An Effect of Extremely Low Frequency Magnetic Field on TNF-alpha Concentration in Serum

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Abstract

The influence of extremely low frequency (ELF) magnetic field on the TNF-alpha concentration in serum of Wistar rats was studied. The study was carried out on male Wistar rats in 4 experimental groups and in a control group. The rats were exposed during 3 or 6 days (8 minute a day) to an ELF magnetic field of a complex shape generated by a device used in medicine. Two different RMS values of magnetic field induction: B₁=0.06mT and B₂=0.14mT were applied during the experiment. The concentration of TNF-alpha in serum of rats increased after exposure to the ELF magnetic field.

Keywords: extremely low frequency (ELF) magnetic field, TNF-alpha

Introduction

In our preliminary study we described that extremely low frequency (ELF) magnetic field may change the function of immunological system, because ELF magnetic field increased IgG concentration in serum of rats [1]. Cytokines are non-immunoglobulin polypeptides secreted by monocytes and lymphocytes in response to interaction with a specific antigen, a non-specific antigen, or a non-specific soluble stimulus. They affect the magnitude of inflammatory or immune responses. Although secretion of cytokines may be triggered by the interaction of a lymphocyte with its specific antigen, cytokines are not antigen-specific; thus they bridge innate and learned immunities [2]. Tumor necrosis factor-alpha (TNF-alpha) is secreted by macrophages in response to inflammation, infection, and cancer. TNF-alpha plays a major part in tissue inflammation and remodeling by stimulating production of collagenase gene expression. This cytokine may also be important in stimulating apoptosis of either inflammatory or fibrogenic cells through its interaction with death receptors [3].

The aim of our paper is to present the studies of the influence of the ELF magnetic field on the TNF-alpha concentration in serum.

Material and methods

The experiment was carried out on 30 rats, males of Wistar FL strain, sexually matured. The rats came from the Central Experimental Animal Quarters of the Medical University of Silesia. The animals were kept in unchanged conditions, with maintenance of the circadian cycle day-
night, and with the standard food and water available ad libitum.

The rats were exposed to the ELF magnetic field of a complex shape generated by a device [4] used in medicine during 3 or 6 days. Five groups were used in this experiment:

Group 1 – control group, absence of ELF magnetic field
Group 2 and 3 – exposure to the ELF MF B_{max}= 0.06 or 0.14 mT during 3 days, 8 min. a day
Group 4 and 5 – exposure to the ELF MF B_{max}= 0.06 or 0.14 mT during 6 days, 8 min. a day

The animals were sacrificed for experiment in 2nd day after exposure to the ELF magnetic field. From the blood samples serum concentration of TNF-alpha (ELISA, R&D Systems) was obtained. Statistical analysis was done with Statistica 5.1 using test t for the dependent variables.

**Results and discussion**

Concentrations of TNF-alpha in serum of rats after exposure to ELF magnetic field in comparison with control group are shown in Table 1. In rats of groups 3, 4 and 5 the concentration of TNF-alpha increased.

**Table 1. **TNF-alpha concentration (pg/ml) in serum of rats during experiment. Mean values with standard deviation (SD) and significance level p in relation to the control group.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Means ± SD</th>
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<tbody>
<tr>
<td>Control group, absence of ELF magnetic field</td>
<td>14.67 ± 5.06</td>
</tr>
<tr>
<td>Group 2 3 days B_{max}=0.06mT</td>
<td>19.07 ± 2.51</td>
</tr>
<tr>
<td>Group 3 3 days B_{max}=0.14mT</td>
<td>149.08 ± 43.74*</td>
</tr>
<tr>
<td>Group 4 6 days B_{max}=0.06mT</td>
<td>136.92 ± 35.70*</td>
</tr>
<tr>
<td>Group 5 6 days B_{max}=0.14mT</td>
<td>179.45 ± 33.75*</td>
</tr>
</tbody>
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* p<0.0005 experimental group vs control group

It was reported that extremely low frequency (ELF) electromagnetic field causes biological effects in vitro and in vivo [1, 4-7]. These effects are modulation of DNA, RNA and proteins synthesis, membrane signal transduction, and cell proliferation. Changes in hormone production, cell growth rate, enzyme activity and water properties were also reported. ELF magnetic field may change the function of immunological system, because ELF magnetic field increased IgG concentration in serum of rats.

The immune system is composed of a large variety of cells and mediators that interact in a complex and dynamic network to protect the host against foreign pathogens and to simultaneously maintain tolerance toward self-antigens. This system is categorized into innate and adaptive immunity, both of which are key participants in generating acute and chronic inflammatory responses. Innate immune cells, such as macrophages, natural killer (NK) cells, and dendritic cells (DC) are the first line of defense against a foreign pathogen. These cells maintain tissue homeostasis by continuously monitoring the environment for signs of distress and are critical for the activation and modulation of the specific adaptive immune response.

One component of the immune system that molds the host response to foreign pathogens is cytokines, which are secreted or membrane-bound proteins that regulate the growth, differentiation, and activation of immune cells. These proteins are generally grouped into two categories, pro or anti inflammatory, although several cytokines do not fit specifically into either category. In fact, many cytokines have pleiotrophic functions, and some can act in a synergistic manner. TNF-alpha produced by CD4 Th cells, is generally referred to as pro inflammatory [8].

In our study we reported that concentration of TNF-alpha in serum of rats increased (groups 3, 4 and 5) after exposure to the ELF magnetic field. TNF-alpha affects the immune system directly and indirectly through release of many cytokines. TNF-alpha cooperating with II-1, II-2, II-7 enhances thymocytes proliferation, while with II-6 it may cause an increase in proliferation and differentiation of B lymphocytes. By endo-, para-, and autocrine activity TNF-alpha influences monocytes and macrofages. It also considerably increases cytotoxicity of monocytes, macrophages and NK cells. TNF-alpha increases phagocytic capability of neutrophils and accelerates their release from bone marrow. It may also activate the eosinophils’ cytotoxicity in protozoa infection response. TNF-alpha is capable of inducing the expression of MHC (Major Histocompatibility Complex) class I molecules, but together with IFN-gamma the expression of MHC class II is induced [9].

**Conclusions**

ELF magnetic field changes the function of immunological system.

**References**


