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Introduction. In recent years, the field of biomechanics has seen tremendous advancement in analysis tools and measurement techniques which are highly technical in nature. As a result these are developed in small and highly specialized groups scattered throughout the country and the world. It is difficult for people outside these groups to understand the strengths and limitations of these techniques, especially in a clinical setting. In addition, it is very difficult for researchers outside these specialized groups to develop and implement these techniques and technologies themselves, and to apply them to their own area of interest. Or, more importantly, to integrate them into their own specialized methodologies for the purpose of creating trans-domain (multi-scale) analysis tools. As a result there is a significant gap in the acceptance and application of these new technologies to the most pressing clinical questions raised by clinicians who are typically in private practice or in different academic departments.

Recommendation 1

Establish consortiums with the goal of integrating trans-domain technologies.

My recommendation is to establish consortiums of groups with diverse backgrounds and capabilities to integrate and combine their technologies, skill sets and knowledge. With the advancement of the various areas of biomechanics, it is exceedingly difficult for one department to develop multiple areas of expertise. There is a need for consortiums that have the ability to do cellular and tissue mechanics, joint cadaveric testing, biplane fluoroscopy, optical motion analysis, finite element modeling, forward- and inverse-dynamics musculoskeletal modeling, advanced imaging, etc, related to the same motion, joint or pathology. Within these consortiums researchers and clinicians with varied backgrounds will meet regularly and exchange students to stimulate trans-domain assessments of particular clinical questions. One of the short-term goals should be to create standardized formats for results and of model components for the effective exchange of information between domains, tools and consortium members (perhaps create a repository). For example, the development of a standard is needed so that the results of the measurement of joint motion in a patient's knee using biplane fluoroscopy can be directly transferred into a subject specific finite element model of that person's knee. Subsequently, the output of the finite element model should be directly transferrable to an in vitro experiment which now loads the cartilage or a newly designed artificial ligament with an appropriate physiologic load.

Recommendation 2

The application of advanced biomechanical analyses to clinical questions requires the development of methodologies which allow fast adaptation of subject specific models that have been rigorously validated. The beauty of computer modeling is that one can estimate parameters that are difficult or impossible to measure in vivo. This is also where its weakness lies in clinical applications. Significant effort is necessary to provide sufficient validation of models in a clinical setting to establish more trust in the predictions and outcomes of the model. There is a lack of funding to rigorously validate models and technologies. In addition, adaptation of trans-domain and subject specific models to a particular patient requires advanced imaging information for which there currently is a lack of tools to quickly extract the relevant information and adapt models appropriately. One of the short-term goals should, therefore, be to develop the fast integration of advanced imaging tools such as biplane fluoroscopy, CT and MRI scans with subject specific modeling.

Recommendation 3

To develop a priority list of important clinical applications. Where will biomechanics have the best ability to affect the clinical diagnosis of a pathology, influence clinical decision making, validate treatments and interventions, guide interventions, or establish efficacy of treatment and best practices? A short-term goal would be to establish a few showcase applications to spearhead the development of tools and standards, and to demonstrate the potential impact of biomechanics on clinical applications.

In my opinion, advanced biomechanics will remain primarily a research tool for some time to come with limited direct clinical application (i.e., reimbursed by insurance). Its primary impact will be in the areas of validating treatments and interventions as well as to establish (mechanical) efficacy of treatments and best practices. This is a very important medical research area with the increased emphasis on evidence-based medicine. It should be a priority in the next decade to make our advanced tools: available to a larger group of researchers, trans-domain (multi-level), and more suitable to directly affect clinical care.