Multiphysical modeling of soft tissue-stent interaction

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ABSTRACT

The efficacy of cardiological interventions, including the implantation of prostheses, is highly dependent on patient-specific immunohistology and can be enhanced with computational predictive tools. Therefore, an in silico replication of neointimal hyperplasia shall provide the necessary insights about the biochemical and cellular interactions within the vessel wall, and eventually address the risks of in-stent restenosis in a patient-specific manner. In this context, we set up a multiphysics framework considering key mediators of restenosis and couple them to a continuum mechanical vessel wall model. The governing set of coupled partial PDEs for the underlying mechanobiological system is solved via the finite element method and the results are compared to those obtained using a deep learning framework employing physics-informed neural networks (PINNs). Another interesting cardiological intervention-related problem is the maturation of tissue-engineered cardiovascular implants wherein the evolution of the collagen density affects the tissue's mechanical behavior. The model we present allows us to predict the evolution of collagen density within textile-reinforced heart valves.