



MONITORING BOWED TENDONS

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Overstrain injuries to the superficial digital flexor tendon (SDFT) are among the most common musculoskeletal injuries for all athletic equine disciplines but account for a significant amount of wastage in the thoroughbred racehorse.

Treatment options for such 'bowed tendons' are many and varied, but all have a couple of things in common: time out of training; expense and no guarantee of success.

It makes sense then, that prevention of injury should always be the goal, and failing that, a method to optimally guide rehabilitation is needed.

Unfortunately, limitations of current imaging diagnostics have restricted their use for accurately monitoring the tendon.

A new ultrasound technology, however, called ultrasound tissue characterisation, may get us one step closer to achieving the goals of injury prevention and optimal rehabilitation.

► What would the ideal tendon imaging modality allow us to do?

- Monitor the effects of exercise on the tendon
- Early detection of overstrain injuries
- Be able to stage the lesion, i.e., determine the level of degenerative change within the tendon structure
- Fine-tune therapy
- Guide rehabilitation

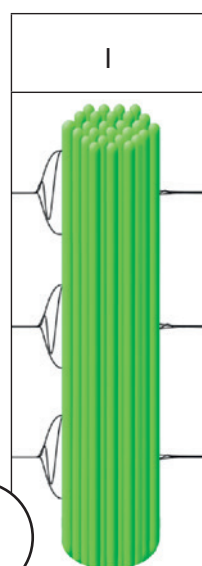


FIG 1



► Why are tendon injuries so tricky?

A normal healthy tendon is made from aligned organised tendon bundles. (Fig 1) Deterioration of this structure ranges on a spectrum from complete disruption (core lesion) to more minor changes, but all affect the ability of the tendon to function optimally.

Degenerative changes within the tendon matrix are not uniform—meaning that not all overstrain injuries to the SDFT are represented

Fig 1: Functionally normal healthy aligned tendon bundles.

by the same level of deterioration or structural change, so there is not a one-size-fits-all pathology or diagnosis, and therefore there cannot be a cure-all treatment.

Most tendon injuries have a sneaky onset with tendon degeneration developing initially without clinical signs, so problems start without you or your horse even knowing about them. Often by the time you realise there is a problem, tendon matrix degradation has already begun.

Staging the structural integrity of the tendon or classifying the extent of structural deterioration present is, therefore, imperative—not only for optimal therapy selection and appropriate rehabilitation guidance but also if prevention of injury is ever to be achieved.

► Why isn't conventional ultrasound enough?

Unfortunately, although conventional ultrasound has historically been used to evaluate equine tendon, limitations have restricted its ability to accurately monitor tendon structure, predict injury or guide rehabilitation.

Clinical improvement is usually not accurately correlated with changes in imaging status using conventional ultrasound, especially in the later stages of healing with conventional ultrasound not demonstrating enough sensitivity to determine the type of tendon tissue under investigation.

So, while regular ultrasound can easily identify the presence of a core lesion when it first appears, by about two months post injury, its capacity to provide information regarding the health of the tendon is limited. Because of its inability to interpret the integrity of the underlying tendon structure accurately, along with inconsistencies in imaging, reliance on operator skills and the inherent lack of ability of a 2D conventional ultrasound image to fully decipher a 3D tendon structure, reliable evaluation and monitoring of the SDFT following the initial acute period is severely restricted.

► What is ultrasound tissue characterisation?

Ultrasound tissue characterisation is a relatively new technique intended to alleviate some of the problems encountered with conventional ultrasound by improving objective tendon characterisation. It does this by providing a 3D reconstruction of the tendon and by classifying and then quantifying tendon tissue into one of four color-coded echo types based on the integrity of the tendon structure.

It can assess in detail the structural integrity of the tendon; it can discriminate a variety of pathological states and is sensitive enough to detect the effect of changing loads on the tendon within days.



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Fig 2: Color-coded ultrasound tissue characterisation echo types represent the stability of echo pattern over contiguous images related to tendon matrix integrity.

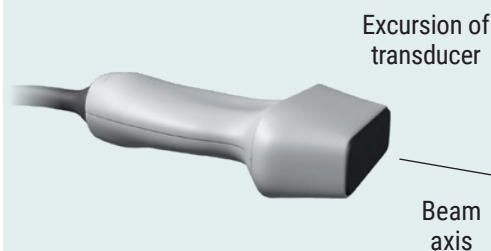


Fig 3: Ultrasound tissue characterisation tracker frame with attached ultrasound probe.

Fig 4: Ultrasound tissue characterisation machine positioned over the SDFT. It is held with gentle steady pressure in this position for the 45 seconds it takes for the probe to move down the tendon and collect images. Horses need to stand still with all 4 limbs fully weight bearing during this time.

FIG 2

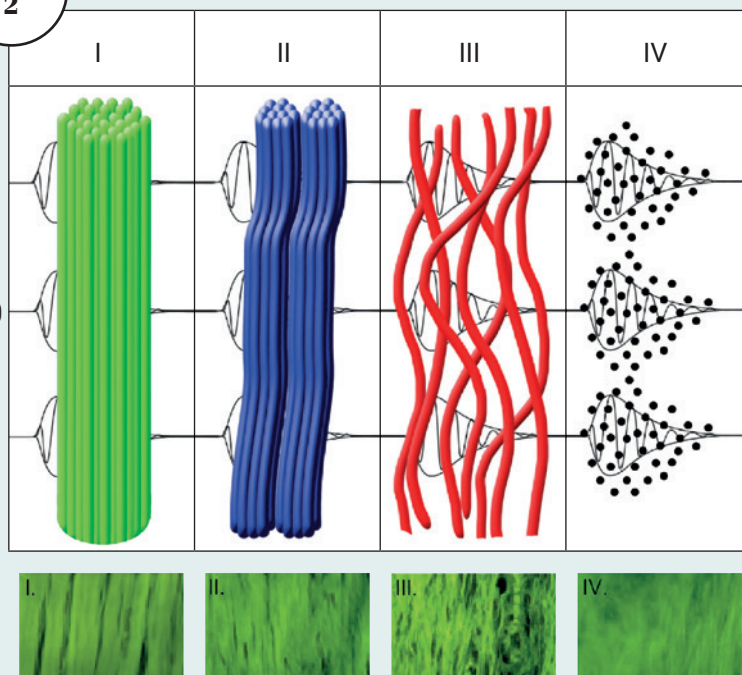


FIG 3



FIG 4



► What do the colors mean? (Fig 2)

Green (type 1 echoes) are normal, well-aligned and organised tendon bundles, and at least 85-90% of this echo type should be found in a healthy tendon (SDFT). Blue (type 2 echoes) are areas of wavy or swollen tendon bundles. They can represent remodelling and adapting tendon or inferior repair. Red (type 3 echoes) represents fibrillar tissue (the smaller basic unit or building block of tendon). This echo type can represent partial rupture of the tendon where they reflect breakdown of normal structure or they can represent initial healing as the tendon begins to rebuild. Black (type 4 echoes) are areas of cells or fluid and represent core lesions where no normal tendon tissue exists.

► How is ultrasound tissue characterisation currently used?

The aim of ultrasound tissue characterisation is not to replace conventional ultrasound but on the contrary, it is recommended to perform an evaluation with both conventional B mode ultrasound and ultrasound tissue characterisation to achieve a complete picture of tendon health.

Currently it is used successfully in elite human athletes such as NBA and soccer players to monitor the health of their tendons (Achilles tendon and patellar tendons) and to guide exercise regimens post injury.

In the equine field, it is used in elite sport horses as part of routine maintenance evaluations to direct exercise, to monitor tendon health and guide rehabilitation following an injury.

► How does it work?

It consists of a standard linear ultrasound probe mounted onto a motorised tracking device (Fig 3). Due to the sensitivity of this equipment, the limbs should be clipped in order to obtain good quality images.

The probe moves non-invasively and automatically down the tendon from top to bottom over a 12-cm scanning distance (Fig 4): As it does so, transverse images are captured at regular distances and stored in real time in a high-capacity laptop for processing. Images are automatically recorded every 0.2 mm to generate a 3D tendon volume made up of 600 images (Fig 5). This precise spatial 'stacking' of images is simply not possible to achieve with conventional ultrasound and is fundamental to the ultrasound tissue characterisation technology. Image acquisition takes approximately 45 seconds.

This tendon volume can subsequently be used for visualisation of the tendon in 3D, for tissue characterisation (to determine the structural composition of the tendon) and for quantification of tendon matrix integrity. (Fig 6)

The color-coded echo types provide objective information regarding the integrity of the tendon matrix and are thought to reflect the underlying tendon health. Ultrasound tissue characterisation can discriminate between healthy normal tendon, adaptive/remodelling tendon and injured/healing tendon—often in cases where conventional ultrasound is unremarkable in appearance. (Fig 7)

The key to this technology is to perform successive evaluations. This allows comparison of differences in tendon structure between scans. Such consecutive examinations, along with clinical data and history, allow veterinarians to determine if a tendon is static, adaptive, healing or degenerating; and this information enables changes in training intensity to be made accordingly. (Fig 8)

► Research

Published research has reported correlation of ultrasound tissue characterisation echo types with histological studies, meaning they correspond to postmortem findings.

Numerous peer-reviewed research studies exist, documenting the ability of ultrasound tissue characterisation to evaluate and monitor tendons both in human and equine athletes.

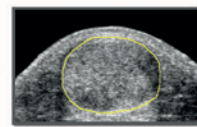
Research has reported ultrasound tissue characterisation to be highly reproducible with the ability to detect subtle changes in tendon structure in response to exercise loads in both human and equine athletes—something not possible utilising conventional imaging modalities.

Two studies specific to the thoroughbred racehorse exist both demonstrating the ability of ultrasound tissue characterisation to monitor changes in tendon structure.

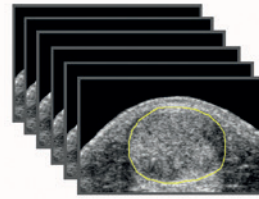
► How can it be used in the racehorse?

It is widely accepted that complete removal of load on tendons post injury is deleterious for tendon health, and the complete removal of exercise is only advocated in the very acute inflammatory phase following a tendon injury. Appropriately progressive loading of the tendon is desired to stimulate remodelling and healing, and this is where ultrasound tissue characterisation may prove to be most useful.

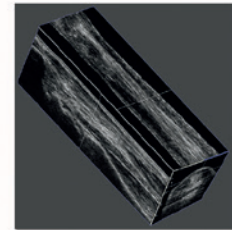
FIG 5



2-D US SCAN
No 3-D Matrix



COMPILATION
600 contiguous images at 0.2 mm



UTC VOLUME
representing 3-D Matrix

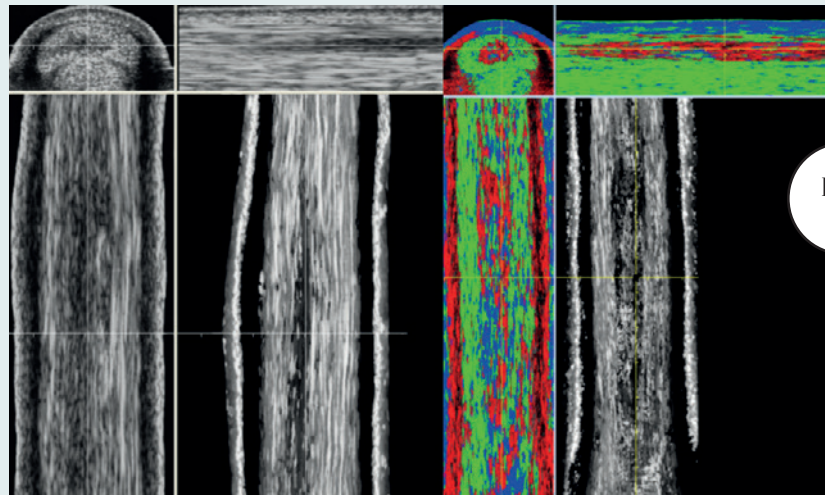


FIG 6

FIG 7

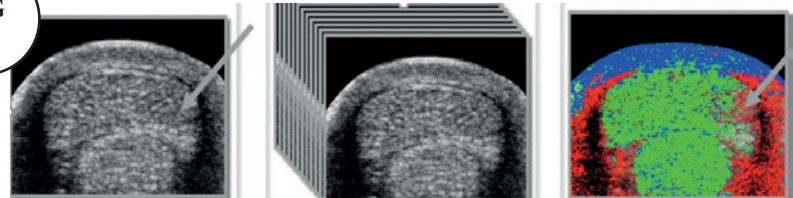
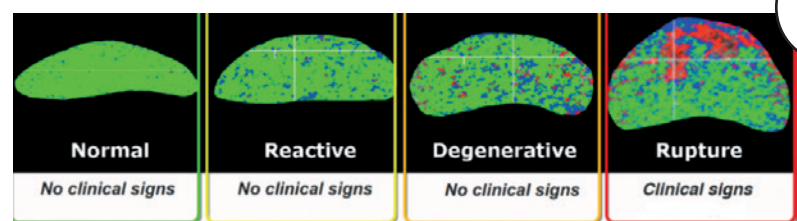


FIG 8



Within 6 months substantial matrix degradation, initially without clinical signs.

Fig 5: Stacking up of regular transverse ultrasound images to create a 3D rendition of the tendon.

Fig 6: Grayscale and colored images of the tendon in transverse, longitudinal, coronal and 3D coronal. To generate the picture in color, the computer classifies and quantifies tendon structure into 1 of 4 color-coded echo types representing structural integrity.

Fig 7: Image on the left shows a conventional grayscale ultrasound image that is unremarkable. Conversely, the image on the right depicts an ultrasound tissue characterisation image of the same tendon and shows an area of suspected injury (see arrow).

Fig 8: Image from a show jumper depicting tendon matrix degradation prior to clinical signs. This information has the potential to provide opportunity for early intervention and a change in exercise level prior to clinical injury. Research is ongoing to validate any predictive capabilities that this technology may have and to develop optimal evaluation programs.

FIG 9

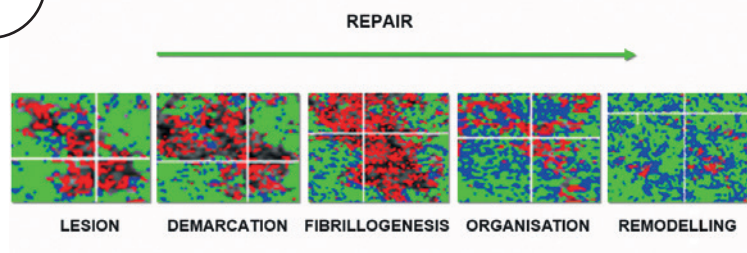


Fig 9: Suggested timeline of repair visualised using ultrasound tissue characterisation. As healing progresses, the proportion of red and black echoes decrease and blue and green increase.

adjust and tailor exercise regimens for the specific needs of the individual tendon and horse, allowing for informed decisions regarding the tendon's capacity for performance. (Fig 9)

► The future: injury prediction?

While the current scientific literature seems to support the use of ultrasound tissue characterisation to guide rehabilitation and monitor the effects of changing loads during training on the tendon, anecdotal accounts from both human and equine clinical practice also report the ability of ultrasound tissue characterisation to warn of impending injury. Although human research is currently

ongoing to definitively confirm this, equine research is needed to determine any predictive capabilities it may have in the thoroughbred racehorse. For now, however, the evidence suggests that ultrasound tissue characterisation can reliably and accurately be used to help guide rehabilitation of injured tendons—in both humans and horses—providing potential for a more successful return from injury. **T**

References

- 1) van Schie HT, Bakker EM, Jonker AM and van Weeren PR. *Efficacy of computerized discrimination between structure-related and non-structure-related echoes in ultrasonographic images for the quantitative evaluation of the structural integrity of superficial digital flexor tendons in horses.* Am J Vet Res 2001; 62(7): 1159-1166.
- 2) van Schie HT, Bakker EM, Cherdchutham W, Jonker AM, van de Lest CH, van Weeren PR. *Monitoring of the repair process of surgically created lesions in equine superficial digital flexor tendons by use of computerized ultrasonography.* Am J Vet Res. 2009; 70(1): 37-48.
- 3) Docking SI, Rosengarten SD, Cook J. *Achilles tendon structure improves on UTC imaging over a 5-month pre-season in elite Australian football players.* Scand J Med Sci Sports. 2016;(26) 557-563.
- 4) Docking SI. *Tendon structure changes after maximal exercise in the Thoroughbred horse: use of ultrasound tissue characterization to detect in vivo tendon response.* Vet J. 2012 Dec;194(3):338-342.
- 5) S. Plevin, J. McLellan, H. van Schie, T. Parkin. *Ultrasound tissue characterization of the superficial digital flexor tendons in juvenile Thoroughbred racehorses during early race training.* Equine Veterinary Journal 2019;51:349-355.
- 6) Jarrod Antflück. *Management of Tendinopathies with Ultrasound Tissue Characterization.* SportEX Medicine 2014;61(July):26-30.

Typically, an exercise regimen post injury follows a generic format using clinical signs and conventional ultrasound as the only methods of assessment. But because most early tendon degradation is silent and conventional ultrasound struggles to decipher the integrity of the tendon unless a lesion is present, it has been traditionally difficult to precisely guide exercise regimens during rehabilitation.

By providing real-time information regarding the integrity of the tendon matrix, ultrasound tissue characterisation, in contrast, allows veterinarians to take advantage of the limited-time window of opportunity that exists for appropriate tendon remodelling after injury. By mapping the ultrastructure of the healing tendon and its remodelling response to exercise at each step in the rehabilitation regimen, it allows optimisation of the most vital tool we have in our rehabilitation arsenal: exercise.

While ultrasound tissue characterisation technology is groundbreaking in its ability to non-invasively evaluate tendon structure and aid in tendon rehabilitation, it must be remembered that once a tendon is injured it will always be inferior to an uninjured tendon. Scar tissue will always be scar tissue. So, while green echoes are the goal (normal and aligned tendon bundles) and represent success for a rehabilitating tendon, they still just represent scar tissue—albeit aligned appropriately and in the best state to combat the strains of training and racing. This technology doesn't remove the risk of reinjury in the bowed tendon, and it doesn't provide information regarding its biochemical makeup. It simply tells us if the tendon is structurally normal; and by doing so, it improves our ability to monitor and guide healing. It provides veterinarians the best opportunity, currently, to

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