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An integrated computational approach for aortic mechanics including geometric, histological and chemico-physical data

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Abstract

A novel computational approach for simulating aortic mechanical response is proposed. Patient-specific geometric description is coupled with a multiscale structurally-motivated tissue constitutive model, explicitly accounting for histological, biophysical and biochemical parameters. Accordingly, geometric and constitutive features can be straight included in highly-personalized numerical analyses, allowing to easily incorporate also effects related to possible pathological tissue defects. A parametric home-made code has been developed by integrating an image segmentation technique, a multiscale (nano-to-macro) tissue mechanical description, and a non-linear finite-element strategy. Preliminary numerical results, based on a case study involving a thoracic aortic segment, are presented and discussed, highlighting soundness and effectiveness of the adopted non-linear constitutive modeling. Moreover, the influence on the aortic macroscale response induced by a localized defect affecting the crimp of collagen fibers is analyzed, proving that the proposed multiscale computational framework is able to provide special insights into both etiology of some cardiovascular diseases and physio-pathological remodeling mechanisms.

Keywords: Aortic mechanics, Patient-specific computational models,

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