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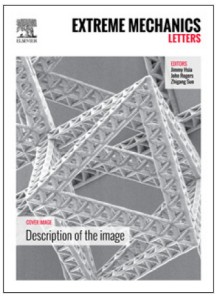

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Full-Volume Displacement Mapping of Anterior Cruciate Ligament Bundles with dualMRI

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Abstract

Full-field displacement measurement techniques can be used for more accurate, comprehensive constitutive characterization of biological materials than traditional mechanical testing methods. In this study, displacements under applied loading by magnetic resonance imaging (dualMRI) was used to produce full-volume displacement maps of six anteromedial (AM) and posterolateral (PL) bundles of ovine anterior cruciate ligaments (ACLs) pulled in the mean fiber direction at four force levels. The Lagrange strain fields computed from these displacement fields show large transverse strains as well as large and inhomogeneous shear strains. Mean volumetric strains were positive and large. These results suggest that the ACL bundles are not incompressible as previously assumed, and that homogeneous uniaxial tension was not achieved. Constitutive characterization of highly anisotropic materials like the ACL should reevaluate the appropriateness of these traditional assumptions and ensure that mechanical property measurements are independent of specimen geometry.

Keywords: ACL · ligament · biomechanics · full-field · full-volume · deformation · elastography

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