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EFFECT OF EXPOSURE TO 50 Hz, 5 mTESLA MAGNETIC FIELD ON SEX HORMONE STATUS IN MALE RATS

Yasser M. Moustafa[1], Randa M. Mostafa[2] and Fadel M. Ali[3]

[1]*Department of Pharmacology and Toxicology, Faculty of Pharmacy, Suez Canal University, Ismailia, Egypt*
[2]*Department of Physiology, Benha Faculty of Medicine, Zagazig University, Benha, Egypt*
[3]*Department of Biophysics, Faculty of Science, Cairo University, Cairo, Egypt*

لقد أثار انتباه العلماء تأثير المجالات المغناطيسية شديدة الانخفاض على الأنظمة الحيوية ، وأن كانت الاحتمالات النظرية لكيفية حدوث التفاعل مازالت مجهولة. وفى هذا البحث تمت دراسة تأثير المجال المغناطيسى شديد الانخفاض (50 Hz, 5 mTesla) المخلقة فى حجرة مغناطيسية على الهرمونات الجنسية فى ذكور الجرذان. ولقد تعرضت الجرذان للمجال المغناطيسى فى مجموعات لمدة أسبوع ، ولمدة أسبوعين، ولمدة أربع أسابيع مقارنة بمجموعات ضابطة لكل منهم. ولقد ثبت لدينا عدم تأثر هرمون Testosterone فى كل المجموعات. كما أظهرت النتائج زيادة هرمون FSH زيادة ملحوظة فى المجموعة التى تعرضت لمجال مغناطيسى لمدة أسبوع ، وكذلك زيادة هرمون LH زيادة ملحوظة فى المجموعة التى تعرضت للمجال المغناطيسى لمدة أربع أسابيع مقارنة بمجموعتهما الضابطة وبمجموعات التعرض الأخرى. اما هرمون Prolactin فقد ازداد بشكل تصاعدى فى المجموعات التى تعرضت للمجال المغناطيسى. ونستخلص من هذه النتائج أن المجال المغناطيسى شديد الانخفاض (50 Hz, 5 mTesla) له تأثيرات واضحة على الذكورة فى ذكور الجرذان.

The question of whether extremely low frequency magnetic fields can affect biological system, has attracted attention by many research groups for quite some time. Still today, the theoretical possibility of such an interaction is often questioned and the site of interaction is unknown. In the present study, the influence of Extremely low frequency magnetic field of 50 Hz, 5 mTesla on sex hormone status in male rats was studied. 60 male albino rats, divided into 6 groups of 10 animals each. Animal groups were continuously exposed to 50 Hz, 5 mTesla magnetic field generated by magnetic field chamber for periods of one week, two weeks and four weeks. For each experimental point, sham treated group was used as a control. Assay of serum testosterone hormone, Lutenizing Hormone(LH), Follicular stimulating hormone (FSH) and prolactin hormone were performed. Serum testosterone hormone level showed no significant changes, serum FSH showed significant increased than sham exposed group only after 1 week magnetic field exposure, serum LH showed significant increase than sham exposed group only after 4 weeks magnetic field exposure while serum prolactin hormone level showed significant increase in all magnetic field exposed groups than sham exposed animals. We conclude that exposure to 50 Hz, 5 mTesla magnetic field for periods of 1,2 and 4 weeks has no effect on testosterone level, some changes on FSH and LH serum levels and increase in serum prolactin level.

INTRODUCTION

An electrical magnetic field is composed of two components, electric and magnetic field.[1] The question of weather extremely low frequency magnetic fields (ELFMF) can affect biological systems, has attracted attention by many research groups for quite some time. ELFMF, such those originating from residentially proximate power line, household electrical wiring, medical devices, cellular phone and wireless communication, have been reported to produce a variety of biological effects.[2-7]

Recently, the possible health effects of magnetic fields on reproduction and development including gametogenesis, fertilizaton, implantation, embryogensis and

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endocrine systems have been extensively studied on human and experimental animals[8-11] however, the results of similar studies have often differed markedly from one another.

Gonadotrophin releasing hormone (GnRH) is synthesized in hypothalamus and released into the hypophyseal portal system in a pulsatile nature to stimulates and regulates FSH as well as LH synthesis and release. The major hormone controlling GnRH secretion is testosterone which inhibits gonadotropin secretion via negative feedback at both the hypothalamic and pituitary level.[12,13] FSH stimulates the Sertoli cells in the seminiferous tubules to produce mature sperm while LH stimulates testosterone production from the leyding cells of the testis. Testosterone acts systemically to produce male secondary sexual characteristics, anabolism and the maintenance of libido. On the other hand, testosterone feeds back on the hypothalamus pituitary to inhibit LH releasing hormone (LHRH) secretion.[14]

Prolactin is a glycoprotein hormone produced in the anterior pituitary. It is the principal hormone responsible for lactation and immune response by stimulating expression of receptors on T lymphocytes.[15] In human, prolactin may inhibit the secretion of gonadotropins or their effects on the gonads and hyperprolactinemia in male may cause loss of libido and impotence.[16,17]

In this study the influence of ELFMF of 50 Hz, 5 mTesla on sex hormone status in male rat has been examined.

MATERIAL AND METHODS

a) Animals

Sixty male Wister rats (125-175g Faculty of Veterinary, Moshtoher, Egypt) were used in this experiment. After 3 days of habituation to the laboratory environment, animals were housed in either a magnetic field chamber or a similar chamber without a magnetic field. The colony room was held under 12-h light/ 12-h dark cycle (light 7 am-7 pm) and at room temperature. They had a free access to food and water. Animals were removed daily for cleaning and renewing food and water supply.

b) Magnetic field chamber

It consisted of a parallel double walled cylindrical cage made of copper plate (2-mm thick) and was 114-cm internal diameter, 140-cm external diameter and 152-cm long. The two cylinders were sealed at each end with copper to permit water flow between the two layers. Four coils of 270 turns each from electrically insulated 2.2-mm copper wire were wound around the outer cylinder at equal distance. The four coils were connected in parallel to minimize the total impedance of the wire and allow homogenous magnetic field within the chamber volume. The cylinder was grounded. A mesh from copper was used to cover both ends of the cylinder. The coils were connected to a variac fed from the mains (220V and 50 Hz). The magnetic field inside the camber was measured at different locations using a hand-held Guass/Tesla meter model 4048.001 (USA) of ±2% accuracy was used to calibrate the magnetic field. The field strength can be varied by means of variac up to 2.5 mTesla inside the homogenous zone without an increase in the chamber temperature (±0.5°). Ten animals were located inside magnetic chamber at a time. The magnetic field at the location of the animals was 5 mTesla for the treatment groups and 0.01 mTesla for control group.[5]

c) Exposure

Rats were divided into six groups, 10 animals in each group. Group I was used as control for group II and was not exposed to ELFMF. Rats in group II were exposed to ELFMF of 50 Hz, 5 mTesla while maintaining in their cages inside the magnetic field chamber for one week. Group III was used as a control for group IV and was housed for two weeks in the magnetic chamber that was turned off. Group IV was exposed to ELFMF of 50 Hz, 5 mTesla for two weeks. Meanwhile, group V was used as a control for group VI and was maintained for four weeks in the magnetic chamber without exposure to ELFMF while group VI was exposed to ELFMF of 50 Hz, 5 mTesla for four weeks.

d) Hormonal assay

Each rat was anaesthetized with ether and scarified by cervical dislocation. Trunk blood was collected in centrifuge tube and immediately centrifuged at 4000 rpm for 10 minutes. Serum was collected and stored at -20° until assayed for FSH, LH, testosterone and prolactin hormones. The hormonal measurements were done by radioimmunoassay methods according to the methods described by Immulite kits. Reagents for determination are packed in commercial kits provided by Diagnostic Products Corporation (DPC).[18]

RESULTS AND DISCUSSION

Table (1) summarize all the getting data. The results in Table (1) indicate that exposure to 50 Hz, 5 mTesla magnetic field for 1, 2 or 4 weeks has no significant effect on serum testosterone level in male rats as compared with their control and in-between exposed groups as shown in Figure (1). On the other hand, the results in Table (1) show that serum prolactin level gradually increased significantly ($p< 0,05$) in the groups exposed to magnetic field for 1, 2 or 4 weeks than their control. Also, the serum prolactin level in the group exposed to magnetic field for 4 weeks shows significant ($p<0.05$) increase than the level of prolactin in the groups exposed to magnetic field for 1 and 2 weeks as shown in Figure (2). Serum FSH level in the group exposed to the magnetic field for 1 week shows significant ($p<0.05$) increase than its control as shown in Figure (3). On the other hand, serum LH level in the group exposed to the magnetic field for 4 weeks shows significant ($p<0.05$) increase than its control and than the level of LH in the groups exposed to 50 Hz, 5 mTesla magnetic field for 1 and 2 weeks as shown in Figure (4).

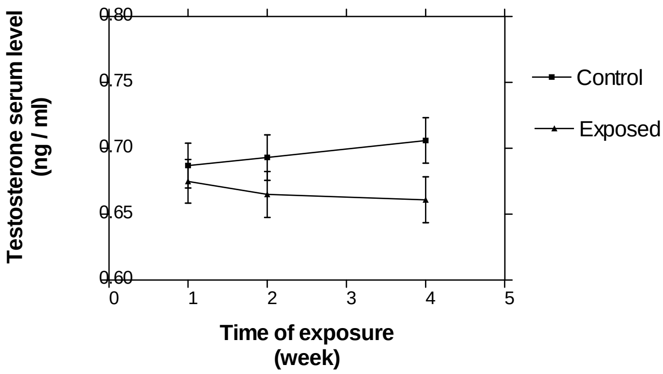

Fig. 1: Effect of exposure to ELFMF (5 mTesla) on testosterone serum level of male rate.

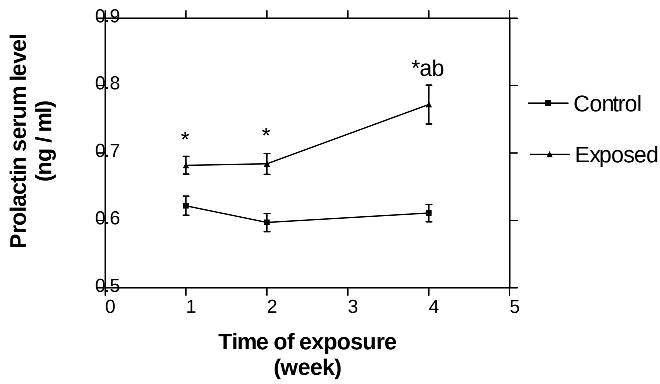

Fig. 2: Effect of exposure to ELFMF (5 mTesla) on prolactin serum level of male rate.

Table 1: Effect of ELFMF 50 Hz, 5 mTesla on the level of sex hormone of male rats.

Hormone Type	One week		Two weeks		Four weeks	
	Control	Exposed	Control	Exposed	Control	Exposed
Testosteron (ng / ml)	0.687± 0.01700	0.675± 0.01655	0.693± 0.01732	0.665± 0.01746	0.706± 0.01733	0.661± 0.01741
Prolactin (ng / ml)	0.622± 0.01405	0.682± 0.01315*	0.597± 0.01359	0.684± 0.01543*	0.611± 0.01269	0.772± 0.02687*ab
FSH (IU / ml)	0.0829± 0.002601	0.1107± 0.004876*	0.084± 0.003386	0.1009± 0.007406	0.0875± 0.006697	0.0906± 0.008531
LH (IU / ml)	0.599± 0.01487	0.562± 0.01083	0.604± 0.01593	0.577± 0.01783	0.597± 0.01739	0.651± 0.01871*ab

(*) Significant difference from its respective control group.
(a) Significant difference from one week exposed group.
(b) Significant difference from two weeks exposed group.

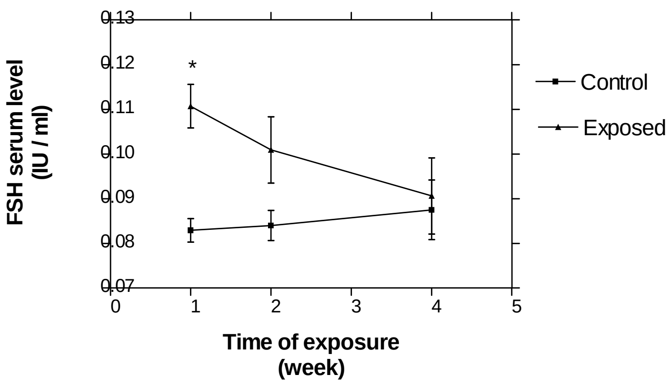

Fig. 3: Effect of exposure to ELFMF (5 mTesla) on FSH serum level of male rate.

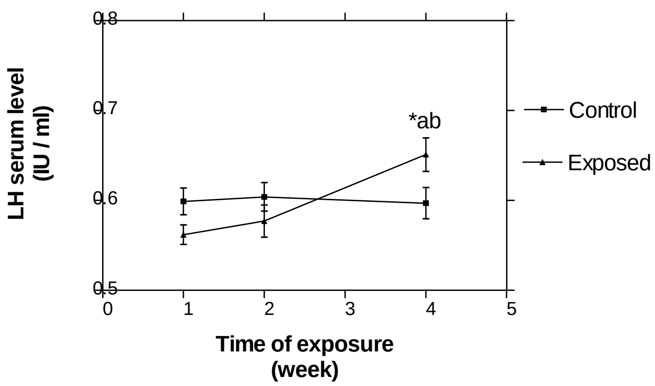

Fig. 4: Effect of exposure to ELFMF (5 mTesla) on LH serum level of male rate.

The previous results demonstrate that chronic exposure to 50 Hz, 5 mTesla magnetic field produces a significant increase in the level of prolactin hormone in all studied groups in a time dependent manner, a significant increase in FSH level in the group which exposed to magnetic field for one week only and a significant increase in the level of LH hormone in the group which exposed for the magnetic field for four weeks only. These results are added to the growing evidence of possible health hazards on male sex hormone from continuous exposure to ELFMF of some electric and electronic appliances in daily use.

On the other hand, exposure to 50 Hz, 5 mTesla magnetic field has no significant changes on serum testosterone level. This finding is in harmony with the results of several studies pointed to the effect of ELFMF on testosterone level.[9,19,20,21]

Small Increases of prolactin level can be caused by physical or physiological stress. Hyperprolactinemia can lead to disturbances of male reproductive functions via various mechanisms. At the hypothalamic levels, hyperprolactinemia can cause impairment of pulsatile GnRH release.[22] The gonadal increase in prolactin serum level in the exposed groups may be one of the factors which lead to the gradual decrease of FSH level in the exposed groups but does not explain the rise of LH level in the group exposed to the magnetic field for four weeks.

The significant increase of FSH serum level in the group exposed to 50 Hz, 5 mTesla magnetic field for one week is consistent with previous study carried by Grajewski et al (2000). This study indicates a significant rise in FSH level accompanied with insignificant decrease in testosterone Level. This increase is possible due to the effect of magnetic field on germinal epithelium with sufficient compensatory increase in gonadotrophin levels to maintain normal semen quality.[23]

On the other hand, absence of significant changes in the level of LH hormone in rats exposed to 50 Hz, 5 mTesla magnetic field for one and two weeks is compatible with the absence of plasma testosterone changes. This result is in harmony with the finding of previous study.[24] While, the significant increase in the level of LH hormone in the groups exposed to the magnetic field for four weeks may be caused by variability of LH data among rats. In deed, testosterone release is mainly controlled by LH.[24]

It has been postulated that the ELFMF may modulate cellular calcium regulatory mechanism which affecting the function of transmembrane proteins or the affinity of calcium binding proteins such as calmodulins. The modulatory effect of calcium acts in a time dependent manner and may affect pituitary gonadal axis with subsequent effect on spermatogenesis and male fertility.[25]

Conclusion

In conclusion, the debate between potential hazards of ELFMF on pituitary gonadal axis and spermatogenesis will continue until the mechanism of interaction has been clarified. Further studies are recommended with longer periods of exposure and with higher intensities.

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