

# SPORTS INJURIES OF THE UPPER LIMBS

Rogério Teixeira da Silva

## ABSTRACT

*Sports injuries of the upper limbs are very common in physical activities and therefore, they need to be studied in detail, taking into consideration specific aspects of the types of sports practiced. Special attention should be paid to the dynamics of the shoulder girdle and the entire scapular belt, since the most appropriate treatment for athletes can only be provided in this*

*manner. This can also help to prevent recurrences, which can occur in some cases because athletes always seek to return to their pre-injury level of sports activity. This article will focus primarily on the management of upper-limb tendon injuries, from the physiopathology through to the new methods of injury treatment that are more prevalent in sports practice in Brazil.*

**Keywords** – Sports injuries; Shoulder; Elbow; Tendinopathy

## INTRODUCTION

Upper-limb injuries occur very frequently in sports and, in relation to many types of sports activities, orthopedists may need to have knowledge of their physiopathology in greater detail in order to achieve the best possible treatment. Although some sports that frequently cause upper-limb injuries are not played much in Brazil (such as the specific case of baseball, for which a vast body of published studies exists in the medical literature), others such as tennis, volleyball and handball also make great biomechanical demands on the shoulder. Such demands mean that this joint is subjected to supraphysiological forces during a good proportion of the sports movement. For example, at the time of the serve, an amateur tennis player may generate angular rotation forces of the order of 7,000 degrees per second during the acceleration phase<sup>(1)</sup>.

In this article, the main focus will be on specific diagnoses and physiopathology, which are important factors for understanding the treatment strategies. Specific treatments introduced more recently will also be mentioned, focusing particularly on treatments for tendinopathy, which is a condition very frequently encountered among athletes.

## Principal upper-limb injuries in sports:

### Adolescent athletes

Injuries to the distal epiphysis of the radius (gymnast's wrist)

Injuries to the proximal epiphysis of the humerus (Little Leaguer's shoulder)

Osteochondritis of the humeral capitellum (Little Leaguer's elbow)

*Os acromiale*

Shoulder instability (minor)

Shoulder instability (multidirectional)

Generalized joint weakness

Scapular dyskinesia

### Adult athletes

#### Shoulder

Fracture due to stress on the distal humerus

Shoulder instability

Pinching syndrome

Rotator cuff injuries (tendinopathy/rupture)

Injuries of the acromioclavicular joints (trauma and joint degeneration)

Scapular dyskinesia

#### Elbow

Medial and lateral epicondylitis

Orthopedist and Sports Physician; MSc and PhD in Orthopedics and Sciences from Unifesp; Coordinator of the Sports and Orthopedics Study Group (NEO), São Paulo; Medical Director of the Brazilian Tennis Confederation; President of the Sports Traumatology Committee of SBOT 2009/2010.

Correspondence: Rua Botucatu, 591, 18<sup>º</sup> andar, Vila Clementino, 04023-062 São Paulo, SP – E-mail: rogerio@neo.org.br – Web: www.neo.org.br

We declare that there is no conflict of interests in this article

Triceps tendinitis  
 Chondral injury of the humeral capitellum  
 Posterior interosseous compressive syndrome  
 Synovitis of the elbow

### **Wrist and hand**

Injuries to the triangular fibrocartilage  
 Tendinitis of the ulnar extensor of the carpus  
 Overloading of the carpal bone  
 Fracture due to stress on the ulna

## **SHOULDER INJURIES IN SPORTS**

It has been estimated that shoulder injuries account for 8% to 13% of all sports injuries<sup>(2)</sup>. In addition to visits to consultation offices, these injuries are often seen at walk-in clinics, as shown by a study conducted in Germany, with support from the local ministry of health. This study showed that between 1997 and 1999, a total of 124 cases of individuals with injuries requiring medical attendance were seen<sup>(3)</sup>. Out of the total number of injuries reported, 3.1% were sports injuries and the majority were reported as dislocations, torsions or ligament injuries (60%). It will be seen from the present paper that it is important to study sports injuries, even for physicians who are not specialists attending athletes alone.

This paper provides a summary of the main injuries encountered in daily practice, while taking into account that wide-ranging analysis of each specific type of injury would not be possible.

### **a) Subacromial pinching syndrome**

This disorder is frequently seen among athletes, particularly those who perform throwing mechanisms (volleyball, handball and tennis, among others). There are two types of pinching in clinical practice:

a1) Primary subacromial pinching: caused by the impact of the rotator cuff between the greater tuberosity and the coracoacromial arch or acromioclavicular joint. The causes are mainly anatomical abnormalities of the acromion (acromion type III), subacromial osteophytes and acromioclavicular arthrosis<sup>(4,5)</sup>. Neer classified such pinching into three stages:

Stage 1: characterized by edema and hemorrhage in the subacromial bursa and supraspinal tendon, as a result of repeated trauma (for example, the serve movement in tennis);

Stage 2: at this stage, the inflammatory process produces fibrosis and tendinitis in the distal insertion portion of the tendons;

Stage 3: characterized by partial or total rupture of the tendon (any of the components of the rotator cuff).

Even though this classification is old, it provides a very good idea of the evolution and prognosis of shoulder pains in athletes and should always be borne in mind when dealing with sports players with shoulder pains. Depending on the stage at which the injury currently is, different treatments will be proposed, going from exclusively clinical treatment to performing corrective surgery consisting of bursectomy or acromioplasty, among other procedures<sup>(6)</sup>.

a2) Secondary subacromial pinching: in sports, this type of pinching is particularly important, particularly among populations of young sports players (at the age of bone growth). Pains in the shoulder region that are attributed to primary pinching are often confounded with pain secondary to minor instability, and careful examination needs to be paid to the clinical examination. The main causes that can lead to secondary pinching are minor conditions of instability<sup>(7)</sup>, weakness acquired following episodes of trauma and inappropriate movement of the scapula, also known as scapular dyskinesia<sup>(8)</sup>.

From a practical point of view, for sports players, it is of interest to think of states of subacromial pinching and make a differential diagnosis with disorders that could cause secondary pinching: rotator cuff injuries, glenohumeral instability and scapular dyskinesia. It is essential to treat these disorders together, for sports players who make throwing movements, in order to achieve a good result from the treatment and allow the athlete to return to an adequate and desired sports level.

### **b) Scapular dyskinesia**

Although insufficient movement of the scapula during high throwing movements in sports is not a separate disorder, it is very important to bear in mind such information when thinking of pathological conditions of the shoulder. One of the authors who has studied this disorder most among sports players is Kibler<sup>(9)</sup>, and many of his papers speak of the importance of assessing scapular movement not only for treatment but also especially for injury prevention.

The clinical examination of scapular positioning and movement must be done by watching the patient from behind, without his shirt on, in order to observe the position of the scapula at rest and also dynamically, when the patient makes frontal elevation and lateral arm movements.

Abnormalities of scapular protraction and retraction movements are important factors in generating shoulder injuries during throwing movements in sports. Loss of the complete movement of scapular retraction into the thorax causes loss of the potency from stability during the preparatory phase of the throwing action, thereby diminishing the explosive power during the acceleration phase of the action. Failure to make the complete movement of scapular protraction from the thoracic wall increases the deceleration force of the shoulder during the throwing movement, which increases the chance of occurrences of pinching of the rotator cuff. This movement is especially important because these athletes usually present great tension in the posterior capsule of the shoulder<sup>(10,11)</sup>.

The treatment for this pathological condition is eminently clinical, through appropriate rehabilitation programs with the following objectives: adequate stretching of the posterior capsule of the shoulder, balancing of the muscle forces from internal and external rotators of the shoulder, and specific work for strengthening and proprioception of the scapulothoracic joint.

### **c) Rotator cuff injuries**

These are very common injuries among sports players who make throwing movements<sup>(12,13)</sup>. In Brazil, the main sports causing such injuries are tennis and volleyball.

Tendinopathy (going from inflammation to tissue degeneration) usually occurs more frequently in the younger population, while ruptures (partial or total) are seen more often in populations of sports players over the age of 40 years. For example, in a study by Lehman, shoulder pains were found in 24% of young tennis players (12 to 19 years of age), while the incidence was around 50% in the population over the age of 50 years<sup>(14)</sup>. This is because of the wear and dehydration that tendon structures suffer with advancing age, and this explains the importance of thinking in terms of prevention for this specific population.

Treatments for rotator cuff injuries may be complicated among sports players, particularly in relation to professional tennis players or amateurs who play regularly. The painful condition often does not correspond to what the imaging examinations say about the anatomical injury. From time to time, tennis players with

complete ruptures of a tendon (for example, the supraspinous tendon) who manage to play normally, practically without reporting any pain, may be encountered. It is especially important to bear this in mind among populations over the age of 50 years: such individuals may present good results from physiotherapeutic treatment, even in cases of complete rupture of a single tendon of the rotator cuff.

Good results from repair surgery on the cuff tendon have been presented in the medical literature, and such surgery can be performed both arthroscopically and as open procedures<sup>(15,16)</sup>. It is preferable to perform arthroscopic repair, but the technique should be chosen on a case-by-case basis, and the surgeon needs to be comfortable with the technique chosen. A good procedure performed using open surgery is without doubt preferable to poorly performed arthroscopy.

### **d) Glenohumeral instability**

Instability is also a form of injury that can be found among sports players who make throwing movements, and particularly cases of instability that can be considered to be long-term adaptations of throwing movements (such as previous microinstability that was caused basically by a deficit of internal rotation of the shoulder due to greater tension in the posterior capsule, which is very commonly observed among juvenile tennis players, for example). The most important diagnosis to make here is to determine whether the athlete presents glenohumeral internal rotation deficit (GIRD). This abnormality is characterized by diminished internal rotation of the shoulder, in comparison with the contralateral arm, and it is caused both by soft-tissue problems and by bone problems<sup>(17,18)</sup>. It is important to diagnose this abnormality in athletes early on: since shoulder injuries occur frequently in competitive life, the literature recommends preventive work whenever athletes presenting this deficit are encountered<sup>(19)</sup>.

The present article will not go into details about the different types of treatment for these lesions, if only because such a discussion would not fit within the scope of this review article. Many other articles in this journal have focused on the surgical approach to this pathological condition, and the treatment for it does not differ greatly from the management of injuries among populations that are not sports players.

### e) Proximal biceps tendon injuries and superior labral (SLAP) injuries

Over recent years, increasing numbers of these injuries have been observed, even though they have recently been a focus of discussion in the worldwide literature. There has been much discussion on proximal injuries of the biceps, including their classification. Snyder *et al*<sup>(20)</sup> initially classified these injuries into four groups, while today up to ten types of SLAP injury are envisaged. This in particular may be considered excessive, given that there should be one classification for guiding treatment<sup>(21)</sup>. In the more extensive classification described by Powell *et al*<sup>(21)</sup>, some types can be considered to be variations of the types originally described by Snyder *et al*<sup>(20)</sup>.

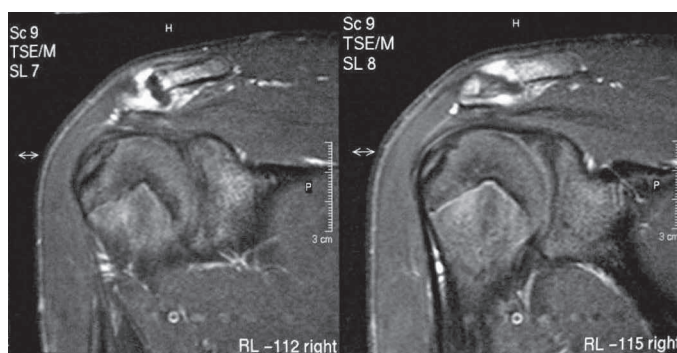
The clinical diagnosis is not always easy, since many pathological conditions may be associated with SLAP injuries among sports players who perform throwing movements. For this reason, magnetic resonance imaging should always be used when such injuries are suspected. With machines produced more recently (2.0, 2.5 and 3.0 Tesla), it is no longer necessary to ask for magnetic resonance imaging with intra-articular contrast (“arthroresonance”).

Among sports players who perform throwing movements, it is very common to find degeneration of the insertion of the proximal biceps. Care needs to be taken so that a surgical view of repairing such injuries does not always have to be taken. However, when the injury is very symptomatic and the labrum is found to be stable, surgical repair should be carried out, preferably using an arthroscopic route<sup>(22-24)</sup>.

Another point in the literature that deserves attention is the association between rotator cuff injuries and SLAP lesions. Whenever many symptoms of the latter are present together with cuff tear, the surgical result is better when two procedures are performed, to repair the injuries to both the labrum and the cuff<sup>(25,26)</sup>. Although good results from these procedures performed in professional athletes are shown in the literature, the data may not be so encouraging and returning to the previous sports performance level may not be achieved. This is because of the extensive demands for rotation and muscle balance that professional athletes routinely make, and cases in which surgery shortened the careers of these athletes are not uncommon.

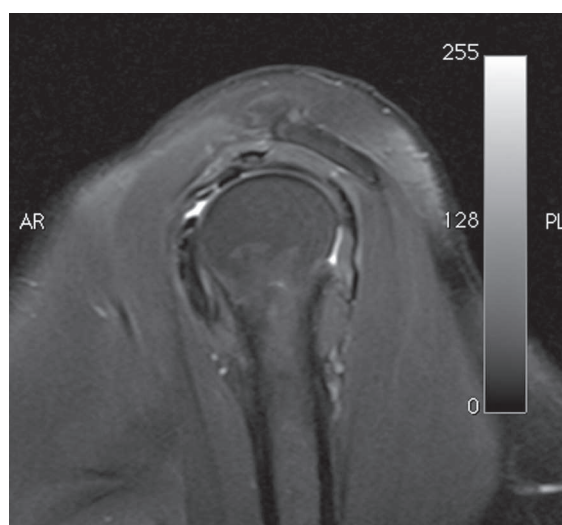
### f) Acromioclavicular joint injuries

It is very common for sports players who perform throwing movements to present worn-out acromioclavicular joints. There is often a largely pain-free clinical picture in which major degeneration of this joint is seen on radiographs (Figure 1). It must always be borne in mind that such radiological abnormalities need to be correlated with the athlete’s clinical data, since the latter should prevail over the former.



**Figure 1** – Note the inflammation of the acromioclavicular joint in this 16-year-old amateur tennis player. This athlete did not report any pain in this region, despite the abnormality in the image. The examination was requested in order to evaluate the rotator cuff.

One very important point that should be remembered relates to the morphology of the acromion. Some years ago, in relation to shoulder surgery, procedures to achieve a flat acromion were much more frequently recommended, whereas today, it is known that such procedures are not always necessary (Figure 2).



**Figure 2** – Note that the type II (curved) shape of the acromion does not necessarily have an impact on the tendons of the rotator cuff (the curved shape adapts to the curved shape of this region of the humeral head and the tendons that are inserted into it).

Another important point relates to the distance between the acromion and the humerus and its relationship with abnormalities of scapula positioning. We recently published a study on this relationship among tennis players<sup>(27)</sup>. Through clinical tests and imaging examinations, we observed that whenever the subacromial space diminished by more than 20% between measurements at 0 and 60 degrees of abduction, using ultrasonography, tennis players had a very great chance of presenting scapular dyskinesia (Figure 3). Although our study was not longitudinal (which would have allowed the relationship between this finding and cuff injuries to be observed), we believe that this relationship should be borne in mind in order to think towards prevention of shoulder injuries among young competitive tennis players.

## ELBOW INJURIES IN SPORTS

The most common elbow injury in sports is tendinopathy. Traumatic injuries will not be dealt with here, but will be considered in other articles.

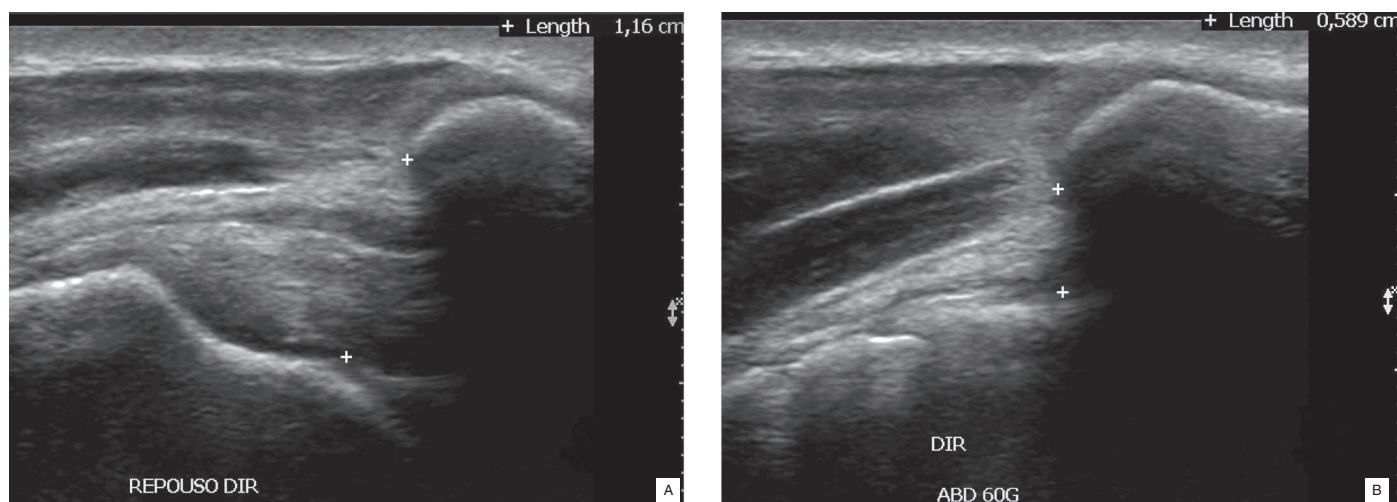
### a) Lateral epicondylitis

Lateral epicondylitis can be described as a specific pathological disorder originating from the musculature of the lateral epicondyle, generally caused by overload. In this, microlesions are generated in the region of the insertions of extensor tendons of the wrist and fingers, most frequently the short radial extensor of the carpus. To a lesser degree, the long radial extensor of the carpus is affected, along with the anterior portion of the common extensor of the fingers.

The pain generally starts in a mild form and progressively worsens in the region of the lateral epicondyle. It may radiate to the forearm, wrist, hand and shoulder. As the tendinopathy worsens, simple tasks such as picking up a milk carton or turning a door handle may become difficult to perform.

In relation to sports practices, the main topic of this review, the biomechanics of tennis must always be borne in mind, since this is the sport that most frequently causes such injuries. Reports in the Brazilian and worldwide literature have provided estimates that nowadays, around half of all tennis players will present such lesions, known as tennis elbow, at some time during their sporting lives<sup>(28,29)</sup>. The grip and return shots in tennis require wide-ranging use of forearm extensors. The extensors become injured as the muscles reach fatigue through repetitive activity.

Incorrect technique in making shots is the factor that most frequently causes lateral epicondylitis<sup>(30,31)</sup>. Patients who develop tennis elbow generally perform backhand shots with the “elbow in front”, without completing the movement as far as the end of the swing. It is known that this causes excessive stress on the lateral epicondyle and abnormal activity of the forearm musculature. Another important tip for prevention is that if the tennis player can manage to perform backhand shots using both hands, this also prevents injuries. This can be explained in two ways: firstly, the player dissipates the impact forces of the shot in both arms; and secondly, the player is also forced to turn the trunk more during the phase of preparing for the shot, which will



**Figure 3** – Ultrasound examination to measure the distance from the acromion to the humerus. Note that when the shoulder is at rest (A), there is a good space, but when abduction at 60 degrees is performed (B), this space diminishes greatly in tennis players with scapular dyskinesia

cause the angular energy to be greater, thereby avoiding effort by the dominant arm alone. In our personal sample, from our consultation office, out of a total of 326 tennis players with lateral epicondylitis who were treated between 2004 and 2009, only four performed backhand shots with two hands.

Lateral epicondylitis may occur through the use of inadequate equipment. The size of the racquet grip should be noted carefully and personalized according to each tennis player's hand size. The cord tension of the racquet should also be measured. It can be routinely recommended, whenever tennis players have no objection regarding decreased performance, that wide-profile racquets should be used. These have a larger head and larger area of minimum vibration ("sweet spot"), which prevents excessive vibration at the time of making the shot.

Another important tip for tennis players is that cording tensions of more than 57 pounds also increase the chance of injury. For this reason, it is now recommended that the equipment chosen should be appropriate for each player's type of game and the shot power normally used.

### **General recommendations for preventing lateral epicondylitis among tennis players:**

- a. Avoid hitting late balls.
- b. Learn to perform the repertoire of shots (serve, right, left and volley) adequately.
- c. Seek to make contact between the ball and the racquet head with the elbow always positioned in extension.
- d. Prepare the trunk rotation well, before backhand shots, in order to be able to perform the shot with the elbow extended.
- e. Avoid playing using very old balls.
- f. Use a maximum cording tension of 56/57 pounds.
- g. Give preference to synthetic or natural gut cords.
- h. Use racquets with a wide head profile, since these have a larger central area of minimum vibration (sweet spot).
- i. Make use of the flexion force of the knees at the time of serving.
- j. Try to play backhand shots with two hands.

### **Etiopathogenesis**

The constant overload that occurs in many sports activities (such as tennis) generates microtraumas in the tendons and muscles of the lateral epicondyle, and the overload factor is the main mechanism generating the injury. Microtraumas promote the appearance of angiofi-

broblastic hyperplasia in the affected tendon, consequent to the chronic repetitive stimuli. These findings suggest that chronic epicondylitis is more a degenerative entity than an inflammatory entity. After the initial trauma, these areas become injured more frequently, leading to hemorrhage and the formation of deposits of granular and calcified tissue within the surrounding tissues<sup>(32)</sup>.

In tennis, the classic example of a sport in which this type of pathological condition occurs very frequently, the pain is generally exacerbated through backhand shots, and it generally affects patients between 35 and 50 years of age.

### **Clinical picture**

The main symptom is pain, which is reported in the external part of the elbow and may occasionally radiate from the forearm to the wrist and shoulder. Difficulty in extending the forearm may be a frequent symptom (because of inflamed muscles and tendons). This pain may continue for weeks or months, and it is not uncommon for patients to seek care when they cannot even perform a handshake. The injury is considered to be chronic when the symptoms have lasted for at least three months.

### **Clinical diagnosis**

The clinical diagnosis takes into consideration several aspects of sports practices relating to tennis. A very detailed anamnesis regarding the development of the disorder, the length of time practicing the sport, the ways in which the pain increases and decreases and the basic movements that the sports player makes, along with specific special tests (Maudsley, Cozen and Mill tests)<sup>(33)</sup>, usually confirm the diagnosis.

### **Radiology**

Simple radiological examinations are performed routinely, in anteroposterior and lateral views. Ultrasound may be used, and this is an excellent imaging method for acute injuries. In chronic cases, in which several treatments may already have been undertaken, magnetic resonance imaging should be requested, since this may bring out data of greater precision regarding the pathological conditions that can cause pain similar to that of lateral epicondylitis (such as posterior interosseous compression syndrome)<sup>(34)</sup>.

### **Differential diagnosis**

The middle finger test helps in the differential diagnosis between posterior interosseous nerve syndrome and

lateral epicondylitis. This should be performed with the elbow at 90 degrees of flexion and the wrist in the neutral position. The third finger is pressed, while avoiding its active extension. An increase in the pain level through this maneuver suggests posterior interosseous syndrome. Another test used in the differential diagnosis between these two pathological conditions consists of infiltration of 1.0 ml of lidocaine at the level of the lateral epicondyle. In cases of lateral epicondylitis, the symptoms will disappear, while in cases of posterior interosseous nerve syndrome, the symptoms will persist<sup>(35)</sup>.

### Clinical and surgical treatment

Many treatments for diminishing the pain among patients suffering from lateral epicondylitis have been described in the literature. However, practically all of these relate to populations that are not sports players<sup>(36)</sup>, and this may bring in a conflict of data when dealing with athletes (basically tennis players, the sports population in which such injuries are most prevalent).

In dealing with acute injuries, the treatment consists of analgesics and non-hormonal anti-inflammatory agents. This management is always indicated together with physiotherapeutic treatment, since the aim is adequate muscle balance, analgesia and proprioception of the upper limb as a whole, while respecting the work of adaptation to the sports movements practiced<sup>(37)</sup>.

Infiltration with corticoids may be one way to improve the local situation of pain, although it is made very clear in the medical literature that most of the effects are fleeting and that over the long term, patients who practice sports may start to feel the pain again, given that corticoids do not cure the tissue degeneration that is often seen in chronic conditions<sup>(38,39)</sup>.

Another alternative for conservative treatment that can be used is to apply shockwaves. Recently, many studies with a good level of scientific evidence have spoken in favor of the use of this therapy in cases that do not evolve well with conventional physiotherapy<sup>(40-42)</sup>.

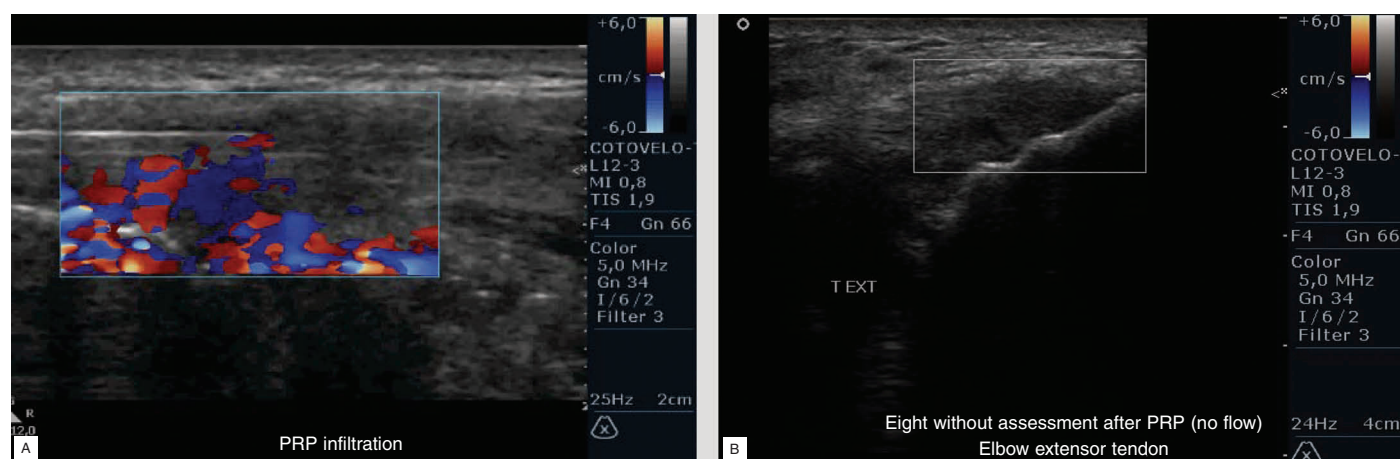
Surgery for lateral epicondylitis can only be indicated for chronic injuries. When the symptoms have been apparent for six months, and non-surgical medical treatment and physiotherapy have been unsuccessful, surgery is indicated. The procedure consists of removal of the degenerated fibrotic tissue that is located at the origin of the extensors. Partial release of the origin of the extensor in the lateral epicondyle of the humerus can be performed, but the release and lowering of the

tendon is avoided in sports players. In some cases, this is done in association with ostectomy of the epicondyle, or even bone perforation.

More recently, treatment with platelet-rich plasma (PRP) has been used as an alternative to surgery. We have now treated 40 such cases over the last three years, and we will shortly be publishing the results. In principle, these are promising, provided that the athlete follows the recommendation to stay away from the sport for at least six to eight weeks following the infiltration. Therapy using an application of PRP seeks to improve the platelet cell support in the degenerated tissue, with the aim of repairing and regenerating the tendon cells<sup>(43)</sup>. After aggregation, these platelets release platelet growth factors, among which vascular growth factors (VEGF), fibroblast-related growth factors (FGF) and insulin-related growth factors (IGF), among others (Table 1).

Therapy with PRP to treat lateral epicondylitis was first described in the literature by Mishra and Pavelko<sup>(44)</sup>, and it has been used routinely for cases that are refractory to conservative treatment, as an alternative to surgery<sup>(45)</sup>. Ultrasound-guided infiltration is preferred, so that the application of PRP is only made in the injured area, thereby avoiding certain complications such as reactive synovitis, which could occur if the injection puts more volume into the site than is necessary<sup>(46)</sup>. This is very important, because even with adequate centrifugation, PRP presents a small quantity of red blood cells in its composition after preparation (which may range from 2 to 4%). If these cells come into contact with the synovial lining of the elbow (which is very close to the region of the common extensor tendon), they may cause reactive synovitis, and this may compromise the patient's rehabilitation. In the initial cases of our sample, some patients presented reactive synovitis: this improved after three weeks, but during the first few days, it caused a painful condition when these individuals performed complete extension of the elbow. Through the use of an ultrasound-guided procedure, we reduced the chances of this problem occurring, since we were able to place the needle very well, exactly at the location of the injury.

Another benefit of ultrasonography is that we were able to use Doppler to observe the local vascularization. This was also very important in evaluating the tissue regeneration process that occurred up to the eighth week (Figure 4). We usually follow up the healing process by performing Doppler ultrasonography in the fourth,



**Figure 4** – The use of Doppler for ultrasound evaluation of tendons is important. In such cases, it helps in controlling PRP infiltration (A) and in establishing the cure criteria, for which it shows absence of vessels in asymptomatic patients (B)

eighth and, when necessary, twelfth week. Vascularization in the tendon usually occurs at an increased rate until the fourth week and is seen to have diminished in the examination in the eighth week. It should be absent in the Doppler examination in the twelfth week, at which point the patient can be released to play competitive tennis again (Table 1).

### Physiotherapeutic treatment

Controversy still surrounds the rehabilitation for lateral epicondylitis, perhaps because many techniques are used at the same time with the aim of enabling patient recovery as quickly as possible. The techniques most used for this treatment are ultrasound, shortwave, electrostimulation and ice<sup>(47)</sup>.

When patients undergo treatment consisting of plasma-rich platelet infiltration, physiotherapy has a fundamental role in tissue recovery. Laser and ultra-

sound are used routinely in the initial phases, and light exercises for wrist and finger extension and flexion can be started early on (from the second day after applying PRP). Patients then progress to performing mild eccentric exercises and proprioception (from the first week onwards), always with the aim of improving all of the proprioception of the upper limb.

From the fourth week onwards, athletes are well enough to perform specific exercises for their sport, and exercises with a lighter racquet without cords, with or without elastic resistance, can also be performed in order to incorporate the work of gaining muscle strength.

Right and left movements can be made using a lighter ball in the rehabilitation clinic from the sixth week onwards and, from then on, a sports movement reeducation program can be started. Athletes are released completely for games and competitions between the tenth and twelfth weeks.

**Table 1** – Summary of the most important growth factors derived from platelets, and their functions<sup>(7)</sup>

Growth factor	Places where it comes from	Function
TGF beta (transforming growth factor beta)	Platelets, extracellular bone matrix, cartilaginous matrix, macrophages, monocytes and neutrophils	Stimulates proliferation of undifferentiated mesenchymal cells; regulates endothelial mitogenesis of fibroblasts and osteoblasts; inhibits lymphocyte and macrophage proliferation; regulates the mitogenic effect of other growth factors; regulates collagen synthesis and collagenase secretion
bFGF (basic fibroblast growth factor)	Platelets, macrophages, mesenchymal cells, chondrocytes and osteoblasts	Promotes growth and differentiation of chondrocytes and osteoblasts; mitogenic for mesenchymal cells, chondrocytes and osteoblasts
PDGFa-b (platelet-derived growth factor)	Platelets, macrophages, monocytes, mesenchymal cells, chondrocytes, osteoblasts and muscle cells	Mitogenic for mesenchymal cells and osteoblasts; stimulates chemotaxis and mitogenesis in fibroblasts, glia cells and muscle cells; regulates collagenase secretion and collagen synthesis; stimulates chemotaxis of macrophages and neutrophils
EGF (epidermal growth factor)	Platelets, macrophages and monocytes	Stimulates chemotaxis and endothelial angiogenesis; regulates collagenase secretion; stimulates epithelial and mesenchymal mitogenesis
VEGF (vascular endothelial growth factor)	Platelets and endothelial cells	Increases angiogenesis and vascular permeability; stimulates mitogenesis of endothelial cells



## **b) Other tendon injuries of the elbow in sports**

Medial epicondylitis and tendinopathy of the brachial triceps are also injuries that may mess up sports players' lives. These pathological conditions will not be dealt with in detail here, but it should be borne in mind that they may require long-term treatment, particularly in relation to sports in which powerful throwing movements are needed (the serve in tennis, the pitcher's throw in baseball and attack shots in volleyball, among others).

The treatment should follow the same routes as described above for lateral epicondylitis, starting with analgesic physiotherapeutic measures and passing on to muscle strengthening and proprioception. In cases in which conservative treatment does not achieve good results after a period of three to six months, even if performed correctly, other therapies may become necessary. These may include shockwave therapy, application of platelet-rich plasma and surgery in cases that are refractory to these treatments.

Rupture of the distal biceps is another tendon injury that can be found among sports players, particularly among weightlifters, because of the great force that these athletes have to exert in order to achieve good results. One important point is that whenever dealing with such injuries, it has to be ascertained whether the athlete was using anabolic steroids, since there is a direct relationship between the use of these substances and ruptures of this tendon in the elbow.

## **c) Differential diagnosis for tendinopathy of the elbow in sports**

### **Uncommon shoulder and elbow injuries in sports**

Other shoulder and elbow injuries that are less common may also affect sports players who make throwing movements. Among these, the following can be highlighted:

a) Nerve injuries – The most common of these in sports players' shoulders is compression of the suprascapular nerve, but the axillary and long thoracic nerves may also present abnormalities, particularly of chronic nature. In the elbow, the best known nerve compression is posterior interosseous nerve compression syndrome, which should be an obligatory differential diagnosis for chronic conditions.

b) Stress-induced bone injuries – The bone overload that is most common in the upper limbs is in the region of the distal humerus. We recently published a case series reporting on this diagnosis among tennis players<sup>(48)</sup>. It is important to bear this differential diagnosis in mind when sports players present subacute and chronic pain

in the distal region of the humerus of the dominant arm. The treatment should consist of temporarily staying away from the sport and undergoing physiotherapy. Although rare, bone overload may also be a source of pain in the hand and wrist region<sup>(49)</sup>.

c) Tumors – This diagnosis should always be borne in mind in cases of pain close to joints, particularly if the pain is insidious and in athletes who are still at the growth phase. The most commonly encountered tumors are benign, but malignant tumors may also occur, mainly affecting the proximal region of the humerus in adolescent athletes.

d) Muscle-tendon tears – In the shoulder region, one injury that is infrequent but may be found in sports is tearing of the pectoralis major muscle, which occurs among competitive weightlifters. These injuries may also be associated with the use of anabolic steroids and, within the Brazilian setting, some studies have already reported on the need for surgery to correct such cases among sports practitioners. In the elbow, as cited earlier, tears in the distal biceps may also be a problem for such athletes, and adequate correction for them generally requires surgical procedures.

e) Chondral injuries – These should be borne in mind when athletes present chronic pain in the shoulder and elbow joints. In certain situations, these may lead them to feel cracking or even produce crepitation during the sports movement. Especially in populations that are still at the growth stage, it should be remembered that osteochondritis may be the cause of pain around joints. This diagnosis needs to be borne in mind in investigating such injuries, or else they may remain unnoticed in the initial clinical examination on such athletes.

## **CONCLUSIONS**

As can be seen, upper-limb sports injuries may form part of the daily routine of any physician, even those who do not exclusively provide care for tennis players. Tendinopathy, which is common in the upper limbs, needs to be studied so that its chronic form can increasingly be avoided, given that chronic tendinopathy may lead to a requirement for treatments that are lengthier and more costly for the healthcare system.

It is hoped that this article will aid readers in managing such pathological conditions, with the aim of providing the best possible care, both for sports-playing and for non-sports-playing patients. The literature reviewed here was extensive, and supplementary reading of the articles referenced in this study will provide details to complete the information presented here.

## REFERENCES

1. Silva RT. Lesões esportivas no tênis. In: Cohen M, Jorge RA. Lesões nos esportes: diagnóstico, prevenção e tratamento. Rio de Janeiro: Revinter; 2002. p. 709-32.
2. Hill JA. Epidemiologic perspective on shoulder injuries. *Clin Sports Med.* 1983;2(2):241-6.
3. Schneider S, Seither B, Tönges S, Schmitt H. Sports injuries: population based representative data on incidence, diagnosis, sequelae, and high risk groups. *Br J Sports Med.* 2006;40(4):334-9.
4. Bigliani LU, Morrison DS, April EW. The morphology of the acromion and its relation to rotator cuff tears. *Orthop Trans.* 1986;10:228.
5. Zuckerman JD, Kummer FJ, Cuomo F. The influence of coracoacromial arch anatomy on rotator cuff tears. *J Shoulder Elbow Surg.* 1992;19(1):4-13.
6. Doneux PS, Miyazaki AN, Pinheiro Jr JA, Funchal LFZ, Checchia SL. Tratamento da síndrome do impacto em tenistas. *Rev Bras Ortop.* 1998;33(12):939-44.
7. Jobe CM, Pink MM, Jobe FW, Shaffer B. Anterior shoulder instability, impingement, and rotator cuff tear: theories and concepts. In: Jobe FW, editor. *Operative techniques in upper extremity sports injuries.* St. Louis: Mosby; 1996. p.164-76.
8. Kibler WB. The role of the scapula in athletic shoulder function. *Am J Sports Med.* 1998;26(2):325-37.
9. Kibler WB, Uhl TL, Maddux JW, Brooks PV, Zeller B, McMullen J. Qualitative clinical evaluation of scapular dysfunction: a reliability study. *J Shoulder Elbow Surg.* 2002;11(6):550-6.
10. DiGiovine NM, Jobe FW, Pink M, Perry J. An electromyographic analysis of the upper extremity in pitching. *J Shoulder Elbow Surg.* 1992(1):15-22.
11. Kibler WB. Biomechanical analysis of the shoulder during tennis activities. *Clin Sports Med.* 1995;14(1):79-85.
12. Arroyo JS, Hershon SJ, Bigliani LU. Special considerations in the athletic throwing shoulder. *Orthop Clin North Am.* 1997;28(1):69-78.
13. Abrams JS. Special shoulder problems in the throwing athlete: pathology, diagnosis, and nonoperative management. *Clin Sports Med.* 1991;10(4):839-61.
14. Lehman RC. Shoulder pain in the competitive tennis player. *Clin Sports Med.* 1988; 7(2):309-27.
15. Rudzki JR, Shaffer B. New approaches to diagnosis and arthroscopic management of partial-thickness cuff tears. *Clin Sports Med.* 2008;27(4):691-717.
16. Weber SC. Arthroscopic debridement and acromioplasty versus mini-open repair in the treatment of significant partial-thickness rotator cuff tears. *Arthroscopy.* 1999;15(2):126-31.
17. Ellenbecker TS, Roetert EP, Bailie DS, Davies GJ, Brown SW. Glenohumeral joint total rotation range of motion in elite tennis players and baseball pitchers. *Med Sci Sports Exerc.* 2002;34(12):2052-6.
18. Crockett HC, Gross LB, Wilk KE, Schwartz ML, Reed J, O'Mara J, et al. Osseous adaptation and range of motion at the glenohumeral joint in professional baseball pitchers. *Am J Sports Med.* 2002;30(1):20-6.
19. Lintner D, Mayol M, Uzodinma O, Jones R, Labossiere D. Glenohumeral internal rotation deficits in professional pitchers enrolled in an internal rotation stretching program. *Am J Sports Med.* 2007;35(4):617-21.
20. Snyder SJ, Karzel RP, Del Pizzo W, Ferkel RD, Friedman MJ. SLAP lesions of the shoulder. *Arthroscopy.* 1990;6(4):274-9.
21. Powell SE, Nord KD, Ryu RK. The diagnosis, classification, and treatment of SLAP lesions. *Oper Tech Sports Med.* 2004;12(1):99-110.
22. Barber FA, Field LD, Ryu RK. Biceps tendon and superior labrum injuries: decision making. *Instr Course Lect.* 2008;57:527-38.
23. Paxinos A, Walton J, Rütten S, Müller M, Murrell GA. Arthroscopic stabilization of superior labral (SLAP) tears with biodegradable tack: outcomes to 2 years. *Arthroscopy.* 2006;22(6):627-34.
24. Rhee YG, Lee DH, Lim CT. Unstable isolated SLAP lesion: clinical presentation and outcome of arthroscopic fixation. *Arthroscopy.* 2005;21(9):1099.
25. Franceschi F, Longo UG, Ruzzini L, Rizzello G, Maffulli N, Denaro V. No advantages in repairing a type II superior labrum anterior and posterior (SLAP) lesion when associated with rotator cuff repair in patients over age 50: a randomized controlled trial. *Am J Sports Med.* 2008;36(2):247-53.
26. Voos JE, Pearle AD, Mattern CJ, Cordasco FA, Allen AA, Warren RF. Outcomes of combined arthroscopic rotator cuff and labral repair. *Am J Sports Med.* 2007;35(7):1174-9.
27. Silva RT, Hartmann LG, Laurino CF, Biló JP. Clinical and ultrasonographic correlation between scapular dyskinesia and subacromial space measurement among junior elite tennis players. *Br J Sports Med.* 2008. [Epub ahead of print]
28. RT, Santos MB. Tennis Elbow: a survey among 839 tennis players with and without injury. *Med Sci Tennis.* 2008;13(1):36-41.
29. Bisset L, Paungmali A, Vicenzino B, Beller E. A systematic review and meta-analysis of clinical trials on physical interventions for lateral epicondylalgia. *Br J Sports Med.* 2005;39(7):411-22.
30. Roetert EP, Brody H, Dillman CJ, Groppe JL, Schultheis JM. The biomechanics of tennis elbow. An integrated approach. *Clin Sports Med.* 1995;14(1):47-57.
31. Knudson D, Blackwell J. Upper extremity angular kinematics of the one-handed backhand drive in tennis players with and without tennis elbow. *Int J Sports Med.* 1997;18(2):79-82.
32. Nirschl RP, Ashman ES. Elbow tendinopathy: tennis elbow. *Clin Sports Med.* 2003;22(4):813-36.
33. Chumbley EM, O'Connor FG, Nirschl RP. Evaluation of overuse elbow injuries. *Am Fam Physician.* 2000;61(3):691-700.
34. Tuite MJ, Kijowski R. Sports-related injuries of the elbow: an approach to MRI interpretation. *Clin Sports Med.* 2006;25(3):387-408.
35. Bencardino JT, Rosenberg ZS. Entrapment neuropathies of the shoulder and elbow in the athlete. *Clin Sports Med.* 2006;25(3):465-87.
36. Johnson GW, Cadwallader K, Scheffel SB, Epperly TD. Treatment of lateral epicondylitis. *Am Fam Physician.* 2007;76(6):843-8.
37. Stasinopoulos D, Stasinopoulou K, Johnson MI. An exercise programme for the management of lateral elbow tendinopathy. *Br J Sports Med.* 2005;39(12):944-7.
38. Newcomer KL, Laskowski ER, Idank DM, McLean TJ, Egan KS. Corticosteroid injection in early treatment of lateral epicondylitis. *Clin J Sport Med.* 2001;11(4):214-22.
39. Hay EM, Paterson SM, Lewis M, Hosie G, Croft P. Pragmatic randomized controlled trial of local corticosteroid injection and naproxen for treatment of lateral epicondylitis of elbow in primary care. *BMJ.* 1999;319(7215):964-8.
40. Radwan YA, ElSobhi G, Badawy WS, Reda A, Khalid S. Resistant tennis elbow: shock-wave therapy versus percutaneous tenotomy. *Int Orthop.* 2008;32(5):671-7.
41. Lebrun CM. Low-dose extracorporeal shock wave therapy for previously untreated lateral epicondylitis. *Clin J Sport Med.* 2005;15(5):401-2.
42. Chung B, Wiley JP. Effectiveness of extracorporeal shock wave therapy in the treatment of previously untreated lateral epicondylitis: a randomized controlled trial. *Am J Sports Med.* 2004;32(7):1660-7.
43. Mishra A, Woodall J Jr, Vieira A. Treatment of tendon and muscle using platelet-rich plasma. *Clin Sports Med.* 2009;28(1):113-25.
44. Mishra A, Pavelko T. Treatment of chronic elbow tendinosis with buffered platelet-rich plasma. *Am J Sports Med.* 2006;34(11):1774-8.
45. Silva RT. Treatment of chronic tennis elbow with platelet-rich plasma. *Case Report. Adv Orthop.* 2009;1(3):108-11.
46. Connell DA, Ali KE, Ahmad M, Lambert S, Corbett S, Curtis M. Ultrasound-guided autologous blood injection for tennis elbow. *Skeletal Radiol.* 2006;35(6):371-7.
47. Perkins RH, Davis D. Musculoskeletal injuries in tennis. *Phys Med Rehabil Clin N Am.* 2006;17(3):609-31.
48. Silva RT, Hartmann LG, Laurino CF. Stress reaction of the humerus in tennis players. *Br J Sports Med.* 2007;41(11):824-6.
49. Silva RT, Cohen M, Matsumoto MH, Gracitelli GC. Avaliação das lesões ortopédicas em tenistas amadores competitivos. *Rev Bras Ortop.* 2005;40(5):270-9.