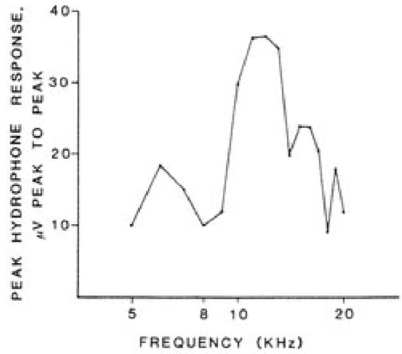

Fig. 3. Hydrophone response in the 14-cm diameter model to a three-pulse burst of 35-µs wide pulses at 1.10 GHz.

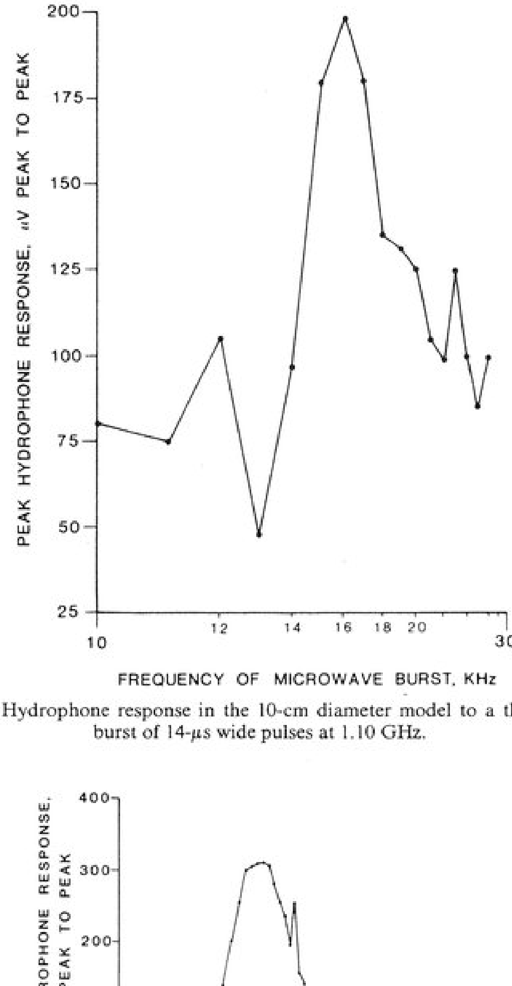

Fig. 4. Hydrophone response in the 10-cm diameter model to a three-pulse burst of 14-µs wide pulses at 1.10 GHz.

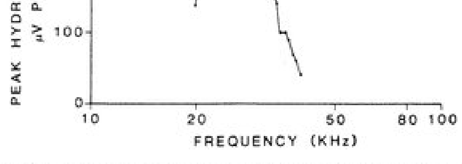

Fig. 5. Hydrophone responses in the 6-cm diameter model to a three-pulse burst of 10-µs wide pulses at 1.10 GHz.

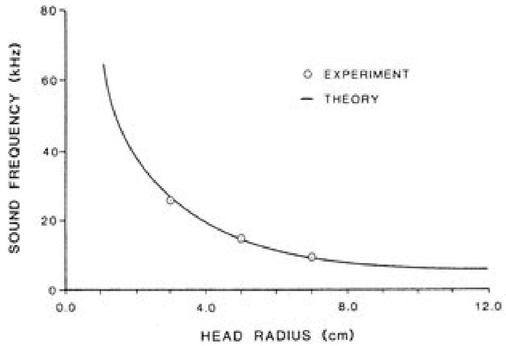

Fig. 6. Comparison of measured and predicted frequency of pressure waves in spherical head models as a function of head radius.

frequency at 16 kHz. This is also revealed in the response "tuning curve" shown in Fig. 4 which peaked at 16 kHz.

In the 14-cm diameter model, single-pulse irradiation yielded a "ringing" frequency of slightly above 10 kHz, and a pulse width of 35 µs produced maximal acoustic response. Fig. 5 shows the results of irradiating the 14-cm model with various combinations of three-pulse bursts. Clearly, a pulse repetition frequency of 11.5 kHz gave the highest pressure amplitude indicating a resonant frequency around 11.5 kHz.

IV. Discussion

The results given in Figs. 3–5 demonstrate that microwave pulses can indeed generate measurable acoustic pressures in spherical models of human and animal heads. Further, they show that appropriately selected pulse repetition frequencies stimulate acoustic resonances that can elevate the microwave-induced acoustic pressure by severalfold. For example, the acoustic signal produced by a three-pulse burst was increased by threefold over the response to a single pulse. In general, the hydrophone response gradually increases from a low value to a peak amplitude at the resonant frequency and then falls off rapidly as the pulse repetition frequency further increases.

It is significant to note that the measured resonant frequencies of pressure waves in the spherical models compared favorably with those predicted by the thermoelastic theory based on a homogeneous brain sphere with stress-free boundaries (see Fig. 6). Specifically, measured resonant frequencies for 6-, 10-, and 14-cm diameter brain spheres were 25.5, 16, and 11.5 kHz, respectively. The corresponding fundamental frequencies of sound pressures calculated from the thermoelastic theory were 26.6, 16, 11.4 kHz, respectively. Except for the 6-cm model, the calculated and measured frequencies were essentially the same. The slight discrepancy at 6-cm (about 4 percent) probably resulted from the fact that the spherical brain had to be disengaged (with consequent changes in shape and dimensions) from the polystyrene foam to increase microwave coupling efficiency.

Thus, the results confirm the existence of microwave-induced acoustic pressures in spherical head models filled with brain-equivalent materials. Also, the agreement between calculated and measured frequencies of acoustic pressure waves lend further support to the thermoelastic mechanism of interaction.

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