

Imaging Bubbles in Vessels

Author:

Tom Matula, H. Chen, A. Brayman

Institutions:

University of Washington, Center for Industrial and Medical Ultrasound 1013 NE 40th St., Seattle, WA 98105, USA

Device and producing company:

Introduction: Cavitation is a possible mechanism for generating beneficial bioeffects in shock wave therapy. But how do the bubbles interact with tissue and blood vessels? We have been able to study the instantaneous direct interaction between a bubble and a blood vessel.

The interaction shows that blood vessels dilate with bubble expansion and invaginate with bubble collapse.

Methods: Stabilized microbubbles are injected into a rat superior mesenteric artery. The ex vivo mesenteric tissue is then placed under a high-powered microscope. A region is insonified with ultrasound and imaged with a high-speed camera. The bubble growth, collapse and corresponding vessel motion is analyzed.

Results: The growth of bubbles is highly constrained compared to what occurs in the absence of tissue. In many cases, vessel wall invagination is much greater than dilation. The maximum velocity of the vessel wall during invagination can be tens of m/s.

Discussion: When a bubble expands, a large area of the vessel wall dilates. When the bubble collapses however, we often see a very localized invagination, even "jetting" of the tissue into the blood vessel. We hypothesize that this localized invagination is associated with microcapillary damage. It is possible to consider the blood and surrounding tissue as two different "fluids" with an elastic, breakable membrane that separates these two fluids.

Conclusion: Using high speed photography, we have observed the coupled interaction of an oscillating bubble with a vessel wall. The interaction shows vessel wall dilation, invagination, and even rupture when the pressure amplitude is high. (Support provided by NIH 1R01AR053652 and 5R01EB000350).