Title: Using a confined space to facilitate jetting for fluid-containing biocompatible cavitation nuclei

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Keywords:
low-amplitude, ultrasound-assisted jetting

Abstract

A bubble collapsing near an interface may result in the formation of a liquid jet protruding from the distal bubble side, through the bubble, towards the interface. Ultrasound-assisted jetting has been observed when subjecting fluids to acoustic amplitudes above the inertial cavitation threshold, limiting its application in medicine. The purpose of this study was to investigate the feasibility of low-amplitude jetting for fluid-containing biocompatible cavitation nuclei, by placing the region of interest in a confined space to ensure a standing wave field. Droplets of Quantison™ ultrasound contrast agent were pipetted into a Perspex cylindrical compartment of 8-mm diameter and 2-mm height, which was part of an imaging system. The contrast agent was subjected to 3-cycle ultrasound pulses with a centre frequency of 1 MHz whilst being observed with high-speed photography. The high-speed camera was operating at a frame rate of ten million frames per second. Jetting was observed in an acoustic regime whose free-field mechanical index was 0.6. Empirical curve matching showed a pulse amplification by a factor of six owing to the chosen geometry. In conclusion, jetting was observed to occur with microbubbles nucleated from ultrasound contrast agent microbubbles. Visible jet lengths of twice the bubble radius on the verge of collapse were measured. Owing to the confined space, the local acoustic amplitude was amplified to surpass the cavitation threshold. This finding is of interest for medical ultrasonic applications where the local environment comprises strong reflectors.