Trabajo Fin de Grado en Veterinaria

Title: Relationship between the treatment used in superficial digital flexor tendon (SDFT) tendinitis and its prognosis in Thoroughbred horses in Canary Islands.

Student:
Blanca Alvarado Rodríguez

Tutor:
María Luisa Díaz-Bertrana Sánchez

Co-Tutor:
Lidia Pitti Ríos

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UNIVERSIDAD DE LAS PALMAS DE GRAN CANARIA
Facultad de Veterinaria

INDEX

ABSTRACT

Musculoskeletal injuries are the main cause of loss of sporting performance in horses, with the superficial digital tendon (SDFT) being affected on a large number of occasions. In spite of having investigated on multiple occasions different lines of treatment, there is still no standardized single treatment that is affordable, effective and that allows the injured horse to return to its previous sporting level.

In the Canary Islands, due to the great tradition of racing on asphalt, there are a large number of English thoroughbred horses (PSI). Therefore, in this study, with the help of ultrasound, we seek to observe the possible relationship that may exist between a better or worse recovery depending on the treatment used.

For this purpose, 27 PSI horses that had been treated at the Veterinary Clinical Hospital of the ULPGC were selected. The inclusion criteria were: having suffered from tendinitis of the SDFT, having been treated and having ultrasound images in their histories.

A greater number of lesions were observed affecting area 2B; as well as a better evolution in the cases in which PRP + Conventional was used as treatment ($p>0.05$).

Although much progress has been made in the treatment of tendinitis in horses, there is still no treatment that works in most equids in a predictable way, allowing them to return to compete at the same level as before the injury. For this reason, and because of the great economic loss to their owners, it is necessary to continue to study tendinitis because, although we are getting closer, a standardized treatment has not yet been achieved.

INTRODUCTION

Current horses (Equus caballus) belong to the Order Perissodactyla, Family Equidae; and like their ancestors (Equus ferus caballus) are animals that have been in contact with humans for more than 5000 years; before this time they were hunted, but around 3700 -3000 BC, in the settlement of Botai, seems to be the first settlement where the use of domesticated horses for hunting wild horses is evidenced (Lira & Director, 2019). With the passage of time domesticating the horse, not only were coats selected; but some breeds became extinct, and many others originated.

Image 1. Representation of a horse with winter coat. Black Room of the Niaux Cave (Ariège, France) (Photo: Bradshaw Foundation).

As needs and lifestyles have changed over the centuries, horses have gone from being a fundamental part of everyday activities for more than 5000 years, to being present in human life mainly for sporting purposes.

Currently, there are different sports disciplines within the equestrian sport. The vast majority are regulated by the International Equestrian Federation (FEI): Show Jumping, Dressage, Eventing, Eventing, Driving, Raid and Vaulting (Fédération Équestre International, www.fei.org, 2011-2024); on the other hand, we find horse racing. The latter are regulated by national associations of each country that share their data and the basis of the competitions in the International Federation of Horseracing, being the Spanish Jockey Club the one that regulates them in Spain (Jockey Club Español, 2024).

Depending on the discipline performed, there will be a series of breeds that are more suitable, due to better morphological adaptations or the ability to achieve a better performance. In the case of gallop races or Turf, the Racing Code itself, issued its last update in July 2023 by the Spanish Jockey Club, makes reference to the fact that the Thoroughbred horses (TBH), unless otherwise indicated, are the only ones admitted in smooth races, and therefore any other breed may only participate if the race regulations specify it, as specified in Article 53 of the Racing Code of the Spanish Jockey Club.

The fact that nowadays horses have become part of a sporting environment, makes them develop activities and exercises with a high level of physical demand to achieve a higher performance. As it happens with human beings when they develop a high level exercise, there will be a series of pathologies more characteristic or specific to those specimens that are in this more sporting environment, and there will even be a variability depending on the equestrian discipline to which they are dedicated and based on their morphological characteristics (Thorpe et al., 2010).

In the Canary Islands we find the so-called traditional races, which can take place in a racecourse; and the traditional races on asphalt (Federación Canaria de Hípica, 2023).

This discipline also follows animal welfare criteria, performing veterinary tests and being necessary that they do not present any affection at the time of the race. Likewise, the fact of running on asphalt makes it a discipline that generates a more rapid degeneration of the structures of the extremities, both bony and tendon or ligamentous, either during the race itself or during training (Kai et al., 1999); thus, increasing the likelihood of tendinopathies or demopathies, as in the TBH that perform races on racetracks.

In the present study, being the breed used par excellence in smooth races (which are those that take place in the Canary Islands), we are interested in knowing the characteristic morphology of the TBH that makes them suitable for these races.

TBH are horses that are characterized by a long-limbed morphology, having long and slender limbs, elongated neck and thin thorax. We can observe that, due to

their morphology, they are good athletes to carry out explosive exercises that require them to reach high speeds (Real Federación Española de Asociaciones de Ganado Selecto, www.rfeagas.es/razas/equino-caballar/pura-sqangre-ingles/, 2021).

Image 2. Image of TBH horse (Source: worpress.com).

Their training begins at an earlier age than other breeds or horses dedicated to other disciplines, usually starting at around 2 years of age, since the minimum age to compete is 2 years old (Jockey Club Español, 2024). This means that, on many occasions, the muscles, tendons, ligaments and bones are quite immature and that all the work overload they receive may predispose them to have a series of typical injuries, and these great stresses can affect an earlier degeneration of the tendons and ligaments (Plevin et al., 2019).

The most common diseases in horses are those affecting the musculoskeletal system (Carmona et al., 2011). Likewise, it is stated that 82% of the cases of loss of performance are associated with lameness; of which between 46% and 53% are due to tendon and ligament injuries. The most affected limbs are the forelimbs, being the superficial digital flexor tendon (SDFT) the most affected structure (75-93%); while in the rest of the cases the suspensory ligament is the one that usually suffers the injury (Thorpe et al., 2010).

With the develop of the digital era, including ultrasound, which allows a more accurate, accessible and minimally invasive diagnosis, it has become the technique of choice in the study of soft tissue injuries that occur in horses. It was in the mid-eighties when the use of ultrasound was described for the first time to diagnose injuries in the

locomotor apparatus in horses, especially in the palmar region of the metacarpus (Genovese R.L. et al., 1986; María De Los Llanos Martínez & Murcia, 2005).

In addition, when applying certain treatments based on perilesional and intralesional infiltrations, whether they are tendinitis of the SDFT or desmitis of the suspensory ligament, among others, the use of ultrasound allows a better approach to the affected area.

Imagen 3. Tendon ultrasound on LF. (Own elaboration).

Different treatments have been proposed over the years that, instead of being cutaneous or systemic, seek to act locally to achieve regeneration of the damaged area. Initially, the use of hyaluronic acid or corticosteroids was observed.

As the years have gone by and the difference between the repair and regeneration of a tendon structure has been understood in greater detail, treatments have been oriented more towards the use of Platelet Rich Plasma (PRP), mesenchymal cells and the importance that the use of insulin-like growth factor I seems to have in a lower possibility of recurrence and a better prognosis and faster recovery of pre-injury activity (Carmona et al., 2011).

ANATOMY OF THE SDFT IN THE FORELIMBS

The SDFT has its origin in the superficial digital flexor muscle, which is composed of a single muscle belly that originates in the medial epicondyle of the humerus. It extends distally until, prior to reaching the carpus, the SDFT is formed. At the level of the carpus, it receives the accessory ligament, which originates from the medial reverse of the body of the radius. Initially, it runs mediopalmar to the deep digital flexor tendon (DDFT), but as it becomes more distal, it is located completely palmar (María De Los Llanos Martínez & Murcia, 2005).

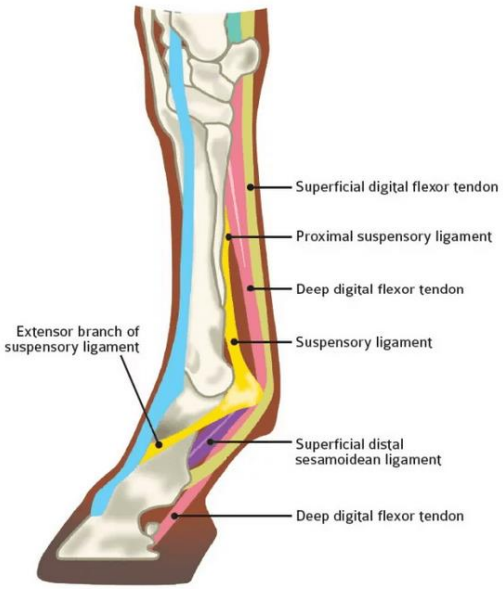


Image 4. Graphic representation of the tendinous and ligamentous structures present in the equine digit.

In the most distal area, it forms a cuff (pierced tendon) that surrounds the DDFT (perforator tendon), inserting a fascicle (proximal) in the distomedial end of the proximal phalanx; on the other hand, the other fascicle (distal) inserts laterally and medially in the flexor tuberosity of the middle phalanx (Sandoval, 1998) (María De Los Llanos Martínez & Murcia, 2005).

The flexor tendons are covered by a synovial sheath that extends from the distal area of the forearm to the middle of the third phalanx (Sandoval, 1998) (María De Los Llanos Martínez & Murcia, 2005).

The tendon is a highly organized structure that connects a muscular belly to a distal skeletal element; it is formed almost exclusively by type I collagen fibers (dense connective tissue) embedded in an aqueous matrix of proteoglycans and to a lesser extent other types of collagen. The subfibrils, composed of tropocollagen microfibrils, are almost parallel along the tendon and are concentrated in a primary (fibers) and secondary (fascicles) group, all of which form the tertiary bundle. The collagen fibers are divided into tight bundles of bundles that run in longitudinal parallel rows orienting the tenocytes. The transverse section of a tendon surface reveals the presence of interfascicular septa (Carmona et al., 2011; María De Los Llanos Martínez & Murcia, 2005).

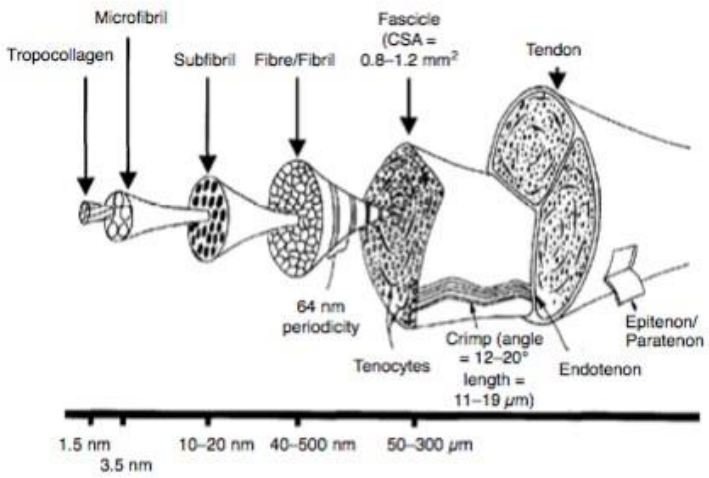


Image 5: Representation of the hierarchical structure of the SDFT (Source: A review of tendon injuries: why is the equine superficial digital flexor tendon at greatest risk? Thorpe C., et al)

ULTRASOUND FUNDAMENTALS

The operation of ultrasound is complex to understand, but very useful to use. The production of the waves in ultrasound is based on the echo-pulsed principle; this consists of recording the reflected echo of high-frequency waves.

The transducer emits a beam of waves (generated by the piezoelectric effect, in which the piezo crystals present in the transducer generate ultrasound from electric current) towards the tissues to be studied. These waves interact with the different

tissues in different ways depending on their composition and can penetrate or be reflected in the form of echoes. Once these echoes are captured by the transducer, the computer processes them and generates a two-dimensional image from them. This process in which waves are emitted and their echoes are received is repeated millions of times per second (María De Los Llanos Martínez & Murcia, 2005; Redding W.R., 2014; Lidia del Pilar Pitti Ríos, 2018).

Ultrasound is a high frequency sound, higher than 2 MHz; it is not audible to the human ear.

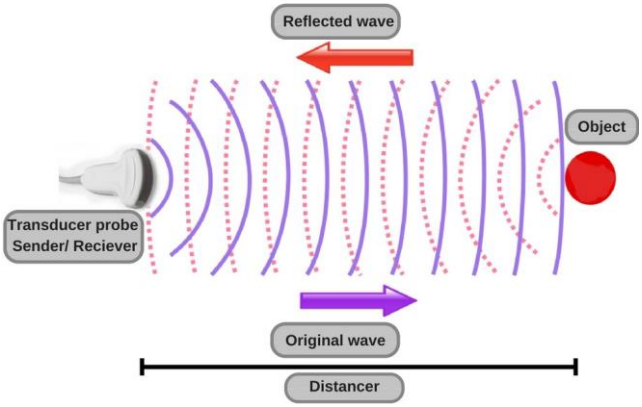


Image 6. Schematic representation of how ultrasound works (Source: www.scienceabc.com).

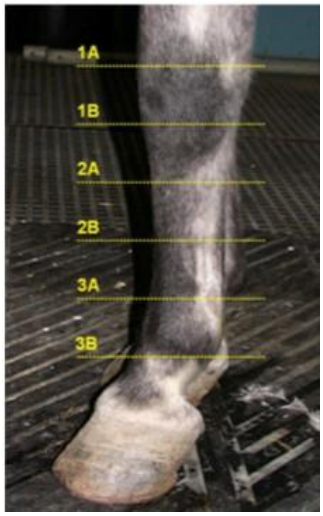
ULTRASOUND ANATOMY

The purpose of this ultrasound description is to find a guide of how we will find the tendon in normal conditions in order to be able to discern between pathology and normality.

The extremity is divided distally to the carpus, equidistantly, approximately every 5 cm, with the most proximal zone being zone 1A, then 1B, 2A, 2B, 3A, 3B and finally 3C the zone closest to the hoof.

- Zone 1A: Here it is observed that the SDFT is oval, palmar to the DDFT and slightly hypoechoic compared to it. Dorsal to the DDFT the accessory ligament or check ligament is observed, and it is the most echogenic structure of the three.

- Zone 1B: It is the zone of the superior portion of the III metacarpal. The change at ultrasound level compared to zone 1A is that the SDFT appears more flattened dorsopalmarly and the DDFT more rounded.
- Zone 2A: In this zone, the SDFT continues to flatten, while the DDFT does not undergo significant changes. The accessory ligament flattens and inserts into the DDFT at this level.
- Zone 2B: In this zone the SDFT is more flattened than in the previous zone and the accessory ligament is still distinguishable, but in close contact with the DDFT.
- Zone 3A: It corresponds to the distal third of the III metacarpal. It is in this zone where the SDFT acquires a crescent conformation, the accessory ligament and the DDFT are already fused and in the distal part of this zone the suspensory ligament is divided in the two branches (lateral and medial).
- Zone 3B: It is a more extensive area than the other zones, here it is observed that the SDFT begins to wrap, more flattened, the DDFT, which acquires a more ovoid conformation.
- Zone 3C: The intersesamoid ligament is observed (María De Los Llanos Martínez & Murcia, 2005).



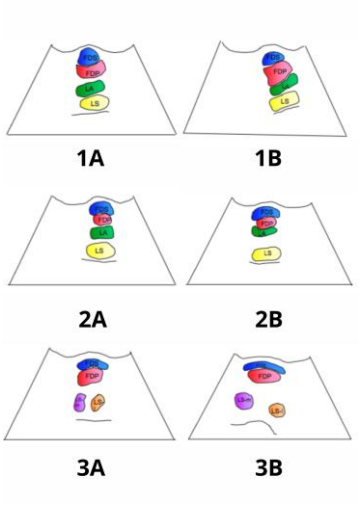


Image 7. (Left) Left forelimb of a horse with the ultrasound regions indicated.

Image 8. (Right) Schematic representation of how the tendinous and ligamentous structures of the forelimb of a horse are observed in each anatomical region on ultrasound.

OBJECTIVE OF THE STUDY

Ultrasound monitoring is of great importance in the control of the evolution of tendinopathies, as well as the treatment used; this is why in the present work a retrospective study was carried out in which ultrasound measurements available in the clinical histories of the different animals studied before and after having been treated were evaluated and a correlation was sought between the treatment used and a better recovery and reintroduction into their training and competition routine. In this case, as the breed that is mostly used in traditional asphalt races is the PSI, it was analyzed in this breed.

MATERIAL AND METHODS

In this project a retrospective study of cases treated at the Hospital Clínico Veterinario de la Universidad de Las Palmas de Gran Canaria that had suffered from TDFS tendinitis and of which there were diagnostic and post-treatment control ultrasound studies was carried out.

The ultrasound characteristics were analyzed, and the possible relationship of the evolution experienced with each of the different treatments used was studied.

MATERIALS:

- **Shearing machine:**

It is necessary to use a shearing machine, since the presence of excessive hair, together with the possible dirtiness of the extremities, can cause numerous artifacts to be observed in the image or even make it impossible to visualize the tendon structures under study. For this reason, all animals were shaved.

- **Ultrasound machine + Transducer:**
    - **Ultrasound machine**

An Edan Acclarix AX3 ultrasound scanner was used to take the ultrasound images and perform the measurements. This ultrasound scanner is made of magnesium alloy, which makes it quite light (4.5kg), allowing it to be a portable ultrasound scanner. The battery allows it to be used without the need to be connected to the mains, as it has a battery life of 2 hours. This factor is important since in several of the farms where the animals were housed, electricity was not available or there was no accessible outlet during the scan (Edan, 2020).

Image 9. Edan portable ultrasound scanner model Acclarix AX3.

This model of ultrasound scanner has both B-mode, normal and color Doppler, and M-mode, among others. There are several transducer models that can be used.

To perform the ultrasound scans, Quick echo gel and alcohol were used for better penetration of the ultrasound waves.

- **Array Transducer**

An Edan array transducer, model L12-5Q, was used. This one is a linear type, operating at a frequency between 5-12 MHz. It is used for the study of small parts, musculoskeletal structures, nerves and vascular structures. This array was chosen because it is the most suitable for the study of tendon structures (Edan, 2020). No tendon pack was used.

Image 10. Linear array transducer for tendon study, Edan brand, model L12-5Q.

- **Gestorvet**

Gestorvet is an online platform through which you can manage all the needs of a veterinary center or hospital, from storing all kind of information such as radiographic images, ultrasound scans or documents generated with laboratory tests in the medical records of each animal, to generating new consultations, scheduling new appointments, creating invoices, inventory control, etc. In this case, the Clinical Veterinary Hospital of the ULPGC makes use of this online software, thus being able to access the veterinary records of each equine studied (*Gestorvet*, 2024).

- **Selection of horses to be studied**

In the present study 31 horses were selected, the criteria used were:

- Be of PSI breed,
- be trained on hard surfaces and, if possible, participate in asphalt races,
- have had a tendinous lesion of the SDFT in the forelimbs,
- having ultrasound images of the lesion.

After selecting the individuals to be studied, it was observed that 4 of them had not suffered injury to the SDFT, but rather desmitis of the suspensory ligament; therefore, they were excluded from the study, leaving the sample size at n=27. The age of the horses at the time of injury was between 2 and 10 years old, of both sexes (27 males and 4 females, leaving 23 males after exclusion of those affected by suspensory ligament).

As this was a retrospective study, it was not possible to know the subsequent evolution of the animals or if there was a recurrence of the lesion because they had asked another veterinarian to treat them, had been sold or had been taken to another place in Spain.

Likewise, horses that had injuries prior to 2020, the corresponding measurements are not available because the follow-up was performed with a different ultrasound scanner.

Datos TFG — Última edición: Hace 3 m — Compartir

caballos	Tto usado	Recogida de datos	Fecha	Edad cuando lesiona	Zona de la lesión	Recidivas
1	Conservador	Lista	16 de marzo de 2023	9 años	EAI: 2A-2B	No
2	Conservador	Lista	29 de septiembre de 2021	3 años	EAD: 3A	Sí
3	Sin tocarlo	Lista				
4	Sin tocarlo	Lista	7 de junio de 2021	5 años	EAI: 2B	Sí
5	PRP + Convencional	Lista	25 de mayo de 2017	8 años	EAI: 1A-2B	Sí
6	Sin tocarlo	Lista	21 de marzo de 2021		EAI: solo piel inflamada y EAD:	
7	PRP + Convencional	Lista	23 de enero de 2023	7 años	EAI: 2A-3B	No
8	convencional	Lista	3 de agosto de 2022	5 años	EAD: 2A-3C	No
9	PRP + Convencional	Lista	14 de junio de 2021	5 años	EAI: 2A-3A	No
10	suspensor	Sin empezar	5 de diciembre de 2022	6 años	EAD: SUSPENSOR	
11	Sin tocarlo	Lista	18 de agosto de 2023	5 años	EAD: 2B	No
12	PRP + Convencional	Lista	9 de abril de 2021	4 años	EAD: 2A-3A	No
13	convencional	Lista	19 de febrero de 2019	6 años	EAD: 3A-3B	Sí
14	Cáustico	Lista	29 de junio de 2022	10 años	EAD: 2A-3B	No
15	Conservador	Lista	30 de agosto de 2022	5 años	EAI: 2A-3B	No
16	Conservador	Lista	14 de enero de 2023	7 años	EAI: 1B-2A	No
17	Cáustico	Lista	8 de junio de 2022	5 años	EAI: 2B-3A	No
18	PRP + Convencional	Lista	11 de mayo de 2022	4 años	EAD: 2B-3B	No
19	Cáustico	Lista	21 de junio de 2023	3 años	EAI: 2A-2B	No
20	suspensor	Lista	27 de septiembre de 2023	9 años y medio	EAI	No
21	Conservador	Lista	13 de noviembre de 2023	2 años	EAI: 1A-1B	No
22	Conservador	Lista	30 de enero de 2023	4 años	EAI: 2B	Sí

Image 11. Screenshot of the table used in the categorization of the horses studied, anatomical location of the lesion, age at the time of injury, etc. Program used: www.notion.com (Own source).

METHODS:

- **Obtaining ultrasound images:**

The veterinarians of the equine service unit, María Luisa Díaz-Bertrana Sánchez and Lidia Pitti Ríos, were the ones who treated the equids introduced in this study. They obtained B-mode ultrasound images of the different sections of the SDFT, taking measurements of the lesions observed in each area and capturing images that were subsequently stored in Gestorvet where they could be consulted.

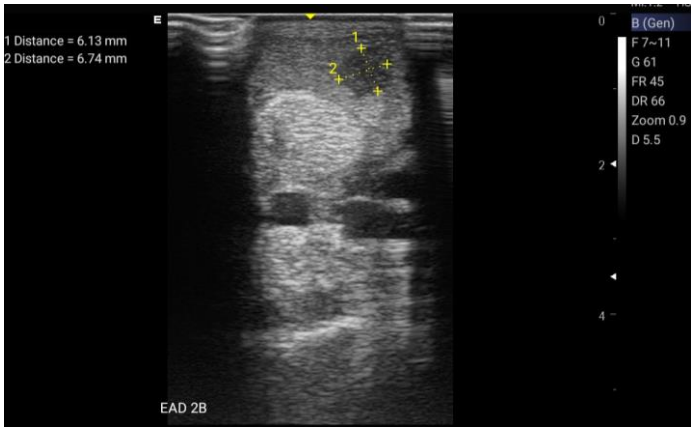


Image 12. Ultrasound performed on one of the horses in the study showing the lesion presented in the EAD in zone 2B with measurements of the size of the lesion.

On some occasions, the measurements were taken with the knowledge that they would be used in this study because they occurred in the last year (2023). Likewise, and since most of the measurements were taken without the intention of being studied later, there are follow-ups in which measurements were found to be missing.

At the time of performing the ultrasound scans, the gain, depth of field and power adjustments were performed manually in each ultrasound study that was carried out. Likewise, since all the studies were performed by the same people, interpersonal variations are eliminated; on the other hand, the depth of field does not influence us to a great extent, since the lesions were measured with the meter provided by the ultrasound scanner.

There must be a good contact between the transducer and the skin of the area to be studied, with no traces of dust, sand or large hair; for this reason, before performing the ultrasound study, the limb was always washed with soap and water after shaving it; likewise, there should be no air spaces, since artifacts would appear. In this case the tendon pack was not used at the time of performing the ultrasound scans in any of the studies. On the other hand, excessive pressure should not be exerted, since, apart from disturbing the animal, the ultrasound image is altered, thus altering the measurements to be taken (María De Los Llanos Martínez & Murcia, 2005).

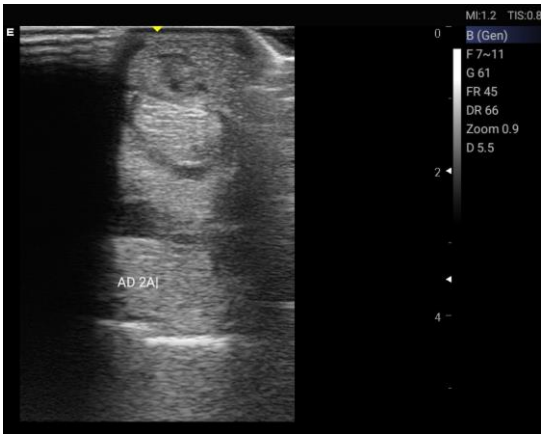


Image 13. Ultrasound performed on one of the horses in the study showing the lesion presented in the EAD in zone 2A with measurements of the size of the lesion.

- **Determination of the parameters for the statistical analysis**
    - **Study of the clinical history of the different treatments received:**

The following variables were selected for statistical analysis:

- Anatomical region of the affected SDFT: They were categorized following the same pattern as previously mentioned (zones 1A-3C).

- Treatment employed: there were displayed 5 different variables:
    - Rest:

Sometimes there are owners who, for economic reasons or due to lack of knowledge, prefer not to institute specific treatments in their horses when they have tendinitis (as if there were a desmitis) and prefer the animal to rest. This has been used in the past, but it has been seen that it involves a long recovery period, requiring 6-12 months to repair small defects in the affected structure and gradual introduction of exercise (M'Cloud et al., 2024).

On many occasions it is complicated to carry them out in an adequate way, since they are animals that need frequent exercise and with great temperament, which makes their handling very difficult during these months and causes frequent failures in their development when handling them.

    - Conservative:

At this point we find from rest to other interventions such as the administration of NSAIDs, hydrotherapy, massaging the area using any commercial gel that refreshes to employing rehabilitation therapies, such as shock waves, laser or radiofrequency (Torres; Juan Manuel, 2018). NSAIDs at an initial stage are beneficial to reduce the inflammation that is formed by the injury, but once there is no more inflammation, they should be stopped due to the possible negative effects they can generate (gastric ulcers, etc). In addition, these treatments usually also involve rest (M'Cloud et al., 2024).

- Caustic:

The use of this type of treatment today is not allowed. They are used during the acute phase of the lesion after the phase of hemorrhage and edema, topically once the area has been depilated, or applied with a brush or rubbing brushes. The therapeutic rationale, is healing by second intention, causing an increase in irrigation and inflammation mediators (Torres; Juan Manuel, 2018). The drugs used were cedar oil and iodine, Reducine (pine tar) or matte red.

- Conventional:

This type of treatment is based on performing peritendinous infiltrations based on corticosteroids. In this case, 18 milligrams (mg) of triamcinolone acetonide (Trigon Depot) were used, which were administered with a local anesthetic, which in this case was lidocaine; in addition to gentamicin (prevention of iatrogenic infections). The use of depot corticosteroids allows a longer duration of action of the drug, as well as reducing inflammation (Francisco Hernández, 2021).

- Platelet Rich Plasma (PRP) + Conventional:

PRP has recently been described as a treatment capable of modifying the course of musculoskeletal disease in horses (M'Cloud et al., 2024). PRP is a concentrated suspension of centrifuged blood containing high concentrations of thrombocytes. It is presumed to promote tissue healing and regeneration. The premise of its use is that the high concentrations of platelets in PRP release significant amounts of growth factors (Lagunas & Especial, 2006).

In this section there are treatments in which perilesional infiltration was performed based on a mixture of PRP and corticosteroids; being the drug used triamcinolone acetonide (Trigon depot). It has been suggested that performing these combinations of treatments helps regeneration of the injured area and faster and more effective recovery (M'Cloud et al., 2024).

- Subsequent evolution: Here we arranged 3 different variables depending on:
    - Whether they returned to training on hard ground and competing at the same performance they were at prior to the injury (variable labeled: **Running**).
    - If they did not return to training and running at the same level at which they were prior to the injury (variable called: **Retired**).
    - If we could not know their evolution up to the date of the study because they had been sold (variable called: **Unknown**).

- Relapse: Another important variable to consider was the possibility of recurrence, being a dichotomous variable. It could be yes or no. Of the individuals studied, it was determined that 8 of the 27 horses studied had a recurrence.

- Size of the lesion: Based on the ultrasound scans available in Gestorvet with the measurements of the size of the lesion, they were compared according to the anatomical region of the tendon where the lesion had occurred.

D	E	F	H	I	J	K	L
PRE		ZONA		EVOLUCIÓN		TRATAMIENTO	
6,1x9,25		2B				PRP+Convencional	
5,2x5,9		Cicatriz 2B		Retirado		Conservador	
6,67x9,97		3A				Conservador	
8,4x8,44		3B				Conservador	
6x7		2A		Retirado		Cáustico	
5,83x7,29		1B		Corriendo		PRP+Convencional	
8,6x3,3		2B AI		No se sabe		PRP+Convencional	
10,7x4		2B AD		No se sabe		PRP+Convencional	
Lx sin datos						Sin tocarlo	
Lx sin datos						Cáustico	
Lx sin datos						Convencional	
3,27x4,51		2B		No se sabe. Vendido		Convencional	
No hay medidas				Retirado		Se usó de todo y nunca quedó bien	
No imágenes		2B		Corriendo		Sin tocarlo	
No imágenes		2B				Conservador	
7,1x3,2		2B		No se sabe. Vendido		Conservador	
Lx difusa		1A-1B		Corriendo y ganando		Conservador	
6,56		2A		Corriendo		Cáustico	
4,92x6,29		2B				Conservador	
4,71x7,57		3A		Corriendo		Conservador	
7,35x3,22		2B		No se sabe		Cáustico	
6,43x7,44		2A		Murió		Conservador	
7,12x11,7		2B		No se sabe		Conservador	
7,4x4,17		2B		Corriendo		Cáustico	
No info		3B		Retirado		Convencional	
						Convencional	
2,29x6,62		2B		Corriendo		PRP+Convencional	
3x2,8		2B		Vendido		Sin tocarlo	
4x7,18		2B		Corriendo		PRP+Convencional	

Image 13. Microsoft Excel table made with all the parameters evaluated in this study separated by colors the different variables of each parameter. (Own source).

- **Statistical analysis:**

  It was performed:

  - The calculation of the arithmetic mean and median for the size of the pre-treatment lesion, measured in millimeters.

  - The percentage of horses that received each treatment,

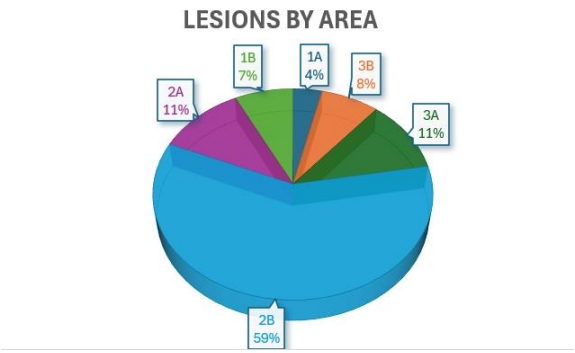
  - of the horses that received each treatment, the percentage of how many returned to run at the same level as before the injury, how many were withdrawn and how many are unknown because they were sold.

  - On the other hand, a multiple linear regression was performed to determine the possible influence that the area where the injury was located could have on the subsequent recovery, the possible influence of the treatment on the future evolution of the animal or if the size of the injury prior to treatment could affect the application of one treatment or another.

A significance level of $p<0.05$ was established. Microsoft Excel was used to perform the tables and calculations of basic proportions and the RStudio statistical program was used for the multiple linear correlation study.

RESULTS

The mean lesion size, regardless of the portion affected, was **5.599 x 5.696 mm**, with a sample size of **n=27**; since the initial lesion measurements were not available for one of the individuals. In 16 of the 27 horses, it was observed that the area most affected was zone 2B, in 3 of them the zone with the greatest area of anecogenicity was zone 2A. The other 8 horses were affected in the other areas, with zone 1A and 3C being the least frequently affected.



Graph 1. Graphical representation in percentage of the incidence of lesions in each zone (own elaboration).

Of the 27 horses studied, it is known that 10 of them had recurrences. Of those that relapsed, 6 had the zone with the largest diameter lesion in zone 2B and suffered the recurrence in the same zone; 1 had the lesion in zone 3B and relapsed affecting zone 3B again; in the remaining 3 cases the zones between the first lesion and the second did not coincide.

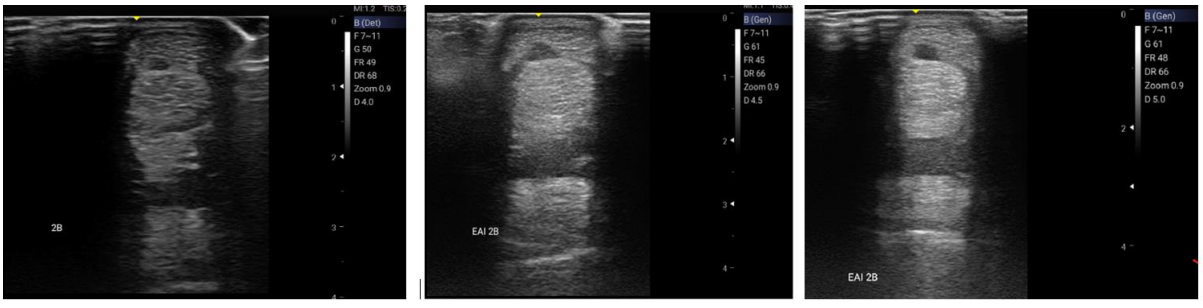


Image 14. Ultrasound of the lesion of a horse in the study (left) and the successive recurrences (center and right), being characteristic that the recurrences were very similar to the original lesion.

A calculation of percentages of results was made based on the treatment used, where it was seen that:

- The number of animals that received treatment based on PRP + Conventional was **10**; of these 63% are currently running, 13% are retired and 25% unknown; of these, 2 recurred and on one of the occasions it was the second treatment employed after conservative treatment had been used. The sample size remained at n=8 of those animals that only received treatment based on PRP + Conventional.

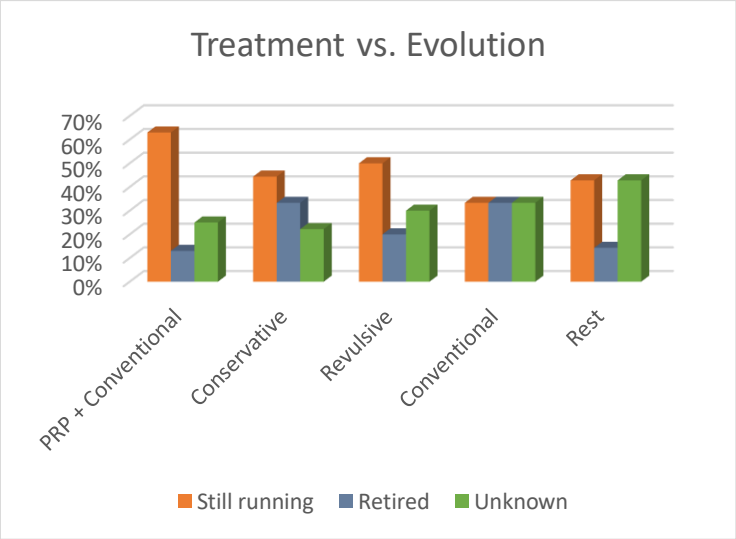
- Of the animals that received Conservative treatment, of which there were **9**, 44.4% are running, 33.3% are retired and the other 22.2% are unknown or died. Of these animals, 1 had previously received PRP + conventional treatment and was eventually withdrawn, another after relapse was re-treated with caustic and eventually withdrawn, and another after relapse and re-treatment with conservative treatment, returned to running.

- The Caustic treatment was received by **6** animals, of which 50% are running, 20% are retired and the evolution of the remaining 30% is unknown. The animal that was previously retired had received conservative treatment for previous injuries, one of the animals whose evolution is unknown, this treatment was used in a relapse and continued to have subsequent relapses in which conventional treatment was used; finally, one of the horses that continues to run, had had a previous injury and had a subsequent one in which no type of therapy was applied except rest.

- In the cases in which conventional treatment without PRP was used, which in this study were **3**, one third (33.3%%) is running, another third (33.3%) is unknown and the last third (33.3%) is retired. In the horse that is running, he had no further injury to the affected hand, but had an injury to the contralateral hand subsequently that was treated with PRP + conventional; the other two animals were treated on two occasions, for recurrences, with the same

conventional treatment, one of them having been previously treated with caustic and on another occasion only with rest.

- Finally, in the cases in which no treatment was performed, Rest group, in **7** of the animals, 42.8% are running, another 42.8% were sold and it is unknown if they are currently running or have been withdrawn from their pre-injury activity and the remaining 14.3% were retired. Of these, one of the sold horses that received rest recurred on multiple occasions when caustic or conservative treatment was used.



Graph 15. Representation of the evolution observed based on the treatments used in each case. Graph made with Microsoft Excel (own elaboration).

Regarding the influence of the area of the lesion on recovery to return to the previous activity, only the values for the lesions in the area defined as 2A ($p<0.05$) and the area where scarring remained after treatment in area 2B ($p<0.05$) were significant. Therefore, it was understood that the fact that there was a lesion in zone 2A or that there was scarring in zone 2B had a worse prognosis for the equine to return to its pre-injury activity, being more likely to recur or to be withdrawn from its sporting activity.

The rest of the parameters studied did not obtain significant values ($p>0.05$), probably due to the small sample size.

Injuries in zone 2B or 3A-3B obtained very high estimates, which despite not being significant (p>0.05), reflect a worse prognosis for individuals to be reintroduced to their pre-injury activity (continue running).

Likewise, the injuries that exclusively affected zone 3A, despite not obtaining significant values (**p>0.05**), obtained estimate values that reflected that having been injured did not affect their reincorporation to their pre-injury activity as negatively.

Also, a very low correlation was obtained between the influence of treatment as a function of prognosis/evolution after treatment (**0.405**); furthermore, the influence of the size of the injury, measured in mm, versus prognosis/evolution after treatment was not very significant, obtaining a low correlation (**0.665**), as was the influence of the size of the injury when applying one treatment or another (**0.551**).

DISCUSSION

The high stresses to which the SDFT is subjected undoubtedly contribute to the high incidence of injury it suffers (Thorpe et al., 2010). It has been proposed that not only mechanical factors affect, but there are also a series of biochemical factors (Carmona et al., 2011) and physicochemical changes in the environment (Thorpe et al., 2010) that influence the appearance of these tendinopathies; as well as the influence of the surface on which they run, genetics, number of exits or age, among other factors (Anderson et al., 2004).

If we add to this the fact that the forelimbs support great stresses when in season, and even greater when galloping, we can understand the greater predisposition for the SDFT to be affected; likewise, the suspensory ligament, which also suffers great stresses, is also affected by these factors or physicochemical changes. Natural repair mechanisms do not allow injured tendons and ligaments to fully recover, which influences horses that carry out natural repair to be more prone to relapse (Carmona et al., 2011).

Currently, therapies focused on regenerating damaged tissue are being employed, which, seen from a biological point of view, is a great advance and probably has greater practicality. When a tissue is damaged, the natural form of repair is to generate scar tissue, where the collagen does not have the same disposition, elasticity or resistance to tensile forces that the tissue has naturally; therefore, using therapies that seek to regenerate the tissue that was previously there so that it has the same disposition and characteristics as the healthy tissue can lead to an improvement in the prognosis of these pathologies (Zuffova et al., 2013; M'Cloud et al., 2024).

The influence of the discipline performed by the horse on the propensity to suffer one type of pathology or another has been discussed, showing that in horses that perform Dressage the suspensory ligament is mostly affected, and that horses that participate in the National Hunt have a greater propensity to affect the SDFT than horses that participate in races on smooth ground; as well as the influence exerted by the type of shoeing used (Carmona et al., 2011).

Likewise, it would be interesting to observe the influence that training and competing on asphalt can have on the greater or lesser presentation of tendinitis of the SDFT. Attempts have been made to demonstrate whether high-intensity exercise generated tendon degeneration, but they were unable to prove their hypothesis as they did not find significant changes in the matrix after studying its composition (water content, tissue fluorescence, amount of type III collagen, etc.) (Birch et al., 2008). This may also be due to the small sample size used (n=12).

Regarding the results obtained in this study, the most commonly used treatment was PRP + Conventional (n=10), followed by Conservative treatment (n=9), in which hydrotherapy, local cold and systemic treatments based on NSAIDs such as phenylbutazone were used. Observing all the parameters obtained, it can be seen that, a treatment based on PRP + Conventional obtained better results than the other treatments proposed, followed very closely by treatment with caustic products. As can be interpreted, these values are not very representative due to the small sample size, since, as shown in other studies, the use of PRP offers greater advantages.

Also, in most of the studies published to prove the effectiveness of one treatment or another, there are limitations such as small sample sizes, variations in follow-up

periods, breeds of horses, discipline in which they were engaged, dose used in each case and laboratory analysis (M'Cloud et al., 2024). Something similar occurs in this case, since we had a very small sample size (n=27) and although all the horses selected are of the same breed (Thoroughbred), they did not all perform the same training routine, nor were they subjected to the same loads. Likewise, it is unknown in many cases if, prior to the injuries reflected in this study, they could have been damaged by previous owners.

Studies mention that the periods between revisions were very variable, since they passed from a few weeks to several months between revisions performed to some horses or others, this may reflect variations in the progression of the injury and does not allow to know exactly the speed of recovery in some cases or others, nor to compare this parameter between one treatment or another (M'Cloud et al., 2024). This also happened in the current study, varying the periods for even more than a month in some cases.

It has been suggested that the variability in the content of platelets, red blood cells or leukocytes in the blood extracted from each horse, as well as the variability found between different sexes, breeds or with age, or not using a standardized method of obtaining PRP, significantly influence the benefit that the use of PRP can exert in one animal or another; having seen that moderate variations in the content of platelets influence the evolution of each animal (Geburek et al., 2016).

In one study they obtained results showing that the incidence of severe posterior tendon injuries was significantly higher in horses with an enlarged tendon or subcutaneous edema, with no hypoechoic areas observed on ultrasound studies, compared to control horses (Iimori et al., 2022), which may be of interest in terms of preventing possible major severe injuries that horses may suffer.

Although this study presents treatments based on infiltrations with corticosteroids, combinations of PRP + corticosteroids, rest, conservative treatments based on systemic NSAIDs, hydrotherapy or local cold or, the now in disuse, treatment with caustic products, studies are being conducted in which mesenchymal stem cells are used to try to find a greater and faster regeneration of damaged tissues (M'Cloud et al., 2024).

It has been proposed that a single perilesional infiltration based on PRP accelerated the disappearance of lameness, an earlier decrease in the temperature of the affected area, a better prognosis and a faster reorganization of collagen fibers (Geburek et al., 2016). Despite obtaining significant values in all parameters, it should be noted that the sample size of the case-control study they performed to reach these conclusions was very limited, being 20 horses in total.

Likewise, it has been proposed to perform an integral treatment that includes treatments based on innovative regenerative therapies together with coadjuvant treatments such as shock waves, laser or radiofrequency, massaging the area, gradual reintroduction to exercise or help with therapeutic tools that favor or help to release tension in the damaged area (Dowling et al., 2000; M'Cloud et al., 2024).

Although a higher incidence of lesions affecting region 2B of the SDFT was observed, due to the small sample size it was not possible to demonstrate the influence that the area of the lesion might have on the probability of recurrence or the relationship it might have with the prognosis of each horse. This represents a line of research that can help to better understand the future evolution of each animal. In the event that a worse prognosis is observed depending on the affected area, perhaps the possibility of using one type of treatment or another could be considered, adapting it to the injured area.

Most of the studies consulted are prospective case-control studies where in some a previous study of the tendon structure was performed before starting to study the structural changes it could undergo (Plevin et al., 2019), in others the gradual training they performed was controlled and the treatment was homogenized to all the horses studied (Zuffova et al., 2013) or animals with similar age, training or sex were selected (Bladon et al., 2010).

Because of this, results can be obtained that allow a more accurate comparison to be made between the effectiveness or not between treatments or prognosis. Likewise, these studies were carried out between a group affected by TDFS tendinitis and a control group that did not suffer from any type of condition, using a single type of treatment and not comparing different treatment options, as is proposed in the study (M'Cloud et al., 2024), which compares PRP-based treatment with stem cell-based

treatment. Both in this study, as in others, the benefits of the use of Insulin-like Growth Factor-I and the improved prognosis of its use are raised (Thomas H. Witte, 2011).

CONCLUSION

Much progress has been made in the treatment of TDFS tendinopathies, having focused mainly on regenerative rather than reparative treatment, as a better evolution has been observed. Despite all this, there is still no standardized procedure, but it depends on the experience of each veterinarian or the cost of treatment and the willingness of each owner to assume one or another treatment, among other factors. For this reason, it would be interesting to continue researching in order to standardize the management of tendinopathies, especially with the importance they have in the sporting life of horses.

Likewise, in spite of not having obtained significant values in terms of the influence of the affected area of the SDFT, it would be interesting to go deeper into this question that has been raised; in the same way, it would be convenient, for future studies, to know the starting point of the horses studied, as well as to make a more homogeneous follow-up and subject them to the same conditions both in training and in the surfaces on which they run.

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