

## Accepted Manuscript

Full-volume displacement mapping of anterior cruciate ligament bundles with dualMRI

Callan M. Luetkemeyer, Luyao Cai, Corey P. Neu, Ellen M. Arruda

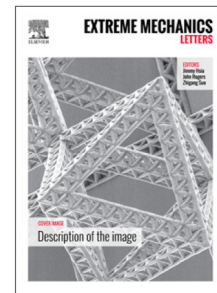
PII: S2352-4316(17)30170-0  
DOI: <https://doi.org/10.1016/j.eml.2017.12.004>  
Reference: EML 333

To appear in: *Extreme Mechanics Letters*

Received date: 16 October 2017  
Revised date: 4 December 2017  
Accepted date: 9 December 2017

Please cite this article as: C.M. Luetkemeyer, L. Cai, C.P. Neu, E.M. Arruda, Full-volume displacement mapping of anterior cruciate ligament bundles with dualMRI, *Extreme Mechanics Letters* (2017), <https://doi.org/10.1016/j.eml.2017.12.004>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



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

Callan M. Luetkemeyer<sup>a</sup>, Luyao Cai<sup>b</sup>, Corey P. Neu<sup>c</sup>, Ellen M. Arruda<sup>a,d,e</sup>

<sup>a</sup>Department of Mechanical Engineering, University of Michigan, Ann Arbor, MI, USA

<sup>b</sup>Department of Biomedical Engineering, Purdue University, West Lafayette, IN, USA

<sup>c</sup>Department of Mechanical Engineering, University of Colorado Boulder, Boulder, CO, USA

<sup>d</sup>Department of Biomedical Engineering, University of Michigan, Ann Arbor, MI, USA

<sup>e</sup>Program in Macromolecular Science and Engineering, University of Michigan, Ann Arbor, MI, USA

---

### 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

---

\*Corresponding author

Email address: [cmluetke@umich.edu](mailto:cmluetke@umich.edu) (Callan M. Luetkemeyer)

Download English Version:

<https://daneshyari.com/en/article/7170713>

Download Persian Version:

<https://daneshyari.com/article/7170713>

[Daneshyari.com](https://daneshyari.com)