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Liquid Plug Propagation in a Flexible Microchannel: Experimental and Numerical Studies[1] YING ZHENG, University of Michigan, Ann Arbor, SHIYAO BIAN, HIDEKI FUJIOKA, YUSUKE TORISAWA, DONGEUN HUH, SHUICHI TAKAYAMA, JAMES B. GROTBERG, University of Michigan — The lung's small airways can close due to the formation of a liquid plug bridge, or airway wall collapse or a combination of both in diseases such as chronic obstructive pulmonary disease (COPD) and respiratory distress syndrome (RDS), and in the external instillation of therapeutical drugs or surfactants. The propagation of a formed plug can produce high pressure, high shear stress, and large gradients of each, which may damage the cells lining the airway walls. This study is motivated by an interest in the effect of wall flexibility on the plug propagation and its resulting wall stresses in small airways. We fabricated a flexible microchannel to mimic the flexible small airways using soft lithography. As the plug propagates along the flexible microchannels, the local wall deformation is observed in the plug core region, which increases with plug speed but slightly increases with plug length. The pressure drop across the plug is measured and observed to increase with plug speed and is slightly smaller in a flexible channel compared to that in a rigid channel. A computational model is then presented to model the steady plug propagation through a flexible channel corresponding to the middle plane in the experimental device. The results show qualitative agreements with the experimental measurement.

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