Fall 2015 Joint Colloquium
Materials Department & Materials Research Laboratory

Professor Ellen Arruda
Mechanical Engineering
University of Michigan

Friday, October 2nd, 2015
11:00 am, Elings 1601

Pizza served afterwards.

The Anterior Cruciate Ligament: Mechanical Property Characterization, Constitutive Modeling, and Tissue Engineering Strategies for Repair

The soft tissues of the knee, especially the anterior cruciate ligament (ACL) and cartilage, are particularly susceptible to traumatic injuries and degenerative diseases. There are an estimated 500,000 knee ligament reconstructions performed annually in the United States. The majority of these surgeries include replacing a torn ACL with grafted tissue. Surgical reconstructive procedures yield positive short-term outcomes in adults; however, current techniques do not have the same success long-term, with complications associated with injury recidivism and a strong correlation between reconstruction and the development of early onset osteoarthritis. This lecture will focus on characterization and modeling of ACL and knee biomechanics to further our understanding of ACL injury mechanisms and elucidate injury prevention strategies, and in the tissue engineering of ACL grafts for restoration of native anatomy and function of the knee.

Our experimental methods involve mechanically testing in uniaxial loading as well as anatomical positions using digital image correlation analysis to describe the strain fields arising from mechanical heterogeneity in each experimental condition. We demonstrate that the anterior bundle of the ACL may be functionally graded along its length whereas the posterior bundle appears to be mechanically homogeneous axially. Anisotropic, non-linear viscoelastic mathematical models of the ACL bundles have been developed and implemented into a finite element framework for analysis of the ACL during physiologically relevant loading conditions. Our computational model is able to predict clinically relevant locations of high strains. Replicating the material and geometrical requirements of the ACL with an engineered replacement is an arduous task. A tissue engineering approach to ACL replacement that can fully heal and restore proper biomechanics to the knee will be described, along with results to date using a large animal model.

BIO Professor Ellen M. Arruda is a Professor of Mechanical Engineering at the University of Michigan. She also holds appointments in Biomedical Engineering and in Macromolecular Science and Engineering. Professor Arruda earned her B.S. in Engineering Science and her M.S. in Engineering Mechanics from The Pennsylvania State University, and her Ph.D. in Mechanical Engineering from the Massachusetts Institute of Technology. She joined the UM faculty in 1992. Professor Arruda teaches and conducts research in the areas of theoretical and experimental mechanics of macromolecular materials, including polymers, elastomers, composites, soft tissues and proteins, and in tissue engineering of soft tissues and tissue interfaces. She is also active in the mechanics of polymers in a variety of applications including helmet design for optimal impulse mitigation, non-woven polymer networks, and stress wave propagation in anisotropic, viscoelastic layers. Her work has recently earned several honors and awards including the Ann Arbor Spark Best of Boot Camp award 2012, the 2012 Excellence in Research Award by the American Orthopaedic Society for Sports Medicine. Professor Arruda is a Fellow of the American Society of Mechanical Engineers, the American Academy of Mechanics, and the Society of Engineering Science.

http://sitemaker.umich.edu/arruda/home

Hosted by Tresa Pollock