ALTERED IN VIVO LYMPHOCYTE MIGRATION FOLLOWING WHOLE-BODY RFR EXPOSURE: DIFFERENTIAL EFFECTS ON T- AND B-LYMPHOCYTES

[redacted]

Spleen lymphocytes exhibit altered in vivo migration patterns when transplanted into recipients which are then immediately exposed to microwave radiation (2.5 GHz, 30 mW/cm^2, 45 W/g SAR, 30 min at 25^{o}C) (R. Liburdy, 1978 IMPI Symposium, Ottawa, Canada; The Journal of Microwave Power, in press). These studies have demonstrated that microwave exposure results in lymphocyte trapping in the lung, impaired lymphocyte migration to the spleen, and an increased number of lymphocytes being driven into the bone marrow. The present investigation was conducted to identify which subpopulation of lymphocytes, the T- or B-cell fraction, contributes to microwave-induced alterations in lymphocyte migration. A novel double-isotope labeling technique employing Cr-51 labeled T-lymphocytes and In-111-oxine labeled B-lymphocytes was used to follow both cell types simultaneously in the same mouse. In these studies T- and B-cells were purified on a Sepharose 6MB anti-mouse Ig affinity column, labeled with isotope, and i.v. transplanted into mice immediately prior to RFR exposure. Migration patterns were determined 18 hours post-exposure by quantitating CPM/organ/gm organ for the lungs, spleen, liver, and bone marrow. T-lymphocytes ($\geq$95% negative for surface immunoglobulin, Ig$^-$) exhibited altered in vivo migration characterized by marked trapping in the lungs, reduced traffic to the spleen and a significant redirection of lymphocytes into the bone marrow. This pattern is identical, although more marked in degree, to the altered migration for unfractionated spleen cells. B-lymphocytes ($\geq$85% Ig$^+$), however, were essentially unaffected by microwave irradiation. These results indicate that T-lymphocytes are preferentially sensitive to microwave effects on in vivo lymphocytes migration. An alteration of T-lymphocyte compartmentalization may affect cell-mediated immune function since T-lymphocytes are required for initiation and effector phases of cell-mediated immune processes. (See R.P. Liburdy, "Serum and Lymphocytes From Microwave Exposed Mice Enhance Cell-Mediated Effector Function: Increased Lymphocyte-Mediated Cytotoxicity During Allograft Rejection of EL-4 Lymphoma Cells", this symposium).

The animals involved in this study were procured, maintained, and used in accordance with the Animal Welfare Act of 1970 and the "Guide for the Care and Use of Laboratory Animals" prepared by the Institute of Laboratory Animal Resources - National Research Council.

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SUMMARY

I. Introduction

Microwave radiation induces in vivo compartmentalization of unfractionated spleen lymphocytes in the mouse (2.5 GHz, 30 mW/cm^2, 45 W/g SAR, 30 min at 25°C) (1, 2). Whole-body microwave exposure results in a 1.6-fold reduction in lymphocytes leaving the lung to migrate to the spleen at 24 hours post-irradiation. In addition, a 3.0-fold increase in lymphocytes entering the bone marrow occurs. This shift in lymphocyte compartmentalization may be directly responsible for previously reported alterations in the immune system, such as peripheral blood lymphopenia (3, 4, 6), alteration of spleen lymphocyte B- and T-cell frequency (4, 5), suppression of delayed-type hypersensitivity (4, 9), and suppression of allograft rejection (7, 8). Since T- and B-lymphocytes are responsible for particular immune processes it is important to identify whether these lymphocyte cell-types are preferentially affected by microwave radiation. Here are presented data that indicates T-lymphocyte migration is selectively altered in vivo following whole-body microwave radiation.

II. Methods

Exposure to microwave radiation (2.5 GHz; 30 mW/cm^2, 45 W/g SAR; 10 mW/cm^2, 15 W/g SAR; 30 min at 25°C) and dynamic animal core temperature measurements were performed as described earlier (1, 2, 9). Whole spleen cell preparations obtained from female Balb/c mice were fractionated on a Sepharose-6MB immunoaffinity column derivatized with the Ig fraction of rabbit-anti-mouse-Ig antiserum (10-11). The T-cell fraction was $\geq$95% Ig^-, the B-cell fraction was $\geq$85% Ig^+. T-lymphocytes were radiolabeled with $Na_2{}^{51}CrO_4$ (12). B-lymphocytes were radiolabeled in a novel application of In-111-oxine (13). Both radiolabeled lymphocyte fractions were mixed and delivered i.v. to female Balb/c recipients and then immediately exposed to microwave radiation. Eighteen hours post-irradiation surgery was performed and spleen, lung, liver and bone marrow tissue was counted on a dual-well automated gamma scintilation counter. Chromium-51 has a favorable gamma emission at 320 KeV (7%) and In-111-oxine at 173 KeV (74%).

III. Results and Discussion

Microwave radiation that was associated with significant absorbed power (30 mW/cm^2, 45 W/g SAR) resulted in altered in vivo T-lymphocyte migration (TABLE 1). There was a significant ($P<0.05$, $N\geq11$) increase in T-cell migration to the lung and liver, and bone marrow, while migration to the spleen was markedly reduced. This pattern of lymphocyte redirection was previously observed for unfractionated spleen cells (1, 2). No altered compartmentalization of T-lymphocytes occurred in the spleen, liver, or lung for 10 mW/cm^2 incident power density. Bone marrow, however, did exhibit a signif-

cant increase in uptake. The biological significance of this singular increase is unclear. Heating curves indicate no measureable increase in macroscopic temperature during the 10 mW/cm^2 exposure (Figure 1). In contrast to the effects on T-lymphocytes, B-lymphocytes were unaffected by microwave irradiation (TABLE 1). These results indicate that T-lymphocytes (Ig^+) are preferentially sensitive to microwave effects on in vivo lymphocyte migration. Alteration of T-lymphocyte in vivo compartmentalization may affect cell-mediated immune function, since T-cells are associated with these processes (See R.P. Liburdy, "Serum and Lymphocytes From Microwave Exposed Mice Enhance Cell-Mediated Effector Function: Increased Lymphocyte-Mediated Cytotoxicity During Allograft Rejection of EL-4 Lymphoma Cells", this symposium).

IV. References

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TABLE 1: Effects of Microwave Radiation on *In Vivo* T- and B-Lymphocyte Migration.

T-cell (Ig^-) Migration (CPM/T. CPM)

	Spleen	Liver	Lung	Bone Marrow
SHAM	46.9±3.0	49.2±4.1	2.87±0.30	0.925±0.06
10mW/cm^2	43.0±7.7	51.8±5.0	3.25±0.40	1.86±0.10*
30mW/cm^2	35.1±6.1*	60.1±5.5*	4.42±0.42*	2.49±0.11*

* $P<0.05$, $N\geq 11$

B-cell (Ig^+) Migration (CPM/T. CPM)

	Spleen	Liver	Lung	Bone Marrow
SHAM	21.7±2.1	72.0±6.3	4.75±1.3	1.33±0.61
10mW/cm^2	18.5±1.9	75.6±5.4	4.24±0.9	1.69±0.32
30mW/cm^2	20.4±0.6	74.1±4.9	4.16±1.4	1.36±0.45

FIGURE 1: Heating Curves for Mice During Exposure to 2.5 GHz Microwave Radiation in an Environment Equilibrated to 25°C.