Effects of Whole Body Exposure to 50Hz Electromagnetic Fields on the Intramicrovascular Leukocyte Adhesion in Mice

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ABSTRACT

Whole body exposure effects to threshold levels of 50 Hz electromagnetic fields (3.0, 10.0, 30.0 mT for acute exposure and 0.3, 1.0, 3.0 mT for subchronic exposure) on intramicrovascular behavior of leukocytes in the cutaneous microcirculation was evaluated by a dorsal skinfold chamber technique in mice under conscious conditions. The results indicated that the exposure intensity at 3.0 mT is a threshold level for increasing leukocyte adhesion to the endothelial walls.

KEYWORDS

50 Hz EMF exposure, leukocyte adhesion, microcirculation

INTRODUCTION

Effects of 50Hz electromagnetic fields (EMF) exposure on leukocyte are mainly performed in vitro system, however, little information of these is available in vivo experiments. In order to investigate the acute and subchronic exposure effects of threshold levels of 50Hz EMF on leukocyte behavior in vivo system, we measured the behavior of intra-microvascular leukocytes in the cutaneous microcirculation in mice by use of a dorsal skinfold chamber (DSC) technique (Fig 1, 2).

Fig. 1. Mouse Having A DSC
MATERIALS AND METHODS

Male mice (BALB/c) having the DSC were subjected to intravital-microscopic study. We have developed the DSC with non-metal materials of Duracon resin, which could not be physically affected by EMF exposure. For visualization of intra-microvascular leukocytes, fluorescent dye (rhodamine 6G; 0.3mg/kg, iv) was injected. The numbers of leukocyte rolling or adhering to the venular walls were measured by confocal laser microscopy and recorded into VCR and analyzed from the images (Fig 3, 4). The magnetic flux densities used for the acute exposure (30 minutes) were controlled at 3, 10, 30 mT at the center of animal body (n=10 each), respectively. For subchronic exposure study, mice were divided into 4 groups(n=10 each), i.e., exposure group with 50 Hz EMF at 0.3, 1.0 and 3.0 mT and control group with sham exposure. The 50Hz EMF exposure was intermittently performed everyday from 16:00 to 12:00(20hours/day) for 15 days (Fig 5). Plasma cytokine (IL-1β, TNF-a) concentration was measured by ELISA.
Dye: 0.02% Rhodamine 6G
Dye was injected from tail vein.

Fig. 3. Experimental Set-Up For Visualization Of Leukocytes
Leukocytes labeled with rhodamine 6G are visualized under confocal laser microscopy system with EB-CCD and CSU10

Fig. 4. Video Image of Intravascular Leukocyte
arrow shows labeled leukocyte.
Fig. 5. Experimental Protocol

Fig. 6. Changes In Rolling Leukocyte Counts Due To Acute Exposure (30min) Of 50 Hz
Statistically significant difference (p<0.05) was noticed between pre- and post-exposure at 30.0 mT
RESULTS AND DISCUSSION

Acute Effects: A tendency to increase the adherent cell count of leukocytes due to the 50 Hz EMF exposure toward higher magnetic field intensity was recognized. Following the exposure at 30 mT, the counts of adherent cell was significantly higher than those obtained before exposure (p<0.05, Fig 6).

Subchronic Effects: Following subchronic exposure to 50Hz EMF at 3.0 mT, statistically significant increases (p<0.05) in adherent leukocyte counts were noticed, however, there was no statistically significant changes between before and after exposures in any other groups (Fig 7,8). No noticeable changes in IL-1β and TNF-α concentration were observed in any groups.

Subchronic Effects: Following subchronic exposure to 50Hz EMF at 3.0 mT, statistically significant increases(p<0.05) in adherent leukocyte counts were noticed, however, there was no statistically significant changes between before and after exposures in any other groups (Fig 7,8). No noticeable changes in IL-1β and TNF-α concentration were observed in any groups.

The results indicated that 50 Hz EMF exposure may influence cell to cell interaction between venular endothelial cells and leukocytes. Previous observations using human monocyte in in vitro system indicated that changes in cytokine profile of monocyte were induced by exposures of 50 Hz EMF [1,2]. We hypothesize that 50 Hz EMF exposure effects on leukocyte and endothelial cell interaction due to change in cytokine levels, however, IL-1β and TNF-α may not be involved in this phenomenon (Fig 9). Further studies will be required.

REFERENCES


2) Jonai H, Villamueva MBG, Yasuda A: Cytokine profile of human peripheral blood mononuclear cells exposed to 50 Hz EMF. Industrial Health, 34: 359-368, 1996