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EFFECT OF ELECTROMAGNETIC FIELDS ON CHANGES OF RBC, WBC CORTISOL HORMONE AND IMMUNE SYSTEM IN GUINEA PIGS

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ABSTRACT

Electromagnetic field have various effects on living organisms such as blood composition or enzymatic changes. The effects devoted on the electromagnetic magnitude and time of exposure. This study is carried out to measure variations of RBC, WBC, Lymphocyte and Cortisol Hormone level in 36 adult male Guinea pig. Group A as control group exposed to nil electromagnetic field for 2 h per day for 5 days duration , group B exposed to 0.013 μT in 5 Hz to the same duration period , group C exposed to 0.207 μT in 50 Hz in similar condition , group D exposed for 4 h per day for 5 days in 0.013 μT, group E tested in 0.207 μT as group D , group F used as controlled group exposed for 4 h per day in nil electromagnetic field. Blood of Guinea pig tested after 5 days then data analyzed by Dunnett test and one way ANOVA that indicated a significant difference between control group and tested group of four hours, RBC, WBC and Lymphocyte level decreased , only WBC in group C increased but Cortisol Hormone in group C decreased .

Key word: Electromagnetic field- WBC - RBC - Lymphocyte- Cortisol Hormone- guinea pig

INTRODUCTION

Human is in exposure of varieties of electromagnetic fields arise from natural and artificial sources such as earth radiant and heat radiances with intensity about 0/003 W/M^2 and with frequency more than 300 GHz (Ali, 2001). Electromagnetic fields are part of the natural environment perceived and is employed by various specious. An good example of this phenomena is a certain electric senses in some Fish species used in searching for food or for orientation during migration (Peter, 2002). Also Several home/ environmental sources generating field (EMMA), such as 50-60 Hz high voltage transmission lines, video display terminals, electric blankets, clinical nuclear magnetic resonance (NMR) imaging procedures, etc, may interact with the human body (Flipo, 1998; Azza, 2002).

Extremely low frequency (EMF) covers the frequency range of 3 Hz up to 3 KHz. The most intensely studied frequency is the power frequency of 50-60 Hz. Electric appliances and power lines emit 50-60 Hz EMF (Lai, 2001). There has often been the repeated question in the past whether and if so, to which extent electromagnetic fields are capable to affect biological systems, in particular, of the human organism. Therefore in recent years numerous investigations on the issue of interactions between low and high frequency electromagnetic fields with organisms have been performed and published (Peter, 2002). Although the harmful effects of weak electromagnetic fields produced evidences by home equipments electric are doubtful, but there exists some evidences of four term exposure to computer monitor (on the spur of the occupation) increased abortion of fetus probability in pregnant women (Soleimanirad, 2001).

Also exposing to electromagnetic fields with specific intensity, leads to a decrease. In Melatonin hormone and testosterone hormone and increases prolactin, estrogen hormones and the risk of breast cancer in individuals susceptible to breast cancer (Bahaediny, 2002; Mercola1,1998; Richard, 1993; Moolgav-Kav, 1980; Blask, 1990).

It has recently been hypothesized that exposure to EMF during an extended period of tumor development might increase the effects of Known carcinogens (Tarantion, 2005). Since cancer of the blood forming elements is frequently reported in connection with EMF exposure. It is reasonable to expect that any progressive change, be manifested in a phenotypic change in blood cells (Andrew, 1995). Mentioned information indicate the increase of application of electromagnetic fields in medical industry for various intentions, which necessitates multilateral investigation on effects of electromagnetic fields with different intensities and various frequencies on physiologic functions. Therefore the effects of electromagnetic fields with the magnitude of 0.013 μT and 0.207 μT have been used on RBC and WBC levels in this study.

MATERIALS AND METHODS

Adult males (36) Guinea pigs with an average weight of 363.17 ± 10.58 were used. The animals were rested 12 hours in light condition and 12 h in darkness. Water and food were freely provided. Animals were dividend in to

6 groups. 1) Group A: were exposed , 2 h daily for 5 days to nil magnitude. 2) Group B: was exposed 2 h daily for 5 days to a field of 0.013 μT with 5 Hz frequency. 3) Group C: was exposed to a field of 0.207 μT with 50 Hz frequency for the same period of time . 4) Group D: was treated for 5 days , with 4 h daily exposure to a field of 0.013 μT with 5 Hz frequency . 5) Group E: treated for 5 days, with 4 h daily to a field of 0.207 μT with 50 Hz. 6) Control group (F): to treated for 5 days, with 4 h daily at nil field.

Solenoid (electromagnetic field generator) of a cylindrical armature winding consist of 15 rings of armature winding with each ring consisting of 100 rounds of wire i.e. A total of 1500 rounds of wire were used in this solenoid. For generating field rate with intended frequencies, function generator connected to solenoid was used. After exposing animals to the mentioned fields for 5 days. Blood samples from the Guinea pigs with contaminated hubbub at heparin (for Inhibition of Clot) was taken. After the amount of EBC and WBC had by cell counter, blood serum was separated and the amount of cortisol hormone was measured by RIA. For statistical analysis we used a "one-way ANOVA test" and "Dunnett test". Resulted to significant level of $p \leq 0.05$.

RESULTS AND DISCUSSION

In this study the effect of electromagnetic fields with 1) 50 Hz Frequency and 0.207 μT strength , 2) 5 Hz of frequency and 0.013 μT strength on the change of RBC and WBC density in the blood was studied. In test carried out for five days. The effect of 2 and 4 h exposure on adult male guinea pigs was studied. A remarkable difference was noticed between 2 and 4 h of exposure control and test groups. Results from this survey conclude that, EMF based on the situation of the tested cell (Walleczek, 1990; Cossarizza, 1989; Conti, 1986) and the field parameters can act like controllers or activators.

There is a significant decrease in the average RBC level in Control and test groups with four hours of exposure to the strength of 0.013 and 0.207 μT in 5 and 50 Hz frequencies (Table 1).

Table 1.Level average of RBC.

Four hours	Two hours	*Group $10^{12}/L$*
5.04 ± 0.22	5.006 ± 0.08	5Hz-0.013 μT test group
5.12 ± 0.15	4.96 ± 0.28	50Hz-0.207 μT test group
5.71 ± 0.12	4.49 ± 0.22	Control group

The results indicate level of WBC of test and control groups in four hours exposures decrease significantly with field rates of 0.207 μT and 0.013 μT in 5 and 50Hz frequencies, in the level of $p<0.05$. In the contrary there is a significant increase between the WBC in the test and control groups of two hours exposures with the strengths of 0.013 and 0.207 μT in 5 and 50 Hz frequencies (Table 1 & 2).

Table 2. Average Level of WBC.

Four hours	Two hours	*Group $10^{9}/L$*
3.57 ± 0.37	6.22 ± 0.86	5Hz-0.013 μT test group
7.49 ± 0.89	4.05 ± 0.49	50Hz-0.207 μT test group
11.46 ± 1.68	3.04 ± 0.18	Control group

The results indicate that a significant ($p \leq 0.05$) increase in the level of Lymphocytes in 4 h of test and control groups with field rate 0.027 μT in 50 Hz frequency, a significant increase of $p \leq 0.05$ (Table 3).

Table 3. Average percentage of Lymphocyte in two and four hours.

Four hours	Two hours	Group 10^9/L
74.86 ± 4.46	58.75 ± 4.86	5Hz-0.013 μT test group
53.90 ± 2.24	52.45 ± 1.49	50Hz-0.207 μT test group
33.61 ± 3.59	54.11 ± 2.59	Control group

The density of cortisol in the guinea pigs of test and control groups of two and four hours shows that there is a significant decrease between the cortisol in the of test and control and test groups in two hours time period with the strength of 0.207 μT and 50 Hz (Table 4)

Table 4. Average serum concentration of cotisol hormone.

Four hours	Two hours	*Group ug/l*
439.12 ± 58.50	568.46 ± 25.4	5Hz-0.013 μT test group
452.50 ± 42.74	327.65 ± 34.29	50Hz-0.207 μT test group
332.25 ± 54.67	586.67 ± 50.35	Control group

CONCLUSIONS

Mukewar (2003) studied females and males rat sprague subjected to electric fields of 1/5 KV/m and 10 KV/m strengths for 30, 60 and 120 days. The study indicated that leukocytes or white blood cells upon exposure to 1/5 KV/m electric field showed significant decrease in both, males (P<0/001) and in females (p<0/05) initially in 30 days, but significant increase was observed in numbers, from 90 to 120 days. Leukocyte count observed in 10 KV/m exposure group was increased from 30 to 120 days both in males and females while total RBC count suffered significant reduction in females in 1/5 KV/m exposure (p<0/01) and in 10 KV/m exposure (P<0/05) on day 30.

Marino (1995) studied the health status of personnel exposed to emission characteristics of the experimental radar and high frequency radio equipment at the Naval Research Laboratory (NRL). The daily average exposure of the workers to EMF varied from 1 to 8 hours per 8 hour shift, and the length of exposure varied from 2 to 52 months. The cell amount increased progressively with number of months of exposure to EMF but the RBC count was not correlated with time of exposure to EMF, while WBC count was significantly correlated with months of exposure.

Bonhomme (2003) studied effects of EMF on the immune systems. He examined immunological disorders in 6 individuals who had been exposed occupationally to environmental electromagnetic fields during 8 hr/ day for 5 yr in a Laboratory.The lab was located above electrical transformers and high tension cables with low frequency electromagnetic fields of 0.2-6.6 microtesla. Six months exposure resulted, to lymphocyte increase, as had CD_4, CD_3 and CD_{19} counts. At the same time, 12 swiss male mice housed in cages were exposed in the same room in which the human subjects had been exposed (I,e., 5- μT 50-Hz magnetic Field) for 109 days.

Under high magnetic field and volatilized aromatic hydrocarbon exposures a significant increase in mean T3 and T8 levels, and also a significant alteration in T4/T8 ration in ten of the subjects due to disproportionate

elevations of the T8 subpopulation were observed (Davis, 1990; Garaj, 1990). In the present study the results indicate that electromagnetic fields with intensities 0/013 and 0/207 μT for 4 h led to a decrease in the number of RBC, while lymphocytes percentage increased. Electromagnetic field with the intensity 0/013 μT for two hours caused to increase in the number of WBC. The result of this research in relation with decreasing the number of RBC and WBC and the effect of electromagnetic fields on the bone marrow in connection with previous studies confirms the fact that electromagnetic fields cause the decrease of the cellular proliferation and differentiation (Wult, 2005;Van, 2001).

With attention to above fact, it seems that decreasing of RBC and WBC numbers is due to effect of electromagnetic field on bone marrow. Also it seems that decreasing the number of WBC and increasing lymphocytes percentage demonstrate the effect of electromagnetic fields on immune system, that lead to increase immune system activity, probably because of releasing CSF (colony stimulating factor). But in relation with increasing the number of WBC in electromagnetic field with the intensity 0/013 μT for two hours , results indicate that decreased level of cortisol hormone in this study. We know that the increasing of cortisol hormone cause to decreasing of WBC number. Therefore it seems that increasing of WBC is due to decreasing of cortisol hormone.

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