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Finite Element CURVIB method for fluid-structure interaction simulations of tissue heart valves ANVAR GILMANOV, HENRYK STOLARSKI, TRUNG LE, FOTIS SOTIROPOULOS, University of Minnesota — A new fluid-structure interaction (FSI) model is developed for solving the three-dimensional unsteady Navier-Stokes equations in domains with arbitrarily complex tissues undergoing large deformation. The method employs the sharp-interface CURVIB method [L. Ge, F. Sotiropoulos, JCP, 225 (2007) 1782-1809] for handling complex moving boundaries, with a finite element (FE) model, which can handle large structural/tissue deformations using the nonlinear Kirckhhoff thin shells theory. A new treatment of the flexible immersed body is introduced to handle the thin body surfaces. A version of Aitken's acceleration for strong fluid-structure coupling is used to calculate the responses of the flexible bodies to the applied fluid load. The new, rotation-free finite element formulation for large deformations of thin shells has been extensively tested and validated for a range of relevant problems. The coupled FE-CURVIB FSI model is validated for vortex induced oscillations of a flexible cantilever and applied to simulate physiologic pulsatile flows through a tissue aortic heart valve in an anatomic artery geometry. The results show the good convergence property of the new FSI algorithm and demonstrate its promise for a broad range of biological applications.

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