



BARÇA
INNOVATION HUB
Universitas

PATHOLOGY IN TEAM SPORTS

TENNIS

→ 4.2 Pathologies per sports: tennis

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Introduction

Tennis is one of the most practiced sports worldwide, with more than 200 countries affiliated with the International Federation of Tennis, and with one of the highest numbers of federation licenses (Pluim, Staal, Windler, & Jayanthi, 2006).

As in many other sports, there are amateur, semi-professional and professional participants. Many injuries are common to other sports, but it is important to take into account that tennis has a very particular profile, which can vary based on the age or the level at which it is played (Pluim, & Safran, 2004).

The different equipment used, the constant changes of game surface during the season, the particular biomechanics of each athlete, the physical demands of a competitive calendar and of an extremely demanding ranking scoring system result in an injury profile that differs from other racket or shot sports.

All sports injuries, including those of tennis, are a frequent cause of disability, and in some cases absence from work. This can have a high economic, personal and social cost.

Aspects to take into account in tennis injuries

Before beginning to speak about the most frequent injuries in tennis, it is imperative to know it more specifically.

It is a sport in which great aerobic efforts (duration of matches or of championships) are mixed with anaerobic efforts (the force of the strikes, runs and abrupt changes of direction from one end of the court to the other), combined with a wide

variety of different strikes and with different mechanics that result in a very particular injury profile.

As in most sports with maneuvers above the head, the shoulder and the elbow can be negatively affected by overuse and by repetitive microtraumas.

As for acute injuries due to an indirect mechanism, these tend to involve the lower extremities to a greater extent.

Biomechanical

Mainly 4 main biomechanical regions must be taken into account as a tennis player's weakest points.. In the upper extremity, the shoulder and the elbow; in the torso, the lumbar spine, and finally the lumbo-pelvic region. The impact of these anatomic regions is produced by a repeated and continuous overload without a correct compensation.

In the serve mechanism (Figure 1), one of the most aggressive strikes that exists in tennis begins with a recruitment of muscular fibers from the musculature of the calf and quadriceps, is transferred to an activation of the lumbo-pelvic region and from the spine to the shoulder, the elbow, the wrist and the hand to finish with a swift eccentric contraction of the abdominal musculature in rotation of the torso, with practically polymetric unipodal support to be able to begin the run. For example, Kibler (1995) managed to calculate that the leg-hip-torso component produced 51% of all kinetic energy of this athletic motor pattern.

Figure 1: Complete serve mechanism



Source: Taken from <https://bit.ly/2rSmPtp>

If these anatomic localizations are taken into account, according to various epidemiological studies, the injuries could be distributed in the following manner (Pluim et al., 2006; Hutchinson, Laprade, Burnett, Moss, & Terpstra, 1995):

- Lower extremities: 31 % to 67 %.
- Upper extremities: 20 % to 49 %.
- Torso: 3 % to 21 %.

Material used and game surfaces

One of the most influential aspects in tennis injuries is the material used and the changes made thereto. Many tennis injuries are due to repeated microtraumas that provoke an overcharge poorly tolerated by the athlete. It's at this point that the material is especially important.

Included in the material are mainly rackets and balls. As in many sports, there are commercial interests to play with a type of racket or a specific type of balls, and additionally these change based on the competition.

In the racket there are multiple factors to take into account.

- **The grip or type of grip:** there are different types of grip. The semi-western, full western, eastern and continental (Figure 2) stand out.
- **The weight of the racket:** there are rackets that weigh a few grams more than others to be able to make stronger and faster strikes.
- **The tension of the strings:** each player plays with a specific tension adapted to their type of game. As a general rule, the higher the tension the better control of the ball, but to get it to run at the same speed it is necessary to add more force to the strike. This tension can be varied when the coach or the player believe it is convenient.
- **Way of holding the racket:** based on the type of game (and also the tennis culture of the country where they play), the racket can be held in one way or another.

Figure 2: Types of grip in tennis



Source: Taken from <https://bit.ly/2rPuRTS>

It is easy to think that any change made in any of these components can produce a decompensation in the player. For example, if a player has been playing with a specific type of grip and string tension for 9 years, if they make a sudden change in the tension and grip and the same activity continues, a situation of overload will be produced that is more probable to lead to an injury due to overuse.

This makes it possible for different injuries to be related based on, for example, the type of grip used. In this manner, the players that use a semi-western or a western tend to have more injuries to the wrist ulnar, and the players that use an eastern type grip tend to have more injuries on a radial level (Tagliafico et al., 2009). The same thing happens with the balls and with the changes of game surface. In the tennis circuit, different surfaces are played on. The main ones, from least to most aggressive, are: grass, clay and hard surface.

In addition to the foregoing, one of the main injury risk factors for tennis players is training errors. Included in these are the types of material used.

Main injuries in tennis

The main injuries that affect the tennis player around the anatomical region will be addressed. In table 1, which is a modification of the Dines et al table (2015), a summary of the main pathologies that affect the tennis player can be seen.

Among these injuries there are some that may be common to other sports, but there are others that are really specific to tennis. It is precisely these that are going to be addressed in this chapter:

- Injury or impingement of the suprascapular nerve.
- Pathology of the ulnar-carpal space.
- Injury of the rectus abdominis musculature.
- Spondylolysis/lithesis.
- Femoroacetabular hip impingement.

Table 1: Main injuries in tennis

ANATOMIC REGION AND INJURY	MECHANISM
SHOULDER	
Internal impingement	Repeated movements around the top of the head
SLAP injuries	Repeated movements around the top of the head
Injury of the Suprascapular nerve	Repeated movements around the top of the head
ELBOW	
Lateral epicondylitis	Backhand strikes with the wrist bent
Medial epicondylitis	Very wide forehand and/or short-handed strikes
WRIST	
Lower ulna tendinopathy	Ulnar deviation of the non-dominant arm in the 2-handed backhand
Subluxation of lower ulna	Sudden forced ulnar bending movement
Ulnar - carpal impingement	Repeated micro-traumas in ulnar deviation
ABDOMINAL WALL	
Tear of the rectus abdominis	Forced eccentric contraction after serve or smash
LUMBAR REGION	
Backache.	Continuous overload
Spondylolysis/ listhesis.	Continuous overload, especially in adolescents
HIP	
Femoral-acceptabular impingement	Forced and repeated movements of rotation of hips with load

LEG	
Medial head injury of the gastrocnemius	Eccentric contraction with extended knee and ankle dorsiflexion.

Source: modified from Dines et al., 2015.

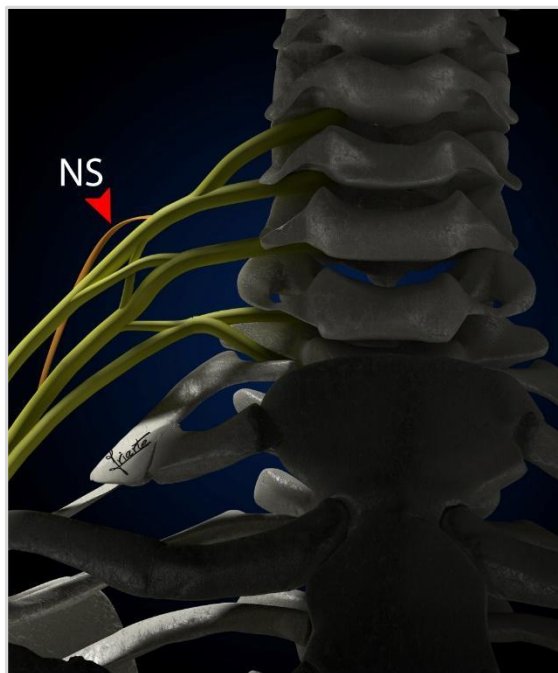
Injury/impingement of the suprascapular nerve.

While this is not the most frequent injury of the anatomic region of the arm, it is one of the most characteristic injuries of tennis. Its difficult diagnosis, if it is not suspected, makes it so that it tends to be found in advanced stages of the pathology, and therefore its treatment is more complicated.

The suprascapular nerve comes from the lower roots of the primary upper trunk of C5-C6 (Figure 3) and presents 2 points of conflict: one in the caracoid notch and the other the spine of the scapula (Figure 4).

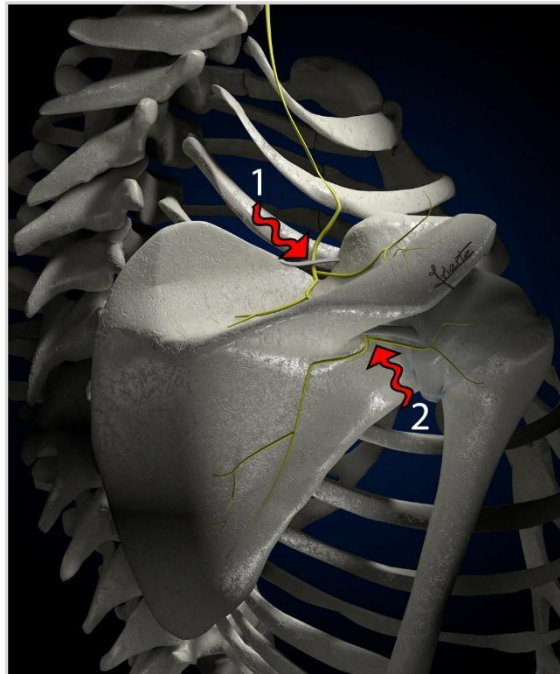
The injury consists basically in the trapping of this nerve in any of these points and the clinic derived therefrom.

Figure 3: Brachial plexus. The suprascapular nerve (SN) coming from the primary upper trunk formed by roots C5 and C6



Source: Prepared by the author.

Figure 4: Main points of conflict of the suprascapular nerve: in the caracoid notch (1) and in the spinoglenoid (2)



Source: Prepared by the author.

Production mechanism

Anatomic factors of each person that favor the compressions in the recently mentioned osteoligamentous gaps.

Dynamic factors, such as the repeated stretching of the scapula in each forehand strike. A “sweeping” effect of the same scapula is produced on the rib cage.

The maneuvers that produce this injury in tennis are the following:

- The end of the forehand strike (forced adduction + antepulsion).
- End of the serve (antepulsion + internal rotation).
- High one-handed backhand (wide horizontal retropulsion).
- Service swing (horizontal retropulsion).

Clinical and examination

This is a pathology that is difficult to diagnose, due to the fact that the pain can be severe or, more frequently, very progressively severe. It is located on the back edge of the armpit and in the infraspinatus pit of the

scapula; generally with irradiation in the dorsal region which worsens at night.

It is additionally associated with secondary subacromial pain, which complicates the diagnosis even more.

This pathology should be suspected when notable atrophy of the supraspinatus muscle, and essentially of the infraspinatus, is detected in the examination (which is additionally painful upon direct palpation) (Figure 5).

If the patient is required to perform bends, this atrophy is even more manifest. It is not uncommon to see a winged scapula due to the association of a dysfunction of the long thoracic nerve that causes weakness of the anterior serratus (Figure 6.)

Figure 5: Atrophy of the right infra infraspinal musculature



Source: Developed by the author.

Figure 6: Provoking maneuver with 90° abduction and anteversion, which manifests winged scapula (due to alteration of the long thoracic nerve)



Source: Developed by the author.

Diagnosis

Taking the foregoing into account, it can be said that the key tools for diagnosing the impact of the suprascapular nerve are clinical suspicion and examination.

As for complementary tests, that which provides the most information is the electromyogram of rest and of effort. It must be performed by expert hands, since it is not one of the most habitually examined root nerves.

Treatment

This compression of the suprascapular nerve is favored, in most cases, by an imbalance between internal rotators and external rotators (very typical in the tennis world). It is for this reason that the first therapeutic option consists of decreasing or fully ceasing the sports activity along with beginning physiotherapy exercises that contribute to the rebalancing of the scapular waist.

In those cases in which the pain makes these exercises impossible, ultrasound-guided infiltrations on the scapular notch can be helpful.

Finally, in case of severe clinical compression before a poor response to conservative treatment, one must opt for surgical treatment through the release of the nerve.

Pathology of the ulnar-carpal space.

There are several types of injuries in the pathology in the ulnar-carpal space. The main ones in the world of tennis are: ulnar-carpal impingement, injuries of the lower ulnar tendon and injuries of the triangular fibrocartilage complex.

The pain in all of these is located in the ulnar recess. It is produced by repeated mechanisms of wrist flexion and adduction (Figure 7) that cause continuous micro-traumas on this space.

Figure 7: Movement of forced counter-resistance carpal deviation in the forehand strike



Source: <https://bit.ly/2Gsc0Z6>

Clinical examination is also very similar in all entities, since they are generally related to each other. The patient will indicate the pain by touching the ulnar-carpal space, which increases when performing ulnar deviation maneuvers and passive pro- and supination with the open hand.

Ulnar - carpal impingement

The anatomy of the ulnar-carpal space is complex. It is formed by the ulnar-carpal articulation, the ulnar styloid, the lunate, the pyramidal and the pisiform with respect to bony edges. The homologous meniscus or meniscoid, the triangular fibrocartilage, the infra- and extracapsular ligaments and the lower ulnar tendon, as soft elements (Figure 8)

Figure 8: Ulnar - carpal space

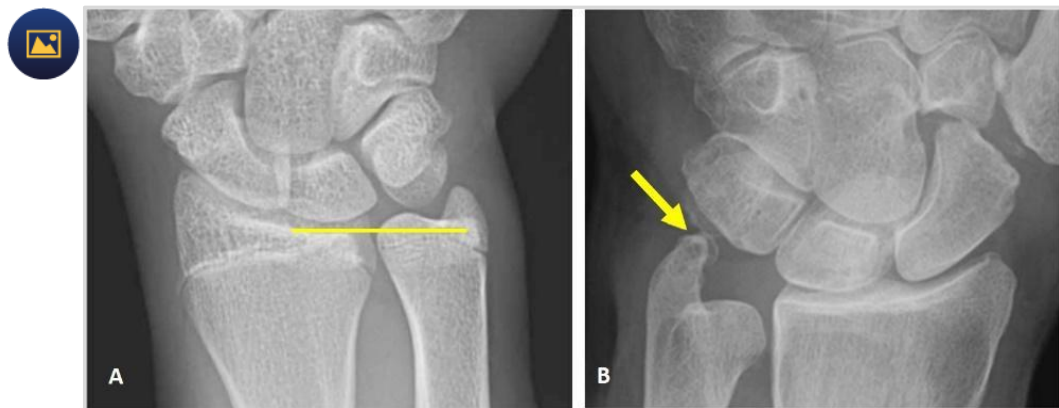


Source: Prepared by the author.

Regarding Figure 8: FSL: semilunar pit; FES: pitting for scaphoids; EUC: extensor carpi ulnaris ; LCS: semilunar ulna ligament; LCP: pyramidal ulnar ligament; IE: styloid insertion; MH: homologous meniscus.

The main risk factors of suffering an ulnar-carpal impact are the anatomic variant, known as ulna plus, or a magna ulnar styloid (Figure 9) If the repeated wrist flexion and adduction mechanisms are added to these particularities, it is probable that the tennis player will develop an ulnar-carpal impingement syndrome (Tagliafico et al., 2009; Vezeridis, Yoshioka, Han, & Blazar, 2010). Evidently, the type of handle of the racket used cannot be ignored, since the more closed it is the more impingement is favored.

Figure 9: Conventional radiography that shows a congenital ulna plus (A) and a magna ulnar styloid (B): both condition ulnar-carpal impingement

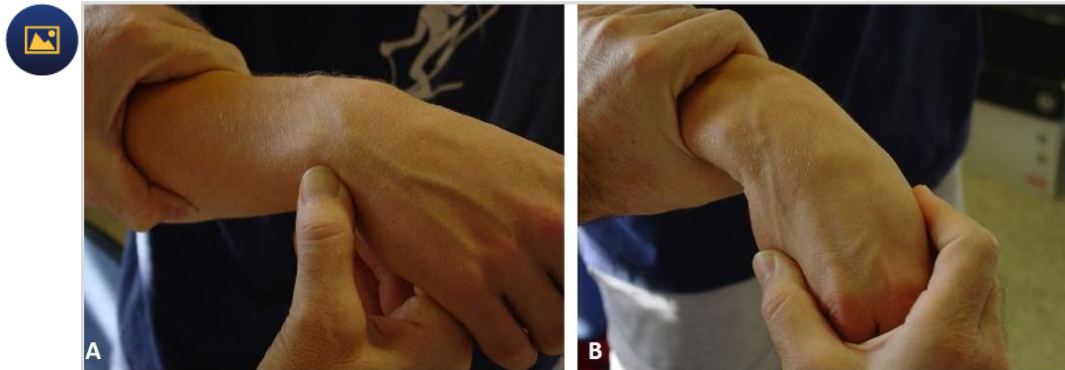


Source: Prepared by the author.

Diagnosis

The initial diagnosis is through clinical suspicion and conventional ultrasound (Figure 10 and Figure 11). The ultrasound tends to be done in neutral position and in forced radial and ulnar deviation to observe the behavior of this space (Figure 12).

Figure 10: Clinical provocation maneuvers of ulnar-carpal pain. Pain is seen upon infra-styloid palpation (A) and pain upon forced ulnar deviation (B)



Source: Prepared by the author.

Figure 11: Passive pro- and supination maneuvers



Source: Developed by the author.

Figure 12: Images of the conventional ultrasound projections to assess the possible ulnar-carpal impingement that include the ultrasound in ulnar deviation (A) and in radial deviation (B)



Source: Developed by the author.

The magnetic resonance (MR) is useful in the cases in which any injury of associated soft parts is suspected (very frequent, especially in cases of long evolution) or for the premature diagnosis. The MR can detect marrow edema as a premature sign of ulnar impact, before changes are detected in the conventional ultrasound (Vezeridis, et al., 2010).

In some doubtful cases, an anesthetic blockage used as a *test* in the ulnar-carpal space can also be of great use in the testing of this pathology.

Treatment

The initial treatment is always conservative. The objective is to try to conduct an ulnar-carpal stabilization through the muscular, ligament and tendinosis elements through physiotherapy exercise guidelines.

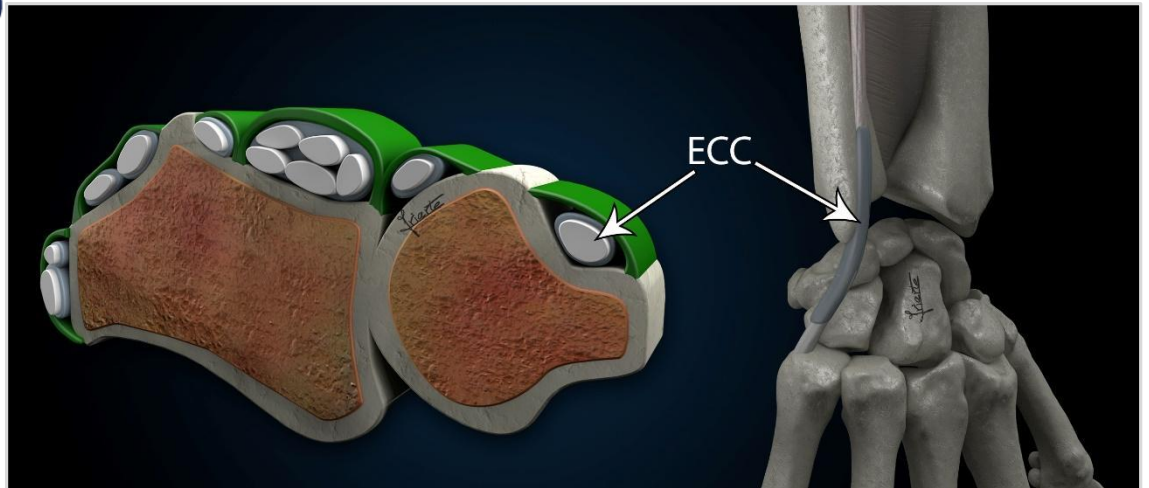
In the first weeks a rigid orthosis can be used, especially to avoid the forced movement in ulnar deviation.

In the cases in which the degree of pain cannot be controlled through conservative treatment, or when it returns when reintroducing the activity, the surgical option must be proposed to decompress this space or to solve the existing injuries.

Pathology of the lower ulnar tendon

The lower ulnar tendon originates on the level of the medial epicondyle of the humerus and is inserted on the level of the internal tubercle of the base of the fifth metacarpal. On the wrist level is the sixth valve of the extensor muscles, which serves as a “roof” of the ulnar-carpal space and is strictly related to the triangular fibrocartilage and with the meniscoid of this space (Figure 8 and Figure 13).

Figure 13: Anatomic schemes of the extensor carpi ulnaris tendon (ECC, Spanish acronym)

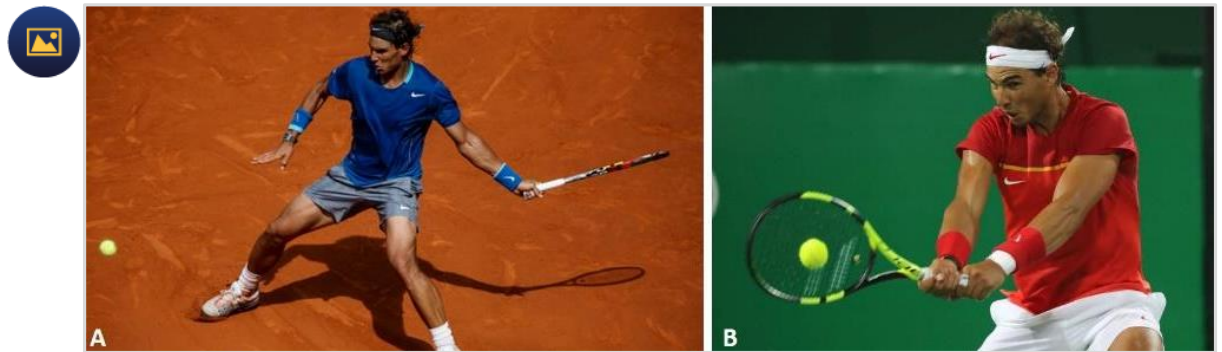


Source: Prepared by the author.

Its function is that of carrying out wrist extension and adduction, and additionally stabilizing the distal radial-ulnar in pronation (the ligament system is relaxed in this position, and the lower ulnar blocks the radial-ulnar). Therefore, it is a tendon that constantly suffers aggressions while practicing tennis.

The injury mechanism is produced when they go from a neutral position of the wrist (dorsal flexion and discrete radial inclination) to a forced position of volar flexion + ulnar inclination + pronation. In tennis this takes place in the topspin forehand and in the backhand strike (Figure 14).

Figure 14: Strikes in tennis that cause irritation on the lower ulnar tendon. Topspin forehand strike (A) and backhand (B)



Source: Developed by the author.

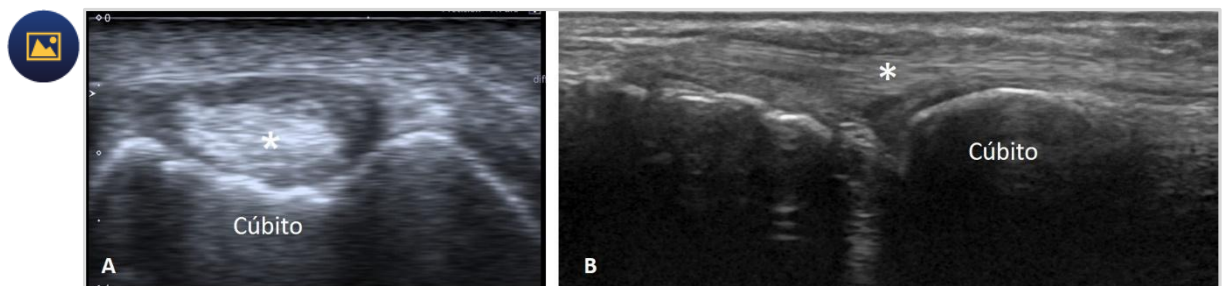
Diagnosis

The pain is sharp after a topspin forehand strike or a backhand strike, and there may be discreet swelling in the ulnar edge in the cases in which there is mainly an injury to the tendon.

The forced passive supination maneuver is very painful, the passive pronation is painful and the isometric contracting is annoying.

In the pathology of the lower ulnar, the ultrasound is a big help; in fact, it is the image selection technique, which, both cases of sudden injury with tendinopathy or tenosynovitis and in cases of luxations or subluxations (through dynamic maneuvers), the ultrasound can give a reliable diagnosis (Figure 15 and Figure 16).

Figure 15: Ultrasound examination in short axis of the lower ulnar (A) and ultrasound exploration in long axis on the lower ulnar (B)



Source: Prepared by the author.

Figure 15 to the left (A) shows a circular hypo-echoic image that wraps the tendon of the unaltered lower ulnar (asterisk). This image corresponds to a tenosynovitis of the lower ulnar. To the right (B) is an image of discreet alteration in the echotrama of the lower ulnar (asterisk). Image compatible with mild tendinopathy of the lower ulnar

Figure 16: Short axis ultrasound exploration of the lower ulnar



Source: Prepared by the author.

In figure 16 it can be seen how the tendon of the lower ulnar (asterisk) is partially outside its valve. Image compatible with dislocation of the lower ulnar in dynamic examination.

Treatment

In the cases in which there is isolated tendinopathy or tenosynovitis of the lower ulnar, the treatment shall be conservative. This is to avoid the injury mechanism and perform physiotherapy treatment. Immobilization is reserved for cases in which there is an injury to the tendon sheath.

In the cases in which a severe sheath injury is detected, the treatment is orthopedic through immobilization, approximately 4 weeks (in slight ulnar extension and inclination), and thereafter the rehabilitation treatment must begin.

In case of a chronic or old injury of the sheath, the treatment is conservative through relative rest (avoiding the injury mechanism), functional wrist bandaging, if necessary, physiotherapy treatment, and in some cases in which the pain obstructs correct rehabilitation treatment one can opt to perform an ultrasound-guided infiltration.

In the cases in which the ultrasound or the RM manifest a breakage or dynamic dislocation of the lower ulnar, repairing surgical treatment shall be opted for.

Injuries to the triangular fibrocartilage complex

Injuries to the triangular fibrocartilage complex include the injury of the fibrocartilage itself or the injury to the meniscoid.

The production and clinical mechanism are the same ones that have been mentioned prior to this section. If this ulnar-carpal impingement and the forced movements of ulnar impactation are prolonged over time with no previous clinical manifestation, an injury of the meniscoid or of the triangular fibrocartilage can be caused, which are the components in this ulnar-carpal space together with the distal radioulnar palmar and dorsal ligaments, the ulnar lunate ligament, the sheath floor of the lower ulnar and the joint capsule (Esplugas, and Aixalà, 2014).

Another possible production mechanism is a fall on the hyperextended wrist with the forearm in pronation.

Diagnosis

The certain diagnosis of these injuries is mainly through MR, or even better, with arthro-MR (with contrast injection), since it allows the impact of the meniscoid, of the fibrocartilage or even the sheath or sub-sheath of the lower ulnar to be more accurately viewed.

Conventional radiographs or ultrasounds can be of aid at first, but they do now allow the diagnosis to be confirmed.

Treatment

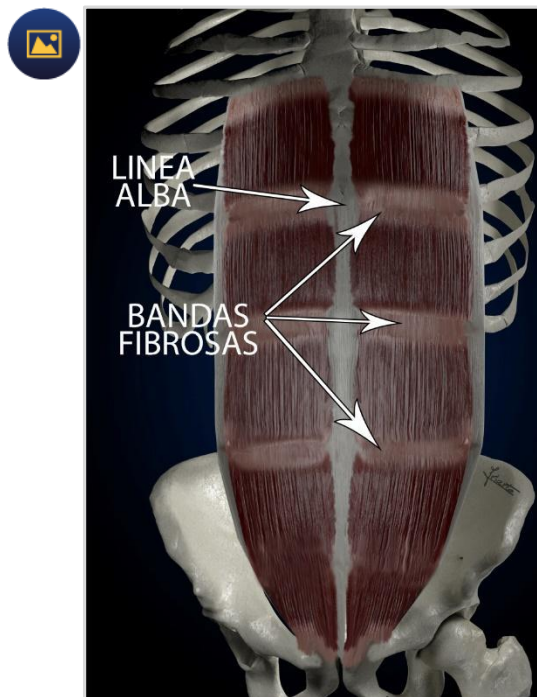
The treatment of triangular fibrocartilage complex injuries will largely depend on the level of injury and on the affected structures. In a high level tennis player (even if not professional), the treatment must be surgical through repair arthroscope.

Injury of the rectus abdominis musculature.

The rectus abdominis (RA) musculature is formed by pairs of muscles separated at the midline by the linea alba. Each one of these groups has two tendinosis origins: a media head, which rises from the previous surface of the pubic symphysis, and a larger lateral portion, which originates in the upper edge of the crest. Both are joined to be inserted in

the fifth, sixth and seventh costal cartilage. The muscle is partially interrupted by three fibrosis bands or tendinosis intersections that are inseparably mixed with the previous layer of the rectus sheath. These bands are on the level of the navel, the zyphoid process and halfway between both (Figure 17).

Figure 17: Anatomic scheme of the Rectus abdominis



Source: Prepared by the author.

In shot and asymmetrical sports, injuries on an RA level are typical. Therefore, they are injuries in a non articular, (which is not habitual) multilaminar muscle and produced by an eccentric contraction mechanism during very specific athletic motor patterns, such as the serve and the smash in tennis, or the spike in volleyball (Balius et al., 2011).

The injury mechanism is produced after a hypertension of the lumbar spine and a stretching of the abdominal musculature with a contraction of the latter in the phase of lifting the serving arm. Thereafter a flexion movement of the spine is performed with large contraction of the entire abdominal musculature. The movement is always with the twisting of the spine toward the side of the injury, that is, it affects the contralateral side of the serving or smash arm.

Several studies have shown professional tennis players have greater muscle development of mass and in volume of the RA on the non-dominant side versus the dominant side (Balius, Pedret, Galilea, Idoate, & Ruiz Cotorro, 2012; Sanchis-Moysi, Idoate, Dorado, Alayón, & Calbet, 2010). This adaptation is produced at early ages and must be taken into account when assessing possible injuries at this level.

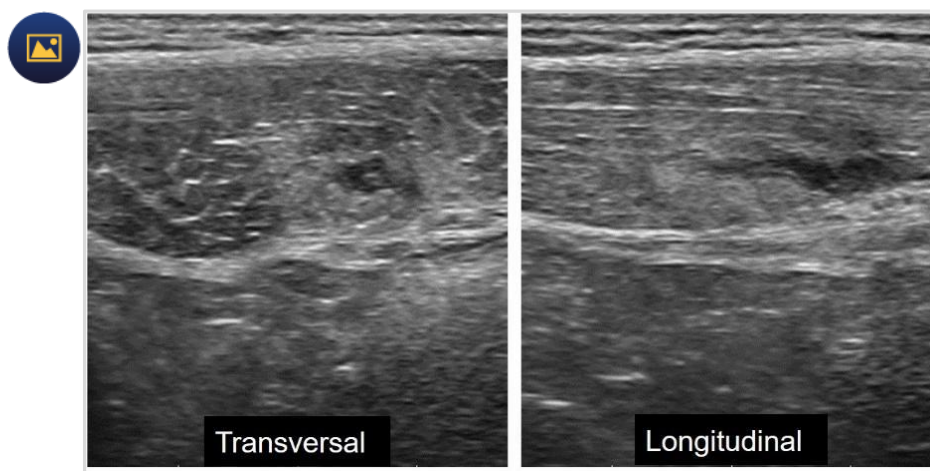
Muscle injuries through an indirect mechanism of the RA are microconnective. In cases of breakage in tennis players, the injury is practically always alongside the lower connective plane in the deep epimysium.

Diagnosis

The tennis player refers to a sharp and disabling pain after a serve or a smash is performed by pointing to it. It is a pain with clearly mechanical characteristics and generally falls below the navel, that is, in the lower abdominal part.

In these cases, as is the case with most muscle injuries, ultrasound is the diagnostic test of choice. On the ultrasound image you will notice solution buildup at the fibrillar network level located within the epimysium, which may at times be accompanied by a small pocket of fluid (Figure 19).

Figure 19: Ultrasound scanning in the transversal and longitudinal axis of an RA injury



Source: Developed by the author.

Observe the fluid buildup with fibrillar pattern as well as the injury status deep within the muscle.

Treatment

The treatment should always be conservative and via physiotherapy. It should begin with one to two weeks of relative rest including adjuvant rehabilitative treatment. Service and smash motions should still be avoided after this time period (the player may train without performing these movements). Once the pain has completely disappeared, progressive stretching treatment should be initiated.

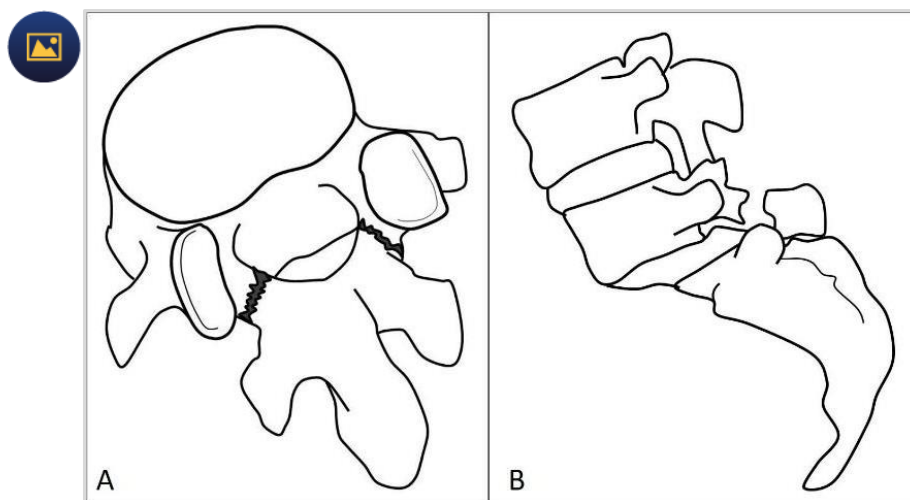
Recurrence is common and is the main complication of this injury since the injury mechanism is quite aggressive and, at times, the *return to play* time frame is much too short.

Spondylolysis/lithesis

Spondylolysis is a bone defect at the *pars interarticularis* vertebrae level (Figure 20, A). The pars interarticularis is a small isthmus located between the facet joints of the upper and lower vertebrae. It generally presents bilaterally, affecting L5 (85-95%) and is much less likely to affect the proximal lumbar vertebrae ((Ruiz-Cotorro, Balias Matas, Estruch Massana, & Vilaro Angulo, 2006), in which case it would typically present unilaterally. Unilateral isthmic injury is noted in around 14-30% of cases.

By the term spondylolysis, we mean the displacement of one vertebra over the one immediately below it (Figure 20, B). This displacement occurs most often in the lumbosacral hinge.

Figure 20: Image of spondylolysis (A) and spondylolisthesis (B)



Source: Developed by the author.

The game of tennis has undergone several changes within the past few years. Changes in rackets, strings, courts and even balls has allowed for an increase in strike power and velocity which is defined by alignment with the ball and a much quicker follow-through after a strike. This movement requires a more sudden lumbar rotation (with an associated flex-extensional element) as well as a more powerful impact in both forehand and backhand strikes.

There is debate around whether this increased spinal rotational load is due more to forehand/backhand strikes or to the serving mechanism (which produces a forced lumbar flex hyperextension with more or less rotational elements depending on the type of serve used). In our experience in the Spanish federation, we believe that currently a forehand or backhand strike is more likely to cause a possible spondylolysis injury.

The mechanisms and movements of the game itself, combined with any abdominal musculature weakness or excessive tightness of the hamstring musculature, causes a stress reaction at the lumbar spinal level, with a higher percentage of sufferers within the sports population.

In fact, the prevalence of isthmic injuries among the Caucasian population who play sports is 10-20% higher than for non-athletes. Isthmic injury is prevalent among sports that predominantly use flex extension (gymnastics, the butterfly stroke in swimming). It is also sometimes seen with body rotations (tennis, high jump) or in sports with load simultaneity such as weightlifting, trampoline or taekwondo ((Ruiz-Cotorro et al., 2006; McCleary, & Congeni, 2007).

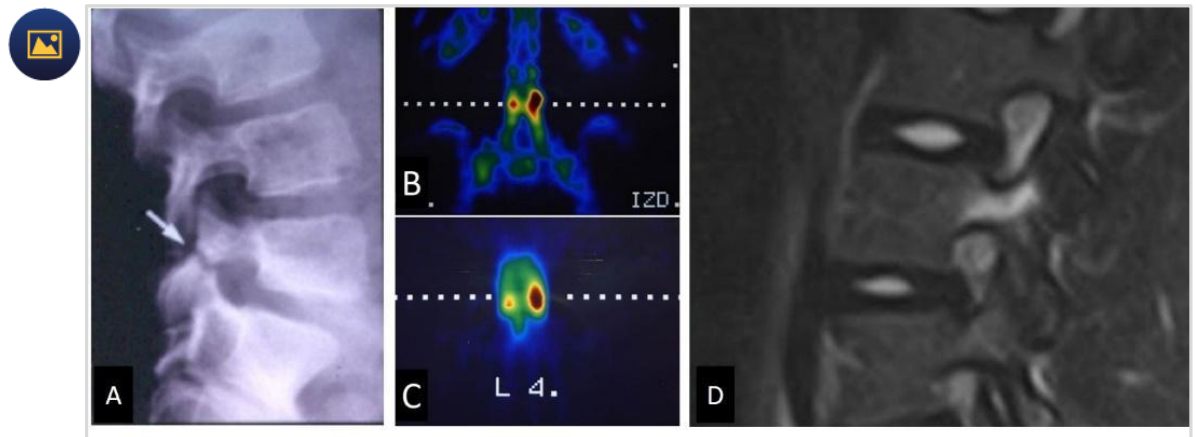
Diagnosis

Correctly reversing spondylolysis in an adolescent athlete depends largely on receiving an early diagnosis. For this reason, spondylolysis should be suspected when dealing with an athlete who suffers from acute or ongoing lumbar pain that increases with lateralization, lumbar rotations and in the *one-legged lumbar hyperextension test*, accompanied by decreased hamstring flexibility and for athletes suffering from severe or minor radiculopathy.

There are four additional tests available, each with its own distinct properties and characteristics. In all cases, a combination of medical records together with some or all of these tests will give a concrete idea about the natural stage of progression of the injury.

The tests are: plain X-ray (especially lateral and oblique screenings), SPECT scan + gammagraphy, computed tomography (CT) and MRI. A combination of these tests will enable a positive diagnosis (Figure 21).

Figure 21: A closer look at images relating to spondylolysis



Source: Developed by the author.

Regarding Figure 21:

- A: an image of spondylolysis (lateral view).
- B and C: SPECT + gammagraphy images that show increased uptake revealing active spondylolysis.
- D: MRI image that shows an increase in signs at the pars interarticularis level consistent with bone marrow edema at this level (stress reaction).

Treatment

Except in advanced cases or those with associated complications, the treatment for spondylolysis for a tennis player is conservative. Pars reconstruction can be achieved using different types of hard or soft braces (Ruiz-Cotorro et al, 2006) meant to limit spine curvature or lumbar extension (McCleary, & Congeni, 2007).

The debate is still ongoing as to how long a brace should be worn. Some studies recommend two to three months of immobilization or less, while others suggest that a brace should be worn for up to six months. In many cases an excellent clinical result can be achieved without pars reconstruction, which remains visible on x-rays, while isotopic or MRI scans show no activity.

The use of a brace and taking some time off should be accompanied by the gradual introduction of lumbar recovery exercises after the third or fourth week of wearing the brace.

Femoroacetabular impingement

In the past few years, injuries to the hip joint have been on the rise in the tennis world due to changes in equipment, training methodologies and playing style. Actually, it has become one of the most limiting and most prevalent injuries in the world of tennis nowadays (Pluim et al., 2006; Dines et al., 2015).

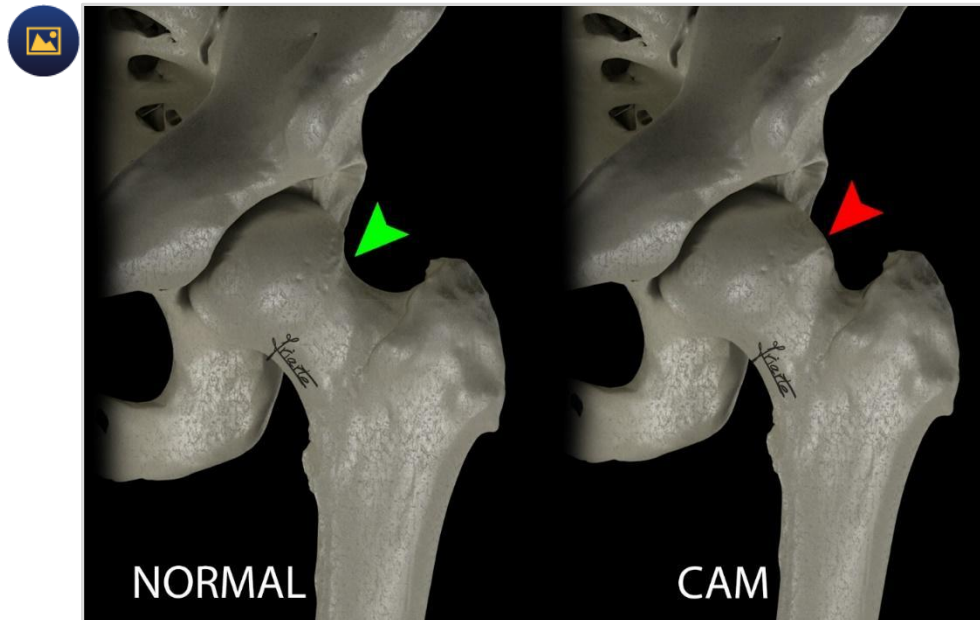
It mainly has to do with Femoroacetabular impingement (FAI) and all of its associated variants.

FAI has recently been defined as a dynamic clinical disorder related to the hip, which encompasses a triad of symptoms, clinical signs and imaging findings. It is a result of symptomatic impact between the femur head and the acetabulum (Griffin, et al., 2016). This dynamic definition of FAI has gained acceptance in recent years as one of the primary causes for hip pain and osteoarthritis.

Impingement can be the result of various conditions, as defined by Sankar et al. (2013):

- Abnormal morphology of the femur (CAM-type deformity) or the acetabulum (PINCER-type deformity) (Figure 22).
- Excessive contact between the femur and the acetabulum.
- Repetitive motions within a supra-physiological mobility range that result in abnormal contact between the femur and the acetabulum.
- Repeated microtraumas.
- Presence of soft tissue injuries.

Figure 22: Image of the normal morphology of the hip joint and of CAM-type deformity as one of the main causes of anterior femoroacetabular impingement



Source: Developed by the author.

In summary, the production mechanism would be repeated microtraumas and sharp movements for an athlete who typically already has a CAM or Pincer-type deformity. This mechanism is very common in tennis due to the speed and power of execution required for strikes from the far end of the court. The predetermining factors for the high number of injuries among tennis players are the abrupt trunk and hip rotations in the sequence used to reach the ball and the forceful, sudden impact when making a second strike.

The development of FAI is often progressive. It begins with the athlete experiencing discomfort in the inguinal region, although it can also affect the gluteal region, the front of the thighs or the lumbosacral region. Once it has become established, forced-flex hip movements may cause deep, sharp pain at the inguinal level – limited internal and external rotation mobility is also typical.

It should be noted that progressive injuries in this anatomical region are frequently accompanied by chondral injuries and injuries to the hip labrum. When these injuries are present alongside FAI, it can complicate treatment and prognosis.

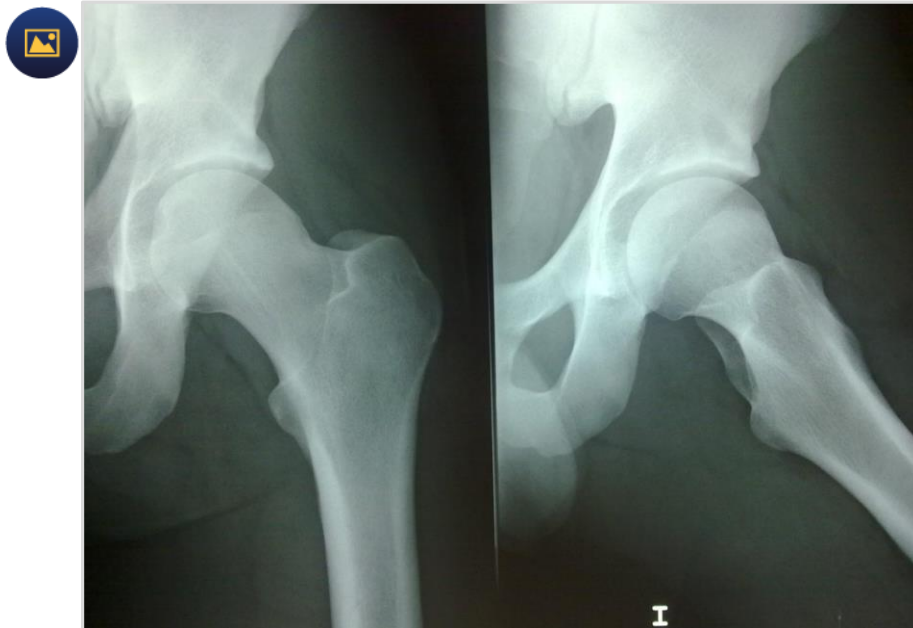
Diagnosis

The diagnosis should always be clinical, with exploration and medical imaging. At the clinical and exploration level, the aforementioned information should be kept in mind since this section focuses on image testing.

Firstly, a conventional anteroposterior x-ray should be taken, as well as oblique x-rays of both hips in order to observe the existing space between the femur and the acetabulum (Griffin et al., 2016).

If a chondral or labral joint injury is suspected, a contrast arthrogram MRI will provide the most information, since the release of the contrast dye could expose a labral defect or a defect in the joint capsule of the coxofemoral joint (Figure 23 and Figure 24).

Figure 23: Conventional X-ray image of the left hip in AP (left image) and oblique (right image) that show a mixed-type FAI (CAM+PINCER-type deformity)



Source: Developed by the author.

Figure 24: Collection of arthrogram MRI images in which you can see an anterior labral injury in the context of an FAI syndrome



Source: Developed by the author.

Treatment

FAI syndrome can be treated conservatively or with surgery (reserved for cases which cannot be resolved with conservative treatment). The conservative method consists mainly of correcting alterations to the mechanical axis of the lower extremities (should they exist), correction to stride alterations and modification/correction of activity and the intensity of the athlete's tasks.

From the very beginning, all of these activity modifications must be accompanied by intensive physiotherapy. The objective of this treatment is to stabilize the lumbo-pelvic complex and improve neuromuscular strength control, range of motion and movement patterns.



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