EFFECT OF MILLIMETER WAVES ON TUMOR METASTASIS AND CYTOLYTIC ACTIVITY OF NATURAL KILLER CELLS

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BACKGROUND: Millimeter waves (MWs) are widely used for the treatment of many diseases in Russia and former Soviet Union countries. Three common frequencies employed in these treatments are 42.2, 53.6, and 61.2 GHz. MWs can be used as a mono-therapy or in combination with other treatment methods. As an adjunct to chemotherapy, it has been reported to protect the immune functions from the adverse effect of chemotherapy. However the mechanisms involved in this protection are not known. In previous studies we have shown that immune functions can be modulated by MWs (Logani et al., 1999; Makar et al., 2003). One of the major problems in chemotherapy of cancer is that it can enhance tumor metastasis due to suppression of Natural Killer (NK) cell activity. The present study was undertaken to examine whether MW irradiation (42.2 GHz) can inhibit tumor metastasis enhanced by cyclophosphamide (CPA), an anticancer drug.

METHODS: MWs were produced with a Russian-made YAV-1 generator. The device produced 42.2 ± 0.2 GHz modulated wave irradiation through a 10 x 20 mm rectangular output horn. Peak SAR and incident power density were measured as 730 ± 100 W/kg and 36.5 ± 5 mW/cm2, respectively. The maximum skin surface temperature elevation measured at the end of 30 minutes was 1.50C. Tumor metastasis was evaluated in C57BL/6 mice, an experimental murine model commonly used for metastatic melanoma. The animals were divided into 5 groups, 10 animals per group. The first group was not given any treatment. The second group was irradiated on the nasal area with MWs for 30 minutes. The third group served as a sham control for group 2. The fourth group was given CPA (150 mg/Kg body weight, ip) before irradiation. The fifth group served as a sham control for group 4. On day 2, all animals were injected, through a tail vein, with B16F10 melanoma cells, a tumor cell line syngeneic to C57BL/6 mice. Tumor colonies in lungs were counted two weeks following inoculation. For measurement of NK cell activity, the animals were treated as described above. NK cell activity was measured in splenocytes by the LDH release assay using YAC-1 cells as target cells

Results: CPA caused a marked enhancement in tumor metastases (5 fold) as compared to the control group. Combined treatment with CPA and MWs resulted in a significantly less enhancement in tumor metastasis (1.5 fold). Millimeter waves also increased NK cell activity suppressed by CPA suggesting that a reduction in tumor metastasis by MWs is mediated through activation of NK cells.

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