# Diagnostic and therapeutic applications of microbubbles in medical ultrasound

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The interaction of an ultrasonic field with small gas bubbles, either occurring naturally in the body or introduced as contrast agents, can potentiate cavitation. Ultrasound contrast agents based on stabilized microbubbles (<10 micron diameter) produce nonlinear signals enhance blood flow detection, responding to specialized pulse sequences that suppress undesired tissue signal. These fragile microbubbles can also be eliminated from the imaging plane with modest acoustic fields to provide a method for measuring contrast replenishment and thus perfusion. However, at sufficiently high ultrasound intensity, microbubbles undergo inertial cavitation where the inertia of the fluid is so large that the bubble has difficulty resisting the collapse. The physical effects to tissue surround the bubble can range from very small hemorrhage sites to complete cellular disruption, termed Histotripsy, depending on the pulse parameters used. An additional method for microbubble introduction is to inject superheated perfluorocarbon droplets that when activated by ultrasound, vaporize to form gas bubbles in a process termed acoustic droplet vaporization (ADV). The droplets (<6 micron diameter) produce relatively large bubbles by ADV within tissue for vascular occlusion. The bubbles can also act as barriers and reflectors of ultrasound to shield or enhance acoustic fields. We will discuss the many uses of microbubbles in medical ultrasound, how such innovations are advancing both diagnosis and therapy.