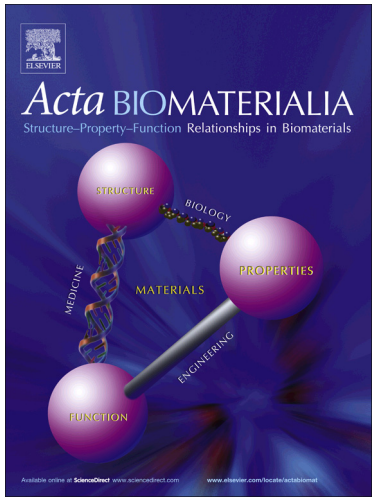

Full length article

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Effects of maturation and advanced glycation on tensile mechanics of collagen fibrils from rat tail and Achilles tendons

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Abstract
Connective tissues are ubiquitous throughout the body and consequently affect the function of many organs. In load bearing connective tissues like tendon, the mechanical functionality is provided almost exclusively by collagen fibrils that in turn are stabilized by covalent cross-links. Functionally distinct tendons display different cross-link patterns, which also change with maturation, but these differences have not been studied in detail at the fibril level. In the present study, a custom built nanomechanical test platform was designed and fabricated to measure tensile mechanics of individual fibrils from rat tendons. The influence of animal maturity (4 vs. 16 week old rats) and functionally different tendons (tail vs. Achilles tendons) were examined. Additionally the effect of methylglyoxal (MG) treatment in vitro to form advanced glycation end products (AGEs) was investigated. Age and tissue type had no significant effect on fibril mechanics, but MG treatment increased strength and stiffness without inducing brittleness and gave rise to a distinct three-phase mechanical response corroborating that previously reported in human patellar tendon fibrils. That age and tissue had little mechanical effect, tentatively suggest that variations in enzymatic cross-links may play a minor role after initial tissue formation.

Statement of significance:
Tendons are connective tissues that connect muscle to bone and carry some of the greatest mechanical loads in the body, which makes them common sites of injury. A tendon is essentially a biological rope formed by thin strands called fibrils made of the protein collagen. Tendon function relies on the strength of these fibrils, which in turn depends on naturally occurring cross-links between collagen molecules, but the mechanical influence of these cross-links have not been measured before. It is believed that beneficial cross-linking occurs with maturation while additional cross-linking with aging may lead to brittleness, but this study provides evidence that maturation has little effect on mechanical function and that age-related cross-linking does not result in brittle collagen fibrils.

Keywords: AGE; cross-link; methylglyoxal; optical marker; pyridinoline.