Achilles tendon (3D): Do the mechanical properties of tendon change in response to exercise?

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Introduction: The elastic properties of the Achilles tendon are crucial for efficient generation of power in locomotor tasks. The Achilles tendon is exposed to high, repetitive strains during tasks like running which makes it highly susceptible to injury. Cyclic loading of the Achilles tendon is known to induce tendon creep, which represents a change to material properties of the tendon. Recent experimental measures suggest that the Achilles tendon shows little or no creep after repetitive loading exercise such as hopping and running. These previous measures have not taken into account the complex three-dimensional shape of the Achilles tendon and have largely ignored the potential changes in elasticity of the free Achilles tendon (distal tendon insertion to soleus muscle-tendon junction). We hypothesised that the free Achilles tendon would experience similar strains to the whole tendon under load and that the tendon would increase in slack length and compliance with exercise.

Methodology: Freehand three dimensional (3D) ultrasound was used to examine the structure of tendon when slack and during force production. We examined this both before and after 20 min of moderate intensity running in young adults (18–35 years, n = 11). By analysing the strain of the tendon during force development, we quantified the slack length and stiffness of the free Achilles tendon and the whole Achilles tendon (distal tendon insertion to the gastrocnemius muscle-tendon junction) as well other structural measures (e.g. tendon cross sectional area).

Results and discussion: Contrary to our hypothesis, the strain of the free tendon was found to be greater than that of the whole tendon at moderate force levels of 50% maximum voluntary contraction ($P < 0.05$). Our initial results suggest that the mechanical and structural properties of the Achilles tendon are relatively robust in response to the moderate running exercise performed. While we found small increases in slack length of both the free Achilles tendon and the whole Achilles tendon, this was not statistically significant ($P = 0.21$). This may be due to the variability in the insertion site for length measurement with changes in the strain at the lateral and medial borders of the muscle with contraction. Further work is required to standardise these measurements in 3D.