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A method of HIFU field characterization in water and deration to tissue

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Acoustic characterization of nonlinear HIFU fields is important for both the accurate prediction of ultrasound induced bioeffects and the development of regulatory standards for clinical HIFU devices. In this work a new characterization method is proposed and tested in water, tissue phantoms, and ex-vivo tissues. The method is based on the combined use of measurements and modeling. Experiments were performed with a 2 MHz transducer of 4.2 cm aperture and 4.5 cm focal length. Low amplitude measurements in water were used to establish boundary conditions for modeling based on the KZK-type equation. High amplitude focal waveforms then were simulated and measured with a fiber optic probe hydrophone in water, within tissue phantom, or adjacent to excised tissue. It was shown that at high amplitudes, the simulations of shock waveforms were more accurate than the measurements. The focal waveforms obtained in water were found to be in a good agreement with those produced in tissue with higher source pressure scaled to compensate for the linear attenuation on the way to focus. This result establishes a method to derate the focal HIFU pressures determined in water to tissue. [Work supported by NIH DK43881, NSBRI SMS00402 and RFBR.]