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A Constitutive Model of Ligaments and Tendons Accounting for Fiber-Matrix Interaction

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Abstract : In this study, a new constitutive model is developed to describe the hyperelastic behavior of collagenous tissues with a parallel arrangement of collagen fibers such as ligaments and tendons. The model is formulated using a continuum approach incorporating the structural changes of the main tissue components: collagen fibers, proteoglycan-rich matrix and fiber-matrix interaction. The mechanical contribution of the interaction between the fibers and the matrix is simply expressed by a coupling term. The structural change of the collagen fibers is incorporated in the constitutive model to describe the activation of the fibers under tissue straining. Finally, the constitutive model can easily describe the stress-stretch nonlinearity which occurs when a ligament/tendon is axially stretched. This study shows that the interaction between the fibers and the matrix contributes to the mechanical tissue response. Therefore, the model may lead to a better understanding of the physiological mechanisms of ligaments and tendons under axial loading.

Keywords : constitutive model, fiber-matrix, hyperelasticity, interaction, ligament, tendon
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