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SUPRA-PHYSIOLOGICAL LOADING OF FIBROUS SOFT TISSUES: MULTI-SCALE MECHANICS AND CONSTITUTIVE MODELING

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Hypoplastic left heart syndrome (HLHS) is a severe problem in a fetus where the growth of the left part of the heart has been stunted. If left untreated, more than 95% of infants with HLHS cannot survive after the first four weeks of life. A high possibility for babies to be born with healthy hearts can be reached by fetal intervention. Under such surgery, tissues on both mother and fetus undergo large range of deformations and demonstrate distinct inelastic effects. Deep understanding of the mechanical response of fibrous soft tissues is therefore essential to ensure the safety for the unborn fetus and its mother. The objective of our research is to develop a multi-scale constitutive model capturing macroscopic inelastic effects in soft tissues (stress softening, hysteresis and permanent deformation) based on micro-damage at lower length scale levels.

In the current contribution, a nano-to-micro model of a single collagen fiber is developed by taking into account the entropic-energetic transition at collagen molecule level [1, 2]. The microscopic damage inside the collagen fiber is elucidated by yielding of overlapping segments of proteoglycan bridges and is included in a statistical mechanical framework. The predictions of this one-constituent-damage-model are comparable to experimental data available in the literature.

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