Achilles tendon mechanosensitivity is preserved in old age: In vivo evidence from a 1.5 years long resistance training intervention

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Introduction

Ageing deteriorates musculoskeletal system structure and function and limits its adaptability to mechanical loading. Medium-term (12-14 weeks) exercise interventions in older adults have been shown to increase tendon stiffness by increasing the tendon's Young's modulus [1], rather than the tendon's cross-sectional area (CSA). However, little is known about the time-adaptive response relationship of the tendon in long-term (years) interventions involving alteration in mechanical loading. Therefore, we investigated whether the older human Achilles tendon (AT) demonstrates mechanosensitivity and alterations in material and/or size in response to long-term mechanical loading.

Methods

Thirty-four older female adults (age: 65±7 y) were recruited to a medium-term (14 weeks; n=21) strength training intervention with high AT strain cyclic loading (five sets of four repetitions of isometric plantarflexion contractions 3 times a week with 90% of MVC as in [2]) or a control group (n=13), with a sub-group of the intervention group (n=12) continuing exercise for 1.5 years. AT stiffness and Young's modulus were quantified in vivo using ultrasonography and dynamometry. Tendon CSA was measured along the whole free AT by means of magnetic resonance imaging.

Results

Following 14 weeks of resistance training, the intervention group showed a significant (p<.05) increase in ankle plantarflexor muscle strength (141.5±36.2 vs 116.3±30.8 Nm at baseline), along with a 23% increase in AT stiffness (598.2±141.2 Nmm^{-1} vs 488.4±136.9 Nmm^{-1} at baseline), 20% increase in Young's modulus (1.63±0.46 GPa vs 1.37±0.39 GPa at baseline) and a homogenous hypertrophy by about 6% along the entire free AT. However, continuing the exercise training for 1.5 years did not cause any further changes in muscle strength and tendon properties. The control group did not show any differences in muscle and tendon functional and structural properties between time points.

Discussion

The AT seems to have the capability to increase its stiffness in response to 14 weeks of mechanical loading exercise by altering both its material and size, and may thereby tolerate higher mechanical loading by reducing both the strain and stress it experiences during tensile loading. Continuing strength training appears to maintain, but not cause any further adaptive changes in tendons, which implies that the time-adaptive response relationship to mechanical loading is non-linear in ageing tendons.

References

1. Reeves et al. (2003). *J Physiol*, 548, 971–981.

2. Arampatzis et al. (2007). *J Exp Biol*, 210, 2743–2753.