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(Research Article)
Modeling and investigating the effect of ultrasound waves pressure on the microbubble oscillation dynamics in microvessels containing an incompressible fluid

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Abstract

Understanding the dynamics of microbubble oscillation in an elastic microvessel is important for the safe and effective applications of ultrasound contrast agents in imaging and therapy. Numerical simulations based on 2D finite element model are performed to investigate the effect of acoustic parameters such as pressure and frequency on the dynamic interaction of the fluid-blood-vessel system. The results show that acoustic waves cause bubble oscillation, pressure on the vessel wall as well as vascular deformation. For a bubble (with a radius of 1.5 μm) in a microvessel with a radius of 5 μm exposed to ultrasonic waves with a frequency of 1 MHz and out put pressures of 0.25 MPa, 0.22 MPa, 0.18 MPa and 0.13 MPa the modeling has been done. It can be seen that with increasing ultrasound pressure, the radius of the bubble changes, the displacement of the vessel wall and the pressure and also shear stress on the vessel wall increase. Also, by increasing the initial radius of the microbubble (1.5, 2.5 and 2.5 micrometers) at constant radiant wave pressure, the pressure on the capillary wall and the amount of capillary wall displacement increase. With increasing capillary wall diameter (1, 1.5, 2 and 2.5 μm) at constant radiant wave pressure, no significant change in pressure applied to the capillary wall and capillary wall displacement is observed. This work was evaluated with the simulation results of other researchers.

Keywords: Ultrasound waves, Microbubble, Incompressible fluid, Ultrasound waves pressure, Blood-brain barrier, Shear stress.

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