Non-rigid speckle tracking exploratory study for tendinopathy signaling in symptomatic subjects

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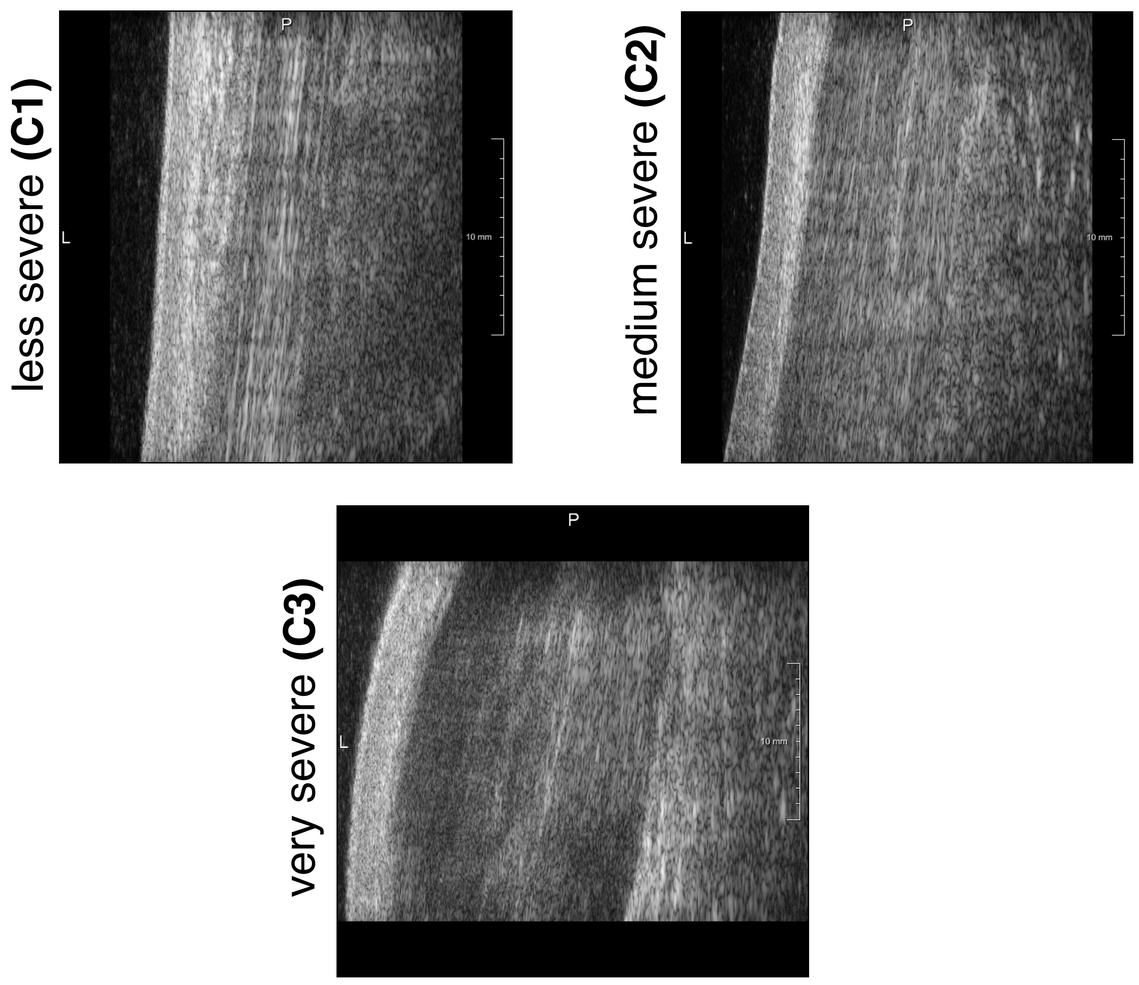
Tendinopathies are one of the most common musculo-skeletal injuries affecting both professional and recreational athletes. Knowledge on tendon biomechanics is scarce and limited to some studies regarding global strain and local tissue deformation estimates in healthy subjects.

The objective of this study is to investigate differences in the biomechanical behavior at the level of local tissue deformation between asymptomatic and symptomatic subjects.

High-frequency dynamic (2D+t) US

Images from 10 asymptomatic (C0) and 8 symptomatic subjects were acquired during maximal isometric contraction. Symptomatic subjects where classified based on clinical interpretation of symptoms and morphological appearance on US in three groups:

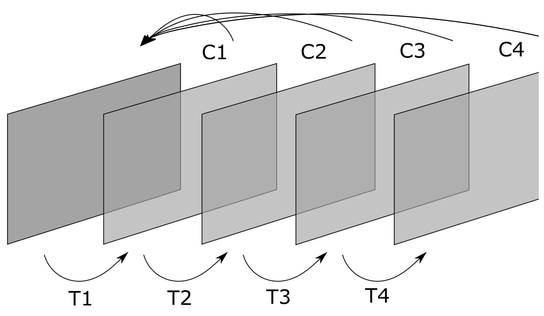


Tissue motion estimator

Tissue displacement was estimated using a pair-wise b-spline image registration approach.

Tissue motion estimator[1,2]
B-mode Image registration
B-spline transformation
Sum of squared difference metric
Quasi-Newton L-BFGS optimizer
Multi-resolution (3 resolutions)

Registration strategy



Results: biomarker selection

Mean tissue displacement for each subject was evaluated by averaging the tissue displacement of superior (Δsup), middle (Δmed) and deep (Δdeep) layers of the tendon. Proximal (Δprox) and distal (Δdist) tissue displacement was also computed.

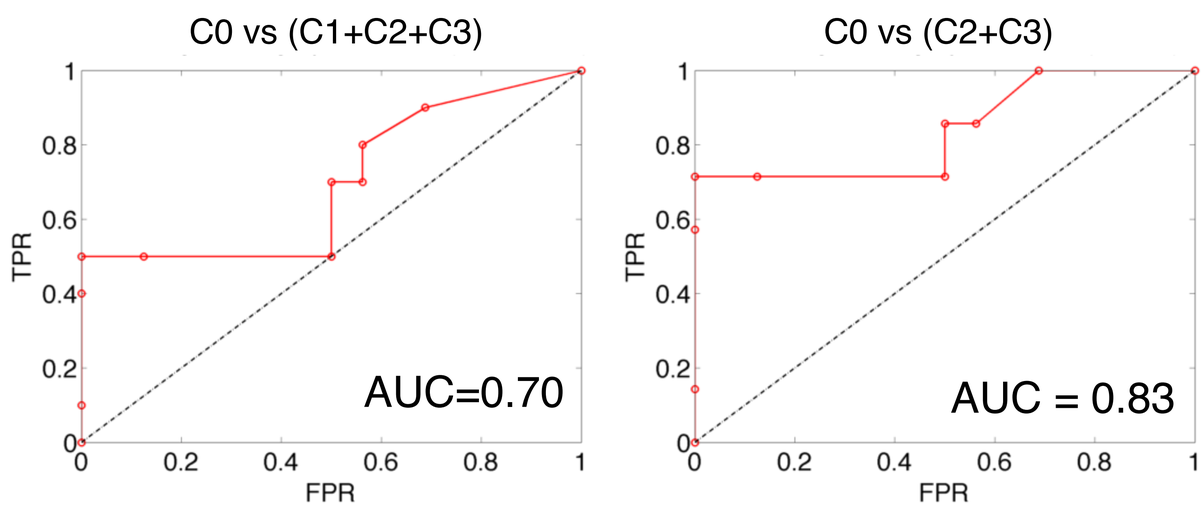
Mixed model analysis for class discrimination

Repetition of the measurement per leg, torque and class were used as fixed variables. Tissue displacement in the superficial, middle and deep layers, as well as proximal and distal regions, were the response variables with the subject being defined as a random intercept variable.

Hypothesis test for mixed model fixed effects

	ΔProx	Δdist	Δsup	Δmed	Δdeep
C0vsC1	0.2873	0.3149	0.3062	0.3029	0.3041
C0vsC2	0.0002	0.0008	0.0001	0.0004	0.0016
C0vsC3	0.0001	0.0002	0.0001	0.0001	0.0009
C1vsC2	0.0813	0.1365	0.0583	0.1019	0.1799
C1vsC3	0.014	0.0213	0.0048	0.0163	0.0497
C2vsC3	0.2735	0.2411	0.1715	0.2538	0.3558

ROC analysis



Conclusion and future work

Presentation, for the first time, of preliminary results for local biomechanical discrimination between more severe tendinopathy cases and asymptomatic cases.

As future work, the size of the dataset should be increased and the differences between C0 and C1 subjects should be investigated.

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References
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[2] D.P. Shamonin *et al.* Frontiers in Neuroinformatics, **2014**, 7, 50, pp. 1-15