Abstract Submitted
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Dynamics of pulsatile flows through elastic microtubes OMER SAN, ANNE STAPLES, Virginia Tech — We investigate pressure driven transient flows of incompressible Newtonian fluids through circular microtubes with thin elastic walls under the long-wavelength and small deformation assumptions, which are valid for many industrial and biological process. An analytical solution of the coupled fluid and solid equations is found using the Navier slip boundary condition and is shown to include some existing Womersley solutions as limiting cases. The effect of the slip length at the fluid-solid interface of the flexible microtube is analyzed for oscillatory pressure gradients using a range of slip-ratio and frequency parameters. We find that for a steady pressure gradient, slip at the boundary simply adds a translational velocity and does not lead to material deformations, while for pulsatile flows with oscillating pressure gradients, the influence of the slip length becomes nonlinear and affects the flow rate, velocity profile, and shear stress. We compare the solutions for elastic and rigid walls with and without slip boundary conditions for broad ranges of the relevant parameters. We show that the elasticity of the microtube couples nonlinearly with the slip velocity and can greatly enhance the flow rate, sigfinifcantly changing its maximum value and effective range as a function of Wormersley number, compared to the no-slip case. Additionaly, we find that increasing the slip length produces less shear stress, which is consistent with the nearly frictionless interfaces observed in many microscale experiments.

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