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A micro-mechanical model to determine changes of collagen fibrils under cyclic loading MICHELLE L CHEN, Johns Hopkins University, MONICA E. SUSILO, JEFFREY A. RUBERTI, Northeastern University, THAO D. NGUYEN, Johns Hopkins University — Dynamic mechanical loading induces growth and remodeling in biological tissues. It can alter the degradation rate and intrinsic mechanical properties of collagen through cellular activity. Experiments showed that repeated cyclic loading of a dense collagen fibril substrate increased collagen stiffness and strength, lengthened the substrate, but did not significantly change the fibril areal fraction or fibril anisotropy (Susilo, et al. Collagen Network Hardening Following Cyclic Tensile Loading, Interface Focus, submitted). We developed a model for the collagen fibril substrate (Tonge, et al. A micromechanical modeling study of the mechanical stabilization of enzymatic degradation of collagen tissues, Biophys J, in press.) to probe whether changes in the fibril morphology and mechanical properties can explain the tissue-level properties observed during cyclic loading. The fibrils were modeled as a continuous distribution of wavy elastica, based on experimental measurements of fibril density and collagen anisotropy, and can experience damage after a critical stress threshold. Other mechanical properties in the model were fit to the stress response measured before and after the extended cyclic loading to determine changes in the strength and stiffness of collagen fibrils.

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