# UTC imaging, a novel approach for injury-prevention and monitoring of tendon lesions in the horse

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Lesions of flexor tendons are amongst the most serious orthopaedic disorders in the horse, frequently threatening the animal's athletic career as these tendons play a vital role in locomotor efficiency. During the first phase of the stance stage, they store elastic energy that is subsequently released as kinetic energy, in fact acting as energy saving springs. This biomechanical function is based on a unique architecture with a collagenous matrix hierarchically organised into tendon bundles. This matrix can deteriorate because of gradual degeneration and/or single (partial) ruptures, eventually leading to an impaired function.

Ultrasonography (US) was introduced as a new imaging modality for tendons and ligaments in the early 1980s. US images have the potential, like no other imaging technique, to provide an inward view because they contain reflections of ultrasound waves against structural entities. However, assessment of integrity is essentially subjective and poorly reproducible due to instrumental variables and transducer handling.[1] Furthermore, conventional US is not reliable for the assessment of stages of integrity because, as a consequence of limits of resolution, every US image is a mixture of structural reflections and interfering echoes: only larger structures ($\geq$ 0.38 mm for 10 MHz and $\geq$ 0.45 mm for 7.5 MHz transducers), like tendon bundles, generate reflections, while smaller entities, such as fibrils and cells, will result in interference, each with their specific dynamism in real-time US.[2] The dynamism of echo-patterns over contiguous images is strongly related to 3-dimensional structural integrity, but this phenomenon is not captured in still 2-dimensional US images.[3]

Therefore, a method for "computerised ultrasonographic tissue characterization" (**UTC**) was developed for quantitative evaluation of the structural integrity. Under standardised conditions, with a high-resolution transducer mounted in a motorized tracking-device, transversal images are collected at regular distances of 0.2 mm.[4] These images are stored instantaneously in a laptop computer and subsequently the dynamism of the echo-patterns

is quantified and related to the structural integrity. In this way, 4 different echo-types can be discriminated, namely:

type I, generated by reflections at intact and aligned tendon bundles (colored green in processed images),

type II, generated by reflections at discontinuous or waving tendon bundles (colored blue in processed images,

type III, generated by interfering echoes from mainly fibrillar components (colored red in processed images),

type IV, mainly generated by cellular components and fluid (colored black in processed images).

This ultra-structural information is visualised tomographically in 3 planes of view and in 3-D. The stage of integrity can be quantified by means of the respective ratios of echo-types.[4,5]

UTC has been tested extensively for clinical applications and some relevant observations in these studies are:

A. the ICC (intra-class correlation coefficient) of intra-observer reliability is 0.98 and the inter-observer reliability, both for equine SDF and human Achilles tendon has an ICC over 0.91, [5,6,7]

B. normal flexor tendons of young-mature horses (2-5 years of age) are characterized by 80-90% echo-type I, 10-15% type II and less than 5% type III plus IV echoes,

C. initial deviations from the normal situation over time ("exercise"?, "ageing"?, "degeneration"?), mostly asymptomatic, are characterised by a limited increase of cross-sectional area (< 15%) and increasing percentages of echo-types III and/or IV. These changes may be reversible within 4-12 weeks, most probably as "training-effects", if not they can be seen as early signs of "degeneration" or "developing lesion"

D. during longitudinal monitoring of tendon repair several stages can be discriminated: (a) till 3 weeks post-injury, "extension and demarcation of the lesion" with a rapid decrease of structure-related echo-types I plus II and a sharp

increase of type IV, (b) from week 3 till 8, “fibrillogenesis” with an increase of echo-type III and a decrease of IV, (c) from weeks 9 till 12, “early bundle formation” with a sharp increase of echo-types I and II, and (d) starting from week 13, “organization and remodelling” with continued increase of type I, a gradual decrease of II and with types II and IV tending to normal. These *in vivo* observations were verified with post-mortem histology and biochemistry.[4]

E. the timetable for non-intervened repair described in D. was subsequently used for the quantitative evaluation of interventions such as intra-tendinous injections with platelet-rich plasma (PRP)[6,7] and short-term immobilisation of acute tendon lesions. Monitoring by UTC quantified at all stages significant differences between treatment and placebo groups. At end-stage, these UTC observations corresponded precisely with the ultimate quality of repair as shown by post-mortem histology.[6]

It is concluded that UTC imaging is a novel technique that can visualise and quantify the structural integrity of tendons with high reproducibility. As such, UTC imaging is an excellent tool for injury-prevention, monitoring of repair and objective evaluation of therapies.

**References**

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