Shear Wave Elastography – A Promising Diagnostic Tool For Evaluating Tendon Regeneration In Chronic Tendinopathy

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Introduction: Tendinopathies are a frequent problem amongst athletes, since they can lead to a loss of training time, resultant in poorer performance and, in some cases, even to the end of an athlete’s career. High-level repetitive loads without sufficient regeneration seem to be the main cause for tendinopathies (Magnusson 2010). The most frequently affected tendons are the rotator cuff, the long tendon of the biceps brachii, the wrist extensors, the patellar tendon and the achilles tendon (Reinking 2012).

To date, diagnostic examinations of injured tendons are performed with B-mode ultrasound, Power Doppler and MRI. Recently, increased attention has been paid to the elastic and mechanical characteristics of tendons. Shear wave elastography (SWE) is a new, simple, and reproducible diagnostic tool (Porta 2013) to measure the degree of tissue stiffness by means of an ultrasound examination of elasticity. Therefore, elastography can potentially be used to diagnose tendinopathies at an early stage as well as to monitor its healing process.

Purpose of this prospective study was to evaluate the correlation between the degree of tendon stiffness using elastography and clinical symptoms in achilles and patellar tendinopathies.

Methods: A cross-sectional cohort study was conducted evaluating the correlation between clinical/morphological parameters and shear wave elastography of subjects with patellar tip syndrome and achilles tendinopathy.

Clinical symptoms were determined by means of a VISA-A score and a VISA-P score. The ultrasound examinations of the tendons consisted of SWE, B-mode ultrasound and power Doppler in the longitudinal and axial directions with a high-resolution linear 15 MHz transducer (Aixplorer, Supersonic Imagine, and Aix-en-Provence, France). In all tendons, at least three SWE color maps were acquired of the distal, middle and proximal part of the tendon. A semi-quantitative analysis was performed by analyzing the SWE color maps (homogenously blue = soft, turquoise=intermediate stiffness, yellow-red= high rigidity) (max. 180kPA). In addition, a quantitative, ROI-based analysis of tendon elasticity was performed (Fig.1). The degree of neovascularization was graded according to the Oehberg score (0-4) (Oehberg 2002) and an especially created neovascularization score (0-6). A grading into degree 0 = none to degree 4 = major change was used for morphological changes in the tendon. For all analyses, SPSS 20.0 was used to assess statistical significance, which was defined as p<0.05. Normality was evaluated using the Shapiro-Wilk test. Unifactorial ANOVA was used to check for differences between the parameters and Spearman Correlation was used to assess for significance of correlation.
Results: A total of 144 tendons were included. The results showed a mean value of 1.29 (SD ± 1.23) for the morphology score, of 1.82 (+-1.85) for the Oehberg score, of 1.70 (+- 2.04) for the neovascularization score, a SWEmean of 96.27 (+-58.91) kPa, a SWEmax of 126.75 (+-66.63) kPa and a clinical score of 77.52 (+- 21.55). Comparison of the parameters with the clinical VISA-A and VISA-P score showed a significant correlation coefficient (p < 0.01) with r SWEmax = 0.784, r SWEmean = 0.761, r Morph = 0.67, r Neovasc = 0.58 und r Oehberg = 0.56. Figure 2 shows decreasing stiffness of the tendon accompanied by increasing morphological changes. Furthermore, we found a significant decrease in tendon stiffness accompanied by an increase in the neovascularization score (grade 0: SWEmean = 127.58 (+- 59.93) to grade 6: SWEmean = 33.20 (+- 7.96); p < 0.01) and Oehberg score (grade 0: SWEmean = 128.53 (+- 60.49) and grade 4: SWEmean = 55,54 (+- 29.21); p < 0.01).

Discussion: The standard diagnostic tools for tendinopathy to date are ultrasound (B-mode, power Doppler) and MRI. Ultrasound examination of tendons in experienced hands is regarded as of equal value to MRI, and in some cases even as superior (Scott 2010). However, with ultrasound and MRI both symptomatic and asymptomatic tendons in athletes show changes in tendon diameter, hypoechoic areas, intratendonal defects, calcification and neovascularization. (Shaikh 2012). Porta et al. have shown that shear wave elastography of the patellar tendon is both practical and easily reproducible (Porta 2013). Dewall et al have demonstrated in an ex vivo tear model that SWE can even be used to detect partial tendon tears (Dewall 2014). In the current study, we were able to demonstrate that elastography can be used to diagnose injured tendons. Furthermore, we found a significant correlation between the clinical symptoms presented and shear wave elastography.

Significance: Shear wave elastography can be used as a diagnostic tool in tendon healing. Especially in athletes this new technique might be a valuable tool to determine when they can return back to training and when they should put load on the tendon again.

References:
Reinking M. Tendinopathy in athletes. Phys Ther Sport. 2012 Feb; 13(1) 3-10
Fig. 1: SWE in an injured patellar tendon

Fig. 2: Decrease in SWE accompanied by increasing morphological changes

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