

Reproducibility of a non-invasive ultrasound technique for the assessment of elastic properties of Achilles' tendon, on healthy volunteers: preliminary results

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Background, Motivation and Objective: Musculoskeletal troubles are the main cause of pain and handicap in adults. Among them, tendinopathies are often associated to modifications of mechanical properties, and the clinical knowledge is still too limited. Achilles' tendon (AT) evaluation is made with clinical examination, sometimes completed by ultrasound (US) or magnetic resonance imaging to evaluate the morphology, disease state or mechanical properties; however these techniques are efficient but have a lack of reproducibility. Another technique, the axial transmission technique, consists to measure the speed of sound (SOS) of an ultrasonic impulse to characterize mechanical properties of AT. Several studies have shown the correlation between tendon tension and SOS for equine tendons during load. The purpose of our study was to investigate the repeatability and reproducibility of axial SOS of an ultrasonic impulse within AT of 40 healthy male patients during an isometric contraction of the sural triceps.

Statement of Contribution/Methods: A dedicated US device, consisting in 1 emitter and 20 receivers, was fixed parallel to the AT. Short US impulses were emitted, allowing the propagation of a lateral wave. The time shift between the 20 received signals was measured; the SOS was then calculated. Each subject was first asked to make the strongest isometric contraction; the corresponding torque, called maximum voluntary contraction (MVC), was recorded. Then, each subject had to make another isometric contraction following the pattern: 20% of the MVC during 5s and contracting up to 80% of the MVC during 5s. Torque and US were synchronously recorded during this pattern. Repeatability was evaluated by calculating intraclass correlation coefficient (ICC) between 3 measures. Reproducibility was evaluated by calculating ICC between 2 sets of 3 measures each; the US device was removed and fixed back between each set.

Results/Discussion: We found an excellent repeatability ($ICC > 0.9$) and good reproducibility ($0.65 < ICC < 0.71$) of SOS measures. In conclusion, our device based on axial transmission technique could evaluate mechanical properties of Achilles' tendon with a level of reproducibility compatible with longitudinal tracking. The next step will be to evaluate its sensitivity to TA diseases.

Repeatability		Reproducibility	
Ultrasound parameter	ICC [95% CI]	Ultrasound parameter	ICC [95% CI]
SOS ₂₀	0.989 [0.982 ; 0.994]	SOS ₂₀	0.710 [0.516 ; 0.835]
SOS ₈₀	0.991 [0.985 ; 0.995]	SOS ₈₀	0.654 [0.436 ; 0.800]

Table 1: Repeatability and reproducibility of ultrasound parameters.

ICC: Intraclass Correlation Coefficient; CI: Confidence Interval; SOS₂₀ (resp. SOS₈₀): speed of sound during the initial contraction at 20% MVC (resp. the contraction at 80% MVC); MVC: Maximum Voluntary Contraction.