How Can We Use the Ever-Increasing Supply of Information To Do Better Computational Biomechanics?

Victor H. Barocas, Ph.D.
Professor, Department of Biomedical Engineering
University of Minnesota

Abstract:

Computational biomechanics is almost as old a field as computational mechanics, and it has consistently faced the problem of developing the right model and solving it the right way. One critical challenge in biomechanics, which has been less of a challenge in computational mechanics, has been the lack of complete information. The constitutive equation for a certain steel or rubber is readily available or easily obtained experimentally, but the constitutive equation for aorta, as an example, is far less clear. The problem is aggravated by complex tissue geometry, complex tissue architecture, and high variability across individuals. Tissues are often heterogeneous, anisotropic, multiscale, and multilinear, and tissue mechanics often becomes multi-physical because of the role of interstitial flow, chemistry, or electrodynamics. All of these factors are difficult to measure and difficult to model even if a measurement can be made.

There is, however, hope, that we can quantify deformations in vivo or in vitro like never before and we can image the structure and composition of a tissue in constantly improving and diversifying ways. I will discuss activities in our lab - current and future - that attempt to leverage the information explosion to improve computational models, with particular emphasis on aortic aneurysm and the facet capsular ligament, two tissues of current interest.