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Peristaltic Wave Propagation in Compressible Maxwell Fluids with Boundary Slip

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Abstract

Boundary slip has recently been demonstrated experimentally by Craig et al. [Phys Rev Lett 87, 054504 (2001)]. Complementing this observation, Tsiklauri [J Acoust Soc Am 112, 843 (2002)] incorporated non-zero boundary slip into a theoretical model of fluid-saturated porous media. This extended previous work by Tsiklauri and Beresnev [Phys Rev E 64, 036303 (2001)], which predicted new phenomena through a generalization of the classic description of peristaltic pumping: non-Newtonian effects produced unexpected changes in fluid behaviour within the deeply viscoelastic regime. Here, we present the most general description of peristaltic wave propagation that has been developed to date, capturing a wide variety of physical effects (including non-zero boundary slip, viscoelasticity, and compressibility). It thus provides an ideal analytical platform for investigating with greater rigour phenomena such as backflow, which has been suggested as a likely cause of vesico-ureteral reflux in urology. We have considered the peristaltic pumping of blood in a human artery, and found that small changes in arterial radius can, in some parameter regimes, give rise to a spontaneous backflow effect. A distinct advantage with our model is that the generality lends itself to the description of flow processes in a range of other physical systems, including geophysical and industrial.