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Coupled simulation of vascular growth and remodeling, hemodynamics and stress-mediated mechanotransduction JIACHENG WU, SHAWN C. SHADDEN, Univ of California - Berkeley — A computational framework to couple vascular G&R, blood flow simulation and stress-mediated mechanotransduction is derived for patient specific geometry. A hyperelastic constitutive relation is considered for vascular material and vessel wall is modeled via constrained mixture theory. The coupled simulation is divided into three time scales - G&R (weeks-years), hemodynamics (seconds) and stress-mediated mechanotransduction (much less than 1 second). G&R is simulated and vessel wall deformation (and tension) is computed to obtain the current vessel geometry, which defines the new boundary for blood flow. Hemodynamics are then simulated in the updated domain to calculate WSS field. A system of ODE's is derived based on conservation law and phenomenological models to describe the signaling pathways from mechanical stimuli (WSS, wall tension) to mass production rate of vascular constituents, which, in turn, changes the kinetics of G&R. To reduce computation cost, blood flow is only simulated when G&R causes significant change to geometry, and steady state response of the ODE system for mechanotransduction is used to characterize the influence of WSS and wall tension on G&R, due to separation of three time scales.

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