Abstracts

Skin heating effects of millimeter-wave irradiation-thermal modeling results

D.A. Nelson, M.T. Nelson, T.J. Walters and P.A. Mason. "Skin heating effects of millimeter-wave irradiation-thermal modeling results." 2000 Transactions on Microwave Theory and Techniques 48.11 (Nov. 2000, Part II [T-MTT] (Special Issue on Medical Application and Biological Effects of RF/Microwaves)): 2111-2120.

Millimeter microwaves (MMWs) are a subset of RF in the 30-300-GHz range, The proliferation of devices that operate in the MMW range has been accompanied by increased concern about their safety. As MMW irradiation has a very shallow penetration in tissue, the specific absorption rate is not a relevant parameter for dosimetry purposes. A thermal modeling program was used to investigate the tissue heating effects of MMW irradiation (100 GHz nominal) on the primate head. The objectives were to determine the extent to which the surface and subsurface tissue temperatures depend on applied energy density and the effects of blood flow and surface cooling on tissue temperatures. Two power ranges were considered: short-duration exposure to high power microwaves (HPMs), with power densities of 1.0, 1.5, 2.0, 2.5, or 3.0 W cm/sup -2/ for 3 s, and longer duration exposure to low-power microwaves (LPMs), with power densities of 0.1, 0.15, 0.2, 0.25, 0.3 W cm/sup -2/ for 30 s. The applied energies were comparable for both HPM and LPM exposures. The authors found both surface and subsurface temperatures increase as the energy level increases, with HPMs having a higher peak temperature than the LPMs for similar exposure energy densities. The surface temperature increase is linear with energy density for the HPMs, except under combined conditions of high blood flow (blood-flow rate of 8/spl times/10/sup -3/ g s/sup -1/ cm/sup -3/) and high-energy density (greater than 7.5 J cm/sup -2/), The LPM surface temperatures are not linear with incident energy. The peak surface temperature is affected by environmental conditions (convection coefficient, sweat rate). The magnitude of the temperature increase due to MMW exposure did not change with environmental conditions. The subsurface temperature increases are considerably damped, compared to the surface temperatures.

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