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Ultrasonographic Measurements of Fetlock Joint Tendons and Ligaments Dimensions in Sound Darehshori Horses

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ABSTRACT

Tendons and ligaments in the palmar/plantar aspect of fetlock joints are always exposed to injuries resulting from traumas and diseases of limbs. Ultrasound has wide extensive use in the diagnosis and measurement of equine soft tissues and musculoskeletal injuries in horses. The purpose of the current research is to measure and comparison of the fetlock joint tendons and ligaments dimensions in the front and hind limbs of sound Darehshori horses. This study consisted of ten healthy Darehshori horses whose mean age and height of them were 11.2 ± 3.5 years and 151.6 ± 10.2 cm. After clipping and washing, the area between 4 cm above the proximal sesamoid bones and distal to the level of the proximal sesamoid bones was divided into 2 levels in sagittal and 3 levels in transverse view. Ultrasonography was performed with a linear transducer 12 MHz Frequency on both front and hind limbs in full weight bearing. Measurements of tendons and ligaments such as the superficial digital flexor tendon, deep digital flexor tendon, and suspensory ligament were done in both sagittal and transverse view. Transverse ultrasonography was made to get the measurements such as thickness, width, and cross-sectional area of tendons and ligaments. Echogenicity and fibrillary pattern of tendons and ligaments were assessed in longitudinal images. In the front and hind limbs, the greatest width of digital flexor tendons and suspensory ligament was related to the front joints while the greatest thickness was related to the digital flexor tendons and suspensory ligament in the hind joints. As the results in the present study revealed, no significant differences were found between the amounts of the left and right front and hind limbs of sound Darehshori horses. In conclusion, this study provides thorough, in-depth knowledge of the normal ultrasound measurements of the tendon and ligaments in the fetlock joints.

Introduction

Darehshori horse is one of the most well-known and oldest indigenous and original Iranian horse breeds, which are distributed in different areas of the country.

Its main origin is Fars province and its main breeders are Qashqai people. Over the years, the breed of Darehshori horses has been well modified and has adapted to the nomadic lifestyle and migration that requires high physical strength, comfortable riding, and

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great endurance. Accordingly, for these reasons, horses are exposed to injuries caused by traumas and diseases related to the movement organs. Though this horse shows many similarities with the Arab horse, the differences in appearance, such as taller height, longer ears, angular rump and smaller hoof, distinguishes this horse from the Arab horse. Their identification documents are based on their phenotype and appearance characteristics.¹ Since 1983, ultrasonography was used for the diagnosis and documentation of tendon/ligament injuries by assessment of echogenicity changes and measuring the dimensions of tendon/ligament.² Tendons are made of dense connective tissue their purpose is to firmly attach a muscle to the bone. Tendons and ligaments do not have a good supply of blood, so they lack the source of oxygen and nutrients that would allow faster healing.³⁻⁵ Ligaments, generally, connect bone to bone. In some instances, they can also help to form an anchor for other structures in the body. Ligaments are also composed of dense connective tissue, but are more elastic than tendons. Ligaments are the structures that hold joints together and provide stability to a joint.³⁻⁵

Ultrasound has a wide extensive use in the diagnosis and measurement of equine soft tissues and musculoskeletal injuries and also in investigating the recovery procedures of flexor tendon/ligament injuries found in horses.⁶⁻¹¹ Ultrasonography can detect both echogenicity and changes of normal tendons and ligaments dimensions.¹²⁻¹⁷ Enlargement of tendon/ligament is seen in inflammation, and an enlargement found over 20% ought to be recognized clinically as a crucial issue.^{6,14,18} It is essential, therefore, to identify the related dimensions of the normal ultrasonographic tendon/ligament for an exact and precise diagnosis.

Thickness, width, and cross-sectional area of tendon/ligament can be measured ultrasonographically both transverse and longitudinal. Measurements of cross-sectional area (CSA) shows valuable information about the extent of tendon/ligament injury.^{7,16,19} Ultrasonographic measurements of tendon/ligament dimensions is important in order to evaluate the healing process.^{7,11,17} Extensive studies have measured the dimensions of tendon/ligament in different breeds of horses. A search in related literature showd that the CSA values of superficial digital flexor tendon (SDFT) and deep digital flexor tendon (DDFT) in Thoroughbreds, Irish Draughts and ponies have been examined and identified in a number of research

works.¹⁹⁻²¹ Furthermore, in some other studies carried out on Dutch Warmblood horses, the values as thickness, width, circumference and CSA values of SDFT, DDFT, accessory ligament of the deep digital flexor tendon (AL), and suspensory ligament (SL) were investigated and calculated in details.^{16,22,23} The thickness and width of SDFT, DDFT, AL, and SL in Thoroughbreds in the USA, Andalusian Anglo-Arabian and Pure Persian Arabian horses were measured in other studies.^{13,19,24} Based on the reported findings in the literature, the differences observed in tendon/ligament dimensions are attributed to the horses' breed, age, body weight, height, and their exercise program, as well as the exactness of ultrasound equipment.¹⁶

The purpose of this study is to investigate and measure the ultrasonographic parameters of tendons and ligaments, including thickness, width and cross-sectional area in the fetlock joints of healthy Darehshori horses in both longitudinal and transverse sections in order to provide normal values for use by veterinarians and other researchers.

Materials and Methods

Ten healthy Darehshori horses with a mean age of 11.2 ± 3.5 years and height of 151.6 ± 10.2 cm were included in this study. Horses used in this study were transferred by their owner from one of the horse care centers to the faculty clinic and the ultrasound was performed in a quiet environment with physical restraint. The clinical examination of fetlock region was performed prior to the ultrasonographic assessment in all horses. For this purpose, the tendons and ligaments of fetlock joints were palpated in a weight-bearing position and only the horses without any signs of lameness at walk or trot were selected for this study. Based on the proximal sesamoid bones, the palmar/planter aspects of the fetlock region were divided into three zones: Zone1 located 4cm above the proximal sesamoid bones, Zone 2 at the level of the proximal sesamoid bones, and Zone 3 distal to the level of the proximal sesamoid bones. After shaving and washing, the ultrasonography of right and left fetlock regions in both front and hind limbs were performed by using a 12 MHz linear transducer (BK Medical minifocus). Ultrasound gel was used to increase contact. The area was examined by ultrasonography in both transverse and longitudinal scan in full weight bearing limbs (Figures 1 and 2). Measurements of tendon and ligament structures for the three levels

were determined by means of Electronic calipers on the ultrasound machine. On each level, width (mm), thickness (mm) and CSA (mm^2) of the SDFT, DDFT, and SL were measured. Measurements of the lateral to medial and dorsal to palmar/plantar dimensions in transverse scan were determined. For conducting statistical comparison of dimensions at each level in left and right limbs of horse, Paired sample T-test was used to examine and measure thickness, width and CSA

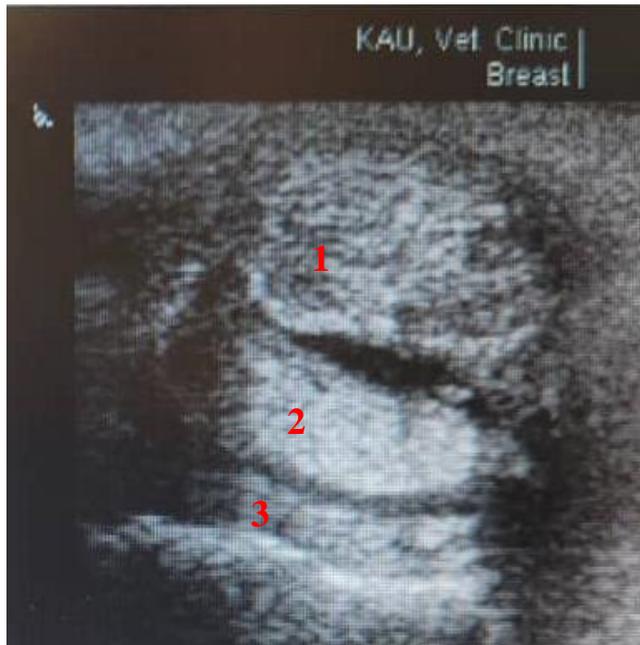


Figure 1. Transverse ultrasonographic image of fetlock tendons and ligaments in sound Darehshori horse indicating parameters: 1. Superficial digital flexor tendon 2. Deep digital flexor tendon 3. Suspensory ligament.



Figure 2. Longitudinal ultrasonographic image of fetlock tendons and ligaments in sound Darehshori horse indicating parameters: 1. Superficial digital flexor tendon 2. Deep digital flexor tendon 3. Suspensory ligament.

values of SDFT, DDFT, and SL. A value of $p < 0.05$ was considered to be significant.

Results

The measurements related to morphometric values of the flexor tendons and suspensory ligament of 10 healthy Darehshori horses are shown in Tables 1 and 2. The amounts of width, thickness, and CSA from left and right limb in both fore and hind limbs are compared. In left and right front limbs, maximum and minimum width (medial to lateral length) of the SDF were seen at levels 1 and 3, respectively, while the thickness of SDF in left hind at level 2 was the maximum and in left front at level 1 was the minimum. The maximum and minimum cross sectional area of the SDF was in left front at level 2 and 3. The minimum width of the DDFT was seen in both right front and hind at level 3. The maximum thickness of DDFT was seen in both right front and right hind at level 1. The maximum thickness of SL was seen in right hind limb at level 3. The greatest thickness of digital flexor tendons and ligament was measured in hind limbs. The greatest width and CSA of digital flexor tendons and ligament was measured in front limbs. The maximum amount of cross-sectional area in both front and hind limbs was related to the deep digital flexor tendon in the left front limb at level 1 while the minimum amount of CSA was related to the superficial digital flexor tendon in the left and right hind limbs at level 3. In the left front limb, greater values of flexor tendons width were observed in levels 1 and 3, while the right limb showed greater values of DDFT width only in level 2. The findings about the suspensory ligament in left front limb showed greater values of the ligament width only at level 2. In the right hind limb, greater values of SL width were observed in levels 1 and 2. As the findings revealed, in this study, no significant differences were recognized between left and right feet of front and hind limbs.

Discussion

Though there have been some research works on calculating measures of morphometric values through using ultrasound conducted on some breeds of horses, a thorough comprehensive investigation of related proportions and measurements concerning all flexor tendons and ligaments in the fetlock joint of Darehshori horses has not yet been reported in the relevant existing studies.^{4,5,13,14,16,22,23,25,26} The relevant measurements were carried out on 3 levels which were

Table 1. Ultrasonographic measurements (Mean \pm SD) of front fetlock joint tendons and ligaments in sound Darehshori horses.

Parameter (mm)		Level 1			Level 2			Level 3		
		Width	Thickness	CSA (mm ²)	Width	Thickness	CSA (mm ²)	Width	Thickness	CSA (mm ²)
Superficial digital flexor tendon	left	15.2 \pm 0.30	2.7 \pm 0.03	38 \pm 0.20	13.2 \pm 0.20	4.4 \pm 0.10	52.7 \pm 0.20	10.9 \pm 0.10	4.3 \pm 0.10	29 \pm 0.20
	Right	14.9 \pm 0.40	3.6 \pm 0.2	42 \pm 0.20	13.2 \pm 0.30	4.5 \pm 0.30	51.0 \pm 0.06	10.4 \pm 0.20	4.5 \pm 0.20	35 \pm 0.20
Deep digital flexor tendon	Left	17.2 \pm 0.10	5.8 \pm 0.08	60 \pm 0.20	13.0 \pm 0.03	3.9 \pm 0.09	48 \pm 0.08	12.4 \pm 0.05	4.3 \pm 0.04	26 \pm 0.20
	Right	15.5 \pm 0.30	6.1 \pm 0.08	52 \pm 0.20	13.9 \pm 0.30	4.5 \pm 0.05	47.0 \pm 0.30	11.9 \pm 0.20	5.0 \pm 0.10	31 \pm 0.20
Suspensory ligament	Left	14.6 \pm 0.30	4.7 \pm 0.10	46 \pm 0.40	13.1 \pm 0.20	3.9 \pm 0.04	41.0 \pm 0.20	12.3 \pm 0.30	2.7 \pm 0.03	26 \pm 0.05
	Right	15.4 \pm 0.40	4.4 \pm 0.20	43 \pm 0.20	12.7 \pm 0.20	3.9 \pm 0.05	43.0 \pm 0.10	12.5 \pm 0.30	2.9 \pm 0.07	25 \pm 0.90

Width = Lateromedial distance, Thickness = Palmarodorsal distance, CSA = Cross-sectional area.

Table 2. Ultrasonographic measurements (Mean \pm SD) of hind fetlock joint tendons and ligaments in sound Darehshori horses.

Parameter (mm)		Level 1			Level 2			Level 3		
		Width	Thickness	CSA (mm ²)	Width	Thickness	CSA (mm ²)	Width	Thickness	CSA (mm ²)
Superficial digital flexor tendon	Left	14.6 \pm 0.30	3.1 \pm 0.10	40 \pm 0.20	14.0 \pm 0.40	4.9 \pm 0.20	38.3 \pm 0.40	11.5 \pm 0.10	3.5 \pm 0.09	22 \pm 0.70
	Right	14.9 \pm 0.40	3.7 \pm 0.10	44 \pm 0.20	13.7 \pm 0.20	4.7 \pm 0.20	35.0 \pm 0.20	11.7 \pm 0.30	3.7 \pm 0.20	22 \pm 0.70
Deep digital flexor tendon	Left	16.4 \pm 0.20	5.0 \pm 0.10	48 \pm 0.40	13.4 \pm 0.40	4.5 \pm 0.20	57.0 \pm 0.30	12.0 \pm 0.10	4.0 \pm 0.10	38 \pm 0.10
	Right	15.5 \pm 0.30	6.1 \pm 0.08	52 \pm 0.20	13.9 \pm 0.30	4.5 \pm 0.05	55.7 \pm 0.30	11.9 \pm 0.20	5.0 \pm 0.10	31 \pm 0.20
Suspensory ligament	Left	11.2 \pm 0.70	4.0 \pm 0.03	34 \pm 0.20	9.1 \pm 0.20	4.2 \pm 0.10	27.0 \pm 0.10	9.9 \pm 0.30	3.8 \pm 0.10	35 \pm 0.20
	Right	11.7 \pm 0.50	4.1 \pm 0.10	38 \pm 0.30	9.6 \pm 0.20	4.4 \pm 0.10	30.0 \pm 0.10	9.9 \pm 0.30	4.9 \pm 0.20	32 \pm 0.8

Width = Lateromedial distance, Thickness = Plantarodorsal distance, CSA = Cross-sectional area.

accordingly established by dividing the palmar/plantar fetlock area into 3 equal regions. They were starting from above the proximal sesamoid bone (level 1) to the region located just distal to the ergot and extended to mid proximal phalanx (level 3) as described previously.^{4,14,16} Therefore, tendons/ligaments of horses were subsequently examined and measured at an equal ratio. Thickness, width and CSA measurements of the SDFT, DDFT and SL in Arabian horse were determined by Celimli *et al.* (2004). Comparing the values obtained from Arabian and Darehshori horses revealed that the thickness of SDFT of Arabian horse was close to values of the Darehshori in this study.³ Width and CSA of SDFT demonstrated significantly lower values in comparison to Arabian horses. Width measurements of the DDFT in this study are close agreement with those of Arabian horse. Other measurements have significantly lower values than Arabian horses. CSA and width measurements of SL in this study were close to those of Arabian horses while the thickness values of Arabian horse was greater than that of Darehshori horse. Thickness and width

measurements of the SDFT, DDFT and SL in Draught male horse determined by mohammed *et al.* (2008), thickness of the SDFT in 3 levels and DDFT at level 3 were found the same values of Darehshori horse in this study.⁴ Width of the DDF at level 3 was close to that of Darehshori horse in this study.⁴ Other measurements showed significantly greater values in comparison to the related ones for Darehshori horses. CSA measures concerning SDFT and DDFT in Thoroughbreds in the (UK and USA), Swedish Standardbred Trotters, Kathiawadi and Marwadi in 4 different studies were higher than those in the Darehshori horses in this study.^{14,22,23,25} In the present study, as the findings revealed, the measurements on thickness and width of flexor tendons in Andalusian Anglo-Arabian horses and Thoroughbreds were recognized to be higher in comparison to those found for Darehshori horses.^{13,19} On the other hand, the measures of thickness, width and CSA mean values which were examined in Dutch Warmblood horses and reported by Van den Belt (1995) were found to be greater than the consequent measurements for Darehshori horses.¹⁶

In summary, as the results showed, tendon and ligament measurements obtained from Darehshori horses confirmed significant differences with those reported in some other studies for other breeds. The differences observed in this study are possibly attributed to horses' breed, age, body weight, height, and their training program and also it can be due to the accuracy of ultrasound equipment.^{14,16} In this study, as the findings revealed, smaller tendon/ligament measures found in Darehshori horses can be explained by the fact that these horses are smaller at their withers, they have a lower bodyweight, and in comparison to other breeds they are slimmer and with finer build. In conclusion, the present study was an attempt to provide a thorough understanding and detailed information on the normal ultrasound measurements of the tendon and ligaments in the fetlock joints. Therefore, these values can reliably be used for diagnosis of fetlock soft tissue injury in this breed.

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Conflict of Interest

The authors declare there is no conflict of interest.

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