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POS-68 Stress Relaxation Mechanism of Single Collagen Fibrils and Relaxation Induced Morphological Changes (G)

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The collagen fibrils are the main building block of connective tissues in mammals where they fulfill both structural and mechanical roles. The structure of a fibril is based on collagen molecules that self-assemble into micro-fibrils and sub-fibrils stabilized by hydrogen bonds and covalent crosslinks. The non-integer staggering of collagen molecules results in a characteristic D-band pattern along the fibril with a periodicity of 67nm. Besides this natural variation, localized damaged sites have been observed along the length of mechanically overloaded fibrils [1], which suggests the inherent existence of structural inhomogeneity along collagen fibrils. To explore this further we are using an atomic force microscopy (AFM)-based manipulation technique that allows us to perform tensile tests on a single fibril in bowstring geometry [2]. In this work, we are investigating the potential impact of structural inhomogeneity on the viscoelastic properties of single fibrils. Fibrils were extracted from bovine extensor tendons, around 50 microns long segments were isolated (n=20), imaged with AFM before manipulation and then stretched to the range of strain between 5% and 20%, held at that strain for 150 seconds(n=13), 1 second (n=3), and 1500 seconds(n=3) then released. There was also one fibril that has been pulled and released very slowly in controlled way for comparison. Comparison between AFM image of the manipulated fibrils and pre-manipulated fibrils demonstrated height fluctuations occurring along the fibril length in the micrometer range. We propose that the inherent structural heterogeneity along the length of the fibril becomes a prominent feature after stress relaxation providing a new mechanism for probing morphological changes in fibril level after stress relaxation.

[1] Veres, S.P. and Lee, J.M. Biophys. J. 2012, 102: 2876-2884.
[2] Quigley, A. S. et al. PLoS One. 2016, 11: e0161951.

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