Electromagnetic Field Radiation at 2450 MHz Induces Morphological and Expression Changes in Heat Shock Proteins and Glucocorticoid Receptors on the Rat Thymus

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Aims: Electromagnetic fields (EMFs) can act as inducers or mediators of stress response through the production of heat shock proteins (HSP) that modulate immune response and thymus functions. In this study, we analyzed cellular stress levels in rat thymus after exposure of the rats to 2.45 GHz radiofrequency (RF) using an experimental diathermic model in a Gigahertz Transverse Electromagnetic (GTEM) chamber.

Main methods: In this experiment, we used H&E staining, the ELISA (Enzyme-Linked ImmunoSorbent)Assay test and immunohistochemistry to examine Hsp70and Hsp90 expression in the thymus and glucocorticoid receptors (GR) of 64 female Sprague Dawley rats exposed individually to 2.45 GHz (at 0, 1.5, 3.0 or 12.0 W power). The 1g averaged peak and mean SAR values in the thymus and whole body of each rat to ensure that sub-thermal levels of radiation were being reached. The results are expressed as means ± SEM; significant differences ($P<0.05$). The results of SAR were determined by one-way analysis, Two-way ANOVA was used to evaluate stress levels in relation to temperature, ELISA using the factors of radiation power (0, 1.5, 3, 12 W) and time after irradiation (90 m or 24 h). The Holm-Sidak test for multiple comparisons was applied subsequently. The morphological count results (number of blood vessels in the medulla, hemorrhagic reticuloepithelial cells, red blood cells and the cortex-medulla relationship) from H&E stained thymus sections were analyzed by two-way ANOVA for the two factors of radiation power (0, 1.5, 3, 12 W) and time after exposure to radiation (90 m or24 h). Multiple comparisons were then obtained by means of the Bonferroni test.

Key findings: The thymus tissue presented several morphological changes, including increased distribution of blood vessels along with the appearance of red blood cells and hemorrhagic reticulo epithelial cells. Levels ofHsp90 decreased in the thymus when animals were exposed to the highest power level (12 W), but only one group did not show recovery after 24 hours. Hsp70 presented no significant modifications in any of the groups. The glucocorticoid receptors presented greater immunomarking on the thymic cortex in exposed animals.

Significance: The combined study of HSP levels and morphological changes in the thymus tissue from radiation at 2.45 GHz with sub-thermal SAR levels leads us to conclude that:

1. Non-ionizing radiation at sub-thermal levels constitutes a quantitative and qualitative modulating agent for Hsp90, but not for Hsp70, in the thymus tissue.

2. There is a relationship between radiation and increased endothelial permeability and vascularization of the thymus.

3. The increase of glucocorticoid receptors in the cortical thymocytes incidates that radiation constitutes a stimulus for immune response.