(66) DEEP LOCAL HYPERTHERMIA BY FOCUSED ULTRASOUND

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Focused ultrasound is the modality of choice for creating a precisely controllable and uniform level of hyperthermia restricted to a deep-seated tumor. In contrast to plane wave ultrasound or microwaves, with focused ultrasound it is possible to restrict the temperature rise in the skin and other tissues surrounding the 'tumor' to levels significantly lower than that in the target volume itself.

A computer-controlled ultrasonic system suitable for clinical use in tumors up to 8 cm in diameter has been designed, fabricated and evaluated in large dogs in vivo. One or more, large aperture, focused transducers at a frequency of 0.6 to 2.7 MHz, are mounted on a precision, computer controlled, 3-dimensional translator. A computer is used to optimise and/or control the frequency, the power-level and the trajectory and velocity of the focused ultrasonic transduce, for the depth, the size and effective heat diffusivity of the particular 'tumor'. The inputs for depth and size can be entered manually or directly from a gray-scale ultrasonograph. The ultrasonic attenuation in the overlying tissues and, the ultrasonic absorption and the effective heat transfer in the 'tumor' itself, is measured by using pulsed ultrasound at low intensity and a 50 micron thermocouple inserted into the 'tumor' through a 22 guage hypodermic needle. The temperature distributions in the 'tumor' and in surrounding and overlying tissues are measured by one or more similar thermocouples retracted through these regions in 0.5mm or smaller steps. The thermocouple motion, data acquisition and display are also under computer control.

"Tumor' temperature distributions under different conditions of tissue perfusion and with tumor locations at various distances from bones and/or air-filled organs have been measured. The temperature rise is uniform within the prescribed 'tumor' volume and its level can be precisely controlled Away from the 'tumor' the temperature drops off smoothly in all directions. The presence of bone or air cavities below or adjacent to the 'tumor' is found to have a negligible effect on the uniformity of temperature distributions. No deleterious effects or evidence of the occurrence of cavitation damage was observed in histological studies of the insonated tissues.

Similar results were obtained in the brain of the cat with transcalvarial insonation through the intact skull. Ultrasonic properties of fresh human calvaria are being measured.

A study of the effects of hyperthermia on local perfusion and pH and evaluation of the system in spontaneous canine tumors is being initiated.

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