MINIATURE MICROWAVE EM APPLICATORS FOR HEATING MALIGNANT TUMORS OF RODENTS

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Heating of malignant tumors of rodents is a necessary and commonly used method of experimental studies of hyperthermia (HT) influence on the efficiency of radio- and chemotherapy treatments for malignant diseases in different combinations of the active agents and environmental conditions. As a rule, HT heating is produced by means of emerging the limb of the rodent in a heat water bath, whereas HT procedures in clinics are dominantly administered by EM or US heating. To eliminate this discrepancy, a miniature EM applicator, capable to heat the rodents' tumors locally, was warranted to be developed. The principle ideologies of the capacity type CFMA applicator [1] and the inductive type applicator with a radiating loop perpendicular to the heated area [2] were taken as key points of the design. Both variants – the capacity and the inductive types – were investigated.

The capacity type applicator antenna, exciting the electrical component of the heating microwave EM field in the heated tissue, consists of two miniature coplanar active electrodes formed by means of photo-lithography technique on one side of a 1.5 mm thick two-side copper-foiled Fluoroplast substrate. Capacities between the two active electrodes, connected by a microstrip inductance, and a shield-electrode on the opposite side of the substrate compose a resonant circuit. To adjust this resonator at the operating frequency chip capacitors are used. The mini-applicators are manufactured with an aperture diameter 12 mm at frequencies of 434MHz or 915MHz. Their overall dimensions are 14 mm in diameter and 5 mm in height. The maximum permissible input microwave power is 5 W. This power is enough to heat the rodents' tumors to temperatures up to 50°C.

The inductive applicators, exciting in the heated tissues the magnetic component of the heating EM field, are developed from the same two-side copper-foiled Fluoroplast substrate. They are parallelepipeds made from this material 1.5 mm thick. The two-side copper foils are short-circuited at one side of the parallelepiped thus forming an inductive loop perpendicular to the surface of the heated tissue volume. To form a microwave resonator, chip capacitors shunt the loop at the side opposite to the short –circuited side of the parallelepiped. The perpendicular to the heated surface position of the loop ensures homogeneous heating of the heated area without hot spots. Inductive mini-applicators were designed and manufactured with two aperture dimensions – (10×12)mm2 and (16×18)mm2. The height dimension of the mini-applicators is 6mm. The maximum permissible input microwave power is 5W.

The miniature dimension of the applicators being comparable with the dimensions of the sensor antenna does not allow measurements of the induced EM field distribution in tissue phantoms. Thus thermal testing of the developed applicators was performed at a piece of liver. Temperature measurements were accomplished by means of needle-like thermo-sensors. With an input microwave power of 1.5W there were achieved coagulation temperatures in a volume about 1cm3. The developed inductive mini-applicators with both aperture sizes are successful used in hyperthermia studies on rodents.

Besides, both types of the developed applicators - capacitive and inductive - provide the possibility of heating the rodent tumor simultaneously with radio- and chemotherapy.

References:

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2. V.N.Mazokhin, D.N.Kolmakov, N.A.Lucheyov et al., 1999, Int. J. Hyperthermia, v.15, #4, pp.309-329