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An eight-element annular array for image-guided high intensity focused ultrasound therapy

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The investigation of High Intensity Focused Ultrasound (HIFU) as a tool for noninvasive thermally ablative therapy has required deeper understanding of the relative roles of nonlinear mechanisms involved in heat deposition. Attempts at quantifying the dose response to particular exposure conditions in vitro are complicated by the interplay of several mechanisms. These include microbubble cavitation, nonlinear acoustic propagation and attenuation, dependence of tissue parameters on temperature and temperature history, and formation and evolution of vapor bubbles due to boiling. One immediately evident consequence of such effects is distortion of coagulative lesion shape and size, colloquially evolving from "cigars" to "tadpoles". Developing a quantitative understanding of the relative roles of relevant nonlinear mechanisms is not straightforward, yet is desirable for design of algorithms for therapy planning and real time monitoring using ultrasound. A historical perspective of research toward this end will be presented along with a recommendation for suitable terminology for the various physical acoustic regimes encountered in HIFU therapy. [Work supported by Army MRMC, NIH DK43881, NSBRI SMS00402, and RFBR.]