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Effects of Extremely Low Frequency Electromagnetic Fields on Testes in *Guinea pig*

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Abstracts: This study is carried out to measure the changes in testosterone hormone level and changes in testes tissue on 36 adult male *Guinea pigs* that divided to 6 groups. Group A as control group exposed to nil Electromagnetic Field (EMF) for two hours 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 conditions, group D exposed for 4 h day⁻¹ 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 four hours per day in nil electromagnetic field. *Guinea pig* blood was tested after 5 days. Then data analyzed by t-test. The results indicated a significantly difference between control group and tested group of four and two hours, testosterone level decreased ($p \leq 0.001$), also testes tissues were sampled and observed main tissue changes in some treatments.

Key words: Electromagnetic field, testes, testosterone hormone, *Guinea pig*

INTRODUCTION

In modern society, humans are commonly exposed to Magnetic Field (MF) including Extremely Low Frequency Magnetic Field (ELF_MF), which is generally produced by power lines and many kinds of electric appliances. Moreover, application of magnetic field devices in medicine as a diagnostic tool (magnetic resonance imaging or magnetic resonance spectroscopy used to study tissue metabolism) or as therapeutic techniques (to enhance bone fracture healing and tissue regeneration), increased the chance of exposure to magnetic fields (Aisha, 2006). One of the mostly discussed contemporary problems is if ELF_MF can affect biological systems (Strasak and Smarad, 2002; Sabo *et al.*, 2002; Okano, 2002). There have been of considerable discussions about the biological response to the exposure of electromagnetic field (EMF). Public hazard and health effect is one of the major concerns (Chen, 1992). 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 (Benquet and Roux, 1998; Azza, 2002). Extremely Low frequency electromagnetic field covers the frequency range of 3 Hz

up to 3 KHz. The highest intensity studied frequency is the power frequency of 50-60 Hz because electric appliances and power Lines emit 50-60 Hz EMF (Henry, 2001). The biological effects of extremely low frequency electromagnetic fields (ELF-EMF) have been a concern since Wertheimer and Leeper reported that children living in homes with an excess of electrical wiring configuration suggestive of high current flow had a higher incidence of cancer (Gang, 2000). 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 (Jafar, 1996). Also exposing to electromagnetic fields with specific intensity, leads to a decrease in Melatonin hormone (Blackman, 2001; Rodriguez, 2004) and testosterone hormone and increases prolactin, estrogen hormones, LH and FSH hormones (Mostafa, 2006). During the past 20 years a number of studies have suggested an increased risk of cancer induced by electromagnetic fields (Bahaediny, 2002; Joseph, 1998; Aisha, 2006).

It has recently been hypothesized that exposure to EMF during an extended period of tumor development might increase the effects of Known carcinogens (Patrizia, 2005). 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 and 0.207 μT have been used on the reproductive organ in this study.

MATERIALS AND METHODS

All procedures in this study done in Biology Laboratory of Science Faculty (Urmia University) from Feb to Sep 2006. Thirty six adult male of *Guinea pigs* (Pasteur Institute Iran) with an average weight of 363.17 ± 10.58 g were used. The animals were rested 12 h in light conditions and 12 h in darkness. Water and food were freely provided. Animals were divided in to 6 groups. Group A was exposed, 2 h daily for 5 days to nil magnitude. Group B was exposed 2 h daily for 5 days to a field of 0.013 μT with 5 Hz frequency. Group C was exposed to a field of 0.207 μT with 50 Hz frequency for the same period of time. Group D was treated for 5 days, with 4 h daily exposure to a field of 0.013 μT with 5 Hz frequency. Group E treated for 5 days, with 4 h daily to a field of 0.207 μT with 50 Hz. Control group F treated for 5 days, with 4 h daily at nil fields.

Solenoid (electromagnetic field generator) of a cylindrical armature winding including of 15 rings of armature winding with each ring consisting 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 (Germany PHYWE). After exposing animals to the mentioned fields for 5 days, In fifth day, animals were anaesthetized with the ether and then blood samples from the *Guinea pigs* with contaminated heparin (for inhibition of Clot) were taken. For testosterone determination, blood samples were collected in plain tubes allowed to coagulate and the serum fraction was recovered and frozen. The concentration of testosterone was determined by RIA. Statistical analysis carried out by t-test and ANOVA using SPSS (version 12) computer software. The results were significantly level of $p \leq 0.001$. After removal of the testes, they were immediately fixed in formalin and embedded in paraffin; 5 μm -thick sections were stained with hematoxylin and eosin.

RESULTS AND DISCUSSION

The effect of EMF on the level of testosterone: The mean values ($\pm\text{SE}$) of testosterone levels for exposed and control in *Guinea pigs* are shown in Table 1. Statistical

Table 1: Concentrations of testosterone (ng mL^{-1}) in serum exposed to magnetic field in *Guinea pigs*

Groups	Hours	
	2	4
5 Hz-0.013 μT	0.25 \pm 0.102	0.320 \pm 0.05
50 Hz-0.207 μT	0.98 \pm 0.180	1.040 \pm 0.08
Control	0.83 \pm 0.190	1.003 \pm 0.22

Data are presented as mean \pm SE

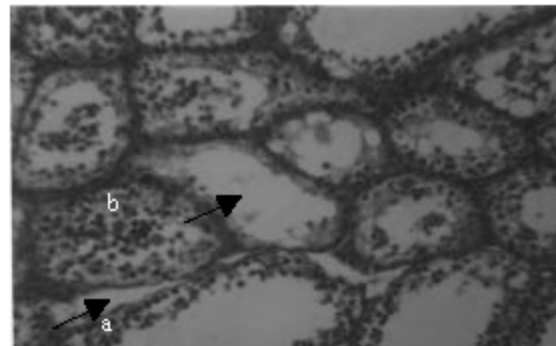


Fig. 1: Section of testis *Guinea pig* exposed to 5 days of EMF, showing (a) atrophied intra-tubular tissue and (b) atrophied seminiferous tubules. H and E, X400

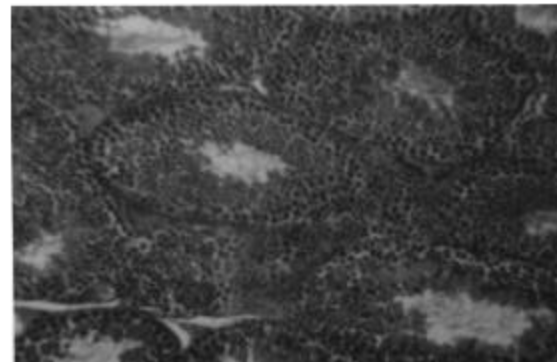


Fig. 2: Normal testis tissue. H and E, X40

analysis gives evidence of significant difference between exposed and control groups. There was significant decrease in group B (5 Hz-0.013 μT -2 h exposure) and group D (50 Hz-0.207 μT -4 h exposure) in compared to their control groups.

Effect of electromagnetic field on testes tissue: EMF exposure-related histopathological alterations were found in testicles. Changes consist atrophied seminiferous tubules and interstitial tissue and decrease of the number of Leydig cells (Fig 1, 2).

Findings of the present study shows that the level of testosterone hormone in B and D experimental groups (exposed to EMF with frequency of 5 Hz) have been decreased significantly, that histological studies on testes

tissue showed that in the groups B and D in addition to decreasing testosterone hormone, there was destructive effects in testes tissue and leydig cell caused by EMF with frequency of 5 Hz (The decrease of Testosterone hormone may have resulted from the inter-tissual space and leydig cells damages).

While in present study, it was observed that EMFs with frequency of 50 Hz in C and E experimental groups have not any effects on testes tissue and testosterone hormone level.

But some previous studies conducted by Ozgune (2005), Lokhmatova (1993) and Persinger (1972) like present study suggest that EMFs with frequency of 5 Hz affect testes and testosterone hormone level in destructive way.

Also reports offered by Aisha (2006) and Zsolt (2004) emphasize the subject the EMFs with frequency of 50 Hz have not significant effect on testes and testosterone hormone level and this confirms present results. While other studies (Zulkuf, 2006; Jafar, 1996) have shown that EMFs can cause alterations in reproduction system.

In case of function mechanism of electromagnetic fields, it's believed that EMF with high energy waves cause to rise local temperature where waves contact together and like ionizing rays through formation of free radicals, create their destructive effects. Free radicals attacking lipid and changing their natures and breaking protein bounds cause cell damaging (Jafar, 1996). EMF in groups B and D cause to increase the inter seminiferous tubes space and damaging leydig cells that increase the inter-tissual space because of increasing intra-tissual liquid and emerging edema that probably arise from testes tissue cells damage. Because of leydig cells damage the level of testosterone hormone in blood decreased and led to disorder in spermatogenesis.

Nowadays some medical devices like MRI that was applied for diagnostic purposes run in intensive electromagnetic base, require to further studies regarding destructive effects of EMFs with certain frequencies concluded the results of previous and present studies.

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