RELATED DEFICITS IN TENDON STIFFNESS AND ANKLE MOBILITY AFTER ACHILLES TENDON RUPTURE

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Introduction

The Achilles tendon is one of the largest and strongest in the body, yet is most prone to unilateral spontaneous rupture. This injury dramatically changes the tissue's composition, which has a significant effect on its mechanical behavior [Voleti, 2006] and presumably on ankle joint function. The relationship between tendon stiffness and post-rupture ankle function may be an indicator of tissue regenerative status, but has yet to be determined in humans. We hypothesize that subjects with higher asymmetries in tendon stiffness will demonstrate similarly higher asymmetries in ankle mobility during gait.

Methods

Sixteen subjects (3 female, 13 male, Age: 45.4±13) were recruited 2-5 years following percutaneous surgery of an Achilles tendon rupture (SM). Achilles Tendon Rupture Scores (ATRS) were recorded for each patient.

Kinematic data of the lower limbs were collected (*f*=120Hz) using a set of 22 reflective markers and 10 infrared cameras (VICON, Oxford, UK) for a minimum of five barefoot walking trials at a self-selected speed. ISB-recommended conventions were used to determine ankle angles [Wu, 2003].

Elastic properties of the Achilles tendon (elongation, strain, and stiffness) were determined using both dynamometry to record the ankle moment (Biodex, NY, USA) and ultrasonography to determine the displacement of the musculo-tendinous junction during five maximal voluntary plantarflexion efforts [Arampatzis, 2006].

Relative asymmetry was found by taking the ratio of injured to contralateral parameters. Pearson's 1-tailed test was used for correlations. All data were processed in MATLAB (Mathworks, MA, USA) and statistical analysis in SPSS (IBM, NY, USA).

Results

Clinical scores showed high patient satisfaction (ATRS=86±11) 2-5 years post-OP. Ankle range of motion (ROM) was limited on the injured side in the flexion-extension (30.3˚ vs. 33.0˚, p <0.05) axis. Tendon stiffness was significantly higher in the injured side compared to the contralateral side (207.9 vs. 94.7 N/m, p<0.05). Tendon elongation (10.1 vs. 17.0 mm) and strain (4.8 vs. 8.7%) were lower on the injured tendon (both p<0.05). Correlation of the kinematic versus stiffness asymmetries yielded a negative correlation of -0.0623 with r=0.62 and p=0.005 (Figure 1).

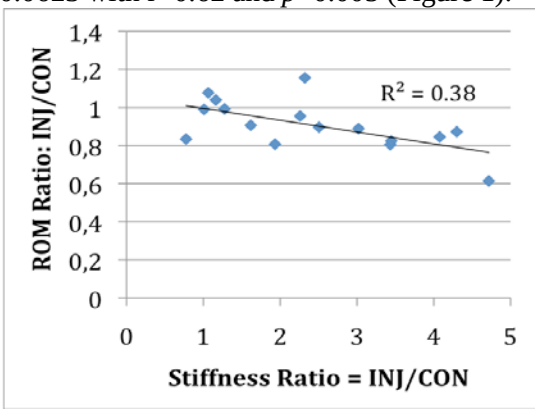

Figure 1: Comparison of the ratio of injured (INJ) to contralateral (CON) ankle range of motion (ROM) in the flexion-extension axis versus the ratio of INJ to CON tendon stiffness.

Discussion

This study shows that even after 2-5 years after tendon rupture, significant functional deficits were present in all patients. Additionally, these were mirrored by a lack of tissue elasticity on the affected side. All of these deficits were not evident in the clinical evaluation of the patients. This discrepancy suggests that patient-reported scores may not be indicative of the biomechanical status of the ankle joint and healed Achilles tendon. The combination of these biomechanical tests could be implemented to more precisely evaluate the relative efficacy and efficiency of various tissue engineering and regenerative therapies.

References

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Voleti *et al*. Annu Rev Biomed Eng 14:47–71, 2012.
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