ULTRASONOGRAPHIC FINDINGS IN HORSES WITH FOOT PAIN BUT WITHOUT RADIOGRAPHICALLY DETECTABLE OSSEOUS ABNORMALITIES

Silvia Rabba, Géraldine Bolen, Denis Verwilghen, Alexandra Salciccia, Valeria Busoni

Foot pain is an important cause of lameness in horses. When horses with foot pain have no detectable radiographic abnormalities, soft-tissue assessment remains a diagnostic challenge without magnetic resonance (MR) imaging. Ultrasonography can provide an alternative to MR imaging when that modality is not available but the extent of changes that might be seen has not been characterized. We reviewed the ultrasonographic findings in 39 horses with lameness responding positively to anesthesia of the palmar digital nerves and without radiographically detectable osseous abnormalities. Thirty of the 39 horses had lesions affecting the deep digital flexor tendon (DDFT), 27 had abnormalities in the distal interphalangeal joint of which six had a visible abnormality in the collateral ligament. Ultrasonographic abnormalities were seen in the podotrochlear bursa in 22 horses and in the ligaments of the navicular bone in two horses. Abnormalities of the navicular bone flexor surface were detected in eight horses. In three of the 39 horses, only the DDFT was affected. The other 36 horses had ultrasonographic abnormalities in more than one anatomical structure. Based on our results, ultrasonographic examination provides useful diagnostic information in horses without radiographic changes.

Key words: equine, foot, horse, lameness, pain, ultrasonography.

Introduction

Foot pain is a common cause of forelimb lameness in sport and pleasure horses.[1–3] With increasing use of magnetic resonance (MR) imaging, the importance of soft-tissue lesions as a cause of foot pain in horses has become apparent.[4] Although MR imaging provides excellent information about soft tissues and bones, it is too costly for some owners.[5,6] Ultrasonography can also be used to image the soft tissues of foot.[7–10] The imaging technique and ultrasonographic anatomy of the podotrochlear apparatus and of the palmarodistal aspect of the equine digit have been described.[9,10] However, little is known about the ultrasonographic features of disease in the foot,[11–15] although some comparisons between sonographic and MR imaging findings in horses with palmar foot pain are available.[16–18]

Our purpose was to review and describe ultrasonographic findings in front feet in a series of horses with foot lameness responding positively to anesthesia of the palmar digital nerves and without radiographically detectable osseous abnormalities.

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Received February 13, 2010; accepted for publication June 18, 2010.
doi: 10.1111/j.1740-8261.2010.01730.x

Materials and Methods

Medical records of horses that underwent ultrasonographic examination of the digit, using dorsal, palmar, and transcuneal approaches, from November 2003 to September 2009 were reviewed. Thirty-nine horses without radiographically detectable osseous abnormalities were selected. There were 16 mares, 21 geldings, and two stallions, aged 4–19 years (mean 10 years). Breeds included 34 (87%) Warmbloods and five horses of different breeds (two Paint horses, two Quarter horses, and one Arabian horse). Twenty-four of the horses were showjumpers, eight general purpose/pleasure horses, four dressage horses, and three western riding horses. All horses had a forelimb lameness and severity of lameness at trot varied from 1 to 4 on a scale of 5 (mean 2,3/5). In 27 horses the lameness was recent, first recognized within 3 months, and in 12 horses the lameness was present for more than 3 months. Thirty-four horses had unilateral lameness (left forelimb in 14 and right forelimb in 20), whereas five were lame bilaterally. All horses had a positive response to anesthesia of the palmar digital nerves performed at midpastern (24 G needle, 1.5–2 ml of mepivacaine*).

The horses had no osseous radiographic abnormalities of the foot. Fifteen had a swelling of the dorsal recess of the distal interphalangeal joint in the lame forelimb, nine of which also had this finding in the contralateral nonlame

*Scandicaine (20 mg/ml), AstraZeneca, Brussels, Belgium.

forelimb. These swellings are considered a common finding in nonlame working horses.[19] Twenty-one horses had conspicuous synovial invaginations along the distal border of the navicular bone considered within the normal range.

Ultrasonographic examinations were performed by the same experienced operator (V.B.) using an Aloka SSD 3500 ultrasound machine† equipped with a 7.5 MHz microconvex, a 7.5 MHz linear, and a 5 MHz convex probe. All horses were examined bilaterally ultrasonographically. Before ultrasonography, the digits were prepared by clipping of the hair and trimming and soaking of the frog.[9,10] The distal interphalangeal joint and associated ligaments and the palmar distal aspect of the digit were examined on the weight bearing limb using dorsal and palmar approaches, including the approach through the bulbs of the heel. The podotrochlear apparatus was also evaluated on the nonweight bearing limb by a transcuneal approach.

Ultrasonographic images were reviewed retrospectively by the first and the last author in consensus and the following features evaluated: distension of the distal interphalangeal joint, podotrochlear bursitis, digital flexor tendon sheath effusion, distal digital annular desmopathy, tendonopathy of the deep digital flexor tendon (DDFT), collateral desmopathy of the distal interphalangeal joint, collateral sesamoidean desmopathy, distal sesamoidean impar desmopathy, irregularity or erosion of the navicular bone flexor surface and enthesopathy of the insertion of the DDFT, and the distal sesamoidean impar ligament on the distal phalanx. The distal interphalangeal joint was defined as distended when the common digital extensor tendon was displaced dorsally and the dorsal distal interphalangeal joint recess had a dorsally convex profile. The distension of the distal interphalangeal joint was then classified as synovial fluid effusion with and without echoic foci, when the synovial membrane was not visible and the recess was filled with an increased amount of anechogenic synovial fluid associated with little or no floating debris, or as chronic proliferative synovitis when the synovial membrane was thickened. An increased amount of synovial fluid resulting in an increase size of the proximal recess of the podotrochlear bursa in comparison to reference images[10] and/or to the contralateral limb was considered indicative of effusion. Effusion of the bursa, with or without echogenic material or synovial membrane and mesotendon thickening, was interpreted as bursitis. Anechogenic fluid in the digital flexor tendon sheath, visible when the pressure on the probe was released, was considered indicative of effusion and interpreted as tenosynovitis. Distal digital annular desmopathy was considered when an abnormal hypoechoic band or a layered appearance of the ligament at the palmar aspect of the DDFT was visible in comparison with reference images.[10] The ultrasonographic appearance of the collateral ligaments of the distal interphalangeal joint, of the navicular bone ligaments and of the DDFT were classified as normal or abnormal based on comparison to previously published reference images.[20] Changes in the collateral ligament of the distal interphalangeal joint had to be seen in two planes and to be visible in comparison to the homologous ligament of the contralateral non lame limb in unilaterally lame horses. A lobe of the DDFT was considered abnormally enlarged when there was a visible increase in dorsopalmar thickness compared with the opposite lobe and/or to the homologous lobe of the contralateral limb in transverse ultrasonographic images. At the level of the navicular bone or distal to it, the DDFT was considered abnormally thickened when its dorsopalmar thickness was uneven palmar to the flexor surface of the navicular bone and/or increased compared with the contralateral limb in longitudinal ultrasonographic images. On the basis of the ultrasonographic findings and their localization, the lesions of the DDFT were described and classified. An irregular appearance of the hyperechoic line of the bone surface of the distal phalanx at the level of the insertion of the DDFT or distal sesamoidean impar ligament was considered consistent with a diagnosis of enthesopathy. Irregularity of the navicular bone flexor surface was considered when the palmar hyperechoic bone profile looked thickened and roughened compared with reference images.[21]

Results

Ultrasonographic images were of sufficient diagnostic quality in all horses although the portion of the DDFT visible varied depending on the conformation of the foot. In all horses about 2/3 (proximo-distally) or more of the flexor surface of the navicular bone was visible using the transcuneal approach and the DDFT could be seen to its distal insertion on the distal phalanx. The lateromedial extent of the visible flexor surface and of the central portion of the DDFT seen transcuneally varied depending on the width of the frog.

Abnormal ultrasonographic findings were detected in all horses included in the study. These included abnormalities of the distal interphalangeal joint, the DDFT and its insertion on the distal phalanx, the podotrochlear bursa, the digital flexor tendon sheath, the navicular bone flexor surface, the distal digital annular ligament, the collateral sesamoidean ligament, and the distal sesamoidean impar ligament (Fig. 1).

Distal interphalangeal joint distension, compatible with synovitis, was detected in the lame forelimb of 27 horses. Anechogenic synovial fluid effusion of the distal interphalangeal joint was found in 10 horses, of which five had floating hyperechoic foci. Synovial membrane proliferation was seen in 17 horses (Fig. 2). In 16 of the 27 horses, distal

†Aloka Co. Ltd., Mitaka, Tokyo, Japan.

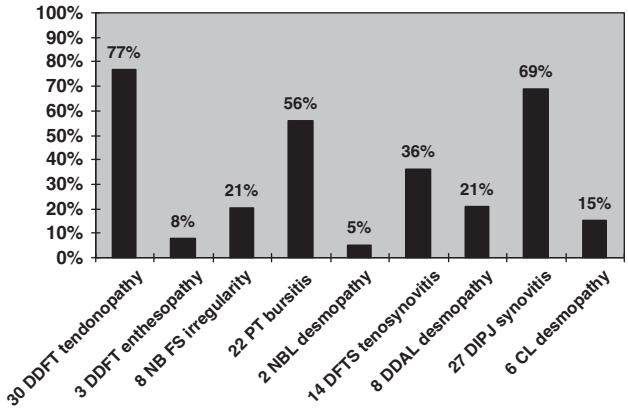

FIG. 1. Prevalence of ultrasonographic abnormalities in the 39 horses without radiographically detectable osseous abnormalities. The number beside the names of the anatomical structures indicates the number of horses affected. DDFT, deep digital flexor tendon; NBL, navicular bone ligaments; FS, flexor surface; PT, podotrochlear; DFTS, digital flexor tendon sheath; DDAL, distal digital annular ligament; DIPJ: distal interphalangeal joint; CL, collateral ligament of the DIPJ.

interphalangeal joint synovitis was also seen in the contralateral nonlame limb.

Collateral desmopathy of the distal interphalangeal joint was found in six horses (Fig. 3). Ultrasonographic abnormalities were thickening of the ligament and/or the periligamentous tissue and alteration of echogenicity and architecture.

Ultrasonographic changes involving the DDFT were identified in 30 horses. In 27 horses with unilateral lameness the DDFT lesions were confined to the lame foot, while in the three other horses with bilateral lameness, bilateral tendonopathy was found. DDFT lesions were most commonly located proximal to the navicular bone at the level of the collateral sesamoidean ligament and proximal recess of the podotrochlear bursa (29 horses). In four horses, DDFT lesions were present in both regions, proximal and distal to the navicular bone. One horse had a single DDFT lesion located at level of the navicular bone flexor surface. The suprasesamoidean DDFT lesions were easier to see on transverse images and involved mainly the lateral lobe (22 lateral lobes affected vs. 11 medial lobes). In two limbs, suprasesamoidean lesions affected both lobes. Ultrasonographic features of the suprasesamoidean DDFT lesions included increased thickness of the affected lobe and abnormal dorsal convexity of the affected lobe (10 lobes), hypoechoic areas located dorsally with an irregular dorsal border of the tendon (12 lobes) and central hypoechoic (six lobes) or hyperechoic (five lobes) lesions without major changes in the dorsal profile of the affected lobe (Fig. 4). Combinations of increased thickness and dorsal lesions with convex or irregular dorsal border of the lobe of the DDFT were common (Fig. 5). The ultrasonographic features of the only lesion located at level of the navicular bone flexor surface were tendon thickening and change of its palmar profile (abnormal convexity) visible on longitudinal images. The four DDFT lesions found distal to the navicular bone were seen as thickening associated with an abnormal palmar border convexity (two digits) or with an undulating palmar tendon border (two digits) visible on longitudinal images (Fig. 6). No DDFT lesion was visible in a nonlame foot.

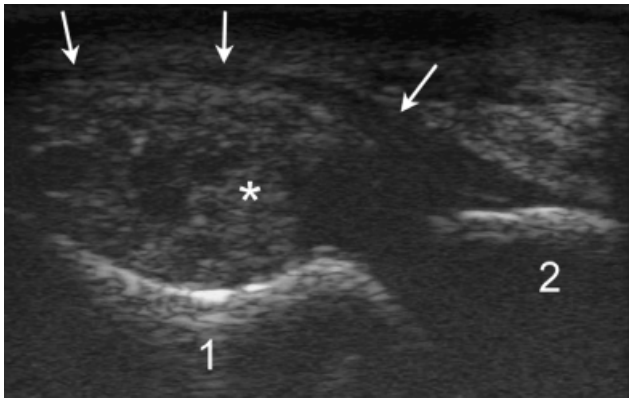

FIG. 2. Longitudinal ultrasonographic image of the dorsal aspect of the distal interphalangeal joint in a horse with a chronic distal interphalangeal joint synovitis (proximal to the left). The image was obtained with a 7.5 MHz linear probe. Moderate fluid distension and severe synovial membrane proliferation (asterisk) of the distal interphalangeal joint are seen. 1, middle phalanx; 2, distal phalanx; arrows, common digital extensor tendon.

Enthesopathy of the DDFT was observed in three horses, as an irregularity of the hyperechoic bone surface of the distal phalanx. In one horse with bilateral lameness, bilateral DDFT enthesopathy was found.

Abnormalities of the navicular bone flexor surface were detected in eight digits. The ultrasonographic changes identified consisted of thickening and roughening of the hyperechoic bone profile (Fig. 7).

Podotrochlear bursitis was identified in 22 horses. Increased amount of anechogenic synovial fluid in the podotrochlear bursa was seen in 10 horses (Fig. 8), whereas effusion with presence of echogenic material within the bursa and/or thickening of the synovial membrane and mesotendon was detected in 12 horses. Digital flexor tendon sheath tenosynovitis was observed in 14 horses, mainly as anechogenic fluid effusion with no synovial membrane proliferation. Four horses with unilateral forelimb lameness had anechogenic fluid distension of the podotrochlear bursa and mild digital flexor tendon sheath effusion in the contralateral nonlame limb.

Ultrasonographic changes in the distal digital annular ligament were seen in eight horses as an abnormal hypoechoic band or as layered appearance of the ligament at the palmar aspect of the DDFT.

One horse had an ultrasonographically abnormal distal sesamoidean impar ligament. This ligament had a convex palmar border and a hypoechoic area in its distal portion.

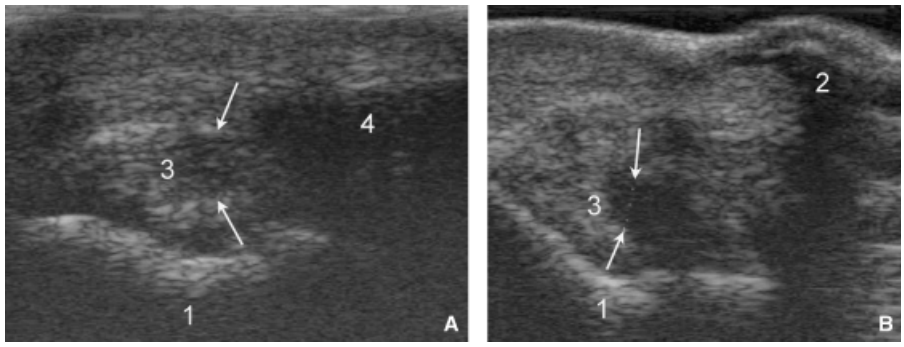

FIG. 3. Transverse (A) and longitudinal (B) ultrasonographic images obtained at the dorso-medial aspect of the distal interphalangeal joint in a horse with distal interphalangeal joint collateral desmopathy (dorsal to the left; proximal to the left). The images were obtained with a 7.5 MHz linear probe. There is a hypoechoic area in the collateral ligament visible in both sections. An alteration of the fiber pattern is also visible on the longitudinal section (arrows). The periligamentous tissue is slightly thickened with loss of definition of the ligament margins. 1, middle phalanx; 2, coronary band; 3, distal interphalangeal joint collateral ligament; 4, ungular cartilage.

Enthesopathy of the distal sesamoidean impar ligament was also seen as a bone surface irregularity in the same horse. Desmopathy of a collateral sesamoidean ligament was seen in one horse as a hypoechoic area in the lateral part of the ligament associated with a slight thickening compared with the medial part (Fig. 9).

Thirty-six of the 39 horses had ultrasonographic abnormalities in more than one anatomic structure. Only three horses had only the DDFT affected. Most horses (30) had DDFT ultrasonographic abnormalities. In five horses distension of the podotrochlear bursa, associated with distal interphalangeal joint distension (three horses) and digital flexor tendon sheath effusion (two horses), was the only visible abnormality. Three horses had abnormalities of the navicular bone flexor surface without visible tendonopathy of the DDFT, with (two horses) or without (one horse) podotrochlear bursitis. All distal digital annular desmopathies were seen in association with DDFT tendonopathy. Enthesopathy of the DDFT, desmopathy, and enthesopathy of the distal sesamoidean impar ligament and the collateral sesamoidean ligament were found in horses with multiple structures affected. Distal interphalangeal joint distension was the second most common ultrasonographic abnormality (27 horses). Ultrasonographic abnormalities of the distal interphalangeal joint collateral ligaments were seen with (four horses) or without (two horses) DDFT tendonopathy.

Discussion

We found a variety of ultrasonographic abnormalities in the foot of lame horses that had no corresponding radiographic abnormalities. The lameness responded positively to anesthesia of the palmar digital nerves performed at midpastern. Because more selective local anesthesia techniques were not applied, it is impossible to establish the relative significance of the ultrasonographic findings in relation to the foot pain.

Effusion of the distal interphalangeal joint was detected radiographically in 15 horses while distal interphalangeal joint distension was found ultrasonographically in 27 horses. This suggests a greater sensitivity of ultrasonography in comparison to radiography for detection of distal interphalangeal joint effusion. Bone surface abnormalities (of the navicular bone flexor surface and of the distal phalanx) were detected sonographically in 12 horses. These bone abnormalities were not apparent radiographically. A high sensitivity of ultrasonography for detection

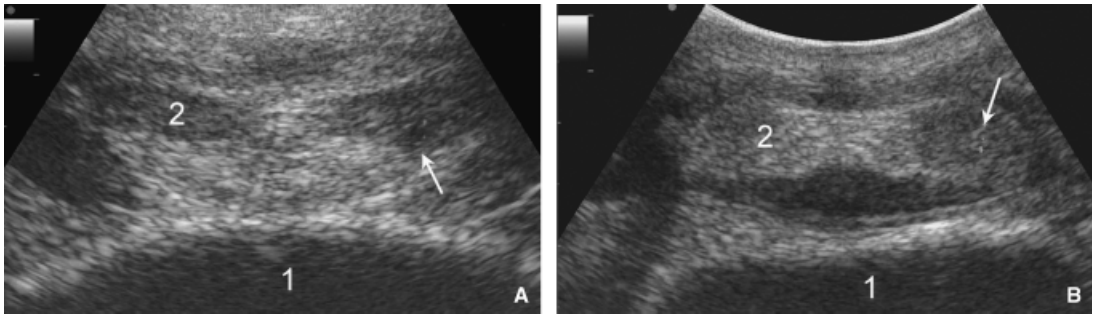

FIG. 4. Transverse ultrasonographic images (A and B) obtained at the palmar aspect of the middle phalanx in two horses with deep digital flexor tendonopathy (medial to the left). The images were obtained with a 7.5 MHz microconvex probe. (A) There is a hypoechoic dorsal lesion creating an irregular dorsal border of the lateral border (arrow) and an asymmetrical shape and thickness between the two lobes (arrow). (B) There is a central hyperechoic lesion (arrow) associated with a slight dorsopalmar thickening of the lateral lobe of the deep digital flexor tendon. 1, middle phalanx; 2, deep digital flexor tendon (medial lobe).

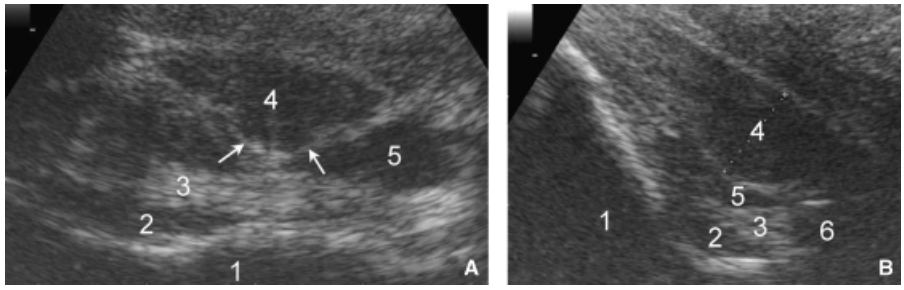

FIG. 5. Transverse oblique (A) and longitudinal parasagittal oblique (B) ultrasonographic images obtained at the palmar aspect of the middle phalanx in a horse with deep digital flexor tendonopathy (medial to the left; proximal to the left). The images were obtained with a 7.5 MHz microconvex probe. Both sections are obtained orienting the probe laterally to image the lateral lobe of the tendon. An increased thickness and a convex dorsal border associated to a hypoechoic dorsal lesion are visible in the lateral lobe of the deep digital flexor tendon (arrows). 1, middle phalanx; 2, proximal palmar recess of the distal interphalangeal joint; 3, collateral sesamoidean ligament; 4, lateral lobe of the deep digital flexor tendon; 5, proximal recess of the podotrochlear bursa; 6, navicular bone.

of osseous changes of the flexor surface of the navicular bone has been reported previously[21] and a higher sensitivity of ultrasonography vs. radiography for detecting bone irregularities is well established in humans with rheumatoid arthritis.[22–24] Ultrasonography may therefore play an important role in the confirmation of equivocal radiographic findings and/or help in the detection of early changes of the navicular bone flexor surface.

Histopathologic examinations were not possible in our patients and MR imaging was not available; thus the sonographic lesions could not be confirmed. The sonographic results were compared with those obtained previously from normal horses and with results from scanning isolated limbs.[9–11,14,17,25–27] Lack of confirmation of sonographic abnormalities is a limitation of our study.

Several types of foot conformation, such as high and contracted heels, collapsed heels, and long toe are considered a limitation for ultrasonographic examination of the equine digit.[17] This is especially true for assessing the DDFT as the foot conformation influences the angle of incidence of the sound beam to the DDFT fibers and to the navicular bone flexor surface.[6,17] For this reason, in most horses there is a "blind zone" where the DDFT cannot be imaged correctly through the heels or frog.[28] Although the use of a 5 MHz probe at the level of the heels bulbs was attempted in some horses to better explore this region, it is possible that we underestimated the extent of DDFT lesions leading to some false negative results. However, considering previous studies in which sonography was compared with MR imaging and gross findings,[14,17,21] a high sensitivity and a high specificity of ultrasonographic findings for the DDFT and the navicular bone flexor surface may be expected. Nevertheless, as ultrasonographic assessment of the equine digit is technically difficult,[6,10] false negative or false positive findings cannot be excluded and interpretation of ultrasonographic findings in relation with a clinical examination is fundamental.

DDFT lesions are a common cause of forelimb lameness in absence of radiographic abnormalities.[4,29] Ultrasonographic changes in the DDFT were seen in 30 horses (77%) and this was the most frequent observation in the present study. This is different from a recent report where 18% of horses with foot lameness without radiographic abnormalities had tendonopathy of the DDFT as the primary diagnosis.[29] However results of the present study are similar to those of previous reports, in which the prevalence of horses with DDFT tendonopathy as the primary diagnosis was 33% and 83%.[2,30] These differences may relate to the

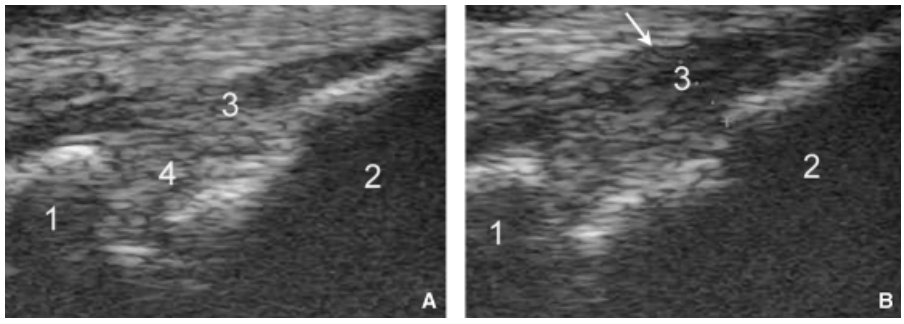

FIG. 6. Longitudinal transcuneal ultrasonographic images obtained on the sound (A) and on the lame (B) foot in a horse with deep digital flexor tendonopathy (proximal to the left). The images were obtained with a 7.5 MHz linear probe. There is a thickening of the distal portion of the tendon associated with an abnormal palmar border convexity (arrow) in the lame limb (B) in comparison with the contralateral limb (A). 1, navicular bone; 2, distal phalanx; 3, deep digital flexor tendon; 4, distal sesamoidean impar ligament.

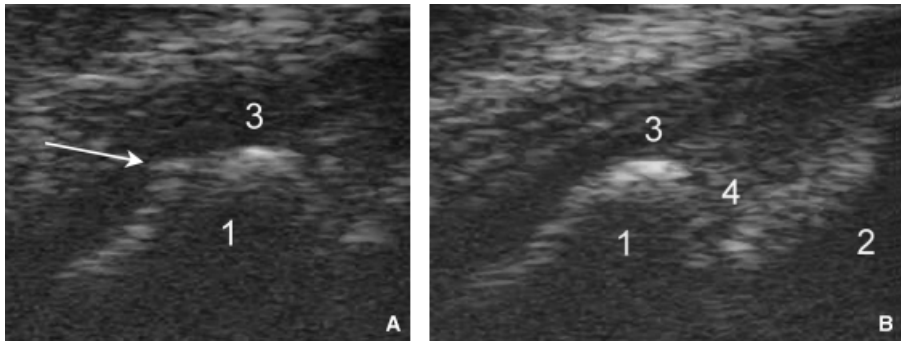

FIG. 7. Longitudinal transcuneal ultrasonographic images obtained in a horse with an abnormal navicular bone flexor surface (proximal to the left). The abnormal navicular bone is in (A), the normal contralateral navicular bone is (B). The images were obtained with a 7.5 MHz linear probe. Slight roughening of the hyperechoic bone profile of the navicular bone associated with and a small spur (arrow) is visible in the lame limb (A) in comparison with the contralateral limb (B). 1, navicular bone; 2, distal phalanx; 3, deep digital flexor tendon; 4, distal sesamoidean impar ligament.

horse population. In the present study jumping horses were most represented as in other previous studies with similar prevalence[2] and jumping horses are more likely to sustain DDFT injury than non jumping horses.[4] In the present study DDFT lesions were most commonly located in the suprasesamoidean part of the tendon in the digital area and involved mainly the lateral lobe. The majority of DDFT lesions were hypoechoic areas located dorsally giving an irregular or convex border. These ultrasonographic findings are comparable to the results of previous ultrasonographic,[15] MR imaging,[4,31,32] and histopathologic[27,31] studies in which this was a common location of DDFT lesions.

Medial to lateral DDFT asymmetry, irregular dorsal tendon border and changes in DDFT echogenicity were the most common ultrasonographic findings in the suprasesamoidean lesions and were most recognizable in transverse images. This is similar to what has been reported previously for MR imaging, in which transverse images are most useful to identify mediolateral asymmetry.[33] For evaluation of the DDFT, the longitudinal plane is useful but difficult to interpret because of the orientation of the tendon fibers.[10,21] For this reason and because the normal DDFT, palmar to the navicular bone, has low echogenicity,[9,21] the diagnosis of tendonopathy of the DDFT is difficult.[10,14,28] Therefore on longitudinal ultrasonographic images, the dorsal and palmar profile of the tendon should be assessed carefully to detect changes, especially in the portion at the level or distal to the navicular bone,[28] and careful assessment of the symmetry of the DDFT lobes on transverse images and comparison with the contralateral foot are also necessary.[13]

Abnormalities of the navicular bone flexor surface were seen together with tendonopathy of the DDFT in five horses while three horses with abnormalities of the navicular bone flexor surface had no visible tendonopathy. In these horses a false negative diagnosis cannot be excluded because of limitations of ultrasonographic assessment of the DDFT palmar to the navicular bone.[9,14,21] In fact, previous reports describe flexor surface abnormalities mainly associated with DDFT damage.[26,27,30,31]

In the present study podotrochlear bursitis was present in 22 horses (56%), the majority of which had tendonopathy of the DDFT and/or an irregularity of

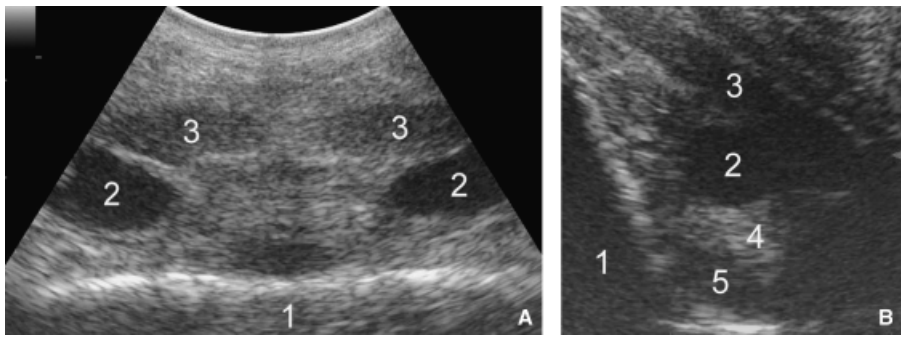

FIG. 8. Transverse (A) and longitudinal (B) ultrasonographic images at the palmar aspect of the middle phalanx in a horse with podotrochlear bursitis (medial to the left; proximal to the left). The images were obtained with a 7.5 MHz microconvex probe. An increased amount of anechogenic synovial fluid is visible in the podotrochlear bursa. 1, middle phalanx; 2, proximal recess of the podotrochlear bursa; 3, deep digital flexor tendon; 4, collateral sesamoidean ligament; 5, proximal palmar recess of the distal interphalangeal joint.

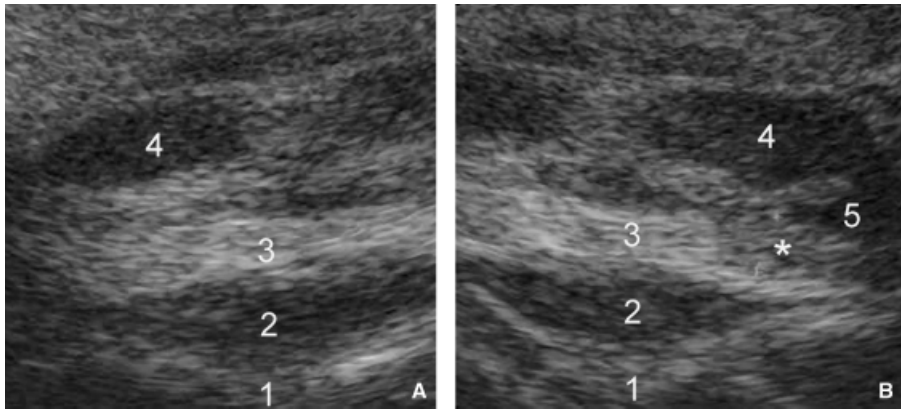

FIG. 9. Transverse oblique ultrasonographic images obtained at the palmar aspect of the middle phalanx in a horse with a desmopathy of the lateral collateral sesamoidean ligament (medial to the left). The images were obtained with a 7.5 MHz microconvex probe. The images are obtained orienting the ultrasound beam in a palmarolateral–dorsomedial (A) and in a palmaromedial-dorsolateral (B) direction in order to image separately the medial and lateral aspects of the deep digital flexor tendon and of the collateral sesamoidean ligament. There is a slight thickening and a reduced echogenicity of the lateral collateral sesamoidean ligament (asterisk in B) in comparison with the medial (A). A hypoechoic dorsal lesion associated with an increased thickness and a convex dorsal border of the affected lateral lobe is also visible in the deep digital flexor tendon. 1, middle phalanx; 2, proximal palmar recess of the distal interphalangeal joint; 3, collateral sesamoidean ligament; 4, deep digital flexor tendon; 5, proximal recess of the podotrochlear bursa.

the flexor surface of the navicular bone. This is in accordance with previous studies[29] and supports the hypothesis that non septic bursitis is rarely seen in horses without other soft-tissue damage in the navicular region.[29] Presence of echogenic material in the bursa was detected by ultrasonography and was likely associated with hypointense scar tissue in the proximal aspect of the bursa, as detected with MR imaging in horses with DDFT damage at this level.[29]

Distension of the distal interphalangeal joint was the second most common observation (27 horses-69%). Distal interphalangeal joint effusion is a common nonspecific finding in lame limbs in horses with foot pain.[2,29] Distal interphalangeal joint distension was always associated with other ultrasonographic abnormalities in this study. This is similar to previous reports in which distal interphalangeal joint effusion was found in association with damage to other structures and was not considered the primary cause of lameness.[2,29,30] Digital flexor tendon sheath effusion was observed in 14 horses. Digital flexor tendon sheath tenosynovitis is also a common nonspecific finding in lame and non lame limbs of horses with foot pain, often associated with DDFT tendonopathy in the lame limbs.[29,34] However, its prevalence is difficult to compare to recent data, as digital flexor tendon sheath effusion is rarely noted in summaries of MR imaging in horses with foot pain.[2,29,30] The distal digital annular ligament is difficult to differentiate sonographically from the palmar aspect of the DDFT.[6,10] In our study, distal digital annular desmopathy was considered when an abnormal hypoechoic band or an abnormal layering was seen palmar to the DDFT. Although a recent report suggests that distal digital annular desmopathy may be seen as a primary lesion,[35] we only found it in association with lesions of the DDFT. This is in accordance with previous MR imaging studies.[2,29]

Six horses (15%) had an ultrasonographic diagnosis of collateral distal interphalangeal joint desmopathy. Ultrasonography is useful for evaluation of desmopathy of the distal interphalangeal joint collateral ligaments.[12] However, for the distal portion of this ligament, located below the hoof capsule, ultrasonographic assessment is not possible and ultrasonography has low sensitivity and specificity in comparison to MR imaging and gross findings.[17] Therefore, false negative and false positive results cannot be excluded in our horses and MR imaging may be the technique of choice for assessing these ligaments.[17] Collateral sesamoidean ligament and distal sesamoidean impar desmopathy were diagnosed sonographically in only 2 horses. This prevalence is lower to that reported previously (10%,5%, and 60% for the collateral sesamoidean ligament[2,29]; 7%, 28%, and 38% in the distal sesamoidean impar ligament).[2,29,30]

The majority of our 39 horses had ultrasonographic abnormalities in more than one anatomic structure and therefore the contribution of each lesion to the lameness is impossible to quantify. This finding is similar to the results of previous MR imaging studies[2,29,30,33] and other reports in which histopathologic changes in horses with palmar foot pain often involved DDFT, navicular bone, podotrochlear bursa, collateral sesamoidean ligament, and distal sesamoidean impar ligament.[27,36]

Most soft-tissue lesions observed in this study were unilateral, except in horses with bilateral lameness where DDFT tendonopathy and enthesopathy was found bilaterally. Distal interphalangeal joint distension tended also to be bilateral in horses with unilateral lameness and this is in accordance

with previous reports.[13,33] Distal interphalangeal joint effusion in the non lame limb in horses with unilateral lameness may be related to asymmetrical loading causing an excessive distal interphalangeal joint workload.[37]

In conclusion, although ultrasonography cannot replace MR imaging for assessing the entire equine digit,[17] ultrasonography can provide useful information when other factors prevent application of MR imaging.

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