Abstracts

Concentric-Ring and Sector-Vortex Phased-Array Applicators for Ultrasound Hyperthermia

C.A. Cain and S.-I. Umemura. "Concentric-Ring and Sector-Vortex Phased-Array Applicators for Ultrasound Hyperthermia." 1986 Transactions on Microwave Theory and Techniques 34.5 (May 1986 [T-MTT] (Special Issue on Phased Arrays for Hyperthermia Treatment of Cancer)): 542-551.

Concentric-ring phased arrays subdivided into sectors (radial slices) can, with appropriate phasing, produce power absorption patterns useful for hyperthermia cancer therapy. The ability of a concentric-ring array to move a focal region along the central axis of the transducer is well known. Less well known is the ability of such an array to produce variable diameter annular (or ring) focal regions. Such focal rings can be effective in heating some tumors if directed around the tumor periphery. These focal rings have been produced in the past by fixed annular focus lenses, or effectively by mechanical scanning of "point" focus ultrasonic transducers. Production of these focal rings by a concentric-ring phased array has the advantage of allowing the focal ring diameter and focal length to be easily changed and scanned by phasing providing much greater heating flexibility. However, under some conditions such arrays produce very large secondary focus effects along the central axis of the amay. Concentric-ring arrays can also provide only patterns of circular symmetry. These problems can be partially solved by dividing the disk of the array into sectors. By appropriate phasing of the sectors, the intensity along the central axis can be greatly reduced. Moreover, appropriate phasing of the rings and sectors can produce patterns that are circularly asymmetric. By controlling these asymmetries, nonspherical tumors can be heated more optimally. Power absorption patterns in Iossy media for this class of applicators are analyzed numerically allowing a quantitative evaluation of both advantages and limitations of this approach. A thermal model based on the bioheat equation is also used to predict temperature distributions in volumes where important thermal parameters, particularly blood flow, are varied.

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