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Effect of elastic waves in the metal reflector on bubble dynamics at the focus of an electrohydraulic lithotripter

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In extracorporeal electrohydraulic lithotripters, a hemi-ellipsoidal metal reflector is used to focus a spherical wave generated by an electrical discharge. The spark source is positioned at one of the ellipsoid foci (F1); this makes the reflected wave focused at the other focus (F2). Despite the common assumption that the reflector behaves as a rigid mirror, the true reflection phenomenon includes the generation and reverberation of elastic waves in the reflector, which reradiate to the medium. Although these waves are much lower in amplitude than the specularly reflected wave, they may influence cavitation at F2. To explore such effects, waves in water and a brass reflector were modeled in finite differences based on the linearized equations of elasticity. The bubble response was simulated based on a Rayleigh-type equation for the bubble radius. In addition, the role of acoustic nonlinearity was estimated by numerical modeling. It is shown that the elastic waves in the reflector give rise to a long "ringing" tail, which results in nonmonotonic behavior of the bubble radius during its inertial growth after shock wave passage. This numerical result is qualitatively confirmed by experimental observations of bubble behavior using high-speed photography. Work supported by NIH-DK43881, NSBRI-SMS00402, NIH-DK075090, and RFBR.