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SPECIAL ARTICLE

Guide to clinical practice for tendinopathies: diagnosis, treatment and prevention

Guía de práctica clínica de las tendinopatías: diagnóstico, tratamiento y prevención

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Received 3 September 2012; accepted 10 September 2012

Introduction

Pain in the tendon, especially in the Achilles tendon and the patellar tendon, known as tendinopathy, is very common among individuals that do sport either competitively or as a hobby. However, and according to several studies, it has been demonstrated that physically inactive individuals also suffer from them. It can therefore be said that physical activity cannot be directly associated to histopathology and that physical exercise may be more important for provoking the symptoms than for being the cause of the injury^{1,2}. It is considered that overuse induces this condition, but the etiology and pathogenesis are not scientifically clear.

The nomenclature used for chronic pain in the tendon is confusing. Until a few years ago, it was considered that chronic Achilles and patellar pain involved the presence of an inflammatory component and the terms tendinitis and tendonitis were commonly employed. Presently, histological evaluation of biopsies, intratendon microdialysis and technological genetic analyses of biopsies have shown that there are no signs of prostaglandin inflammation and, therefore, these words should not be used³.

Meanwhile, it has also been demonstrated that tendons are more metabolically active; the term used nowadays is tendinopathy to describe the painfully chronic symptoms in a sensitive and painful area of the tendon³.

These clinical images can be complicated by the inflammation of the outer casing of the tendon, called the paratendon. The inflammation of this conjunctive casing can arise in isolation, when it is called paratendinitis, or in association with a tendinopathy or tendinosis, almost always characterised by a cracking of the structure^{3,4} (table 1).

Tendinopathies are not an easy pathology to treat. At present, there are many theories that have sought to explain the origin of the pain; the most accepted being based on the vascular model although there are different lines of research regarding the mechanism that produces the pain. This theory is focused on local neovascular development in chronic pathologies of the tendon, which has led to new ideas regarding models of treatment, such as the use of injection sclerotherapy⁵.

It has been demonstrated that conservational treatment using eccentric exercises (with or without pain) offers very good results in the short and medium term in tendinosis patients, being associated with a reduction in fragility and weight loss, benefitting hypertrophy and a more normal appearance of the tendon structure. However, there is no scientific evidence of the histological adaptations caused by eccentric training⁶. There are certain indicators that suggest that a training programme involving eccentric exercises may act by interfering with vasculonervous transmission, which would be close to the action sought by

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Table 1 Classification of tendinopathies

Diagnosis	Microscopic findings
Tendinosis	Tendon degeneration caused by age, ageing of connective tissue, overuse and vascular disorder
Tendinopathy/ Partial breakage Paratendinitis	Symptomatic degeneration with vascular disruption Inflammation of the paratendon, without considering whether it is covered or not with synovial
Paratendinitis with tendinosis	Paratendinitis associated with intratendon degeneration

Adapted from Brukner & Khan (1993)²¹.

injection sclerotherapy. It is also questioned whether the destruction of the degenerate tendon itself might initiate a remodelling process with the help of a programme of eccentric exercises and sclerosants. These and other questions have yet to be resolved.

The objective of this FC Barcelona Medical Services guide to clinical practice is to create a protocol for diagnostic, therapeutic and preventative attitudes in relation to different tendinopathies, especially Achilles and patellar tendinopathy.

This guide does not claim to be an exhaustive review of tendon pathologies in sport but rather a clear, practical and complete working document. So, the protocols presented here are based on current scientific knowledge and the experience of recent years working on a daily basis with this kind of injury.

Physiopathology of tendinopathies

There are four models that seek to explain pain in tendinopathies due to overuse:

Traditional model

Proposes that overuse of the tendon causes inflammation and therefore, pain. As we shall see, the absence of inflammatory markers puts this theory in doubt. Several authors have observed macroscopically that patients of patellar tendinopathy are characterised by the presence of a tendon of soft consistency or with disorganised and dark yellow coloured collagen fibres in the lower posterior portion of the lower pole of the kneecap. This macroscopic appearance is described as muroid or myxoid degeneration. Through the microscope it is observed that the collagen fibres are disorganised and separated by an increase in fundamental substance. Therefore, the degeneration of collagen, along with variable fibrosis and neovascularisation, have been the basic findings of the aforesaid studies^{6,7}.

Other authors propose a transition phase from a normal tendon to tendinosis or degeneration of the muroid substance in which the inflammatory phase, should it exist, would actually be very short as shown by numerous studies^{8,9}.

Mechanical model

Attributes the pain to two situations¹⁰: on the one hand, to an injury to the collagen fibres, although there are situations in which the tendon is completely intact and there is also pain. A variant on this theory claims that it is not the breakage of collagen that produces pain, but rather the intact residual collagen contiguous to that which is injured, due to the added stress that surpasses its normal load capacity.

Data from numerous studies, which have used imaging techniques, contradict the latter^{8,11,12}, as patients with pain in the patellar tendon could have a normal MRI (a patient can have a very small or inexistent morphological anomaly and present significant symptoms) showing that the pain in the tendon is due to something more than the loss of collagen continuity.

In the case of tissue impingement (compression), the tendon is inserted in a location where it suffers compression by part of the bone. Supposedly, these patients should achieve a symptomatic improvement when the tendon is liberated from the compression, but that is not the case.

Biochemical model

Proposes that the cause of the pain is a chemical irritation due to a regional hypoxia and a lack of phagocytes to eliminate the toxic products of cellular activity. Therefore, the pain in the tendinosis could be caused by biochemical factors that activate the nociceptors, the substance P and the neuropeptides.

The nociceptors are located in the lateral and medial retinaculum, the synovial membrane, the periosteum and the infrapatellar fat pad. All these structures could play an important role in the origin of the pain. This third model could be accepted as valid¹⁰.

Vasculonervous model

Finally, the vasculonervous model, based on neural damage and hyperinnervation, suggests that the positive nerve fibres for substance P are located at the bone-periosteum-tendon joint, in such a way that repeated microtraumas in the insertion of the tendon lead to a cyclic process of repeated ischemias that favour the release of nerve growth factor (NGF) and, therefore, substance P facilitating sensitive nociceptive hyperinnervation at the location of insertion.

According to this model, when there is an injury in the tendon due to degeneration, the damaged cells release toxic chemical substances that have an impact on intact neighbouring cells^{8,13-15}.

This latter model is currently the most accepted, although different authors opt for an integrated model that encompasses the four explanatory models explained until now.

Etiology of tendinopathies. Risk factors

The origin of tendon injuries is directly related with the type of force that is exerted on the tendon¹⁶.

Table 2 Summary of the intrinsic factors associated with tendinopathy due to overuse

General	Local
Gender	Misalignments: hyperpronation or hypopronation of the foot, genu valgum/varum, femoral neck anteversion...
Age	Dissymmetry of lower limbs (LL) Weak muscles Muscular imbalances Loose joints Reduced flexibility

From Paavola et al. (2005)¹⁶.

Tendon injuries are mainly produced by the forces of compression, forces of friction, forces of traction, or by different stimuli of little intensity applied repeatedly. That is why these injuries can originate from factors that are internal or inherent to the individual, whether located or not in the actual structure of the tendon, or from external or extrinsic factors including training, footwear or the playing surface¹⁷.

Intrinsic factors

Several studies make reference to ischemia as the main cause of tendinopathy^{18,19}. This situation is produced when the tendon is subjected to a maximum load or is compressed by a bony prominence.

Biomechanical disorders, as an injury factor of the tendon, are frequent. The most common problem is hyperpronation of the foot due to anatomical problems, such as bunion, ligamentous laxity of the mid-foot or weakness of the triceps surae^{16,20}.

Other determinant biomechanical disorders in the appearance of tendinopathies are lateral tibial torsion, tibial varus, pes cavus and dissymmetry of the lower limbs¹⁶. In the latter case, most authors suggest that when these are greater than 1.5 cm they should be considered a risk factor, although it is true that in high level sportspeople this biomechanical defect should be corrected above 0.5 cm of difference between one limb and another.

We should also mention the active component of the body. The imbalance of important agonist and antagonist muscle groups or the type of work or training are factors that are also prone, in some cases, to suffering tendon injuries^{16,21,22}.

Finally, gender is also considered a predisposing factor, females being most prone to suffering tendinopathies. This extreme may be due to the lesser capacity of women and their muscle and tendon system to absorb repeated impacts, together with hormonal imbalances and nutritional shortcomings. Meanwhile, being overweight is also an intrinsic risk factor for suffering tendinopathies^{16,23-25} (table 2).

Extrinsic factors

We highlight as a main cause incorrect planning of training schedules or incorrect attention to the criteria of progression. So, an excessive increase in work schedules,

Table 3 Summary of extrinsic factors

Training method
Excessive duration or intensity
Lack of physiological adaptation
Non adaptation to specificity of the training
Sudden increases in the training programme
Errors in individual adaptation to training
Changes of training/playing surface
Insufficient warm-up
Generally inadequate training
Insufficient recuperation
Problems derived from materials

From Paavola (2005)¹⁶, and Brukner & Kahn (2007)²¹.

training on very hard surfaces, systematic changes of surface, reduction of rest periods, etc., are often causes for the appearance of tendon injuries. Precisely, the type of training surface plays a considerable role given its capacity to absorb the impact of the foot against the ground. So, a study by Fernández-Palazzi et al. (1990) on the appearance of Achilles tendinopathy in dancers is highly significant for observing that in 4% of cases the dance surface is wooden, in 23% it is synthetic and in 45% it is cement, surfaces classified from highest to lowest capacity of absorption^{8,21,26}.

Another important aspect is the lack of acclimatisation (going from a cold atmosphere to a warm one or the amount of relative humidity) which causes the individual to improperly regulate the loss of water and other minerals, which has direct incidence on collagen. There is no scientific evidence of these adaptations being caused by the lack of acclimatisation.

In short, we can observe many contributing factors that influence how prone a tendon is to injury, so it is advisable to make a biomechanical analysis of the sporting discipline, a study of the background and contributing factors affecting sportspeople as well as the external factors that, although not always controllable, can reduce the influences on players. In other words, a tendon becomes pathological when it is unable to tolerate a sequence of loads to which it is subjected; one of our main objectives will be training to adapt to this work rate and knowing how to reduce the demands made of the tendon⁸ (table 3).

The identification and posterior elimination of the factors benefitting the production of the injury is the fundamental treatment of tendinopathies, and is essential if we are to prevent a new injury to the tendon.

Epidemiology

At present, it is essential to be aware of the incidence of these pathologies in high level sport and very specifically in the world of football.

According to studies by the Union of European Football Associations (UEFA), from the 2001-2002 season to that of 2008-2009, there were 32 tendon injuries in the total number of teams that played in European competitions, which represent 6% of the total injuries. Of these 32 injuries,

7 were in the Achilles tendon (2.7% of the total) and 6 occurred in the patellar tendon (2.2% of the total)²⁷.

Different studies show that between 30 and 50% of the total number of sports injuries are caused through overuse, of which problems with the Achilles tendon are considered among the most common^{28,29}.

Likewise, other studies of epidemiology in patellar tendinopathy refer to the incidence of this tendinopathy in different sports such as cycling, football, volleyball, athletics, etc. In this study, it is concluded that the average incidence of patellar tendinopathy is 14%. However, in sports that require faster contraction speeds and greater knee extensor strength (jumping), they are more common, in the case of basketball reaching as high as 31% and 44% in the case of volleyball³⁰.

Diagnosis

An in-depth and detailed physical exploration combined with echography and magnetic resonance (MR) (even though this does not offer total specificity) or biopsy, will help us to establish a correct diagnosis.

Physical exploration normally reveals a more sensitive area of the tendon with pain during load-bearing activity, generally accentuated at 30 degrees of flexion. Likewise, we frequently observe a loss of muscular volume and strength caused by reflex inhibition (mechanism for protection from pain), above all in the quadriceps but also to a certain extent in the ischiotibials.

When doing sport, functional limitation is considerable depending on the level of effect caused to the collagen fibres.

Articular rigidity is a clinical sign to take into account, given that this is produced when the articulation defends itself against the pain or the lack of protective muscular mass, especially when load-bearing. Synovial effusion is not a sign to guide diagnosis, although its appearance is of vital importance for rejecting other injuries such as hofftitis, a patellofemoral syndrome or chondral injuries especially to patellar cartilage.

A good anamnesis and the identification of the contributing biotypological/morphological factors will lead to the detection of the basic risk factors and, consequently, the provision of therapeutic and preventative measures.

At present, the Victorian Institute Sports Assessment (VISA) scale enables us to clinically evaluate patellar tendinopathies and Achilles tendinopathies (VISA-A) and provides us with information about the symptomatic severity and sporting and functional capacity of the sportsperson being evaluated^{31,32}. Although VISA-A has been translated into and validated in different languages, is has yet to be validated in either Spanish or Catalan³³⁻³⁷.

The use of echography and the doppler is considered a reliable method for the study of the structure of the tendon as it enables identification of neovascularisation inside and outside of the area where there are structural changes to the tendon (only in tendons with tendinosis and not in normal tendons)³⁸.

Through the use of tendon level biopsies, neuropeptides have been found, which does not indicate a chemical

inflammation (by prostaglandin E2), but rather a neurogenic inflammation via neuropeptides such as substance P. In any case, the difficulty or excessive aggression for making a biopsy of the tendon, means that it is a minor issue in terms of a methodology for study.

Complementary tests

Simple radiology

Although it is not a vital test for evaluating tendon structures, simple radiology can help to exclude another pathology such as bone tumours that are clinically manifested as tendon injuries, or calcifications of soft tissue. In immature skeletons, we can visualise apophyseal avulsions³⁸. It is used for the detection of predisposing factors: intratendon calcification, position of the kneecap, existence of Osgood-Schlatter, trigonum syndrome, calcaneal exostosis, etc.

Echography

The most widely used test at the moment due to its reliability and ease. Echography provides a good image of the condition of the collagen fibres, as well as the new vessels around the tendon. One of the keys to echography is that it is a dynamic exploration that can complement clinical exploration. It therefore provides useful information on the functionality of the tendon. Echography of the tendons requires experience and is operator-dependent (both MR and echography are operator-dependent)³⁸.

Magnetic resonance

MR is less used today than echography even though the images it provides offer considerable information. Likewise, it provides data on the condition of the other articular structures and is vital for differential diagnosis. The main advantage of MR over echography is that it provides a reproducible vision of the study and from multiple angles, and it also enables the rejection of other pathologies of non tendon origin³⁸.

MR is currently, for load-bearing and dynamic exercise, the test of choice for the evaluation of tendinopathy.

Computed tomography

The role of computed tomography (CT) in diagnosis by imaging of the tendon is very limited. Both magnetic resonance and echography enable better visualization without exposing the patient to ionising radiation³⁸.

Medical treatment

Numerous types of treatment have been described for the conservative handling of tendon pathologies. Unfortunately, very few have been shown to have any major scientific basis, with the exception of eccentric exercise^{39,40}.

Pharmacological and biological treatments

Nonsteroidal anti-inflammatory drugs

The role of nonsteroidal anti-inflammatory drugs (NSAIDs) in tendinopathies is controversial⁴⁰⁻⁴³. NSAIDs inhibit the activity of the cyclo-oxygenase, causing a reduction in the

synthesis of proinflammatory prostaglandins⁴¹. Additionally, it is postulated that they have an analgesic effect, which is possibly unrelated to the anti-inflammatory action⁴⁰.

In the case of acute tendinopathies it is debated whether or not it is useful to block the immediate inflammatory response, for ironically the analgesic effect would enable patients to overcome the initial symptoms, enabling latent evolution of the symptoms, and thus hindering the repair process and favouring chronification^{40,41}. Current evidence is showing that NSAIDs do not prevent degradation of the collagen or loss of the tensile strength of tendons in acute tendon pathologies⁴⁴, but as happens so often, these findings are not universal⁴⁰. So, in the acute symptoms that are not associated with bursitis, tenosynovitis or any accompanying inflammatory pathology inflammatory, treatment with paracetamol seems more appropriate than that with NSAIDs⁴².

With respect to chronic tendinopathy, the role of NSAIDs is similarly uncertain. The literature suggests that chronic tendinopathy presents no inflammatory reaction other than associated bursitis or synovitis⁴³, so there are no rational grounds for the use of NSAIDs⁴¹ for this type of pathology when it is not found to be associated to concurrent inflammatory processes.

In our experience, both in acute and chronic pathology, the use of NSAIDs for a short period of time (up to 7 days) makes it possible to reach a level of analgesia that facilitates the effective onset of treatments that have been shown to be efficient for the modification of the pathology in the long term, such as eccentric exercise. However, we should remember that this medication is not free from potentially serious medical risks (gastrointestinal, renal and cardiovascular), so its rational use should be grounded on adequate anamnesis, physical exploration and correct medical diagnosis⁴⁵.

Corticosteroids

Injections of corticosteroids have been, and are, administered frequently in the treatment of tendinopathies^{40,45,46}. However, this is not a technique without undesired effects, both local (dermal atrophy, fat necrosis, hypopigmentation, increase in post-injection symptomatology, infection); and systemic (transient hyperglycaemia, leukocytosis)^{40,45}. Likewise, it seems possible that the mechanical integrity of the tendon could be affected⁴⁰.

Systematic revisions published on the effect of infiltrations of corticosteroids in epicondylitis and tendinopathy of the rotator cuff, have confirmed the initially beneficial effect (3 weeks) but do not show benefits in terms of long-term results and/or relapse rates^{40,46}.

Tendon ruptures have been described after infiltrations of corticosteroids, in particular in the Achilles tendon. Although studies suggest that corticosteroids reduce the tensile strength of the tendon, theoretically favouring rupture, these findings have been questioned by several authors due to the lack of controlled studies^{39,40}.

There is no bibliography at present that can support the systematic use of corticosteroids in tendon pathologies, so its correct indication depends on careful clinical medical evaluation that is rational and individualized for each case⁴⁵.

Heparin

Heparin is a glycosaminoglycan formed by the union of D-glucuronic acid and D-glucosamine. It is found naturally in the lungs, liver, skin and mast cells. It is a well characterised anticoagulant and has prophylactic and therapeutic effects on arterial and venous thrombosis⁴⁷. Theoretically, heparin in tendon pathologies, and particularly in acute pathology, can help reduce adhesions and transudates of fibrin⁴⁰.

Williams et al. (1986) observed, in a model of chronic Achilles tendinopathy in rabbits treated with heparin, that the orientation of the collagen fibres had improved, while cellularity and neovascularisation had decreased^{40,48}. Later, Tatarski and cols. (2001) studied the effect of heparin in a model of chronic Achilles tendinopathy in rats. But in this study, heparin seemed to have a degenerative effect, without avoiding the degenerative process of the same^{40,47}. There is no sufficient scientific evidence to justify the systematic use of this therapy^{39,40}.

Dextrose

Hyperosmolar dextrose has been used for years as part of prolotherapy treatments for chronic musculoskeletal pain. Prolotherapy is a technique in which a small amount of an irritant solution is injected around the insertion of the tendon or ligament^{49,50}. It is speculated that dextrose causes a proliferative cellular response due to the greater osmolarity of the solution with respect to the interstitial tissue⁵⁰, inducing an inflammatory process that would facilitate the production of growth factors and favouring the proliferation of fibroblasts and increasing the production of extracellular matrix⁵¹. In the area of tendinopathies, series have been published on adductor tendinopathy in football and rugby players, patellar and Achilles tendinopathy, which were satisfactorily treated through prolotherapy with dextrose⁵¹.

A preliminary study published in 2007 by Maxwell et al., modified the technique by echographically guided intratendon injection, the intention being to induce an inflammatory reaction and initiate the healing process and the subsequent collagen synthesis. The study was conducted on patients affected with chronic tendinosis of the Achilles tendon, and significantly reduced the pain at rest and during load-bearing activities. Despite the clinical interest of these results, we should mention the limitation that the study lacked a control group⁴⁹.

Similar results have been observed in patients affected by chronic fasciitis plantar in which infiltration was conducted through echographic control of dextrose. Like the previous case, the study lacked a control group and randomised protocol⁵⁰.

Later, the same group published a two-year clinical and echographic monitoring of Achilles tendinopathy patients (insertional and tendon body) treated through intratendon injection of dextrose under echographic control⁵¹. A significant improvement in the pain was observed in both cases (insertional and tendon body) at rest and in everyday activities. From an echographic point of view, a reduction in the size and severity of the hypoechoogenicity and neovascularisation was obtained. However, the study lacked a control group and randomised protocol⁵¹.

In summary, more data from controlled and randomised studies are necessary before this treatment can be recommended.

Prolotherapy with glucose/ropivacaine/lidocaine

Prolotherapy is a technique in which a small amount of an irritant solution is injected around the insertion of the tendon or ligament. A random study was recently published in which a comparison was made between the effectiveness of eccentric exercise and application of a combination of glucose, ropivacaine and lidocaine through prolotherapy and a combination of both (eccentric exercise plus prolotherapy) in non insertional Achilles tendinopathy patients⁵². Prolotherapy, and especially prolotherapy combined with eccentric exercise provoked a faster clinical improvement than isolated eccentric exercise. However, the results at 12 months, evaluated via VISA-A, were similar in both cases. Like in most conservative treatments of tendon pathologies, more studies are necessary in order to evaluate their efficacy.

Aprotinin

Aprotinin is broad spectrum protease inhibitor. It is commonly used in heart surgery for prophylactic reduction of blood loss⁴⁰.

In the literature there are two studies, both randomised with a control group, and with a number of subjects of about 100. Both studies showed significant benefits for Achilles (insertional and paratendinopathy) and patellar tendon (insertional and tendon body) pathology. The authors suggest that the inhibition of the enzymes that degrade the tendon is the mechanism that favours the repair response⁴⁰. However, aprotinin (Trasylol) was withdrawn from the market in 2008.

Polidocanol

Hoksrud et al. (2006) sustain that the origin of the pain in chronic Achilles tendinopathy is related with neovascularisation. Sclerosis with polidocanol was shown to be effective at reducing the pain by, presumably, reducing neovascularisation and sensory innervation accompanying the same^{5,40}.

These findings made the hypothesis plausible that the surrounding vessels and nerves were responsible for the pain in zones with tendinosis. To confirm this, they conducted different studies and experiments using small volumes of a sclerosant of vessels outside of the tendon (polidocanol), observing results that, both in the short and long term, were positive⁵.

The stipulated period necessary for rehabilitation after receiving an infiltration of sclerosant includes from 1 to 3 days of rest. It will not be until after 2 weeks that the maximum load can be applied on a tendon level. At present, this technique can be considered experimental for two reasons: the procedure is technically demanding and randomised and controlled studies have not been published⁴⁰.

Glyceryl trinitrate

Some studies have recently been published on Achilles tendon, forearm extensors and supraspinatus tendon pathologies. In comparison with the control group, an

improvement was observed in the pathology of the upper limb with the use of glyceryl trinitrate. The action mechanism is uncertain, although the authors speculate that there is an increase in the vascularisation by vasodilatation⁴⁰.

Polysulfated glycosaminoglycans

Improvements have been described in the literature in the pathology of the Achilles tendon in humans and of the superficial digital flexor tendon in horses after treatment with polysulfated glycosaminoglycans (PSGAG). In the study made of humans, PSGAG was compared with oral indomethacin. In monitoring for one year, 66% of the PSGAG group presented a good response, as opposed to 33% of the indomethacin group. Among other methodological aspects, such as the absence of a control group, the study was limited to an evaluation of the peritendinous pathology. More data is necessary before recommendation of this treatment^{39,40}.

Autologous growth factors (platelet rich plasma)

The use of autologous growth factors has raised, in recent years, great expectations given the apparently good clinical results obtained. It is believed that this can favour the healing process through regeneration of collagen and the stimulation of well ordered angiogenesis^{40,53}.

The factors can be administered in autologous blood or platelet rich plasma (PRP) form. Edwards et al described the use of autologous blood infiltrations in chronic epicondylitis with good results. However, a recent systematic revision with respect to its use in chronic Achilles pathology showed major evidence that analogous blood infiltrations do not improve pain or functions^{54,55}.

With respect to PRP, the same revision showed limited evidence with respect to its use in chronic tendon pathologies⁵⁴. In a previous study by the same group, in patients treated with eccentric exercise, the use of PRP did not show improvement in function or pain after the use of PRP, compared with injections of saline⁵⁵.

In addition, there are many unanswered questions in the field of the factors derived from PRP: what is the best volume and frequency for application of the same?⁵⁵.

Finally, we should remember that the use of growth factors is specifically regulated by the WADA⁵⁶.

Stem cells

There is at present major research interest in the role that stem cells might play in the treatment of tendon injuries. There are two basic types of stem cell, "embryonic" (pluripotent, although the research is restricted for ethical reasons) and "postnatal"^{40,53}.

Postnatal stem cells are subdivided into haematopoietic and mesenchymal stem cells. Mesenchymal stem cells have the capacity to differentiate into numerous cells including tenocytes, chondrocytes and fibroblasts. That is why they present such interesting potential as a future alternative treatment^{40,53,57,58}.

Mesenchymal stem cells have been shown to be capable of promoting the healing of the tendon in animal models with acute tendon injuries^{40,58}. In this technique, stem cells were obtained from the bone marrow and were implanted under echographic control in the body of the tendon injury.

Studies have not been published of the results in the long term, but the short term results are promising⁵³.

High volume image guided injections

In recent years, injections have been described of volumes between 20 and 50 ml of a combination of bupivacaine, hydrocortisone and saline as a treatment for different tendinopathies. For both Achilles and patellar pathology, the authors suggest that the injection of these volumes produces a "local mechanism effect" that destroys the neovascularisation, also damaging the accompanying innervations both through direct traumatism and ischemia; which causes an immediate improvement in the patient and permits the initiation of eccentric exercise^{59,60}.

The stipulated period necessary for rehabilitation after receiving a high volume infiltration includes from 1 to 3 days of rest. It will not be until the second week that the maximum load can be applied on a tendon level. At present, this technique could be considered experimental for two reasons: the procedure is technically demanding and randomised and controlled studies have not been published.

Rehabilitation treatment

Cryotherapy

The use of cryotherapy on an acute tendon injury is a common practice⁴⁰. Ordinarily it is applied in the form of crushed ice packs, chemical ice packs, whirlpools, contrast pools and ice massages⁶¹. However, as with many of the therapies used, few studies have analysed their real utility from a scientific perspective^{40,61}. It is believed that cold reduces the blood flow in the tissue, pain, nerve conduction speed, the metabolic rate of the tendon and therefore, the edema and inflammation of an acute injury^{40,49}. The main benefit is postulated to be analgesia, which might justify its popularity⁴⁰.

Heat

Like cryotherapy, this is the other commonly used treatment in tendon pathologies⁴⁰. It is traditionally divided into two categories: superficial and deep. Superficial includes hot packs, infrared lamps, whirlpools, paraffin baths and fluidotherapy. Deep heat includes ultrasound and diathermy⁶¹.

Ultrasound has a thermal effect on the tissue, provoking local warming, although this can be attenuated if pulsed or intermittent. Despite the popularity of ultrasound, there is little scientific evidence to justify its use⁴⁰.

There are three types of diathermy: longwave, shortwave and microwave. The use of longwave has no clinical utility at present, due to the risk of burning. With respect to shortwave and microwave, there is nothing in the literature that describes any impact on the tendon repair process⁴⁰.

Laser

Some authors have advocated the use of low intensity 'cold' laser in the treatment of tendinopathies. However, the results are contradictory and therefore laser cannot be recommended until new evidence clarifies its role^{40,61}.

Manual therapy

Some manual therapies are popular in the treatment of tendon injuries. The two most common are deep transverse massage (popularized by Cyriax) and soft tissue mobilization⁴⁰.

Deep transverse massage has been the object of revision by Cochrane. Only two randomised studies have been found of sufficient quality for inclusion, one in the treatment of tendinopathies of the extensor carpi radialis (epicondylitis) and the other in the treatment of the iliotibial band friction syndrome. In neither of these did deep transverse massage show any benefit for the control group with respect to pain, force or functionality, although the conclusions were limited by the small size of the sample⁴⁰.

Soft tissue mobilization consists of mobilization by massage of the area around the tendon to stimulate a contribution of blood to the area around the injury, thus helping to heal the tendon. In any case, no studies can justify the use of this technique⁴⁰.

Braces

The use of heel supports is a frequently used treatment as an adjuvant in Achilles tendon pathologies. There is only one randomised article. No differences were observed between the use of heel supports and the group that did not, neither at 10 days or at two months⁴⁰.

In epicondylitis, the use of braces was the subject of a Cochrane revision, which included five randomised studies but there was insufficient evidence to justify their use. In tendinopathy of the posterior tibial tendon, the use has been recommended of a support for the medial longitudinal arch of the foot. There are no controlled studies in this respect.

Eccentric exercise

Eccentric exercise causes an active increase in the length of the musculotendinous joint⁴⁰.

The improvement in pain based on an eccentric programme has been demonstrated in the treatment of Achilles tendinopathy but not in that of the patellar tendon. However, as we shall see later, promising results have been found for the use of eccentric exercises as an approach to tendinopathies in terms of the patellar tendon and, recently, for long term evolution tendinopathy of the supraspinatus. The Curwin group in 1980 was the first to describe it and it was later demonstrated by Alfredson^{1,62}. We can establish several hypotheses for the good results obtained by means of eccentric exercise:

- Increase in thickness of the tendon (or maintenance) and its traction force, which would favour the posterior recuperation of its normal structure.
- A stretching effect on the myotendinous unit and consequently less tension.
- Pain in the eccentric exercise that may be associated to a perception disorder.
- One final explanation, associated to vasculonervous theory, tells us that through the use of eccentric exercises the nerves and vessels around the injured zone are broken and disappear, and they therefore do not transmit the pain.

Although among the Scandinavian population eccentric exercises have been shown to be highly effective⁶³, in the study made by another English group its efficacy reached 60%⁵⁸.

Electrotherapy

The physiological effect of electricity can vary depending on the polarity, frequency, pulse duration, wavelength, intensity, cycle, positioning of electrodes and time of treatment⁶¹.

Interest has increased in recent years, given the apparently good results obtained for so-called percutaneous intratendon electrolysis (PIE). Theoretically, it consists of provoking an electrochemical reaction (alkaline until liquefaction) in the region of the degenerated tendon through application of high intensity galvanic current via cathode needles (negative pole). In Spain, this technique is becoming a common tendency in all types of tendon pathologies. Recently, Sánchez Ibáñez JM (2008) reported satisfactory results in patients affected by chronic insertional patellar tendinopathy after 15 to 17 sessions of PIE over a period between 2 and 6 weeks. The action mechanism proposed was dissociation of the water and salt molecules in their constitutional elements to give rise, through ionic instability, to the formation of sodium hydroxide molecules. These sodium hydroxide molecules produced on an active electrode level would provoke a highly localised inflammatory response only and exclusively in the treated region, thus facilitating a phenomenon of fagocytosis and posterior regeneration of the tendon⁶⁴.

However, we have not found in the literature any study that justifies the use of intratendon galvanic current in the treatment of either acute or chronic tendon pathologies.

Extracorporeal shock waves

The use of extracorporeal shock waves has become more common in recent years, particularly in calcifying tendinopathies^{40,65}.

Recently, it has been demonstrated that in the treatment of Achilles tendinopathy, the combination of eccentric exercise and repeated low energy shock wave treatment is more effective than isolated eccentric exercise⁶⁶.

However, there is little evidence for other tendon disorders^{40,61}.

Hydrokinesitherapy

We have not been able to find in the literature any studies supporting the use of hydrokinesitherapy in acute or chronic tendon pathologies.

Advocated for non load-bearing, at present, the use of swimming pools for such exercise is being displaced by anti-gravity treadmills; as they are cheaper, hygienic, easy to maintain and adaptable to any sports facility or treatment.

These are treadmills that can reduce body weight by up to 80% through the creation of a sealed compartment. This enables non load-bearing exercise from very early phases during rehabilitation until high intensity training thus minimizing articular load.

Achilles tendinopathy (non insertional)

As we have commented, tendon injuries, and especially Achilles tendinopathies, originate from repeated microtraumas that lead to failure in the mechanical efficiency of the tendon fascicles^{26,67,68}. These microtraumas cause in the degeneration zone an inflammation (which as explained earlier, have not been made objective in tendon injury production models) and a necrosis that could produce small ruptures of the tendon structure in some cases³⁹.

As is known, the Achilles tendon is able to support up to 17 times the body's weight⁶⁷. When running, it can support up to 10% stretching of its length at rest without suffering changes^{69,70}. It has also been shown that during the running phase, the Achilles tendon is subjected to a load equivalent to 6-8 the individual's body weight^{71,72}, and although most laboratory studies refer to tendons that have been subjected to constant tractions, there is no doubt that the submission of the Achilles tendon to strong repeated loads provokes the injury.

Etiology and risk factors

When speaking of etiology we should mention intrinsic factors such as misalignments, biomechanical imbalances, etc.; and extrinsic factors that mainly include traumatic causes, training errors, environmental factors, etc.^{8,16}.

Intrinsic factors

Hypoxia is considered a determinant etiological factor that, in the case of the Achilles tendon, is accentuated by its peculiar anatomical design, which causes the most central portion of the tendon, approximately some 4 cm from its insertion in the calcaneal zone, to be more vulnerable during repeated impact actions. Given the structure of the tendon, it is in this zone that most strangulation of vessels occurs and therefore the greatest ischemic changes^{67,73}.

So, misalignments of the hip, knee, ankle and foot produce more accentuated efforts for the Achilles tendon to cope with, consequently leading to the risk of injury^{23,24}.

We could especially stress the pronation of the foot, as this has been most associated to this pathology by several authors^{67,74,75}. Also considered in several studies is the heel varus along with medial rotation of the tibia, knee varus, femoral anteversion, etc.⁷⁶.

Meanwhile, the resting tone of the triceps surae, either due to weakness or imbalance, can alter the extensibility of the muscle and tendon complex and impede absorption of impacts by the same, and also increase the degree of pronation with the consequent risk of injury (table 4).

Extrinsic factors

Of the extrinsic factors, the most significant could be poor planning of the load or training sessions. So, both the amount of repeated effort without adequate rest, and the quality of the efforts, are determinant in the appearance of pathologies of the Achilles tendon^{41,71,77}.

Table 4 Summary of intrinsic factors associated with injuries through overuse of the Achilles tendon**Misalignments**

- Hyperpronation of the heel
- Flat foot or pes cavus
- Genu varum or valgus

Muscular imbalances and/or weakness**Inextensibility of soft tissue****Loose joints****Excess weight****Blood supply: ischemia or hypoxia**

From Kader (2005)⁷⁶ and Jurado & Medina (2008)¹⁰.

**Figure 1** Longitudinal exercise on the peritendineum sheath.

Also, and in the same section, we can make reference to inadequate sports shoes, as poor distribution of loads or poor absorption of the impact produced by the same can lead to injury^{68,76} (table 5).

Clinical evaluation and diagnosis

As well as the aforesaid evaluation and exploration criteria and as we shall also see for patellar tendinopathy, other measurement and quantification methods are considered to determine the severity of the injury that we are analysing. Mafulli et al. (1998) have chosen pain, inflammation and the deterioration of performance, as the clinical seal³.

The VISA-A scale enables a clinical classification of Achilles tendinopathy based on symptomatic severity, functional capacity and sporting capacity³¹.

Pain in the Achilles tendon and its functional implication were evaluated the same way as established by Blazina et al. (1973) with the patellar tendon. In state 1, the pain only appears after the sporting activity and does not influence the sportsperson's performance; in state 2, the patient presents pain at the start of the sports activity but this disappears in warm-up and neither does it have a significant effect on sporting performance; in state 3, the pain is present during and after the sports activity meaning that the sportsperson may even be forced to stop doing said sports activity⁷⁸.

The VISA questionnaire for Achilles tendinopathies (annex 1) consists of 8 items with an evaluation range from 0 to 100. The most satisfactory state would correspond to a

Table 5 Summary of extrinsic factors associated with injuries through overuse of the Achilles tendon**Training errors**

Excessive training time, poor recuperation, deficient technique, fatigue etc.

Excessive workload (many repetitions, many similar exercises, etc.)

Inadequate equipment: footwear, playing surfaces.

From Kader (2005)⁷⁶ and Jurado & Medina (2008)¹⁰.

score of 100 and as we approach 0 we are getting nearer to a worse or less satisfactory state of the tendon. Both the clinical classification by Blazina et al. (1973) and the Victorian Institute of Sport Assessment scale have been validated by the scientific community^{31,78} Although the VISA-A scale has been translated and validated in several languages, it has not yet been validated for Spanish or Catalan³³⁻³⁷.

Conservational treatment

There is much controversy regarding the conservational treatment of non insertional Achilles tendinopathy (table 6). A revision by the Cochrane Group in 2001, however, found little evidence to justify the use of any of the most commonly used therapies for this pathology^{39,79}.

Treatment in acute phase

In acute phase, the priority is to get the tendon to acquire the adequate extensibility and viscoelasticity and, in the cases of peritendinitis, to lessen the inflammatory component of the sheath. Therefore, before introducing eccentric exercise to the protocol, condition the structure in accordance with the following steps:

- Bicycle or exercise without impact to warm the tendon.
- Manual therapy.
 - Mobilization of the articulations of the ankle and foot + warming of tendon prior to treatment session.
 - Transversal and tendon extensibility exercise prior to eccentrics (Fig. 1).
 - Longitudinal exercise on the peritendineum sheath.
- Stretching in active tension of the triceps surae prior to eccentric exercise.
- Relaxation massage of calves/soleus/sole of the foot.

Eccentric exercises. Treatment through eccentric exercises has presented promising and very positive results in the short and medium term (unlike concentric treatment) in studies conducted with patients suffering tendinopathy 2-6 centimetres above the level of insertion with the calcaneus, but not in those whose tendon pain appears precisely on the level of insertion^{63,80,81}.

Table 6 Degrees of recommendation for treatment of non insertional Achilles tendinopathy

<i>A degree recommendations: treatment options that demonstrate strong evidence (studies of level I or II)</i>		
No option meets this criterion		
<i>B degree recommendations: treatment options that demonstrate some evidence (studies of level III or IV)</i>		
Surgical treatment of the recalcitrant tendinopathy		
<i>C degree recommendations: treatment options that demonstrate poor or contradictory evidence (studies of level IV)</i>		
Eccentric exercise	Glyceryl trinitrate	Injection sclerotherapy/prolotherapy
<i>D degree recommendations: Insufficient evidence for recommendation (studies of level I or II)</i>		
Rest and modification of the activity	Ultrasound	
Shock waves		Low level laser
Infiltrations with corticosteroid	Platelet rich plasma	
Injections of aprotinin		

From Courville et al. (2009)⁷⁹.

The criteria that establish the level of recommendation in accordance with the level of scientific evidence are defined in table 9.

The protocol used in this case, regardless of the type or number of exercises performed, is the following (standard protocol proposed by Norregaard et al., 2007⁸⁰, Alfredson et al., 1998⁶³ and Öhberg et al., 2004⁸¹):

- Realization of the exercises for 12 consecutive weeks (if the player is in the final stage of recovery, 12 weeks shall be maintained from this moment on).
- Realization of the exercises 2 times a day 7 days a week.
- Six series of 10 repetitions with downward movement (eccentric phase) on the affected leg or two legs, and the upward movement (concentric phase) on the healthy leg or two legs.

Patients know that they can perform the protocol with pain and that they can suffer delayed onset muscle soreness during the first sessions, but as the exercise is repeated in the following sessions the effect disappears^{82,83}.

The load can also be increased by adding a backpack containing weights to increase the intensity of the exercise.

After 12 weeks of eccentric training the pain is reduced and the sportsperson returns to their level prior to the injury¹.

Some studies recommend not training or playing at a high competitive level for the first eight weeks of application of treatment by protocol of eccentric exercise⁷³, while others allow players to continue practicing sport on a daily basis from the first day it starts. The latter obtain better results after 12 months of monitoring.

Although we commented that the exercises can be done with pain or irritation, it is important for the intensity of the proposed exercises to progress gradually.

As the eccentric exercises are successfully completed on the table, work will begin on daily eccentric self-bearing exercise.

In acute phase tendinopathies we use the Alfredson protocol (1998) that we just defined, although in these cases given the aggressiveness of the protocol our preference is for eccentric exercise with the help of a physiotherapist on the table, manually and for the first week in degravitation.

We shall also use variants of the Alfredson et al. protocol (1998)⁶² using the mechanically vibrating platform at 35 Hz^{84,85}, once these exercises can easily be done without vibration, as suggested by the author.

Several studies have been conducted with control groups that seek to compare neuromuscular strength exercises with mechanical vibrations with those done with the conventional load. In almost all cases, authors show that there were considerable gains in strength, and also in neuromuscular efficiency⁸⁴⁻⁸⁶ (Fig. 2).

Partial weight-bearing exercise. In this section of acute phases of Achilles tendinopathies we will work with the anti-gravity treadmill, adjusted to the patient's functional possibilities.

Electrotherapy

- Post sports activity or post treatment session galvanic currents with positive pole close to the area of pain or inflammation.
- US (pulsating at 0.55W/cm² post-session. Never in any case more than 2 min of treatment).
- TENS or interferential combined with cryotherapy. These latter types of current are applied on days when endogenous guided microregeneration is not applied.
- Endogenous guided microregeneration is an applicable technique in acute cases, when after 3 or 4 treatment sessions the pain persists. It consists of an alternating-wave type of current, two-phase and modulated frequency, which is applied in intra-tendon, intramuscular and/or transcutaneous fashion using needles for analgesia and regeneration of soft tissue.

Cryotherapy. Applied in the initial phase 3 or 4 times a day.

Treatment in chronic phase

Before starting the guide to eccentric exercises, we always recommend work to condition the tendon structure:

- Bicycle or work without impact to warm the tendon.



0	Manual eccentric	The physiotherapist does the eccentric exercises on the player on the table and progressively in accordance with tolerance	
1	Achilles eccentric	With the foot horizontal on the flat of the step and the knee bent a max. of 50 to 10° perform the downward movement very gradually for about 10 to 15" and keep down for about 3-4". Then raise only as far as the horizontal with the knee bent the same and without passing the line of the step	
			
2	Achilles eccentric	As for exercise 1 but including mechanical vibration at 35 Hz.	

Figure 2

- Manual therapy.
 - Mobilization of the articulations of the ankle and foot.
 - Transversal and extensibility exercise of the collagen fibres.
 - Massotherapy to activate the triceps surae.
 - Stretching with active tension of posterior chain of lower limbs (Fig. 3).

Guide to eccentric exercise. In chronic pathology we start directly with the Alfredson et al. protocol (1998)⁶³ (exercise number 1). The eccentric exercises from number 2 to number 3 are done in accordance with clinical evolution.

We propose variant eccentric exercises that can be done at early phases of the treatment protocol for chronic tendinopathies and prior to incorporation in training (eccentric exercises from number 4 to 7 in accordance with the player's evolution and tolerance) (Fig. 4).



Figure 3 Transversal and extensibility exercise of the collagen fibres

Partial weight-bearing exercise. We will work with the anti-gravity treadmill, adjusted to the patient's functional possibilities.

Electrotherapy. Post sports activity or post treatment session galvanic currents with positive pole close to the area of pain or inflammation.

Shock waves. Five to 10 tendon pathology sessions that do not improve with standard treatment. Shock wave treatment is not to be done at the same time as percutaneous micro-electrolysis treatment, as both produce aggressive effects on the tendon structure and doing both could be too risky.

Cryotherapy. In the initial phase 3 or 4 times a day and in the non initial phase post sports activity.

Return to competition

Players should satisfy certain requirements before being declared fit following a tendon injury as we have been describing until now and thus be able to return to competition in normal conditions and avoid possible relapses. One of the criteria is in relation to the VISA scale:

- People with a score lower than 60 should not return to work on the field.
- People must have a score of over 80 before rejoining the rest of the group.
- There must have been an improvement of at least 30 points since the first time the questionnaire was answered, as long as the overall total is more than 70 points.

Meanwhile, the subjective sensation of pain on doing eccentric exercise on the Achilles tendon, as recommended by Young et al. (2005)² – exercise number 1 of those




3	Achilles eccentrics		As exercise 2 but including electrostimulation of the sural triceps
4	Two-footed reverence		Standing with heels on the ground. Simultaneously bend the hips, knee and dorsal flexion of the ankle lifting the heel as little as possible (without pain or with tolerable pain). Maintain end position for 3-4" and then return to the starting position
5	One-footed reverence		As exercise 5 but now support with just one foot
6	Backstep		Starting in front of the step, take a step backwards using the affected leg, in such a way that support is first on the tip of the foot and then gradually shift the weight of the body onto the rest of the foot as the body is raised onto the step. Simultaneously, the front foot slightly helps with the lifting phase of the body until it is above the step and once again supported by both legs
7	Backstep		As exercise 6 but with mechanical vibration at 35 Hz

Figure 4

proposed earlier – should reduce by at least half with respect to the start of treatment, according to the subjective pain scale, scored from 0 to 10.

Also, the following requirements should be satisfied:

- Adequate levels of muscle strength and volume.
- Disappearance of neovascularisation around the tendon.
- Completion of at least 5 complete training sessions with the group.

Secondary prevention exercises

Once having rejoined work with the rest of the group, any players that have suffered or are diagnosed with Achilles tendinopathy at any time of the season should continue and maintain preventative exercises in order to avoid relapses of the injury for at least 12 weeks at sessions three times a week, as recommended by the existing biography¹.

This maintenance work will feature the following characteristics:

- The main exercises done in this maintenance phase will be exercises number 1, 2 and 3 of those outlined previously in the annex of eccentric exercises for Achilles tendinopathy.
- They will be done at least three times a week, before training sessions and after doing a specific warm-up for the aforesaid exercises.
- At the end of the sessions manual relaxation shall be done along with exercises for the extensibility of the Achilles tendon, at least two times a week.

In cases in which the troubled player follows the same training programmes as his/her team-mates, the following prophylactic measures should be taken:

- Bicycle or work without impact to warm the tendon, always before training sessions.
- Transversal and extensibility exercise of the tendon before the session on a compulsory and daily basis.
- Massotherapy to pre-activate the triceps surae.
- Manual eccentric exercise 3-4 × 15 rep. alternating execution speed.
- Stretching with active tension before training sessions.
- Eccentric exercises combining two of the types of exercise explained, number 1 with number 4, number 2 with 5, etc. before training sessions.
- Start of phase with impact on specific playing surface shortly before the rest of the group and more gradually.
- At the end of training sessions always end with relaxation of triceps surae and stretching with passive tension.
- Systematically end sessions with 15' of cryotherapy.

Primary prevention exercises

Although it is true that in recent years there has been sufficient scientific evidence to show that a certain type of exercise done simultaneously to strengthening and stretching of the muscle and tendon system prevents some injuries and improves certain pathologies of said structures, recent studies have also spoken of the possibility that they can lead to painful symptomologies in certain tendon structures, which until then had not occurred, after doing

the preventative muscle and tendon exercises in question⁸⁵. In those cases, this work started with tendon pathologies that echographically presented images of tendinosis, but as commented earlier, were not clinically painful.

As well as following the preventative exercises for Achilles tendinopathies, we shall offer certain recommendations that could help to avoid the appearance of this type of chronic pathology, especially in more aggressive periods, such as the preseason.

Questionnaires

It is useful to get players to answer a questionnaire showing such information as age, time practicing the sport, previous tendon injuries, time absent due to said injury, etc.

- Biomechanical analysis of standing on two feet, running and walking to see if there is an alteration in support, pes varus or pes valgum, anterior pronation, limitation in back movement, genu valgum etc.
- Study of footwear most frequently worn by each player.
- Study of the surfaces where training sessions are usually held during the season, especially during the preseason.
- Specific warm-ups before sessions; mainly recommending stretching with active tension and contrast at the start of the session and passive stretching at the end of the session.
- Include, at least two times a week, preventative exercises for Achilles tendinopathies. In the previously recommended stretching that will act on the muscle and tendon structure, an exercise will be included 2 times a week of 6 series of 10 repetitions with each leg of the previously explained eccentric exercise number 1 (Fig. 5).

This can be alternated only doing the downward phase (eccentric phase), the downward phase followed by the upward phase (concentric) only up to 90° or the downward phase followed by the upward phase until maximum flexion of the foot.

Patellar tendinopathy

Many authors described midway through the last century the relation between patellar tendinopathy and certain jumping and impact sports such as volleyball. Blazina et al. (1973) were the first to come up with the name, in 1972, “jumper’s knee”, a type of pathology associated to sports⁷⁸ in which the extensor apparatus of the knee is exposed to certain repeated, sudden and ballistic traumatism, at times at very high force.

Meanwhile, in growing individuals, tendinopathies on the level of this tendon are presented in the form of secondary ossification centres, either in the anterior tubercle of the tibia, called Osgood-Schlatter disease, or in the lower pole of the kneecap, what is known as the Sinding-Larsen-Johansson disease⁸⁷.

Etiology and risk factors in patellar tendinopathy

Intrinsic factors

It is indispensable before analyzing a problem with the patellar tendon to make an analysis of the whole lower

Table 7 Summary of intrinsic factors associated with patellar tendinopathy

Biomechanical disorders
• Excessive pronation of the foot
• Femoral anteversion
• Tibia vara
• High kneecap
• Increased angle Q
Rigidity of soft tissue
• Iliotibial band
• Vastus externus
• Triceps surae
• Hamstrings
• Tensor fasciae latae
Muscular dysfunctions
• Atrophy of vastus externus
• External rotators/ hip adductors

From Jurado & Medina (2008)¹⁰.

kinetic chain as any problem with the hip, ankle or triceps surae may cause manifestations in the knee. For example, flat feet generate a considerable increase in the reactive force on the forefoot and on the lower structures of the lower limbs that can be associated to patellar tendinopathies^{8,10,77}.

The most accepted theory is exhaustion through overuse, which leads to an increase in muscular rigidity with a reduction in the extensibility of the muscle and tendon complex and less capacity for rapid contraction which leads to a large increase in the traction on the tendon^{88,89}.

Several authors have associated patellar tendinopathy with atrophies of the quadriceps, patellar chondropathy, hypermobility of the kneecap, etc. However, the major deceleration at the moment of landing on the ground is the main aetiological factor in this type of pathology⁹⁰. In addition to this factor, there is also the type of training, surfaces, etc. Other authors allude to the underlying fat as the origin of pain as opposed to said tendon. This is one of the models for the production of tendon pain described on the opening pages⁹¹⁻⁹⁴.

Finally, there clearly seems to be a relation between the biomechanical imbalances of the kneecap and insertional patellar tendinopathies (table 7).

Table 8 Summary of extrinsic factors associated with patellar tendinopathy

Training
• Excessive workload
• Inadequately planned loads
Inadequate sports surfaces and materials
• Very hard or soft training surfaces
• Inadequate sports shoes

From Jurado & Medina (2008)¹⁰.

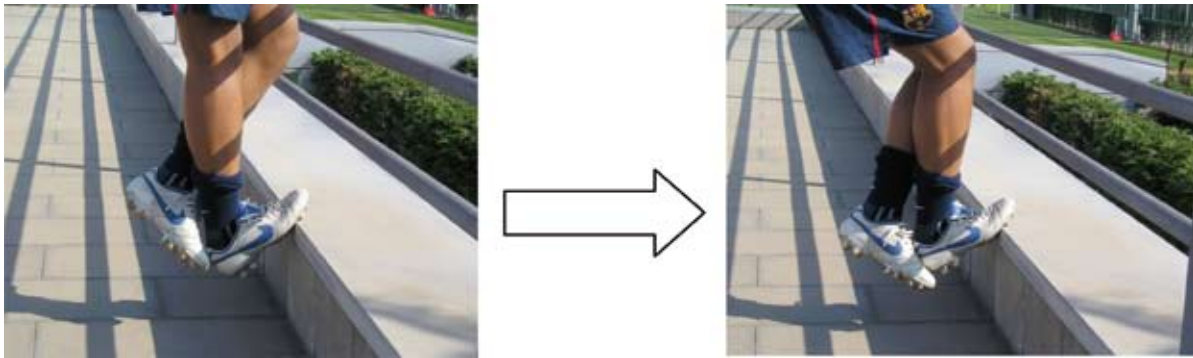


Figure 5

Extrinsic factors

As we have seen on previous pages, when speaking of Achilles tendinopathy, most authors agreed that poor planning of training loads is the main external factor that can influence the appearance of a patellar tendinopathy⁹⁵ (table 8).

Clinical diagnosis

The most used clinical classification for determining the seriousness of this injury is the Blazina et al. scale (1973)⁷⁸, based on criteria for the evolution of pain in accordance with functionality. Phases 1 and 2 generally respond well to conservational treatment, while patients in phase 3 require a prolonged period of rest and sometimes need to stop doing sport altogether. The VISA scale enables a clinical classification based on symptomatic severity, functional capacity and sporting capacity³¹.

In addition to evaluation by palpation of the patellar tendon and of Hoffa's fat pad, evaluation of the misalignment of the extensor apparatus, Insall Q-angle, pronation of the heel, asymmetry of lower limbs, atrophy of the quadriceps and muscular flexibility of the hamstrings, gastrocnemius and quadriceps, a VISA questionnaire (Victorian Institute of Sport Assessment) will be distributed to all of the players with a pathology of the patellar tendon. This questionnaire consists of 8 items with an evaluation range from 0 to 100. The most satisfactory condition would correspond to a score of 100.

We propose that the pain in the patellar tendon and its functional implication should be evaluated in accordance with the classification by Blazina et al. (1973)⁷⁸.

- In state 1, the pain only appears after the sports activity and does not influence the performance of the sports person.
- In state 2, the patient presents pain at the start of the sports activity but this disappears in warm-up and neither does it have a significant effect on sports performance.
- In state 3, the pain is present during and after the sports activity and the sports person might have to retire from their sports activity.

The evaluation will also be made with the VISA scale for patellar tendinopathy (annex 2). Although the VISA-A scale

has been translated and validated in different languages it has yet to be validated in either Catalan or Spanish³³⁻³⁷. However, the VISA-P has recently been translated into Spanish⁹⁶.

Treatment

In acute phase

Like for Achilles tendinopathy, in the treatment of acute pathology of the patellar tendon a sequence shall be applied consisting of the following sections:

- Bicycle or exercise without impact to warm the tendon.
- Manual therapy.
 - Relaxation massage of the crural quadriceps.
 - Mobilization of the kneecap + warm-up of the tendon prior to sports activity or treatment session.
 - Manual extensibility of the transversal tendon, and longitudinal for cases in which the paratendon is affected.
 - Stretching with active tension of the quadriceps. Also posterior chain (Fig. 6).

Guide to eccentric exercise. As with Achilles tendinopathies, exercise for patellar tendinopathies is based on an eccentrics protocol. As shown by the Curling Group⁶² for the Achilles in the 1980s; the Alfredson⁶³ and Cannell et al. Groups recently showed its usefulness for the patellar tendon.

Eccentric exercise causes greater hypertrophy than conventional concentric or isometric strength exercises⁸⁴⁻⁸⁶, something vitally important for the quadriceps in these injuries. The most clearly described protocols with the most promising results for tendinopathies are those referring to Achilles tendinopathy. We shall therefore base our work on these principles as we implement a system of eccentric exercises that we apply to patellar tendinopathy.

The protocol used in this case, regardless of the type or number of exercises done, is the following:

- Realization of the exercises for 12 consecutive weeks. If the player is in the final stage of recovery, 12 weeks shall be maintained from this moment on.
- Realization of the exercises 2 times a day 7 days a week.



Figure 6 Manual extensibility of the transversal tendon, and longitudinal for cases in which the paratendon is affected

- Six series of 10 repetitions with downward movement (eccentric phase) on the affected leg or two legs, and the upward movement (concentric phase) on the healthy leg or two legs.
- Manual eccentric exercise (n. 1). 4 series × 12 repetitions, alternating the speed of execution. The player will sit on the corner of the table, maintaining isometric contraction and it will be the therapist, using the arms, who will provide the resistance to generate an eccentric contraction. The player’s pain must be respected in this phase. As the manual eccentric exercises come to be tolerated, work can commence with the other eccentric exercises proposed below.

We stress the possibility of increasing the load (if there is no pain or irritation) by adding a backpack containing weight^{82,83} (Fig. 7).

Partial weight-bearing exercises: anti-gravity treadmill. In this section, and more specifically in the acute and sub-acute phases of the session, we will basically be working

with 60-70% of the body weight at low intensity on an anti-gravity treadmill.

Electrotherapy

- Post-sports activity or end of treatment session galvanic currents, mainly if the exercises are not very aggressive to the tendon. Applied with positive pole close to the area of pain or inflammation (as long as the paratendon is affected).
- US (pulsating at 0.55 W/cm² post-session and continuous at 0.50 W/cm² before the session. Never under any circumstances more than 2’ and 60 J of total treatment power).
- TENS or interferential combined with cryotherapy at the end of the session. These latter types of current will be applied on days when there is no application of endogenous guided microregeneration (technique described previously in the section on Achilles tendinopathy).

Cryotherapy. Applied in the initial phase 3 or 4 times a day.


Number	Name		
1	Manual eccentric		The player sits on the edge of the table and maintains an isometric contraction of the quadriceps with the knee fully outstretched. The therapist will attempt, using force, to get the knee to some 15-20° of flexion at average speed
2	Eccentric muscle stretching. Only downward		At first, the movement will always be made without pain and only downward. Once in the lowest position, this will be maintained for about 3-4 s
3	Eccentric muscle stretching. Downward and upward		As exercise 2 but including the concentric upward phase which shall be done at a faster speed

Figure 7



Number	Name		
4	Eccentric muscle stretching with electrostimulation		As exercise 2 but including electrostimulation in the quadriceps
5	Eccentric with machine		Work will be done on conventional quadriceps machines both for CCA and CCC with emphasis on the eccentric phase of the movement. This may or may not include electrostimulation. Starts with the knee completely extended and with downward movement, both for CCC and in CCA, until the recommended degrees of flexion to protect the femoropatellar joint. The downward movement must be very slow and the upward movement fast
6	Eccentrics on sloping floor		The player is positioned facing down the slope and will do a quarter of a squat on one foot. The downward movement should only be as far as there is no pain and some 15° of flexion will be held for about 3-4"
7	Eccentrics on sloping floor plus mechanical vibration		

Figure 8

In chronic phase

The same sequence will be observed as for the acute phase.

- Bicycle or work without impact to warm the tendon.
- Manual therapy.
 - Relaxation massage of the crural quadriceps.
 - Mobilization of the kneecap + warm-up of the tendon, prior to the sports activity or treatment session.
 - Manual extensibility of the transversal tendon, and longitudinal for cases in which the paratendon is affected.
- Stretching with active tension of quadriceps. Also posterior chain.

Guide to eccentric exercises

- Manual eccentric exercise as described in the acute phase of the protocol for patellar tendinopathy in acute phase 4 × 15 rep. alternating execution speed. The eccentric exercises will be done gradually, depending on the patient's tolerance, the sensation of pain and the complexity of the exercises.
- In the first sessions, emphasis shall be on the exercises in accordance with the explanation in the work protocol for patellar tendinopathies in acute phase.

Once completed satisfactorily, move on to exercises 3 (described in acute phase) and 4. Finally, before the re-adaptation phase and incorporation in training sessions

(in the case of players that could be absent for medical reasons), insist on exercises 5, 6 and 7 (Fig. 8).

Partial weight-bearing exercises: anti-gravity treadmill.

This will be done in the final phase of the recovery process and at the start of the re-adaptation phase, the initial exercise being low and medium intensity of impact.

Electrotherapy

- Post-sports activity or end of treatment session galvanic currents with negative pole close to the area of pain or inflammation (in case of the paratendon being affected).
- In this phase treatment can be continued with ultrasound therapy, laser therapy, as well as some kind of analgesic current applied in acute phases of the injury.

Cryotherapy. Applied 3-4 times a day.

Return to competition

As occurred for Achilles tendinopathy, the patient should satisfy certain requirements before being declared fit following patellar tendinopathy. In this case, they should also satisfy requirements in relation to the VISA scale:

- People with a score lower than 50 should not return to work on the field.
- People must have a score of over 60 before rejoining the rest of the group.

Table 9

Level of scientific evidence		Level of recommendation
1++	Systematic RCT meta-analysis or revisions of high quality, or RCT with a very low risk of subjectivity	A
1+	Systematic RCT meta-analysis or revisions of a good level, or RCT with a low risk of subjectivity	A
1–	Systematic RCT meta-analysis or revisions, or RCT with a high risk of subjectivity	None
2++	High quality systematic revisions of cohort studies or controlled cases, or studies of cohorts or controlled cases with a very low risk of subjectivity or possibility of the relation being coincidental	B
2+	Studies of cohorts or controlled cases with a low risk of subjectivity and moderate of the relation being coincidental	C
2–	Studies of cohorts or controlled cases with a high risk of subjectivity or possibility of the relation not being coincidental	None
3	Non analytical studies (clinical cases, series, etc.)	D
4	Expert opinions	D

RCT: randomised and controlled trial.

The evidence that can be extrapolated from studies is categorized with a level of scientific evidence, which can mean that the level of recommendation of some categories is classified lower. Thus, 1+ can be B, 2++ can be C and 2+ can be D.

- There must have been an improvement of at least 30 points since the first time the questionnaire was answered, in order to be declared medically fit, as long as the overall total is more than 60 points.

Meanwhile, the subjective sensation of pain on doing eccentric exercises number 1 and 6 of those proposed previously, should decrease by at least half with respect to the start of treatment, according to the subjective pain scale, scored from 0 to 10.

Also, the following requirements should be satisfied:

- Completion of at least 5 complete training sessions with the group.
- Recuperation of strength levels, plus the volumes of the muscle groups.
- Disappearance of the neovascularisation around the tendon.
- Realization of impacts with the ball and jumps made individually and without any irritation.

Preventative work

Although it is true that in recent years there has been sufficient scientific evidence to show that a certain type of exercise done simultaneously to strengthening and stretching of the muscle and tendon system prevents some injuries and improves certain pathologies of said structures, recent studies have also spoken of the possibility that they can lead to painful symptomologies in certain tendon structures, which until then had not occurred (doing the preventative muscle and tendon exercises in question⁹⁷).

In those cases, this work started with tendon pathologies that echographically presented images of tendinosis, but as commented earlier, were not clinically painful. It should be



Figure 9

commented that these studies were all done with Achilles tendinopathies, not patellar tendinopathies.

Therefore, rather than doing a series of preventative exercises for Achilles tendinopathies, we shall offer certain recommendations that could help prevent the appearance of this type of chronic pathology, especially in the most aggressive periods for such soft tissue, for example the preseason.

Questionnaires

It is useful to get players to answer a questionnaire showing such information as age, time practicing the sport, previous tendon injuries, time absent due to said injury, etc.

- Biomechanical analysis of standing on two feet, running and walking to see if there is an alteration in support, pes varus or pes valgum, lack of ADM in the articulation of the knee, limitation of extension, etc.
- Study of footwear most frequently worn by each player.
- Study of the surfaces where training sessions are usually held during the season, especially during the preseason.
- Specific warm-ups before sessions; mainly recommending stretching with active tension and contrast at the start of the session and passive stretching at the end of the session.
- Include, at least two times a week, preventative exercises for patellar pathologies acting on the muscle and tendon

system (6 series of 10 repetitions with each leg of the previously explained eccentric exercises number 2 and/ or 3) (Fig. 9).

Annex 1. Victorian Institute of Sport Assessment (VISA) per a lestendinopaties aquillees

The VISA-A questionnaire: An index of the severity of Achilles tendinopathy

IN THIS QUESTIONNAIRE, THE TERM PAIN REFERS SPECIFICALLY TO PAIN IN THE ACHILLES TENDON REGION

1. For how many minutes do you have stiffness in the Achilles region on first getting up?

100 mins

--	--	--	--	--	--	--	--	--	--	--

 0 mins POINTS

0 1 2 3 4 5 6 7 8 9 10

2. Once you are warmed up for the day, do you have pain when stretching the Achilles tendon fully over the edge of a step? (keeping knee straight)

strong severe pain

--	--	--	--	--	--	--	--	--	--	--

 no pain POINTS

0 1 2 3 4 5 6 7 8 9 10

3. After walking on flat ground for 30 minutes, do you have pain within the next 2 hours? (If unable to walk on flat ground for 30 minutes because of pain, score 0 for this question).

strong severe pain

--	--	--	--	--	--	--	--	--	--	--

 no pain POINTS

0 1 2 3 4 5 6 7 8 9 10

4. Do you have pain walking downstairs with a normal gait cycle?

strong severe pain

--	--	--	--	--	--	--	--	--	--	--

 no pain POINTS

0 1 2 3 4 5 6 7 8 9 10

5. Do you have pain during or immediately after doing 10 (single leg) heel raises from a flat surface?

strong severe pain

--	--	--	--	--	--	--	--	--	--	--

 no pain POINTS

0 1 2 3 4 5 6 7 8 9 10

6. How many single leg hops can you do without pain?

strong severe pain/unable

--	--	--	--	--	--	--	--	--	--	--

 no pain POINTS

0 1 2 3 4 5 6 7 8 9 10

7. Are you currently undertaking sport or other physical activity?

- | | | | |
|----|---|--|--------------------------|
| 0 | r | Not at all | POINTS |
| 4 | r | Modified training ± modified competition | <input type="checkbox"/> |
| 7 | r | Full training ± competition but not at same level as when symptoms began | |
| 10 | r | Competing at the same or higher level as when symptoms began | |

8. Please complete **EITHER A, B or C** in this question.

- If you have **no pain while undertaking Achilles tendon loading sports** please complete **Q8a only**.
- If you have **pain while undertaking Achilles tendon loading sports but it does not stop you from completing the activity**, please complete **Q8b only**.
- If you have **pain which stops you from completing Achilles tendon loading sports**, please complete **Q8c only**.

- A.** If you have **no pain** while undertaking **Achilles tendon loading sports**, for how long can you train/practise?
- | | | | | | |
|-----|-----------|------------|-----------|----------|--------------------------|
| NIL | 1-10 mins | 11-20 mins | 21-30mins | >30 mins | POINTS |
| r | r | r | r | | |
| 0 | 7 | 14 | 21 | 30 | <input type="checkbox"/> |

OR

- B.** If you have some pain while undertaking **Achilles tendon loading sport**, but it does not stop you from completing your training/practice for how long can you train/practise?
- | | | | | | |
|-----|-----------|------------|-----------|----------|--------------------------|
| NIL | 1-10 mins | 11-20 mins | 21-30mins | >30 mins | POINTS |
| r | r | r | r | | |
| 0 | 4 | 10 | 14 | 20 | <input type="checkbox"/> |

OR

- C.** If you have **pain that stops you** from completing your training/practice in **Achilles tendon loading sport**, for how long can you train/practise?
- | | | | | | |
|-----|-----------|------------|-----------|----------|--------------------------|
| NIL | 1-10 mins | 11-20 mins | 21-30mins | >30 mins | POINTS |
| r | r | r | r | r | |
| 0 | 2 | 5 | 7 | 10 | <input type="checkbox"/> |

TOTAL SCORE (/100)

%

Annex 2. Victorian Institute of Sport Assessment (VISA) Scale.

1. For how many minutes can you sit pain free?

0 mins

--	--	--	--	--	--	--	--	--	--	--	--

 100 mins

0 1 2 3 4 5 6 7 8 9 10

POINTS

2. Do you have pain walking downstairs with a normal gait cycle?

strong severe pain

--	--	--	--	--	--	--	--	--	--	--	--

 no pain

0 1 2 3 4 5 6 7 8 9 10

POINTS

3. Do you have pain at the knee with full active nonweightbearing knee extension?

strong severe pain

--	--	--	--	--	--	--	--	--	--	--	--

 no pain

0 1 2 3 4 5 6 7 8 9 10

POINTS

4. Do you have pain when doing a full weight bearing lunge?

strong severe pain

--	--	--	--	--	--	--	--	--	--	--	--

 no pain

0 1 2 3 4 5 6 7 8 9 10

POINTS

5. Do you have problems squatting?

unable

--	--	--	--	--	--	--	--	--	--	--	--

 no problems

0 1 2 3 4 5 6 7 8 9 10

POINTS

6. Do you have pain during or immediately after doing 10 single leg hops?

strong severe pain/unable

--	--	--	--	--	--	--	--	--	--	--	--

 no pain

0 1 2 3 4 5 6 7 8 9 10

POINTS

7. Are you currently undertaking sport or other physical activity?

- 0 Not at all
- 4 Modified training ± modified competition
- 7 Full training ± competition but not at same level as when symptoms began
- 10 Competing at the same or higher level as when symptoms began

POINTS

8. Please complete EITHER A, B or C in this question.

- If you have **no pain** while undertaking sport please complete Q8a only.
- If you have **pain while undertaking sport but it does not stop you** from completing the activity, please complete Q8b only.
- If you have **pain that stops you from completing sporting activities**, please complete Q8c only.

8a. If you have **no pain** while undertaking sport, for how long can you train/practise?

POINTS

NIL 1-5 mins 6-10 mins 7-15 mins >15 mins

-
-
-
-
-

0 7 14 21 30

OR

8b. If you have some pain while undertaking sport, but it does not stop you from completing your training/practice for how long can you train/practise?

POINTS

NIL 1-5 mins 6-10 mins 7-15 mins >15 mins

-
-
-
-
-

0 4 10 14 20

OR

8c. If you have pain which stops you from completing your training/practice for how long can you train/practise?

POINTS

NIL 1-5 mins 6-10 mins 7-15 mins >15 mins

-
-
-
-
-

0 2 5 7 10

TOTAL VISA SCORE

Cuestionario de valoración VIS A-P (Victorian Institute of Sports Assessment) : TEN DINOPATÍA ROTULIA NA

Este es un cuestionario para la valoración de la gravedad de los síntomas en individuos con tendinopatía rotuliana. El término "dolor" en el cuestionario hace referencia a la zona específica del tendón rotuliano.

Para indicar su intensidad de dolor, por favor, marque de 0 a 10 en la escala teniendo en cuenta que

0 = ausencia de dolor y 10 = máximo dolor que imagina.

1.- ¿Durante cuántos minutos puede estar sentado sin dolor?

0-15 min	15-30 min	30-60 min	60-90 min	90-120 min	>120 min
0	2	4	6	8	10

PUNTOS

2.- ¿Le duele al bajar escaleras con paso normal?

Sin dolor	0	1	2	3	4	5	6	7	8	9	10
	10	9	8	7	6	5	4	3	2	1	0

Dolor muy intenso

PUNTOS

3.- ¿Le duele la rodilla al extenderla completamente sin apoyar el pie en el suelo?

Sin dolor	0	1	2	3	4	5	6	7	8	9	10
	10	9	8	7	6	5	4	3	2	1	0

Dolor muy intenso

PUNTOS

4.- ¿Tiene dolor en la rodilla al realizar un gesto de "zancada" →
(flexión de rodilla tras un movimiento amplio hacia delante con carga completa del peso corporal sobre la pierna adelantada)



Sin dolor	0	1	2	3	4	5	6	7	8	9	10
	10	9	8	7	6	5	4	3	2	1	0

Dolor muy intenso

PUNTOS

5.- ¿Tiene problemas para ponerse en cuclillas?

Sin problemas	0	1	2	3	4	5	6	7	8	9	10
	10	9	8	7	6	5	4	3	2	1	0

Incapaz

PUNTOS

6.- ¿Le duele al hacer 10 saltos seguidos sobre la pierna afectada o inmediatamente después de hacerlos?

Sin dolor	0	1	2	3	4	5	6	7	8	9	10
	10	9	8	7	6	5	4	3	2	1	0

Dolor muy intenso/
Incapaz

PUNTOS

Cuestionario de valoración VIS A-P (Victorian Institute of Sports Assessment) : TEN DINOPATÍA ROTULIA NA

7.- ¿Practica algún deporte o actividad física en la actualidad?

PUNTOS

- 0 No, en absoluto
- 4 Entrenamiento modificado y/o competición modificada
- 7 Entrenamiento completo y/o competición, pero a menor nivel que cuando empezaron los síntomas
- 10 Competición al mismo nivel o mayor que cuando empezaron los síntomas

8.- Por favor, conteste A, B o C en esta pregunta según el estado actual de su lesión:

- Si no tiene dolor al realizar deporte, por favor, conteste sólo a la pregunta 8A
- Si tiene dolor mientras realiza el deporte pero éste no le impide completar la actividad, por favor, conteste únicamente la pregunta 8B
- Si tiene dolor en la rodilla y éste le impide realizar deporte, por favor, conteste solamente la pregunta 8C

8A.- Si no tiene dolor mientras realiza deporte, ¿cuánto tiempo puede estar entrenando o practicando?

- 0-20 minutos 6
- 20-40 minutos 12
- 40-60 minutos 18
- 60-90 minutos 24
- > 90 minutos 30

PUNTOS

8B.- Si tiene cierto dolor mientras realiza deporte pero éste no obliga a interrumpir el entrenamiento o la actividad física, ¿cuánto tiempo puede estar entrenando o haciendo deporte?

- 0-15 minutos 0
- 15-30 minutos 5
- 30-45 minutos 10
- 45-60 minutos 15
- > 60 minutos 20

PUNTOS

8C.- Si tiene dolor que le obliga a detener el entrenamiento o práctica deportiva, ¿cuánto tiempo puede aguantar haciendo el deporte o la actividad física?

- Nada 0
- 0-10 minutos 2
- 10-20 minutos 5
- 20-30 minutos 7
- > 30 minutos 10

PUNTOS

Puntuación Total: /100

Nombre:..... Fecha:

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