Latorre, Marcos; **Humphrey, Jay D.**

Fast, rate-independent, finite element implementation of a 3D constrained mixture model of soft tissue growth and remodeling. (English) Zbl 07337981

Comput. Methods Appl. Mech. Eng. 368, Article ID 113156, 33 p. (2020).

Summary: Constrained mixture models of soft tissue growth and remodeling can simulate many evolving conditions in health as well as in disease and its treatment, but they can be computationally expensive. In this paper, we derive a new fast, robust finite element implementation based on a concept of mechanobiological equilibrium that yields fully resolved solutions and allows computation of quasi-equilibrated evolutions when imposed perturbations are slow relative to the adaptive process. We demonstrate quadratic convergence and verify the model via comparisons with semi-analytical solutions for arterial mechanics. We further examine the enlargement of aortic aneurysms for which we identify new mechanobiological insights into factors that affect the nearby non-aneurysmal segment as it responds to the changing mechanics within the diseased segment. Because this new 3D approach can be implemented within many existing finite element solvers, constrained mixture models of growth and remodeling can now be used more widely.

MSC:

76	Fluid mechanics
91	Game theory, economics, finance, and other social and behavioral sciences

Keywords:

growth; remodeling; constrained mixture; mechanobiology; artery

Software:

FEBio

Full Text: DOI

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