Resumen

Introducción: El pádel es un joven deporte que atrae a millones de personas, de ambos sexos, de todas las edades y condición social. Practicarlo aporta numerosos beneficios para la salud, pero también puede inducir lesiones.

Objetivos: Analizar la relación patología vascular y pádel, y presentar los aspectos más significativos del síndrome de Paget-Schroetter, y relacionarlos con dicho deporte.

Metodología: Se realiza una revisión de la literatura, hasta el 1 de agosto del 2019, en PubMed, Google y revistas especializadas; y presentación de un caso clínico.

Resultados: La búsqueda realizada no encontró ninguna referencia entre pádel y vascular pathology, pero identificó 20 artículos que relacionan deportes de raqueta y patología vascular, para inferir algunos de sus aspectos al pádel. Clínica: Un caso es presentado de una trombosis venosa axilo-subclavia derecha (síndrome de Paget-Schroetter), diagnosticado mediante eco-Doppler, y tratado efectivamente mediante fibrinólisis local, y posterior resección de la primera costilla (toracoscopía). Actualmente asintomático y bajo anticoagulación oral.

Conclusiones: 1) Escasa bibliografía asocia el pádel; 2) Baja frecuencia de complicaciones vasculares durante la práctica de racquet sports; and 3) Caso del primer caso de la literatura, de un síndrome de Paget-Schroetter asociado al pádel.

Consecuencias prácticas: 1) El mecanismo de producción se explica por la combinación de factores desencadenantes (repetición de movimientos del hombro, asociados a posiciones forzadas - abducción del brazo), y predisponentes (compresión venosa por anatomías anómalas); y 2) Pensar en esta entidad, fundamentalmente antes de jóvenes, deportistas, y sin antecedentes patológicos; únicamente un manejo precoz evita complicaciones (embolia pulmonar), relapses and sequelae (post-thrombotic syndrome).


Lesiones vasculares asociadas a la práctica del pádel. El síndrome de Paget-Schroetter

Correspondencia: Francisco S. Lozano Sánchez
E-mail: lozano@usal.es
Introduction

Paddle tennis is one of the most recently added sports in the racket and stick sports category (badminton, frontenis, tennis, table tennis, squash, etc).1-3 Conceived as a sporting (amateur and professional) or leisure activity, each day more people - men and women of all ages - take up the sport. In this respect, a report about the sporting habits of Spanish people by the Spanish Sports Council and the Sociological Research Centre, in collaboration with the National Statistics Institute, revealed that in 2015, 4.2 million Spaniards played paddle tennis; some 3 million more than in 2010.4

However, this growing participation in paddle tennis in Spain and other places around the world does not correlate with the number of scientific publications produced about paddle tennis and sports medicine. This fact contrasts with other sports, where the major North American leagues have particular prominence (American football, baseball, basketball and hockey)1-3 or tennis6-8.

We know that playing paddle tennis gives physical and psychological benefits (personal and social), and that it should also encourage healthy living habits.9 There is also some data available about the negative side10. García-Fernández, et al11 have quantified 2.75 injuries per every 1,000 hours of exposure to the risk (similar percentage to the injury rate in other racket sports). Paddle tennis is considered a low static and high dynamic sport, entailing intense yet short bursts of effort; despite its similarity to tennis, it is less aerobic in nature. During the game of paddle tennis, hits and impacts are made and received repeatedly yet intermittently, on a hard surface (hybrid court, somewhere between racket/stick sports and wall and net sports), where numerous turns, jumps, bends and stretches, starts and stops, etc. are performed. In this context, injuries are more frequent among amateur players than among professionals, especially due to the false concept that claims you do not have to be in shape to play paddle tennis. In fact, the number of injuries increases significantly with age and body mass index6-11.

Two joints are particularly affected in paddle tennis: the knees and elbows. This is why the locomotor system is where the highest concentration of frequent injuries is found (epicondylitis or tennis elbow, ankle sprains, etc.) Chard et al10 regarding 631 injuries - excluding paddle tennis players - observed that traumatic injuries were most frequent in squash (59%), compared to tennis (21%) or badminton (20%).

With regards to vascular disease, and following the example of other racket sports, its frequency should be sporadic. However, this can change given the high and growing number of paddle tennis players. Precisely, the recent diagnosis and treatment of axillary subclavian thrombosis (Paget-Schroetter Syndrome) in an amateur paddle tennis player, motivated this study.

Material and method

SA search was performed on PubMed/Medline up to 1st August 2019 using the following terms: “Padel”; “Padel players” or “Padel sport”; 5 references were found, despite none of them being related to vascular disease.

We widened the search using the following terms: “Paddle”; “Paddle Tennis”; “Tennis”; “Tennis player”; “Racket”; “Racket player”; “Racket sport”; “Racquet player”; “Racquet sport”; “Athlete”; and “Sport”; both individually as well as combined with the following terms: “Vascular diseases”; “Vascular disorders”; “Vascular injuries”; “Arterial diseases”; “Arterial disorders”; “Arterial injuries”; “Venous disease”; “Venous disorders”; “Venous injuries”; “Venous thrombosis”, and “Venous thromboembolism”.

Another search was performed collectively, using similar key words, in four Spanish journals: Angiología (channel of communication of the Spanish Angiology and Vascular Surgery Society), Medicina del Deporte Archives (official publication of the Spanish Federation and Society of Sports Medicine), Apunts. Medicina de l’Esport (Consell Català de l’Esport), and Revista Andaluza de Medicina del Deporte (Official publication of the Andalusian Sports Medicine Centre).

Vascular injuries and paddle tennis

We did not find any specific references of paddle tennis (or padle) and vascular injuries. To focus on the issue of vascular injuries we used the bibliography available about racket/stick sports in general and tennis in particular.

Table 1 displays the different pathologies and vascular injuries linked to playing a racket sport. In this respect, at least five arterial and four venous diseases have been linked to the practice of tennis11-14 and these may logically appear in paddle tennis.

Table 2 displays the different pathologies and vascular injuries linked to some racket sports that have been reported in medical literature11-15-33. Evidently, only 15 clinical cases and 5 reviews have been described.

Table 1. Vascular diseases described in racket sports11-14.

<table>
<thead>
<tr>
<th>Arterial disease</th>
<th>Ischaemia in the upper extremities:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Upper thoracic outlet syndrome</td>
<td></td>
</tr>
<tr>
<td>- Entrapment of the humeral artery</td>
<td></td>
</tr>
<tr>
<td>- Raynaud Syndrome</td>
<td></td>
</tr>
<tr>
<td>- Hypothenar hammer syndrome</td>
<td></td>
</tr>
<tr>
<td>Ischaemia in the lower extremities:</td>
<td></td>
</tr>
<tr>
<td>- Entrapment of the popliteal artery</td>
<td></td>
</tr>
<tr>
<td>Compartment exertion syndromes (chronic)</td>
<td></td>
</tr>
<tr>
<td>Dissections:</td>
<td></td>
</tr>
<tr>
<td>- Axillary artery</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Venous pathology</th>
<th>Deep vein thrombosis (DVT):</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Upper extremity (Paget-Schroetter Syndrome)</td>
<td></td>
</tr>
<tr>
<td>- Lower extremity</td>
<td></td>
</tr>
<tr>
<td>Varicose veins</td>
<td></td>
</tr>
<tr>
<td>Venous traumatised:</td>
<td></td>
</tr>
<tr>
<td>- Venous tears (Tennis leg syndrome)**</td>
<td></td>
</tr>
</tbody>
</table>

* Pathology with similar components.
** Tennis leg. Differential diagnosis with the DVT.
Francisco S. Lozano, et al.

120
Arch Med Deporte 2020;37(2):118-124

The exceptionalness of vascular injuries caused by playing a racket sport, is not an excuse for its infra-diagnosis, particularly in sports such as paddle tennis, which is practised by a large part of the general public, who even without playing this sport would suffer its epidemiological impact (by age groups, sex and the presence of other risk factors) on vascular diseases, fundamentally those with a high incidence rate and prevalence (e. g. intermittent claudication, venous thrombosis or varicose veins).

Paget-Schroetter Syndrome

A clinical case is presented, which according to our review is the first described in medical literature in connection with paddle tennis. A collective update is performed (literary review).

Clinical case

34-year old male, with no personal or family antecedents of interest, no toxic habits, no known allergies; claims to have played paddle tennis regularly (2-3 sessions/week, for the past 5 years). He came to A&E with pain and swelling in his right arm that appeared suddenly 5 days before, following one of his regular paddle tennis matches. A D-dimer test (elevated) was requested, as well as an Echo-Doppler, confirming an axillary subclavian venous thrombosis in the upper right extremity (his dominant arm). A diagnostic probability test was not performed.

Given that he did not have any antecedents of interest, except for the exertion mentioned, the patient was diagnosed with Paget-Schroetter Syndrome. The patient was admitted into hospital and administered sodium heparin IV in therapeutic measures. The following morning, the patient was sent to a clinical session; given his age, recent clinical history and low risk of bleeding, the collective opinion was to propose fibrinolytics treatment. After informing the patient (risks and benefits), he accepted to undergo fibrinolytics. Local urokinase was administered intra-thrombus via catheter. The patient was admitted into the intensive care unit. Given that he did not have any antecedents of interest, except for the exertion mentioned, the patient was diagnosed with Paget-Schroetter Syndrome. The patient was admitted into hospital and administered sodium heparin IV in therapeutic measures. The following morning, the patient was sent to a clinical session; given his age, recent clinical history and low risk of bleeding, the collective opinion was to propose fibrinolytics treatment. After informing the patient (risks and benefits), he accepted to undergo fibrinolytics. Local urokinase was administered intra-thrombus via catheter. The patient was admitted into the intensive care unit.

Figure 1. Phlebography and local fibrinolytics via catheter: Pre-fibrinolytics (axillary subclavian venous thrombosis) and post-fibrinolytics (resolution of the thrombus).

Table 2. Vascular pathology in the practice of racket/stick sports. Literary review.

<table>
<thead>
<tr>
<th>Author/s (country)</th>
<th>Review, year</th>
<th>Sport</th>
<th>Pathology</th>
<th>Type publication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coon &amp; Willis (USA)</td>
<td>Arch Surg, 1967</td>
<td>Tennis</td>
<td>Axillary subclavian DVT, Paget-Schroetter Syndrome</td>
<td>C</td>
</tr>
<tr>
<td>Brunner (Germany)</td>
<td>Z Unfallmed Berufskr, 1968</td>
<td>Badminton</td>
<td>Axillary subclavian DVT “exertion-induced”; Paget-Schroetter Syndrome</td>
<td>C</td>
</tr>
<tr>
<td>Gilbert &amp; Ansari (USA)</td>
<td>Hosp Pract (Off Ed), 1991</td>
<td>Tennis</td>
<td>Calf swelling</td>
<td>C</td>
</tr>
<tr>
<td>Capek &amp; Holcroft (USA)</td>
<td>J Vasc Interv Radiol, 1993</td>
<td>Tennis</td>
<td>Traumatic ischaemia in the hand</td>
<td>C</td>
</tr>
<tr>
<td>Stubington &amp; Riggs (GB)</td>
<td>Br J Sport Med, 1995</td>
<td>Squash</td>
<td>Arterial-venous fistula Traumatic superficial temporal artery</td>
<td>C</td>
</tr>
<tr>
<td>Noël &amp; Hayoz (Switzerland)</td>
<td>Vasa, 2000</td>
<td>Tennis</td>
<td>Claudication of the hand (hypothenar hammer syndrome)</td>
<td>C</td>
</tr>
<tr>
<td>Zell, et al (Germany)</td>
<td>Angiology, 2001</td>
<td>Racket</td>
<td>Paget-Schroetter Syndrome</td>
<td>R</td>
</tr>
<tr>
<td>Ise, et al (Japan)</td>
<td>J Cardiol Cases, 2014</td>
<td>Tennis</td>
<td>PTS popliteal (traumatic)</td>
<td>C</td>
</tr>
<tr>
<td>Tracy, et al (USA)</td>
<td>J Hand Surg Asia Pac Vol, 2017</td>
<td>Lacrosse</td>
<td>Arterial-venous fistula Traumatic superficial temporal artery</td>
<td>C</td>
</tr>
<tr>
<td>Abe &amp; Fujii (Japan)</td>
<td>Med J Armed Forces India, 2019</td>
<td>Tennis</td>
<td>Chronic compartment syndrome (forearm)</td>
<td>C</td>
</tr>
<tr>
<td>Lozano (Spain)</td>
<td>Arch Med Deporte, 2019</td>
<td>Paddle tennis</td>
<td>Axillary subclavian DVT: Paget-Schroetter Syndrome</td>
<td>C</td>
</tr>
</tbody>
</table>

USA, United States of America; GB, Great Britain.
* C: Clinical case; R: Review
monitoring unit for analytical monitoring (coagulation, fibrinogen, etc.); in the second angiographic control at 24 hours, re-permeability was observed (Figure 1). The patient was moved to the ward, continuing with anticoagulation (sodium heparin IV). On the 6th day of admission, he was released with oral anticoagulation. During his hospital stay, a thoracic Angio-RM was performed, revealing no osteo-articular alteration of the thoracic outlet. The thrombophilic study was normal. The patient was sent to the thoracic surgery department, where his first rib was successfully resected via video-thoracoscopy. Currently, two months after release from hospital, the patient has no symptoms, and is continuing with the oral anticoagulant treatment (rivaroxaban 20mg/day). He has been advised to refrain from playing paddle tennis until further medical examinations.

**Discussion**

Deep vein thrombosis (DVT) is a frequent illness, linked to serious complications (e.g. pulmonary embolism - PE) and aftereffects (e.g. post-thrombotic syndrome - PTS) that entail important clinical, social and economic repercussions. Its basic etiopathogenicity was described over a century ago (Virchow, 1860). Along this line of ideas, there are numerous illnesses and syndromes associated to DVT. Among them we highlight Paget-Schroetter Syndrome, which in our opinion presents three important characteristics: 1) Infrequent; 2) Fundamentally affects young people (< 40 years), often athletes; and 3) Is relatively unknown by non-specialists in venous pathology; this can lead to errors (diagnostic and therapeutic) with possible consequences, which can occasionally be serious (fatal PE).

Based on our experience and a literary review, we present the most relevant aspects of this syndrome (concept, frequency, etiopathogenicity, clinical history, diagnosis and treatment), with the aim of facilitating early diagnosis, optimising treatment and thus improving the prognostic (mortality rate) of this entity.

**Concept and classifications:** Initially it is necessary to define thoracic outlet syndrome (TOS). The outlet/inlet of the most important neurovascular structures of the thorax to the arm or vice versa, should cross three anatomical areas that can be conflictive: 1) Interscalene triangle (intercostal-scalene space); 2) Costo-clavicular channel; and 3) Coracobrachial tunnel (sub-pectoral/subcoracoidal area). There are a whole host of causes (cervical rib, subclavian muscle hypertrophy, etc.) and syndromes (scalene syndrome, pectoralis major syndrome, etc.) that may compress some or all the existing neurovascular structures (brachial plexus, artery and subclavian vein) (Figure 2). However, the impact is spread differently: neurological (95%), arterial (4%) and venous (1%).

In turn, venous TOS can be classified as: 1) Compression without DVT (denominated McCleery syndrome and characterised with venous swelling), and 2) Compression with DVT: this latter group, depending on aetiology, is subdivided into: a) Primary (25%) or Paget-Schroetter Syndrome (spontaneous or strain-induced axillary subclavian thrombosis) and b) Secondary (75%). Secondary aetiology is linked fundamentally to central venous channelling techniques (diagnostic or therapeutic - reservoirs), but they can also be due to polyclonabits, congestive cardiac insufficiency or extrinsic compressions for different pathologies (e.g. primary or metastatic cancer).

Historical overview: the English pathologist, James Paget (1875) and the Austrian internist, Leopold Schrötter Ritter von Kristelli (known in medical literature as Leopold von Schrötter) (1884), independently studied and characterised the syndrome. In 1949, Hughes performed a literature review and discovered 320 cases, proposing the term “Paget-Schroetter Syndrome” (Figure 3).

Frequency: if the DVT of the upper extremities represent around 5% of all DVT cases, Paget-Schroetter Syndrome represents 1% of all venous thromboses. Over the past 5 years, in our department, 3 or 4 cases/year have been diagnosed/treated; two of them related to playing basketball.
**Etiopathogeny:** although the aetiology of the syndrome is unknown, it is usually related to two factors: a) repeated venous trauma, of diverse intensity and b) anatomical alterations that produce compressions. Strain is present in around 70% of cases. In fact, a third of the cases are people that play physically exerting sports, i.e. those in which the athletes repeatedly use their upper extremities (Table 1)[11-14], and interestingly, it has even been seen in a cheerleader[36]. Another third appears in professionals that also use their arms repeatedly. The remaining third appears in sedentary patients.

Along with the triggering situation (exertion-induced), there are other predisposing factors: anatomical defects (thoracic outlet syndrome), anovulatory defects, or unknown thrombophilic states. Anatomical defects are present in 90% of the cases, and are bilateral in 65%. This anatomical defect (muscular, bone, etc.) induces the compression of some (or all) vascular-nervous structures (in our case, the axillary and/or subclavian vein) that leave/enter the thorax, fundamentally during forced positions upon performing the exertion, which if repeated, causes the thrombosis of said vein. However, there may be anatomic defects without venous thrombosis and vice versa[35,40-42].

Production mechanism: accordingly, an axillary-subclavian DVT, generally in the dominant arm of a paddle tennis player, would be explained through a combination of factors: a) Triggers (repeated shoulder movements, linked to exertion positions - arm abduction) (Figure 4). Predisposition (vein compression by abnormal anatomic structures), not forgetting a hidden thrombophilic alteration or the ingestion of anovulatories (women of fertile age comprise a quarter of all paddle tennis players), which should also be researched.

**Clinical:** more frequent among males (2:1) and young people (average age of appearance: 31 years of age, range between 23-53). The dominant extremity is affected in 70% of the cases, with bilateral cases representing 7%[35,40-42].

The most symptomatic patients presented suddenly-appearing swelling (80%) and pain (30-50%) in the arm. Upon physical examination, there was frequently bruising, alteration of the colour of the skin and collateral circulation (Urschel sign) in the most developed cases[35,40-42].

**Diagnosis:** just as with the lower extremities (LE) (Wells test) for the upper extremities (UE), there is also a diagnostic probability test for DVT (Constans et al. 2008)[43]. This comprises four items: the presence of a catheter inserted in the vein (1 point), localised pain (1 point), unilateral swelling (1 points), and alternative diagnosis (- 1 point). A score below 1 point indicates the unlikelihood of DVT (which is ruled out when associated with a negative D-Dimer); more than one point implies that DVT is likely and requires the use of image techniques to confirm/reject the DVT diagnosis.

The D-dimer is less useful in terms of DVT and LE. The Echo-Doppler (97% sensitivity and 96% specificity), is the test of choice. MRA or angio-CTA (resting and hyper-abduction manoeuvres - Wright) are highly useful diagnostic tools. As phlebography (resting and manoeuvres) is an invasive technique, is relegated as a secondary diagnosis option[35,40-42].

Treatment: although initial standard treatment is anticoagulation (3 months), direct fibrinolytics via catheter is indicated for thromboses with less than 14 days of development, in young patients, and those with low risk of haemorrhaging. Later, in selected cases, a surgical technique can be performed of decompressing the sub-clavicle vein[4]; however, this is a controversial issue that is not part of the objective of this review. The filter of the superior vena cava may be indicated in situations in which anticoagulation is contraindicated[44].

The treatment purpose should be two-fold: a) Preventing the risk of PE, and b) Preventing PTS. Various actions have been trialled: 1) Regarding the thrombus: anticoagulant (not very effective); thrombectomy (classic or percutaneous); systemic or local fibrinolytics. The latter options appear to be the most useful, but for maximum effectiveness it is essen-

---

**Figure 4. Pathogens of the Paget-Schroetter Syndrome. Abduction position of the arm whilst playing paddle tennis.**

---

**Figure 5. Therapeutic algorithm of Paget-Schroetter Syndrome (TOS, thoracic outlet syndrome; PTA, percutaneous transluminal angioplasty).**

---

**Table 1. Distribution of cases of Paget-Schroetter Syndrome.**
tial for the thrombus to be around 7 days old (Figure 1); 2) Regarding compression (diverse techniques, e.g. Reection of the rst rib); and 3) Regarding residual stenosis. Percutaneous transluminal angioplasty (PTA) with/without stent. This therapeutic action is usually gradual. Figure 5 displays a simplification of the algorithm we use in our service.

As a treatment appendix, there are publications that make specic recommendations for the anticoagulant treatment of DVT in athletes.4, 46 Development: PE appears in 5–9% of cases (30% in DVT that affects the LE). PTS appears in 20% (40–50% in LE). Venous rethrombosis is also lower compared to LE DVT.8, 43, 44, 46. Prognosis: early and correct diagnostic-therapeutic handling of the syndrome proers excellent results and allows for a return to sporting activity, as observed in professional players from some of the four major American leagues (baseball, basketball, American football and ice hockey).5, 12. During the anticoagulant (and antiaggregate) treatment, practising sport is completely contraindicated. Despite paddle tennis not being a contact sport, is does entail the risk of falls and trauma (e.g. “Tennis leg”). In any case, the recovery period may extend to 3–6 months.

Conclusion

Basic recommendations: 1) Think about this entity, especially for young, active and healthy patients; 2) Treat the thrombosis with anticoagulation and in select situations with fibrinolytics; and 3) Aim, and on select cases, to treat the anatomic cause.

Adendum

After this drafting of this study, the Angiology and Vascular Surgery Department of the University of Salamanca Healthcare Complex treated a 54-year old male patient who was a regular paddle tennis player and doctor, who had come from Avila with a provisional diagnosis of hamstring-tear syndrome or deep vein thrombosis (DVT). In our department we performed an Echo-Doppler and conrovasion in the muscular veins (calf muscles) of the lower right extremity, without progression to the popliteal vein, and without signs of bruising or muscle tearing. Anticoagulation was recommended with low molecular weight heparin (LMWH) (1–3 months) and elastic compression stockings. Given his position as a doctor, he opted to continue follow-up in his home city.

Comments: 1) Remember that the muscular veins (calves and soleus) belong to the deep vein system of the lower extremities; 2) In these situations it is very important to differentiate between a ndor tear (tennis leg) and DVT (though it may be distal and conroved to the calf); however, occasionally both entities may be present; 3) Only an exact diagnosis facilitates correct decision making, so whilst in the rst case (fibrillar tear) the administration of LMWH would possibly increase the symptoms (more bleeding), in the DVT - despite being distal and isolated - LMWH may be recommendable, especially when the thrombus is extensive (> 5 cm in length) and when it affects more than one muscle vein, such as in this case. If in doubt, the clinical development of the patient can be observed and serial Echo-Doppler sessions (weekly) can be carried out. Anticoagulation can be chosen only if the thrombus progresses to the popliteal vein; however, distal and isolated DVT can - infrequently - also cause pulmonary embolisms.46, 47

Acknowledgements

To Mario Estevarena, who without knowing it, has enabled me to carry out this work. To all the members of his team, coaches, players and friends of Padel You (Salamanca, Spain).

Conflict of interest

The authors claim to have no conflict of interest whatsoever.

Bibliography


41. White JM, Cornerota AJ. Venous compression syndromes. Vasc Endovasc Surg. 2017;51:155-68.


