D
32. Lehto MU, Jarvinen MJ. Muscle injuries, their healing process and treatment. *Ann Chir Gynaecol.* 1991;80:102-8. D
33. Hurme T, Kalimo H, Lehto M, et al. Healing of skeletal muscle injury: an ultrastructural and immunohistochemical study. *Med Sci Sports Exerc.* 1991;23:801-10. B
34. Jarvinen TA, Jarvinen TL, Kääräinen M, Aärimaa V, Vaittinen S, Kalimo H, et al. Muscle injuries: optimizing recovery. *Best Pract Res Clin Rheumatol.* 2007;21:317-31. D
35. Kibler WB, Press J, Sciascia A. The role of core stability in athletic function. *Sports Med.* 2006;36:189-98. D
36. Zazulak BT, Hewett TE, Reeves NO, Goldberg B, Choeck J. The effects of core proprioception on knee injury. *Am J Sports Med.* 2007;35:368-73. C
37. Borghuis J, Hof A, Lemmink K. The importance of sensor-motor control in providing core stability. Implications for measurement and training. *Sports Med.* 2008;38:893-916. D
38. Almekinders LC. Anti-inflammatory treatment of muscular injuries in sport. An update of recent studies. *Sports Med.* 1999;28:383-8. C
39. Mehallo CJ, Drezner JA, Bytomski JR. Practical management: nonsteroidal antiinflammatory drug (NSAID) use in athletic injuries. *Clin J Sport Med.* 2006;16:170-4. C
40. Warden SJ. Cyclo-oxygenase-2 inhibitors: beneficial or detrimental for athletes with acute musculoskeletal injuries? *Sports Med.* 2005;35:271-83. B

41. Baldwin Lanier A. Use of non steroidal anti-inflammatory drugs following exercise-induced muscle injury. *Sports Med.* 2003;33:177-85. C
42. Foster W, Li Y, Usas A, et al. Gamma interferon as antifibrosis agent in skeletal muscle. *J Orthop Res.* 2003;21:798-804. C
43. Sato K, Li Y, Foster W, Fukushima K, Badlani N, Adachi N, et al. Improvement of muscle healing through enhancement of muscle regeneration and prevention of fibrosis. *Muscle Nerve.* 2003;28:365-72. C
44. Bedair HS, Karthikeyan T, Quintero AJ, et al. Angiotensin II receptor blockade administered after injury improves muscle regeneration and decreases fibrosis in normal skeletal muscle. *Am J Sports Med.* 2008;36:1548-55. B
45. Ishii Y, Deie M, Adachi N, Yasunaga Y, Sharman P, Miyanaga Y, et al. Hyperbaric oxygen as an adjuvant for athletes. *Sports Med.* 2005;35:739-46. C
46. Wright-Carpenter T, Klein P, Schäferhoff P, Appell HJ, Mir LM, Wehling P. Treatment of muscle injuries by local administration of autologous conditioned serum: a pilot study on sportsmen with muscle strains. *Int J Sports Med.* 2004;25:588-93. D
47. Wright-Carpenter T, Klein P, Schäferhoff P, Appell HJ, Mir LM, Wehling P. Treatment of muscle injuries by local administration of autologous conditioned serum: animal experiments using a muscle contusion model. *Int J Sports Med.* 2004;25:582-7. C
48. Dvorak J, Feddermann N, Grimm K. Glucocorticosteroids in football: use and misuse. *Br J Sports Med.* 2006;40 Suppl 1:i48-54. D
49. Shneider C, Schneider B, Hanisch J, van Haselen R. The role of a homoeopathic preparation compared with conventional therapy in the treatment of injuries: An observational cohort study. *Complement Ther Med.* 2008;16:22-7. D
50. Mishra A, Woddall J, Vieira A. Treatment of tendon and muscle using platelet-rich plasma. *Clin Sports Med.* 2009;28:113-25. D
51. Kwak H, Lee K, Han Y. Ruptures of the medial head of the gastrocnemius (tennis leg). *Journal of Clinical Imaging.* 2006;30:48-53. D
52. Delgado GJ, Chung C, Lektrakul N, et al. Tennis leg: Clinical US Study of 141 patients and anatomic investigation of four cadavers with MR imaging and US. *Radiology.* 2002;224:112-9. D
53. Balius R, Maestro A, Pedret C, Estruch A, Mota J, Rodríguez L, et al. Central aponeurosis tears of the rectus femoris practical sonographic prognosis. *British J Sports Med.* 2008; 052332. Epub. D
54. Van Mechelen W, Hlobil H, Kemper HC. Incidence, severity, aetiology and prevention of sports injuries. A review of concepts. *Sports Med.* 1992;14:82-99. D
55. Finch C. A new framework for research leading to sports injury prevention. *J Sci Med Sport.* 2006;9:3-9. D
56. VanTiggelen D, Wickes S, Stevens V, Roosen P, Witvrouw E. Effective prevention of sports injuries: a model integrating efficacy, efficiency, compliance and risk-taking behavior. *Br J Sport Med.* 2008;42:648-52. D
57. Soligard T, Myklebust G, Steffen K, Holme I, Silvers H, Bizzini M, et al. Comprehensive warm-up programme to prevent injuries in young female footballers: cluster randomized controlled trial. *BMJ.* 2008;337:a2469. C
58. Arnason A, Andersen TE, Holme I, Engebretsen L, Bahr R. Prevention of hamstring strains in elite soccer: an intervention study. *Scand J Med Sci Sports.* 2008;18:40-8. C
59. Harbour R, Miller J. A new system for grading recommendations in evidence based guidelines. *BMJ.* 2001;323:334-6. A

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