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A Mechanobiological Model for Damage-induced Growth in Arterial Tissue with Application to In-stent Restenosis

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Abstract. In-stent restenosis (ISR) is one of the main drawbacks of stent implementation which limits the long-term success of the procedure. Morphological changes occurring within the arterial wall due to stent-induced mechanical injury are a major cause for activation of vascular smooth muscle cells (VSMCs), and the subsequent development of ISR. Considering the theory of volumetric mass growth and adopting a multiplicative decomposition of the deformation gradient into an elastic part and a growth part, we present a mechanobiological model for ISR. An evolution equation is developed for mass growth of the neointima, in which the activation of VSMCs due to stent-induced damage (injury) and the proliferation rate of the activated cells are considered. By introducing the mass evolution into the mass balance equation, we obtain the evolution of the growth tensor over time. The model is implemented in a finite element code and the procedure of angioplasty is simulated, whereby the features of the proposed growth model are illustrated.

Keywords: Mechanobiological model, finite element simulation, stent deployment, damage-induced growth, in-stent restenosis

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