# Interaction of lithotripter shockwaves with single inertial cavitation bubbles

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Abstract

The dynamic interaction of a shockwave (modeled as a pressure pulse) with an initially spherically oscillating bubble is investigated. Upon the shockwave impact, the bubble deforms non-spherically and the flow field surrounding the bubble is determined with potential flow theory using the Boundary Element Method (BEM). The primary advantage of this method lies in its computational efficiency. The simulation process is repeated until the two opposite sides of the bubble surface collide with each other (i.e. the formation of a jet along the shockwave propagation direction). The collapse time of the bubble, its shape and the velocity of the jet are calculated. Moreover, the impact pressure is estimated based on water hammer pressure theory. The Kelvin impulse, kinetic energy and bubble displacement (all at the moment of jet impact) are also determined. Overall, the simulated results compare favorably with experimental observations of lithotripter shockwave interaction with single bubbles (using laser induced bubbles at various oscillation stages). The simulations confirm the experimental observation that the most intense collapse, with the highest jet velocity and impact pressure, occurs for bubbles with intermediate size during the contraction phase when the collapse time of the bubble is approximately equal to the compressive pulse duration of the shock wave. Under this condition, the maximum amount of energy of the incident shockwave is transferred to the collapsing bubble. Further, the effect of the bubble contents (ideal gas with different initial pressures) and the initial conditions of the bubble (initially oscillating vs. non-oscillating) on the dynamics of the shockwave-bubble interaction are discussed.