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OPERATED AND UNINJURED ACHILLES TENDONS SHOW DIFFERENT LOADING PATTERNS: A SHEAR WAVE TENSIOMETRY STUDY

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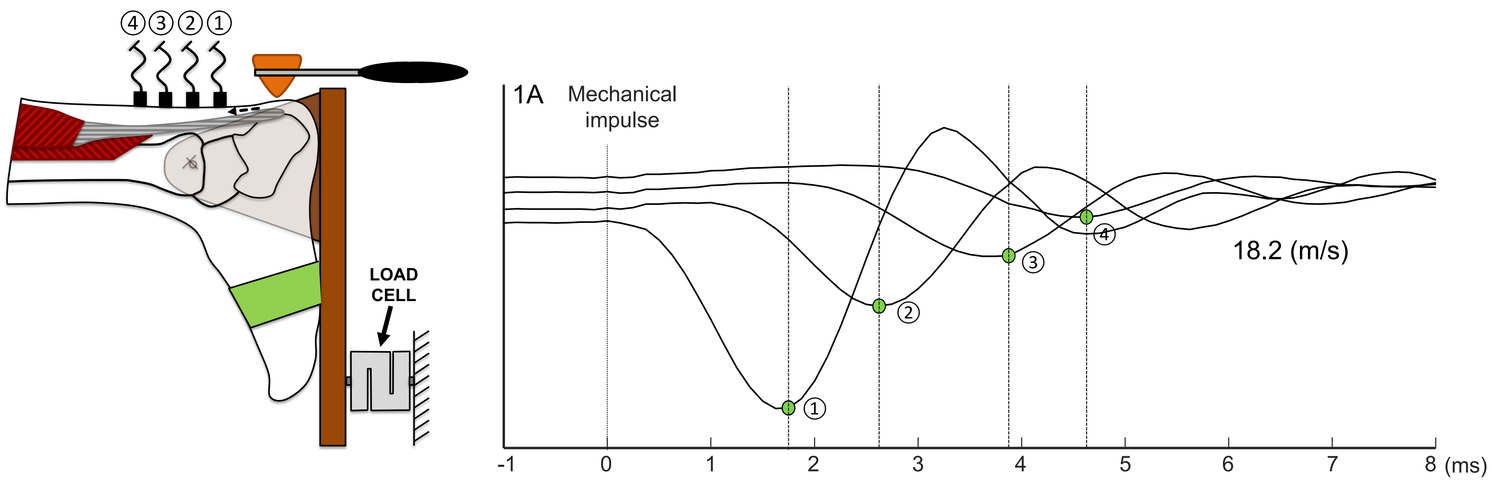
Background and Aim

Shear wave tensiometry is an innovative technology for measuring the speed of propagation of mechanical waves along the tendon. Its capacity to characterize the Achilles tendon (AT) mechanical properties has been confirmed both in vitro and in vivo.[1]
The purpose of this cross-sectional study was to test if shear wave tensiometry is able to detect AT loading changes between a surgically managed AT after rupture and the unaffected contralateral tendon. Our secondary aims were to evaluate differences in mechanical properties when measured with myotonometry and morphological properties of the tendons measured with ultrasound imaging.

Materials and Methods



Schematic of the shear wave tensiometer and shear wave speed signals of the unijured Achilles tendon (1A), and of the operated Achilles tendon (1B). The propagation velocity of the wave was calculated based on the delay between the waves passing from the accelerometers (1-4)

Twenty-one patients with surgically treated Achilles tendon rupture were investigated from 1 to 4 years after surgery.

Clinical features were evaluated using the Achilles tendon total rupture score (ATRS).

Tendon load was measured using a shear wave tensiometer composed of an array of four accelerometers fixed on the tendon. Shear wave speed along the Achilles tendon was evaluated at different ankle torque for both the operated and the unaffected side.

Stiffness of the tendons were evaluated using MyotonPRO in two different regions of the free tendon (distal part: at 3cm; proximal part: at 6cm from the calcaneal insertion).

Morphological properties (thickness and cross sectional area) were evaluated using ultrasound imaging. Thickness images were acquired using a longitudinal scan from 2-7cm from the calcaneal insertion while CSA images were acquired using a transverse scan at 3 and 6cm from the calcaneal insertion.

Non-parametric related-sample Friedman test was used to assess AT difference between tendons, for all the variables.

Results

Participants had a mean age of 47.3±14.2 years and the mean time from surgery was 20.3±8.1 months (range 12-37) ATRS showed a mean score of 88 ±14.7 with the lowest value of 40 and the highest value of 100.

SWS	0 (Nm)		17.5 (Nm)		35 (Nm)	
	H	OP	H	OP	H	OP
Median (m/s)	13.30	18.21	28.85	38.06	41.30	47.48
IQR	3.28	4.91	7.86	5.19	9.14	10.10
p	**<0,001**		**<0,001**		**0,016**	
effect size	0.80		0.70		0.30	
Ultrasound	Thickness (mm)		CSA distal part (mm2)		CSA prox. part (mm2)	
	H	OP	H	OP	H	OP
Median	5.15	13.2	62.4	176	56.1	196
IQR	1.46	2.2	7.3	40	9.1	43
p	**<0.001**		**<0.001**		**<0.001**	
Stiffness	Inferior		Superior			
	H	OP	H	OP		
Median (N/m)	813	919	838	844		
IQR	124	61.5	119	73.25		
p	**0,007**		**0,025**			

*Table showing the difference between unijured (H) and operated (OP) Achilles tendon for the different outcomes. Shear wave speed (SWS) was measured at different ankle torque. S*tatistical significance was set to p<0.05. Effect size was calculated using the Kendall's W, with 0.2, 0.5 and 0.8 representing small medium and large effect respectively

Conclusions

Shear wave tensiometry can precisely detect differences between operated and unaffected AT during astandardized loading procedure. The shear wave speed along the operated tendon, as well as the mechanical and morphological properties, remains higher in the long-term after a rupture.

This study represents the first step towards the implementation of shear wave tensiometry in clinical settings in order to monitor the evolution of the mechanical properties of the AT over time for patients affected by AT rupture and other tendon pathologies.

This study is in press on Foot and Ankle International.

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REFERENCE:

1. Martin JA, Brandon SCE, Keuler EM, Hermus JR, Ehlers AC, Segalman DJ, et al. Gauging force by tapping tendons. Nat Commun. 2018;9(1):1592

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