By Dr R Aubry

ShearWave Elastography in the assessment of tendon stiffness and for monitoring patients undergoing treatment

Recent developments in ShearWave Elastography have resulted in new applications for the assessment of tendon softening. In this clinical application, the technology is helping clinicians assess and evaluate chronic tendinopathy through the quantification of tendon stiffness, including the confirmation of lower elasticity than in normal tendons. These findings show the potential of ShearWave Elastography to become a standard modality in MusculoSkeletal (MSK) imaging and in the monitoring of patients undergoing new treatment therapies

Tendon injuries can occur in any tendon in the body, and can result from a range of activities, from recreational and professional sports to repetitive motion at work. Tendinopathy is the most common tendon disorder, and is characterized by activity-related pain, tenderness at the site, and decreased strength and movement in the affected area [1]. It should be noted that while tendinopathies are often referred to as "tendinitis" in the clinical context, that term can be a misnomer when the tendinopathy does not exhibit any swelling. [2] Achilles tendinopathy, rotator cuff tendinopathy, patellar tendinopathies, and elbow tendinopathies are among the most prevalent injuries related to tendon overuse.[3]

THE TECHNOLOGY

The investigative work described in the article was carried out using the Aixplorer ultrasound system (SuperSonic Imagine), which can evaluate and quantify tissue stiffness in a broad range of clinical applications in organs such as breast, liver, and thyroid as well as in musculoskeletal applications. Tissue stiffness is used by physicians to help identify and characterize potentially malignant lesions or other pathologies and, in the case of tendons, damaged tissue.

For this work the Aixplorer system was equipped with the SHL20-6 probe, a hockey stick high-frequency transducer, enabling high resolution images of muscles, tendons, ligaments and joints. In addition to this high frequency transducer, a full range of other linear transducers for the Aixplorer is also available for all MSK applications.

Prior to the availability of ShearWave Elastography (SWE), Doppler imaging was frequently used to provide information on tendon morphology and vascularization. Now with SWE it is possible to obtain crucial information about tendon stiffness.

Our initial studies of SWE on tendons were carried out on normal tendons. Tendon stiffness varies as a function of articulation position and tendon stress. Increasing tendon stress will usually result in an increase of stiffness and can contribute to the diagnosis of tendinopathy. In the future, the SWE technique has the potential to assess the efficacy of treatment and to monitor the tendon-healing process and patient follow-up.

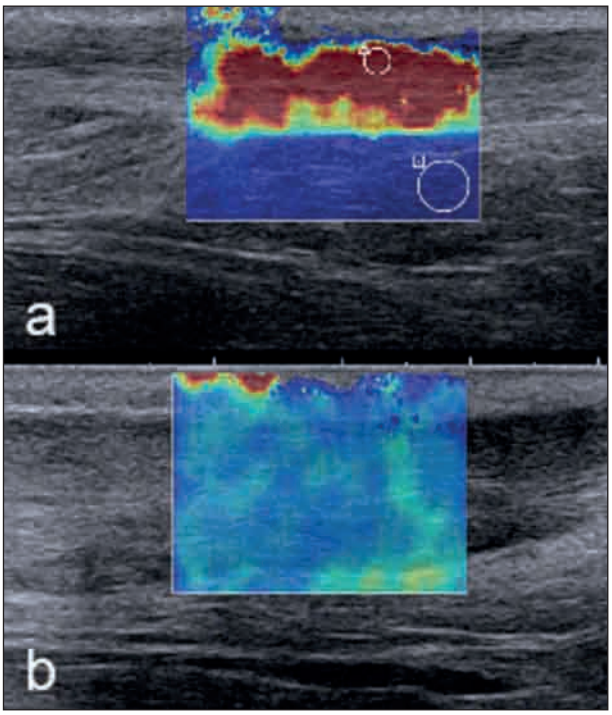

FIGURE 1. a) sagittal SWE image of a normal Achilles tendon. ShearWave velocities reach 16 m.s-1 when the tendon is stretched. b) During achilles tendonopathy, the tendon is softer, ShearWave velocities are lower and the tendon appears blue on the color map.

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TENDON STIFFNESS AS AN INDICATION OF HEALING

An injured tendon is softer than normal tendon [Figure 1]. We can predict that a tendon will recover its viscoelastic properties and become progressively stiffer and harder during the healing process and when it is healed. In the course of our research, we have identified additional, diagnostically significant signs, thus a new symptomatology. [4].

A NEW APPLICATION: COMPLETE VS. PARTIAL TENDON TEAR

ShearWave Elastrography analysis of tendons opens up two major potential approaches that have the potential to have a significant clinical impact.

Firstly, SWE is capable of determining the difference between a complete tendon tear as opposed to a partial tendon tear, including whether a tear is old and where the tendon has a fibrosis scar that is hindering its movement. Before SWE, such an assessment could be difficult. If a tendon is completely torn, tendon stiffness is completely eliminated, which is to say that it will have no stiffness at all because the tension has been released. This is a totally new sign of complete tendon rupture which is significant [Figure 2].

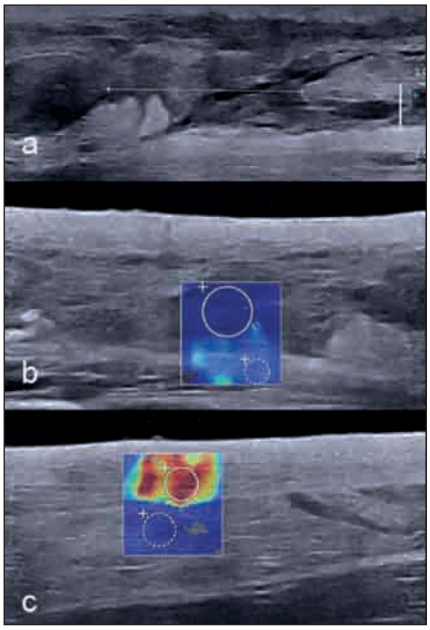

FIGURE 2. a) complete tendon rupture of Achilles tendon at mid-portion (caliper). b) important drop of tendon stump, even during dorsiflexion compared to normal tendon which appears hard when stretched c).

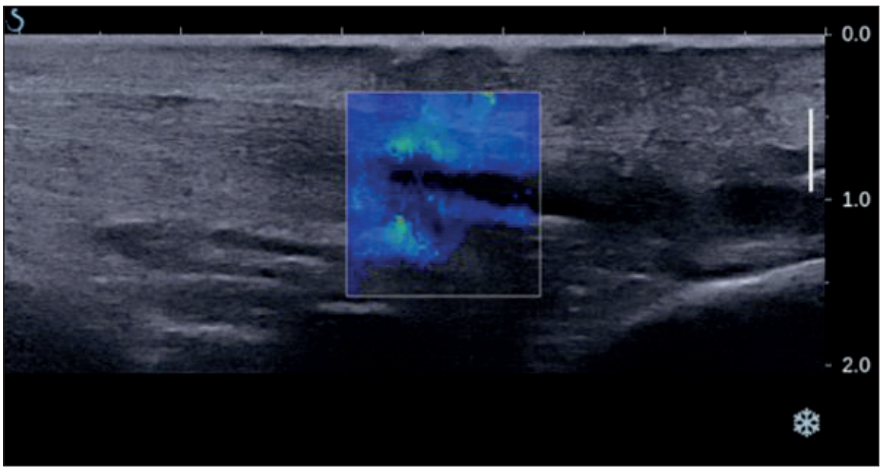

FIGURE 3. Interstitial SWE. Absence of signal consistent with a partial tear of Achilles tendon

Conversely a partial thickness tear in some areas will present an absence of signal and with no loss of tendon stiffness during stress, suggesting that the tear is not complete. SWE evaluation is unique in this regard, since it provides both a visual and quantitative indication [Figure 3].

SWE thus promises to be a new tool for the follow-up of tendons that have been treated with surgery or by other recent therapeutic approaches, such as platelet-rich plasma (PRP) injections, or by new drugs currently under development.

SWE, A RAPID LEARNING CURVE

SWE is an important additional tool in the general MSK unit. Research has demonstrated that the technology has unique capabilities in assessing tendon injuries and monitoring healing and therapies. The relatively rapid learning curve of the Aixplorer adds to its appeal and usability, and is straightforward and intuitive. The new technique is quick to learn and is a valuable addition to the diagnostic exam process.

In general, scanning tendons and muscles is technically more challenging than with soft tissue. Clinicians need to be aware that results vary with tendon tension, and that the orientation of the probe can affect the accuracy of the data. For instance, completely different results can be obtained depending on whether the probe is perpendicular or parallel to the tendon fibers. The device measures ShearWave speeds and it is recommended not to express the results in kilopascal due to the high visco-elastic anisotropy of tendon. That notwithstanding, the unique capabilities of the technology, and of the system in particular, make it highly useful.

LOOKING FORWARD:

Additional research into ShearWave Elastography analysis of muscle tissue is currently underway. Some research effort is being directed towards attempting to detect changes in both tendon and muscle stiffness in patients who have myopathy or are spastic following a stroke. Researchers in this field using SWE are finding the tool to be of increasing value in the management of such patients.

In our unit in Besançon, we have high hopes of our future use of SWE in a variety of MSK clinical applications. Our expectations are that the approach will ultimately not only benefit the patient but also be very cost-effective.

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