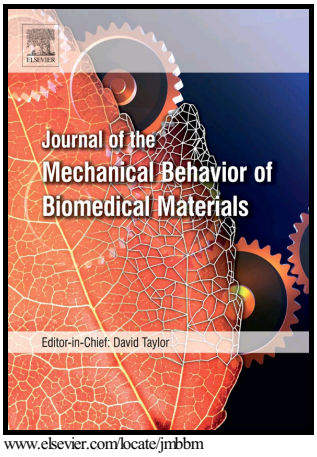
Cyclic Loading of Human Articular Cartilage: The Transition from Compaction to Fatigue

Jonathan T. Kaplan, Corey P. Neu, Hicham Drissi, Nancy C. Emery, David M. Pierce



www.elsevier.com/locate/jmbbm

PII: S1751-6161(16)30348-4
DOI: http://dx.doi.org/10.1016/j.jmbbm.2016.09.040
Reference: JMBBM2097

To appear in: *Journal of the Mechanical Behavior of Biomedical Materials*

Received date: 23 May 2016
Revised date: 26 September 2016
Accepted date: 30 September 2016

Cite this article as: Jonathan T. Kaplan, Corey P. Neu, Hicham Drissi, Nancy C. Emery and David M. Pierce, Cyclic Loading of Human Articular Cartilage: The Transition from Compaction to Fatigue, *Journal of the Mechanical Behavior of Biomedical Materials,* http://dx.doi.org/10.1016/j.jmbbm.2016.09.040

Cyclic Loading of Human Articular Cartilage: The Transition from Compaction to Fatigue

Jonathan T. Kaplan[a,b], Corey P. Neu[c], Hicham Drissi[d], Nancy C. Emery[e], David M. Pierce[a,*]

[a] *Departments of Biomedical and Mechanical Engineering, University of Connecticut, Storrs, CT*
[b] *U.S. Army Natick Soldier Research, Development and Engineering Center, Natick, MA*
[c] *Department of Mechanical Engineering, University of Colorado, Boulder, CO*
[d] *Department of Orthopaedic Surgery, University of Connecticut Health Center, Farmington, CT*
[e] *Department of Ecology and Evolutionary Biology, University of Colorado, Boulder, CO*

Abstract

Osteoarthritis and articular cartilage injuries are common conditions in human joints and a frequent cause of pain and disability. Unfortunately, cartilage is avascular and has limited capabilities for self-repair. Despite the societal impact, there is little information on the dynamic process of cartilage degeneration. We performed a series of cyclic unconfined compression tests motivated by *in vivo* loading conditions and designed to generate mechanical fatigue. We examined the functional (both stress-stretch and creep) responses of the tissue after recovery from a specified number of loading cycles, as well as histology and second harmonic generation microscopy images. The effect of compaction was complimented by the effect of fatigue in our unconfined compression tests. A three-way, repeated-measures mixed model ANOVA showed significant differences between loading with a physiologically relevant low magnitude, and two more severe loading magnitudes, in terms of the resulting specimen stiffness, time to equilibrium and thickness. There was statistically significant effect of loading frequency on a specimen's time to equilibrium and significant interaction of force and frequency on specimen

*Corresponding author. dmpierce@engr.uconn.edu