Computational modelling of the peristaltic contractions of the human stomach

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Abstract

Health problems related to the mechanics of the stomach (gastric mechanics) are among the most important causes of morbidity in industrialized countries. Around 10% - 45% of the general population suffer from dyspepsia (difficult digestion), which seriously compromises individual well-being and economic productivity and is often linked to the motility of the stomach. At the same time, the biomechanics of the stomach still remains poorly understood, especially compared to the cardiovascular system. Currently, biomechanical modeling of the human stomach lags around one to two decades behind biomechanical modeling of the cardiovascular system. To help close this gap between medical needs and the state of science, we are developing a comprehensive computational model of the motility of the stomach. Here we present the theoretical and computational foundations of this model and how it can be combined with patient-specific magnetic resonance imaging (MRI) data. The framework builds upon a robust gastric electrophysiological model with an active-strain finite elasticity model to account for tissue mechanics. It can reproduce essential phenomena of gastric electromechanics, including slow wave entrainment and the propagation of ring-shaped peristaltic contraction waves. It provides a powerful tool for future in-silico studies of physiological and pathological mechanisms of gastric electromechanics.

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