

## Ultrasonography Description of Metatarsal Tendons and Ligaments of the Caspian Miniature Horse

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### Abstract

**Objective-** To consider the possibility of ultrasonography evaluation of the plantar tendons and ligaments and prepare a standard reference for it.

**Design-** Descriptive study

**Animals-** 7 female healthy Caspian miniature horses'-age 7year- no clinical sign of lameness and prior to presentation.

**Procedure-** The ultrasonography of the right and the left metatarsal region was performed using a Pie Medical 100 Falco Vet and an 8MHZ linear transducer. The area for ultrasonography was divided to 9 levels (1a-1b-2a-2b-3a-3b-4a-4b-5a), each 3 cm long afterwards.

**Results-** All the structures started to appear with an acceptable contrast and visibility at the 2a level. SDFT and DDFT were well observed from the level 2a however, no definite borders were recognizable as ICL (except one case) and echogenicity of DDFT from the 2b level was hyperechoic to isoechoic comparing SDFT and SL from this level observed the branching area

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was hyperechoic in compare with DDFT & SDFT, however MSL & LSL were hypoechoic comparing SDFT and DDFT.

There aren't any difference echogenicity between right and left hind limb.

**Conclusion and Clinical Relevance-** Investigations have proved that there's no difference between the echogenicity of each ligament and tendon in different levels in the left and right limbs which was confirmed in the current inspection as well

The conclusions of the current study on the Caspian horse were shown too that highly compatible with the previous vestigations in horses on echogenicity and shape of the plantar tendons and ligaments. Generally it is assumed that transverse images provide a better image of tendons and ligaments and any injury in any part of the above structures can be diagnosed easily, however some probable injuries around the tendon may be left unseen in longitudinal images.

**Key Words-** Ultrasonography, Plantar-Tendon-Ligament, Caspian Horse.

## Introduction

Caspian miniature horse is an ancient rare breed assumed to be extinct more than 1000 years ago. Diagnostic two dimensional ultrasonography for the evaluation of tendons and ligaments in horses was first described as an appropriate method for evaluation of the morphological changes in the above structures in 1982 by Rantanen<sup>1</sup> In 1986, Genovese and others described the morphological features observed in the tendons and ligaments of the Thoroughbred and Standardbred breeds horses.<sup>2</sup> As the Caspian pony is a member of the Ungulates and To date, there are no published data describing the ultrasonography of the hind limbs of the Caspian pony. The purpose of this study is considering the possibility of ultrasonographic evaluation of the plantar tendons and ligaments and prepare a standard reference for it.

## Materials and Methods

This study was performed on seven healthy mares, seven-year-old with available IDs and family trees and no clinical sign of lameness on and prior to presentation. The animals were not related to each other. Ultrasonography examination on the metatarsal region of the right and the left hind limbs, initiated under general anesthesia, with IV injection of acepromazin maleat at a dosage of 0.03mg/kg body weight and xylasine at a dosage of 0.27 mg/kg body weight. The lateral and the medial parts of the metatarsal region from the upper part of the lateral splint to the ergot were shaved after applying a generous amount of foam to the skin. The area was cleaned using alcohol to remove any epidermal fat depositions. The shaved area was divided to 9 levels (1a-1b-2a-2b-3a-3b-4a-4b-5a), each 3 cm long afterwards (fig. 1). The ultrasonography of the right and the left metatarsal region was performed using a Pie Medical 100 Falco vet and an 8MHZ linear transducer. The above area was ultrasonographically examined in both transverse and longitudinal appearances with the same power, depth and focus of the machinery.. The detection of tendons and ligament structures was done comparing them with the images to anatomy and diagnostic imaging reference books.<sup>3,4</sup>

## Results

### Transverse Images

#### *Level 1a (1-3 under tarsal joint)*

In the transverse images of the plantar region, the closest structure to the transducer goes to the top of the image and the most distant which is the plantar surface of the metatarsal goes to the lowest part of the image on the screen. In this area no proper image was recorded.

#### *LEVEL 1b (3-6 under of tarsal joint):*

No proper image was recorded at this level and there were no structures identified to measure.

#### *Level 2a (6-9 under tarsal joint)*

No complete images of the structures were recorded again but some parts of the following structures were seen on the screen: Skin, Subcutaneous tissues, deep digital flexor tendon (DDFT), superficial digital flexor tendon (SDFT). The thickness of SDFT and DDFT were recognizable at this level however at the 9<sup>th</sup> level (level 9), SDFT had a crescent shape that the thick part of it was seen in the medial part and it seemed that SDFT tended to the medial part comparing the DDFT and the longitudinal axis. The echogenicity of SDFT was a little less than DDFT at this level. DDFT had a complete circular shape at the 9<sup>th</sup> level and the width and the thickness of the tendon were almost the same. In the plantar region SDFT and in the dorsal area, soft tissue and vascular space was observed with a higher echogenicity than SDFT. (fig. 2).

#### *Level 2b (9-12 under tarsal joint)*

The observed structures from the top of the image were skin and the subcutaneous tissues, DDFT, SDFT, vascular and soft tissue space, SL and the surface of the 3<sup>rd</sup> metatarsal bone. SDFT had the crescent shape and it was more significant at this level. The thickness of tendon showed an increase and the thick part of the crescent shape was located medial to DDFT and the longitudinal axis of the limb. The echogenicity of this tendon was somehow less than DDFT at this level just as it was in the 9<sup>th</sup> level. DDFT was egg-shaped at this level and its width seemed to be wider than the thickness. In the plantar part, SDFT and in the dorsal part, vascular and soft tissue space was identified. The echogenicity of DDFT was somehow higher than SDFT just as the previous levels. Although the presence of suspensory ligament is obvious, no complete and describable image was recorded. (fig. 3)

#### *Level 3a (12-15 under tarsal joint)*

All the structures were observable at this level. From the top, skin and the subcutaneous tissues, DDFT, SDFT, vascular and soft tissue space, SL and the surface of the 3<sup>rd</sup> metatarsal bone were identified. SDFT at this level had a crescent shape to some extents, and was less tended to the medial part. It seemed to be located at the dorsal part of DDFT. In the plantar part it was less curved than the dorsal part. In the dorsal part, next to DDFT, it appeared to be more crescent. Echogenicity at this level was mostly isoechoic with DDFT. DDFT at this level had an oval shape and its width was wider than thickness. This structure had an Isoechoic and almost similar echogenicity with SDFT. The space between DDFT and SL was reduced at this level. SL is the top (most dorsal) structure of the metatarsal region and the observable area of it was wider than the previous levels with an irregular to square shape. Its echogenicity was significantly lower than DDFT and SDFT at this level which seemed heterogenic and unsteady as well. The echogenic

plantar surface of the metatarsal bone appeared as a condensed white line at the dorsal part of SL (fig. 4).

*Level 3b (15-18 under tarsal joint)*

All the structures were observable at this level as well. Right from the top, skin and the subcutaneous tissues, DDFT, SDFT, vascular and soft tissue space, SL and the surface of the 3<sup>rd</sup> metatarsal bone were identified. SDFT had a crescent shape to some extents, and seemed to be located mostly tending to the dorsal part of DDFT and much less to the medial part. Echogenicity at this level was mostly Isoechoic with DDFT. DDFT in this level had apparently the tendon showed an increase in size with a circular and some how isoechoic shape with SDFT. The space between DDFT and SL was reduced indicatively at this level. SL was more prominent at this level with a rectangular shape and its echogenicity was significantly higher than DDFT and SDFT at this level which seemed homogeny and steady as well. The echo of the 3<sup>rd</sup> metatarsal bone appeared much more notable and hyperechoic. (fig. 5).

*Level 4a (18-21 under tarsal joint):*

All the structures were entirely observable at this level. From the top, skin and the subcutaneous tissues, DDFT, SDFT, vascular and soft tissue space, SL and the surface of the 3<sup>rd</sup> metatarsal bone were detected.

SDFT: In this tendon with a bracket shape and sharp lateral and medial edges, came out to show a boost in width and a drop in thickness. Echogenicity at this level was equal to DDFT.

DDFT: Just like the way it appeared in level 12, with the same circular shape and ecogenicity. The space between DDFT and SL was furthermore reduced indicatively at this level. SL came out as a square shape with unclear borders and heterogenic echogenicity which was isoechoic with SDFT and DDFT. (fig. 6)

*LEVEL4b (21-24 under of tarsal joint):*

All the structures were fully observable at this level such as, skin and the subcutaneous tissues, DDFT, SDFT, vascular and soft tissue space, SL and the surface of the metatarsal bone. SDFT was appeared narrower however its width showed no marked difference comparing the previous level. It had a bracket shape with rather sharp edges. The echogenicity of this structure was less than DDFT.

SL was observed clearly with limpid borders and a butterfly shape and a narrower width which seemed to be close to the branching place of the ligaments. The echogenicity of this structure was a little higher than SDFT and DDFT (fig. 7)

*Level 5a (24-27 under tarsal joint)*

Structure observable at this level were skin and the subcutaneous tissues, DDFT, SDFT, vascular and soft tissue space and SL medial and lateral branches.

Echogenicity and shape SDFT were the same as the former level. DDFT: It showed up as an oval figure with a decrease in thickness and an increase in width. The echogenicity was steady and equal to SDFT. Lateral sesamoid ligament (LSL)

Seen hyperechoic with a rectangular form lateral to SL. MSL Appeared hypoechoic with a rectangular figure. MSL similar to LSL in size. The echo of the 3<sup>rd</sup> metatarsal bone was detected in the middle space of LSL and MSL. (fig. 8).

Level 27: This level is located on the fetlock joint and the detectable structures were: skin and the subcutaneous tissues, DDFT, SDFT, dorsomedial and dorsolateral sesamoid, SL and the Echo of the 3<sup>rd</sup> metatarsal bone. SDFT seemed narrower than level 24 and had an increase in width in a

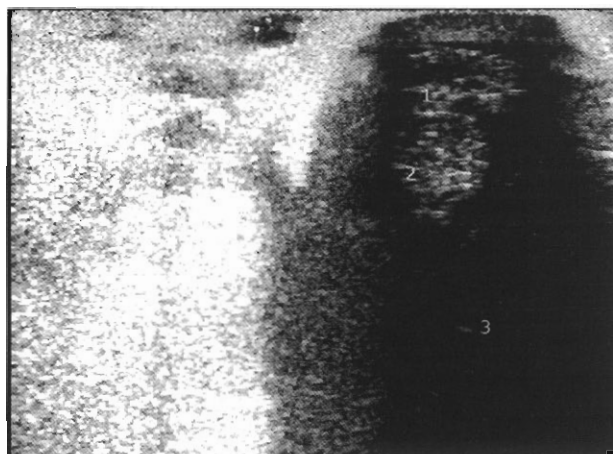
way that extended to the sides of DDFT. Ecogenicity was analogous to DDFT. DDFT had an oval and elongated shape with a growth in width. On the sides and dorsal part of DDFT, two echogen convex lines were identified which were due to the head of the dorsolateral and dorsomedial sesamoid bones causing the sound. Between the above structures and dorsal to the DDFT, a rectangular and hyperechoic structure was recognized which was the plantar intercesamoidal ligaments and on the lateral part of this ligament a small echogenic area or line was observed that related to the middle condyle of the 3<sup>rd</sup> metatarsal. Others branches of SL were not observable at this level. (fig. 9)

### Longitudinal Images

In these images, echogenic narrow and parallel lines are seen all over the tendons and ligament structure longitudinally which indicates the fibrous pattern of these structures. In the longitudinal images at the levels 1a-3a, DDFT and SDFT were so close to each other in a way that the borders were not detectable in some occasions. In these levels vascular and soft tissue space hypoechoic with a lower ecogenicity and the SL border down the vascular and soft tissue space were fully observable. The surface of the 3<sup>rd</sup> metatarsal bone was clearly detected as a hyperechoic line. In the longitudinal images at the levels 3a-4b, DDFT and SDFT were close to each other in a way that the borders could not be recognized again. Vascular and soft tissue space hypoechoic with a lower ecogenicity at the lower part were completely identified. At this level the suspensory ligament was interrupted at the branching place of the ligament. The rest of SL branches are not observable in the longitudinal view and in the middle of metatarses. If the transducer is positioned longitudinally and leaned to the medial or lateral side of metacarpus, the branches of SL were observable which appeared echogenic and hemogenic. At the last level the longitudinal view of SDFT and DDFT were seen and the metatarsal bone surface and the intercondylar process of the 3<sup>rd</sup> metatarsal were observed as an echogenic line. (Fig10).



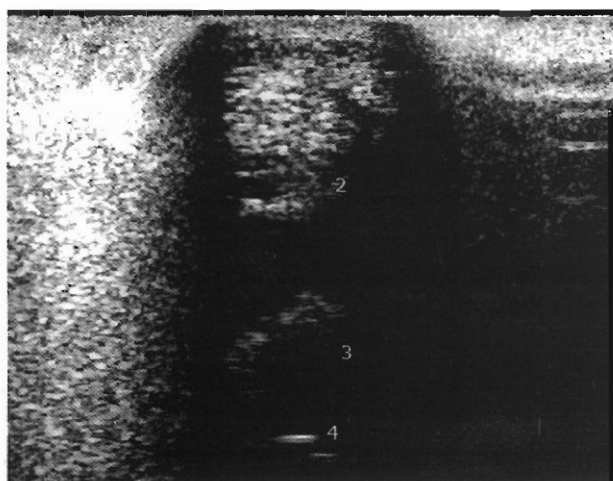
**Figure 1.** The shaved area was divided to 9 levels (1a-1b-2a-2b-3a-3b-4a-4b-5a), each 3 cm long afterwards.



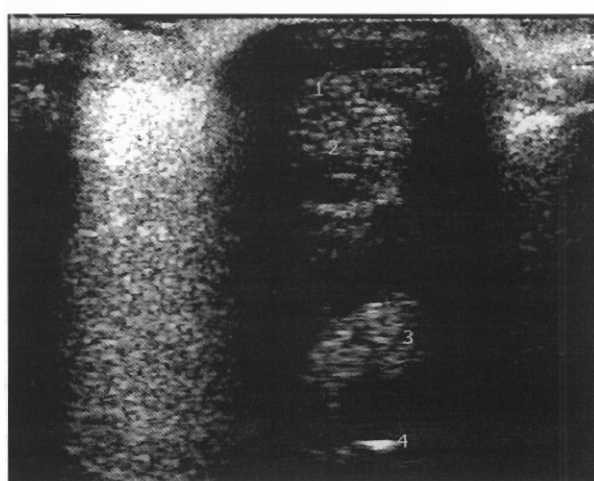
**Figure 2.** No complete images of the structures were recorded again but some parts of the following structures were seen on the screen: Skin, Subcutaneous tissues DDFT (2), SDFT (1), 3rd metatarsal bone.



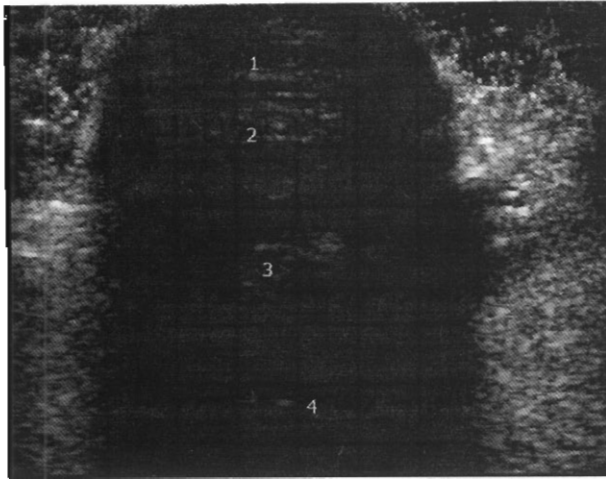
**Figure 3.** The observed structures from the top of the image were skin and the subcutaneous tissues, DDFT(2), SDFT(1), vascular and soft tissue space and SL(3) and the surface of the 3<sup>rd</sup> metatarsal bone(4). Although the presence of suspensory ligament is obvious, no complete and describable image was recorded.



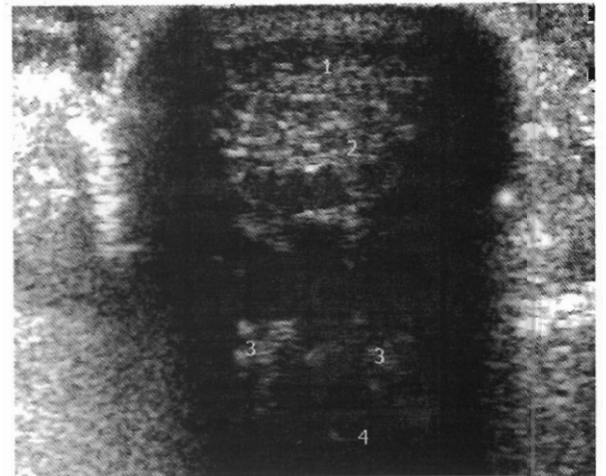
**Figure 4.** SDFT (1) at this level had a crescent shape to some extents, and was less tended to the medial part. It seemed to be located at the dorsal part of DDFT (2). SL (3) is the top (most dorsal) structure of the metatarsal region (4) and the observable area of it was wider than the previous levels with an irregular to square shape. Its echogenicity was significantly lower than DDFT and SDFT at this level which seemed heterogenic and unsteady as well.



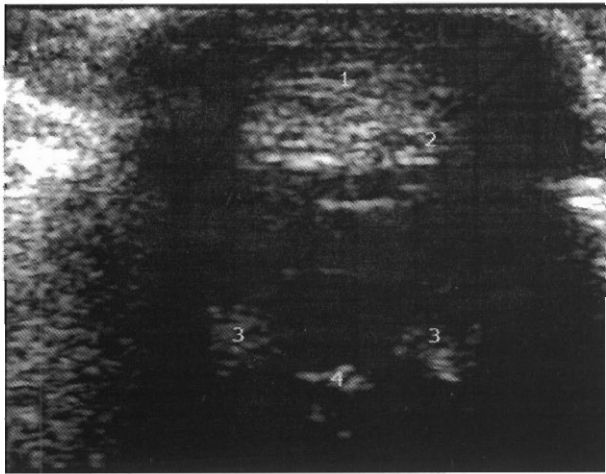
**Figure 5.** Right from the top, skin and the subcutaneous tissues, DDFT(2), SDFT(1), vascular and soft tissue space, SL(3) and the surface of the 3<sup>rd</sup> metatarsal bone(4) were identified. SDFT had a crescent shape to some extents, and seemed to be located mostly tending to the dorsal part of DDFT and much less to the medial part. Echogenicity at this level was mostly Isoechoic with DDFT. SL (3) was more prominent at this level with a rectangular shape.



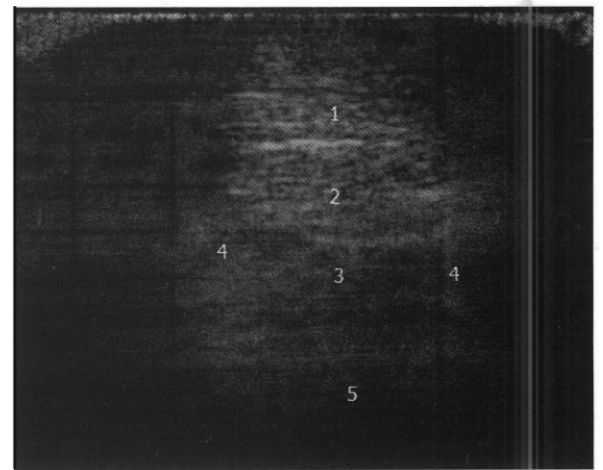
**Figure 6.** SDFT (1) was with a bracket shape and sharp lateral and medial edges, came out to show a boost in width and a drop in thickness. Echogenicity at this level was equal to DDFT (2). SL (3) came out as a square shape with unclear borders and heterogenic echogenicity which was isoechoic with SDFT and DDFT. The 3<sup>rd</sup> metatarsal bone (4).



**Figure 7.** Echogenicity and shape SDFT (1) were the same as DDFT (2). DDFT showed up as an oval figure with a decrease in thickness and an increase in width. SL (3) was observed clearly with limpid borders and a butterfly shape and a narrower width which seemed to be close to the branching place of the ligaments. The 3<sup>rd</sup> metatarsal bone (4).

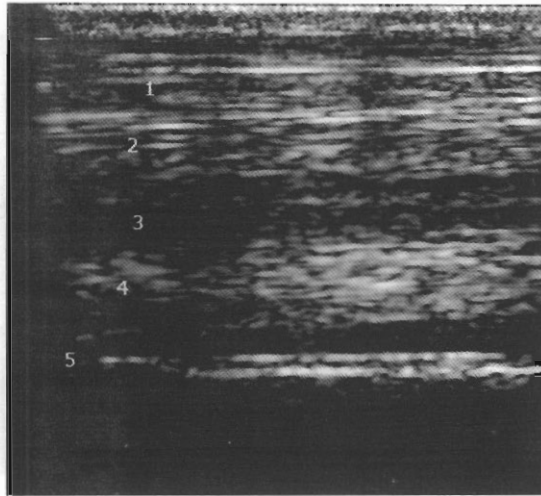


**Figure 8.** This level were skin and the subcutaneous tissues, DDFT (2), SDFT (1), vascular and soft tissue space and SL medial (3) and lateral branches (3). The echo of the 3<sup>rd</sup> metatarsal bone was detected in the middle space of LSL and MSL.



**Figure 9.** This level is located on the fetlock joint and the detectable structures were: skin and the subcutaneous tissues, DDFT (2), SDFT (1), dorsomedial (4) and dorsolateral sesamoid (4), SL and the Echo of the 3<sup>rd</sup> metatarsal bone (5). SDFT seemed narrower than level 24 and had an increase in width in a way that extended to the sides of DDFT. DDFT (2) had an oval and elongated shape with a growth in width. On the sides and dorsal part of DDFT, two echogenic convex lines were identified which were due to the head of the dorsolateral and dorsomedial sesamoid bones (4). intersesamoidean ligament (3).





**Figure 10.** In the longitudinal images at the levels 3a-4b, DDFT (2) and SDFT (1) were close to each other in a way that the borders could not be recognized again. Vascular and soft tissue space hypo echoic with a lower echogenicity at the lower part were completely identified (3). At this level the suspensory ligament (4) was seen. The echo of the 3<sup>rd</sup> metatarsal bone (5).

## Discussion

Diagnosis and treatment of lameness as one of the most important common disorders in horses have always been requested from horse specialist. Before 1950s, the treatment of bones, joints and tendon injuries was restricted to the use of blistering agents, heating the area and taking some rest. Although the development of radiological technique provided a prompt diagnosis of the bones and joints disorders and the surgical procedures such as arthrotomy and arthroscopy besides administration of the drugs such as Non-steroidal Anti-inflammatory Drugs (NSAIDs) and intraarticular steroids were useful and appropriate means in treatment of the osseous and articular disorders. Few investigations have been performed over the tendons and ligaments of the horse limbs due to the difficulties in proper detection of tendon and ligament injuries and the only diagnostic method was the veterinarians' skills in palpation of the structures.

Although ultrasonography was primarily introduced as a mean for diagnostic purposes, it seemed to be efficient and helpful in evaluation of the treatment and following the healing process in the injured tendons and ligaments.<sup>5</sup> The safeness and practical nature of ultrasonography has proposed it as very reliable and valid way in compare with other methods. Several studies have proved the correctness of the ultrasonographical inspections of the tendons and ligaments by comparing them with necropsy findings.<sup>6,7</sup> Additionally there's a meaningful relation between the histological and ultrasonographical findings during healing process which introduces ultrasonography as a safe and harmless method not only in the evaluation of the tendon and ligament structures, but also in the following of the healing process. In the present study, the ecogenicity of DDFT from the 2b level was hyper echoic to isoechoic comparing SDFT and SL from the level observed the branching area was hyperechoic in compare with DDFT & SDFT, however MSL & LSL were hypoechoic comparing SDFT & DDFT. Although the ecogenicity of SL is anticipated to be lower due to the presence of muscular tissue, its increase may be a result of the tension induced by weight bearing pressure in a way that the collagen fibers are extended a little more which leads to increase in exposure of the sound waves resulting to an increase in ecogenicity.<sup>8,9</sup>



The decrease observed in the ecogenicity of MSL & LSL branches can be as a result of the oblique route of internal and external branches tending to the lateral part of the limb, which leads to a poor vertical exposure of the sound waves.

Investigations have proved that there's no difference between the ecogenicity of each ligament and tendon in different levels in the left and right limbs which was confirmed in the current inspection as well.<sup>8,10</sup> MacDiarmid (1995) believed that DDFT is more echogenic than SDFT.<sup>11</sup> Wood and others (1993) concluded that SL is more echogenic than SDFT & DDFT in the transverse view and the brightness of DDFT and SDFT is equal in horses according to their observations over 1340 cases.<sup>8</sup> Genovese et al (1986), announced that inferior check ligament (ICL) has the highest echogenicity in the hind limb structures and the echogenicity of DDFT & SDFT are almost even, however DDFT is somehow more echogenic.<sup>12</sup> Gillis et al (1995) reported that the average echogenicity of SDFT is less than DDFT in horses in all metacarpal levels.<sup>10</sup> Sand (1998) believed in balance of the echogenicity of the DDFT & SDFT in the 1b level however ICL was more hyperechoic than the above structures.<sup>13</sup> They also declared that DDFT has a triangular shape at level 1a in transverse images and SL is more hyperechoic than DDFT and SDFT.<sup>13</sup> Cuesta and others (1995) reported the sameness of DDFT and SDFT echogenicity however in some occasions DDFT showed a higher echogenicity than SDFT due to indefinite reasons.<sup>14</sup> There aren't any difference echogenicity between right and left hind limb.<sup>8,10</sup> The conclusions of the current study on the Caspian horse were highly compatible with the previous vestigations in horses on echogenicity and shape of the plantar tendons and ligaments. Generally it is assumed that transverse images provide a better image of tendons and ligaments and any injury in any part of the above structures can be diagnosed easily, however some probable injuries around the tendon may be left unseen in longitudinal images. No suitable images were provided in the present study in the upper part (1b & 1a) which can be as a result of the anatomical situation and shape of the area in a way that tendon structures are narrow and form a process on the limb with a cavity on the sides. Using a waterproof probe and performing the ultrasonography inside the water seems to be the solution considering the above problem which can be noticed in future investigations. All the structures started to appear with an acceptable contrast and visibility at the 2a level. SDFT & DDFT were well observed from the level 2a however, no definite borders were recognizable as ICL (except one case). This is mentioned in anatomy references as well that ICL is usually so narrow in the hind limbs with an alternative presence that makes the ultrasonographical detection of it in both intact and injured conditions, difficult. For a more precise study, it's suggested to compare ICL with the structure in the opposite limb. Necropsy and looking closely at the structures and examination of their presence and size seems to be necessary for further investigations on the Caspian horse. Totally, the inspection of SL in the hind limbs is more difficult comparing the forelimbs due to some reasons such as this that in the hind limbs the superficial tendons and SL are not as parallel and straight as they are in the forelimbs, which leads to the forming of edge shadow artifacts of the upper structures on the SL. Besides, it seems that due to the irregular shape of the upper part of SL a close comparison with the structure in the opposite limb is required to let us detect the minor disorders. The ultrasonographical inspection of the plantar structures of the Caspian horse appears to be practical, requiring more specific and accurate anatomical information about the area and some suggestive methods to decrease the rate of artifacts leading to better and more qualitative images. By the way more definite and accurate studies on the significance and

prevalence of tendon and ligament injuries and disorders of the plantar region of horses and Caspian horses to reach a reasonable explanation of the matter seems to be necessary.

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## توصیف اولتراسونوگرافی تاندون ها و لیگامان های ناحیه متاتارس اسبچه خزر

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**هدف-** بررسی امکان ارزیابی سونوگرافیک، جهت ایجاد مرجع استاندارد از شکل و اکوژنیسته تاندون ها و لیگامان های ناحیه کف پایی در اسبچه خزر می باشد.

**طرح مطالعه-** مطالعه توصیفی

**حیوانات-** این مطالعه بر روی ۷ اسبچه خزر انجام گرفت. این اسبچه ها دارای شناسنامه، مشخصات فردی و شجره نامه بودند. سن اسبچه ها هفت سال بود و هر ۷ راس، ماده بودند.

**روش کار-** در این اسبچه ها اندام حرکتی خلفی سمت چپ و راست در ناحیه متاتارس مورد آزمایش اولتراسونوگرافی قرار گرفت این ناحیه از ۲ سانتی متری زیر محل بر جستگی مربوط به قسمت بالایی قلم فرعی ۴ به ۹ سطح با فاصله ۳ سانتی متر تقسیم بندی شد و اولتراسونوگرافی ناحیه متاتارس چپ و راست در زمان وزن گیری دام بر روی اندام حرکتی مورد نظر توسط دستگاه اولتراسونوگرافی Pie Medical ، 100 Falco Vet و پراب خطی ۸ مگا هرتز انجام گرفت.

**نتایج-** سطح 2a، تقریباً، شروع محدوده ای بود که همه ساختارها، با وضوحی نسبتاً قابل قبول، قابل مشاهده بودند. تمامی محدوده SDFT و DDFT، از سطح 2a به پایین، بخوبی قابل مشاهده بودند ولی در سونوگرافی که از اندام خلفی این ۷ مورد اسبچه، به عمل آمد، محدوده مشخصی، بعنوان ICL، قابل تشخیص و تعیین نبود در بررسی کنونی اکوژنیسته DDFT از سطح ۹ به بعد نسبت به SDFT هیپر اکو تا ایزو اکو بود و همچنین SL از سطحی که دیده می شود تا محل دو شاخه شدن نسبت به DDFT و SDFT هیپر اکو می باشد این در حالی است که MSL و LSL نسبت به DDFT و SDFT هیپر اکو می باشد همچنین تفاوتی در اکوژنیسته تاندونها یا لیگامنتها در سطوح مشابه بین اندام حرکتی راست و چپ اسبچه وجود ندارد.

**نتیجه گیری و کاربرد بالینی:** به نظر می رسد که بررسی سونوگرافی ساختارهای ناحیه کف پایی در اسبچه خزر قابل انجام می باشد ولی باید اطلاعات دقیق تری در مورد آناتومی ساختارهای این ناحیه بدست آورد و با بکار بردن روشهایی برای کاهش اثر آرتیفکت ها، تصاویری با کیفیت و وضوح بهتری تهیه کرده و با اندازه گیری پارامترهای مورد نظر، بر روی هر ساختار خاص، استانداردهایی برای اندازه این ساختارها بدست آورد. همچنین باید مطالعه ای وسیع تر و دقیق تر بر روی میزان اهمیت و شیوع آسیب ها و ضایعات تاندون ها و لیگامان های ناحیه کف پایی و درصد اهمیت آن در مورد اسب و اسبچه خزر انجام شود تا بتوان توجیه منطقی برای انجام این کار به دست آورد.

**کلید واژگان-** اسبچه خزر، تاندون، لیگامنت، اندام خلفی.