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Diagnostic imaging of Tendinopathies of the Superficial Flexor Tendon in Horses

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Tendinopathy of the superficial digital flexor tendon (SDFT) occurs in all types of sport horses and is a common reason for wastage in the racing Thoroughbred.[1–4] In most clinical cases swelling of the metacarpal or metatarsal area due to tendon injuries is visible and palpable however this is very subjective, and the severity of the lesion cannot be predicted from the clinical picture.[5] After the initial injury overlapping phases of reactive inflammation, fibroblastic proliferation, remodelling and maturation occur.[6,7] These phases can be monitored with the help of grey scale ultrasonographic examinations which are cheap and widely used with mobile equipment allowing examinations in the stable.

During the reactive inflammatory phase, the tendon increases in size and a hypoechoic area of fibre disruption is visible on ultrasonography (Fig 1). This area will fill with blood and debris which appears as heterogeneous hypo- to hyperechoic areas ultrasonographically and cannot always be differentiated from normal tendon tissue. It is hence sometimes overlooked in transverse images but in longitudinal images the loss of fibre pattern can usually be appreciated. At this stage, an increase in cross-sectional area (CSA) of the tendon in unilateral cases can be compared to the contralateral limb and an increase of more than 20% is indicative of a tendon injury.[8] For bilateral cases, the SDFT:DDFT ratio may be a more sensitive indicator of enlargement than absolute values. Moreover, normal values are published for different types of horses and can be used as reference. [8–12]
Due to hematoma formation and presence of immature granulation tissue the lesion will become hypoechoic on ultrasound after a few days. Additionally, repeated bleeding and inflammation can lead to an increase in lesion size up to ten days post injury. Therefore, these injuries are best examined and easier to recognise seven to ten days after occurrence.
For initial assessment and optimal monitoring, the severity of the lesion should be graded and recorded at each examination based on ultrasonographic parameters; lesion type, lesion and tendon CSA, location, lesion fibre alignment, and echogenicity.

Alzola et al. investigated the inter- and intrarater reliability of these different ultrasonographic parameters, and found that the majority of ultrasound parameters showed high agreement however echogenicity is less reliable.[13] Therefore, it is recommended to carry out longitudinal scans alongside transverse scans in order to accurately evaluate fibre pattern of these lesions to not only rely on the echogenicity of the lesion in transverse scans.

In the following proliferation phase, new collagen fibres are formed and will organise over time resulting in immature scar tissue with increased echogenicity on ultrasound (Fig 2). Moreover, new blood vessels will develop in the normally avascular tendon which can be detected with colour-flow Doppler in a non–weight-bearing limb.[14]

Remodelling and maturation of the tendon by replacement of this immature scar tissue with mature tissue will lead to a homogenous echogenicity and result in a longitudinally aligned fibre pattern long term (Fig 3). Despite their appearance as a grainy, mildly heterogeneous area, scar tissue is difficult to distinguish from mature tendon tissue ultrasonographically.[5] It was shown that sonoelastography could distinguish between five and nine months after injury whereas no difference was found in grey scale ultrasound images.[15] In this technique, compressive forces are applied leading to displacement of tissue. The images before and after compression are compared which gives information regarding tissue stiffness and are displayed as colour coding maps.[16]

Ultrasound examinations should be performed every three months for close monitoring of tendon healing, early recognition of re-injuries and for optimal management throughout the rehabilitation period. Ultrasonographic parameters for horses to return to normal use should be a stable CSA, homogeneous echogenicity and well aligned longitudinal pattern.[17] However, an increase CSA is the most sensitive indicator for fibre damage and therefore is the most useful parameter for detecting re-injury throughout the convalescent period.[18] Alzola and other found that CSA showed good intra and intra rater reliability.[13] Moreover, the development of a simple, repeatable, and reliable scoring system which can be used to document the lesion in a standard fashion which will enable consistent comparisons at different time points as well as eliminating variation between different veterinarians performing follow-up examinations.

Tendinopathies of the SDFT are often the result of exercise induced subclinical microdamage leading to degeneration of the tendon matrix. To evaluate these short-term alterations of the tendon tissue ultrasound tissue characteristic (UTC) analysing echo pattern stability on a computerised basis has been performed.[19] Changes were visible in UTC but not in normal grey scale ultrasound images up to two days after training and returned to normal characteristics at day three after training.[20]

In human medicine, magnetic resonance imaging (MRI) is used alongside ultrasonography for evaluation of Achilles tendinopathies. MRI and ultrasonography showed only moderate agreement with clinical Achilles tendinopathies, but MRI grade was correlated to clinical outcome, which was not found for ultrasonography.[21]
In horses MRI of induced and natural lesions of the SDFT have been performed up to twelve weeks after injury. It was found that, except in T2W images, lesions were smaller in ultrasound than in MRI after 12 weeks.[22–24] Despite these investigations only being short-term the major result was that the difference in signal changes over time did not follow the same pattern as lesions of the deep digital flexor tendon (DDFT) in the hoof region. While in the DDFT lesions a good predictor of healing and return to work is absence of signal in short tau inversion recovery (STIR) sequences[25] in SDFT lesions signal decreases earlier in T2 weighted images compared to STIR images.[22–24] Therefore, data gained from DDFT lesion cannot be transferred to SDFT disease and further research needs still to be carried out.

Grey scale ultrasound to diagnose and monitor SDFT tendinopathies should always be performed in transverse and longitudinal orientation to assess fibre alignment, because echogenicity alone is a less reliable parameter. UTC and elastography are more sensitive and show promising results in recognising subtle changes of the tendon tissue. However, so far, long-term studies are still lacking and the ability of UCT and elastography to predict preclinical matrix changes leading to tendinopathies still needs to be investigated.

What you need to know:

- Tendon injuries are easiest to recognised 7 to 10 days after occurrence.
- Follow-up examinations should be performed every three month and lesion type, lesion and tendon CSA, location, lesion fibre alignment, and echogenicity should be assessed.
- For evaluating tendon healing in the proliferation phase the fibre alignment in longitudinal scans should be performed.
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- Echogenicity of the tendon injury especially in the late stages of tendon healing is a less reliable parameter.

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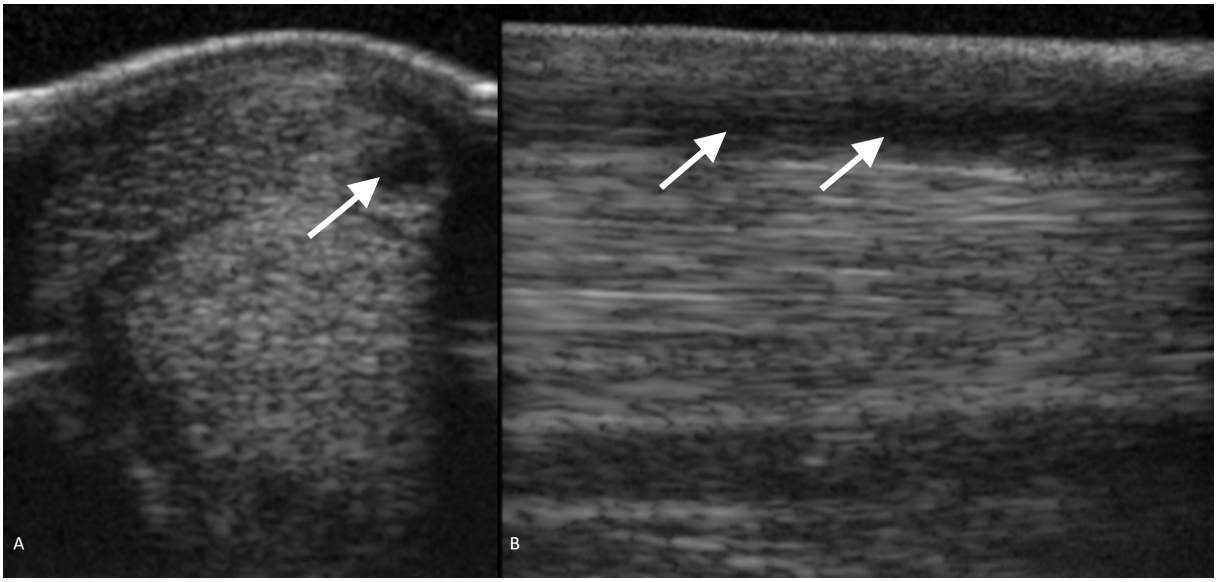

Figure 1:
Transverse (A) and longitudinal (B) ultrasonographic images of the superficial digital flexor tendon of a nine-year old high-level show jumper. The images were acquired seven days after the initial injury occurred. In both planes the lesion is hypoechoic with a complete loss of the fibre pattern (arrows). Medial is to the left (A), proximal is to the left (B).

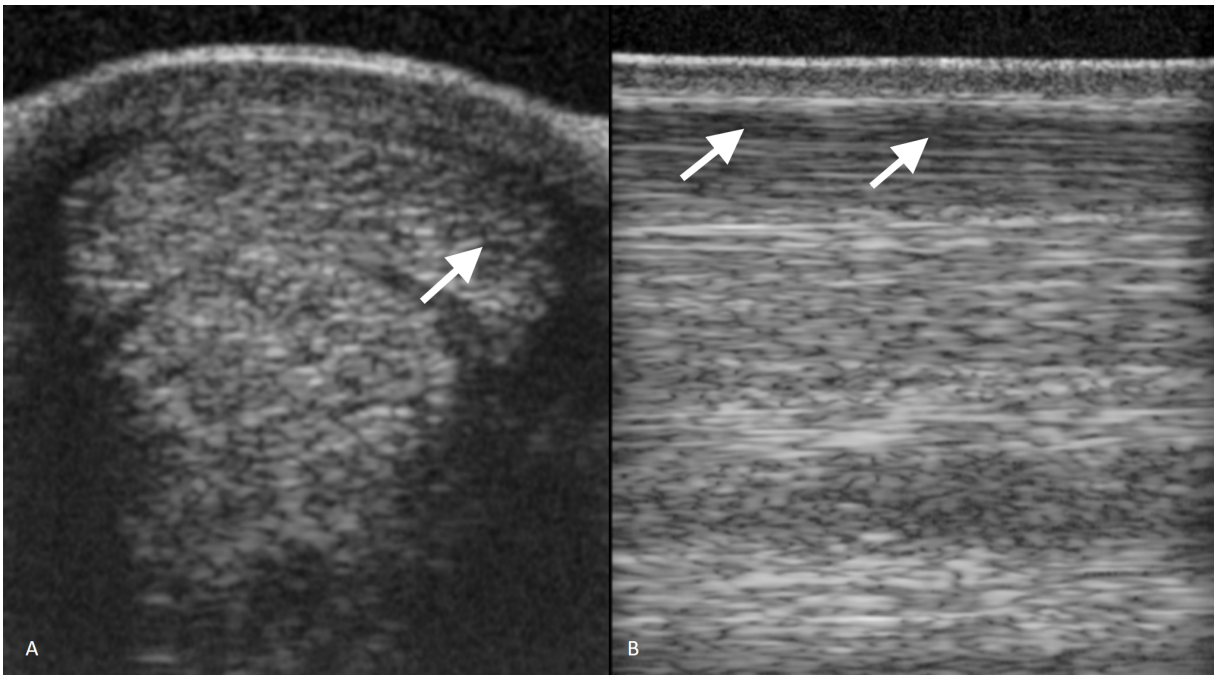

Figure 2:
Transverse (A) and longitudinal (B) ultrasonographic images of the superficial digital flexor tendon of the same horse as in figure 1 six month later. Note that in the transverse image the lesion is isoechoic to the tendon and therefore almost not notable (arrow). In the longitudinal images a mildly loose fibre pattern is still visible (arrows).

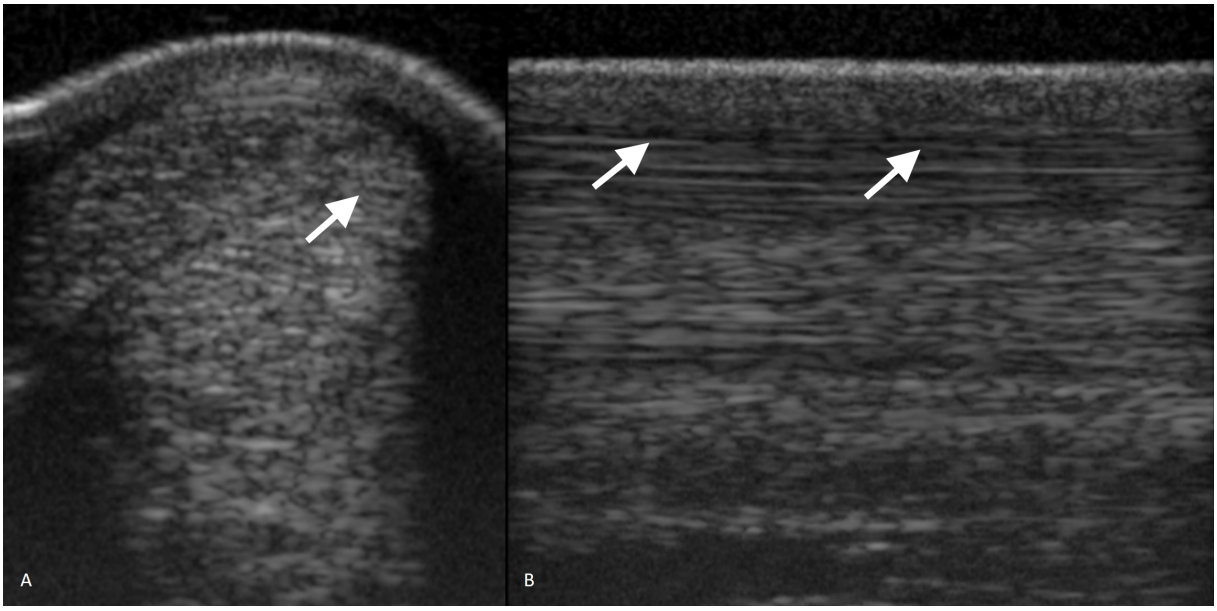

Figure 3:
Transverse (A) and longitudinal (B) ultrasonographic images of the superficial digital flexor tendon of the same horse as in figure 1 six month later. The lesion is no longer distinguishable in both planes. The fibre pattern is now well aligned and the horse returned to previous level of work.