Computational biomechanics: Applications in orthopaedics

Human movement is the result of complex interaction between joint anatomy, passive soft-tissue restraint and active muscle force. When function of a joint is disrupted through injury or disease, the effect on quality of life can be significant, affecting the entire population range from older patients with debilitating osteoarthritis to young active sports people with soft-tissue injury or instability. Computational simulations can provide an ideal complement to clinical or cadaveric studies. Validated computational models may be used to great effect to compare clinical treatment options, optimize an implant design to best suit a patient population, or determine optimal surgical pathways on a subject-specific basis. These models facilitate prediction of muscle forces, joint loads, kinematics, stresses, and strains which are typically not feasible to obtain in vivo or in vitro. This seminar will focus on applications of finite element models in assisting implant design and surgical decisions. These include development of more fidelic lower-limb models which better represent the loads and motions encountered in a patient population, new methods for assessing the stability of knee replacement components, and subject-specific models developed to understand the anatomic predisposition of a patient to patellar dislocation and determine the optimal course of treatment to address the underlying anatomic abnormalities which facilitate injury.

Bio: Dr. Clare Fitzpatrick received her Ph.D. in Mechanical Engineering in 2008 from University College Dublin, Ireland. Since 2009, she has been working at the Center for Orthopaedic Biomechanics at the University of Denver, initially as a Post-doctoral Fellow and, since 2011, as a Senior Research Engineer. Dr. Fitzpatrick is currently co-investigator on a number of industry- and federally-funded research grants, which investigate biomechanics of the implanted knee and hip joint, multi-scale modeling of the natural knee, and anatomic considerations in patients with recurrent patellar dislocation. She has published 28 peer-reviewed journal articles and two book chapters in the area of orthopaedic biomechanics, and is an active collaborator with industry and academic institutions worldwide.