

The Acute Effects of Higher Versus Lower Load Duration and Intensity on Morphological and Mechanical Properties of the Healthy Achilles Tendon: A Randomized Crossover Trial

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Abstract : The Achilles tendon (AT) exhibits volume changes related to fluid flow under acute load which may be linked to changes in stiffness. Fluid flow provides a mechanical signal for cellular activity and may be one mechanism that facilitates tendon adaptation. This study aimed to investigate whether isometric intervention involving a high level of load duration and intensity could maximize the immediate reduction in AT volume and stiffness compared to interventions involving a lower level of load duration and intensity. Sixteen healthy participants (12 males, 4 females; age= 24.4 ± 9.4 years; body mass= 70.9 ± 16.1 kg; height= 1.7 ± 0.1 m) performed three isometric interventions of varying levels of load duration (2 s and 8 s) and intensity (35% and 75% maximal voluntary isometric contraction) over a 3 week period. Freehand 3D ultrasound was used to measure free AT volume (at rest) and length (at 35%, 55%, and 75% of maximum plantarflexion force) pre- and post-interventions. The slope of the force-elongation curve over these force levels represented individual stiffness (N/mm). Large reductions in free AT volume and stiffness resulted in response to long-duration high-intensity loading whilst less reduction was produced with a lower load intensity. In contrast, no change in free AT volume and a small increase in AT stiffness occurred with lower load duration. These findings suggest that the applied load on the AT must be heavy and sustained for a long duration to maximize immediate volume reduction, which might be an acute response that enables optimal long-term tendon adaptation via mechanotransduction pathways.

Keywords : Achilles tendon, volume, stiffness, free tendon, 3d ultrasound

Conference Title : ICHKSPB 2023 : International Conference on Human Kinetics, Sports Physiotherapy and Biomechanics

Conference Location : Amsterdam, Netherlands

Conference Dates : November 06-07, 2023