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Exploring the effects of scaling on a simple model of peristalsis

LINDSAY WALDROP, New Mexico Tech — Functional systems that must operate at or through intermediate Reynolds numbers are often complex and not well understood. Peristaltic pumping by valveless, tubular hearts – widespread among animal groups and scales – is one such system, having many parameters that control functional performance (fluid driven through circulatory systems) in a fluid regime that is dominated by neither viscosity nor inertia. To better understand the relative performance of valveless, tubular hearts, we use uncertainty quantification on a simple model of peristalsis driving fluid in a racetrack to perform sensitivity analyses on three parameters known to influence fluid flow: compression ratio (how much the tube compresses during a contraction), Womersley number (Wo; similar to Re for pulsatile flow), and compression frequency. We find that compression ratio dominates volume flow rates through the circulatory system, while Wo and compression frequency have little or no effect on flow performance. These results point to peristaltic pumping by valveless, tubular hearts as being an effective and robust mechanism to drive fluid flow across scales.

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