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Damage to single biological cells induced by laser-induced tandem microbubbles

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Recent studies have highlighted the potential for using laser-induced micro-cavitation in lab-on-a-chip devices. Shear stress in a liquid can be controlled and significantly enhanced by bubble-bubble interaction, providing new options for in situ cell treatment. Two micro-bubbles (10 μs life time) are generated in a 25-μm liquid layer using 5 ns tandem laser pulses delivered through the objective of a microscope. Bubble-bubble interaction in nearly two-dimensional flow is observed using high-speed video cameras. Two liquid micro-jets moving in opposite directions can be generated when the second bubble is produced at the maximum size of the first one. The jet velocity is estimated about 35 m/s. Particle imaging velocimetry reveals vortex flow motion around the oscillating bubble lasting for about 200 μs. Cell lyses produced by jetting from asymmetric oscillation of tandem microbubbles are investigated at various bubble-cell distances and compared with the results from single symmetric bubble oscillation. The interaction of tandem microbubbles can produce microjetting, leading to damage of adjacent single biological cells.