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Fluid Dynamics of the Generation and Transmission of Heart Sounds: (2): Direct Simulation using a Coupled Hemo-Elastodynamic Method[1] JUNG-HEE SEO, HANI BAKHSHAEE, CHI ZHU, RAJAT MITTAL, Johns Hopkins University — Patterns of blood flow associated with abnormal heart conditions generate characteristic sounds that can be measured on the chest surface using a stethoscope. This technique of 'cardiac auscultation' has been used effectively for over a hundred years to diagnose heart conditions, but the mechanisms that generate heart sounds, as well as the physics of sound transmission through the thorax, are not well understood. Here we present a new computational method for simulating the physics of heart murmur generation and transmission and use it to simulate the murmurs associated with a modeled aortic stenosis. The flow in the model aorta is simulated by the incompressible Navier-Stokes equations and the three-dimensional elastic wave generation and propagation on the surrounding viscoelastic structure are solved with a high-order finite difference method in the time domain. The simulation results are compared with experimental measurements and show good agreement. The present study confirms that the pressure fluctuations on the vessel wall are the source of these heart murmurs, and both compression and shear waves likely plan an important role in cardiac auscultation.

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