Effect of 5Hz electromagnetic waves on movement behavior in male wistar rats (in vitro)

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ABSTRACT

Various stresses during life can affect metabolism and brain activities, immune and endocrine systems directly and indirectly, and ultimately, causes animal behavior change. The cellular and molecular level change in neurotransmitter and hormone concentrations led to the functional changes of operating systems in the intracellular organelles. These events cause of course oxidative stress. All these reactions cause general or limited inflammation that is characterized by increased phenomena of inflammatory cytokines. Electromagnetic waves are the most important stimulus of ions and biomolecules therefore they change ions movement in a living organism. This process can lead to neuronal and behavioral changes. Yet, certainly, radiation pattern, intensity and magnetic field strength will be highly effective in response (reaction). In the present study, short-term (one day) and medium-term (3 days and 7days) and long-term (19 days and 21 days) effects of extremely low-frequency waves (ELF) on behavioral and metabolic activities in male wistar rats with an average weight 180-250g have been investigated.

Keywords: Elderly; Electromagnetic Wave; Movement Behavior; Wistar Rat; Corticosterone; frequency; adrenaline; adrenal receptor.

INTRODUCTION

Extremely low-frequency magnetic fields (ELFMF),such as those originating from residentially proximate power lines, household electrical wiring and medical devices, have been reported to produce a variety of biological effects [1,2,3], interfere with the activity of the brain [4,5,6,7,8,9] and may generate behavioral and cognitive disturbances [10,11]. Frequent and/or prolonged exposure to these devices of an ever-growing number of people of different ages raises some concerns about the effects of ELFMF on human health. Some efforts have been made recently to investigate the incidence of ELFMF on human and animal physiology and behavior. The results of these studies are mostly inconsistent and contradictory [12,13,14,15].

Some reports suggest that ELFMF may act on the hypothalamic– pituitary–adrenocortical axis activity and alter the plasma corticosterone level [16]. Such effects may interfere with memory performance as there is evidence suggesting impairing effects of stress-induced corticosterone release on object recognition in rats [17, 18].

In the present study, we examined the effects of chronic exposure to ELFMF of 2 G intensity on movment behevior in rats and on their plasma corticosterone and adrenaline level.

MATERIALS AND METHODS

Materials

Ketamin Hydrochloride, EDTA %3.5 and PBS (Phosphate Buffer Saline) were provided by Sigma (Sigma-Aldrich Products, Germany). Diazepam 10mg/2ml was obtained from Caspian (Iran). Adrenalin Elisa Kit, Corticostrone Elisa Kit and alpha 1 receptor Elisa Kit were provided by Cusabio® (Japan).

Methods

In present study, a total of 80 male wistar rats were used (n=8 in Five control and the five experimental groups). The animals after adapting to the environment were randomly assigned to

experimental groups for one week and then radiated by 40 Hz frequency for 60 minutes. This process was carried out in the specific radiation shields room that was completely isolated from the environment. One group of the animals, on the first day, after the end of experiment and behavioral testing was anesthetized with high-dose ketamine and then their brain fixed and along with a blood sample with the adrenals is removed for subsequent tests. In the case of second group this process was carried after 3 days, third group after 7 days, and fourth group after 14 days and fifth groups after 21 days. The control groups had all of the experimental group terms, but has not received radiation. Also, sympatric responses were examined along with investigating of adrenaline hormone concentration. Finally, data was stated as the mean ±SEM of each variable. For each phase, one – way analysis of variance (ANOVA) was used to determine significant changes. Significant boundary changes was considered P <0/05. In order to measure movement parameter were prepared without celling boxes with dimensions 100×100 cm entirely transparent that were drawn 10×10 cm homes lines. The 5 HZ waves were radiated on rates using electromagnetic waves generating device for one hour every day and at non-uniform times. Non-ionizing electromagnetic waves generating device produces low-frequency electromagnetic waves and wave intensity was 2 G. In the radiation room, six glass boxes in the size of 80×80 cm were embedded.

RESULTS

Figure1 shows the average number of movement units on the frequency of 5Hz for 1, 3,7,14 and 21 days. According to the figure 1, it can be seen that on the first day and also three and seventh days there is a significant increase in movement relative to the control group. As it is depicted in figure 2, the rate of change can be seen in correspond to the figure 1. For better resolution percentage of changes in movement is illustrated in figure 3. Since locomotion behavior can been affected by hormonal alterations therefore adrenalin and corticostron levels related to the radiated condition are studied and displayed in figures 4 and 5. Amounts of alpha 1 receptor in correspond to the hormone for control 7 day groups are evaluated and shown in figure 6.

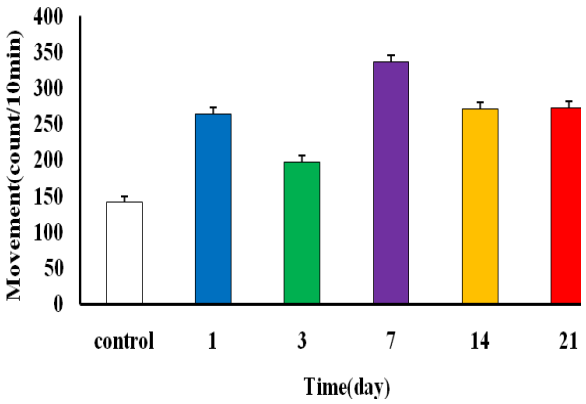

Figure1. Average number of movement units on the frequency of 5Hz for 1, 3,7,14 and 21 Radiation days.

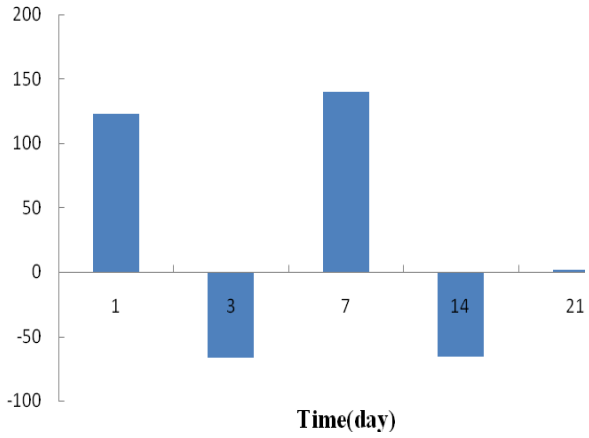

Figure 2. Change of movement unit for each day relative to the previous step. This analysis is corresponded to the data in figure 1.

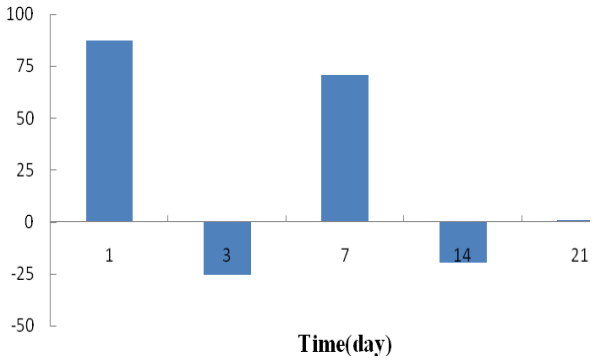

Figure3. Percent of movement unit change for each day relative to the previous step. This analysis is corresponded to the data in figure 2.

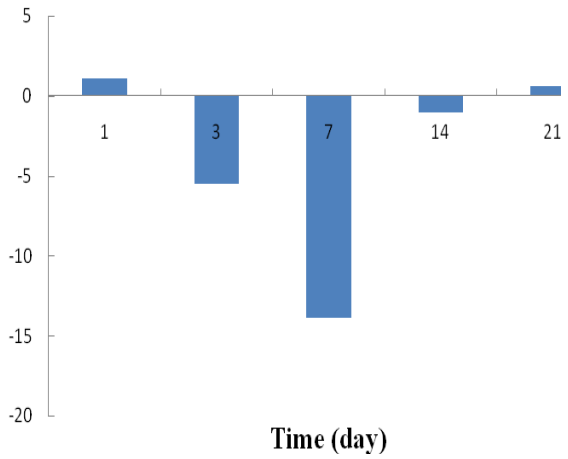

Figure4. Percent of adrenalin change for each day relative to the previous step.

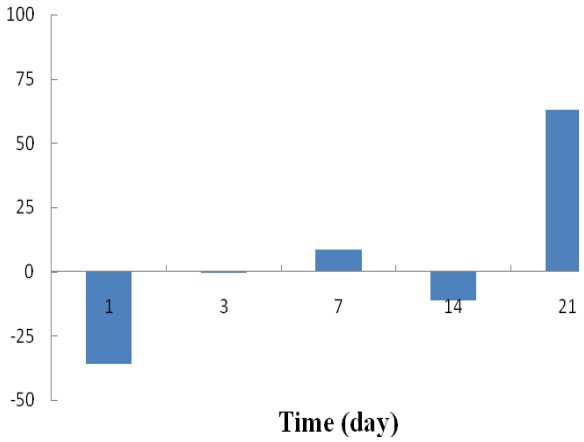

Figure5. Percent of corticostrone change for each day relative to the previous step.

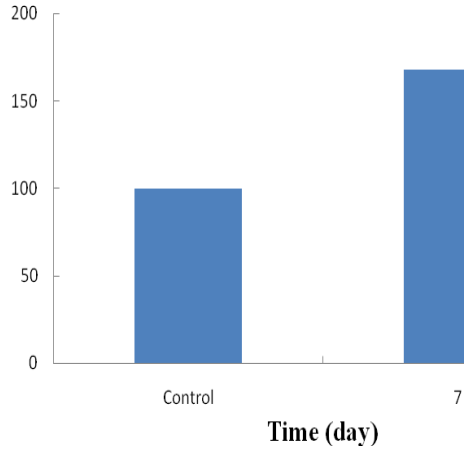

Figure6. Amounts of alpha 1 receptor for control an 7 day groups.

DISCUSSION

Various studies have been reported in the rat movement [19-22] there are also some reports indicating that ELF-EMF waves have affected rat movements. In figure 1, the rate of the movement has been studied for the control group and the other groups during the aforesaid periods. It has been showed that all groups have had meaningful changes as to control group. The rate of P-Value indicates that in some days there is a more significant difference. The rate of changes in movement in each phase, compared with the previous phase, have been calculated in figure 2 to present a more appreciate reflection of these behavioral changes.

As it was expected, comparing figures 1 and 2, it is easily can be realized that the behavioral changes during the days 1 and 7 are very significant. In other words, the figure 2 shows a clearer reflection of the behavioral changes during the experiment days.

In focus on the behavioral changes during the days 1 and 7, it seems that the changes during the day 7 is more than the changes in day 1 (figure 2). The significant point is the processing and information analysis, because the more comprehensive and accurate you analyze the information at issue, the more obvious conception that can be reached. Therefore, to address this point the rate of changes compared with the previous phase, is reported on percentage in figure 3. Considering the figure 3, two points can be propounded:

A: The model used for displaying information in figure 3 is almost the same as in figure 2; that is a repeated emphasis on the changes occurrence during the days 1 and 7.

B: The point that makes the figure 3 different from the figure 2 is the decrease in the changes percentage in the day 7 compared with its previous phase.

These changes can be coupled with molecular changes, gene expression and protein, hormone and metabolite levels alteration. The behavioral control through hormonal system has been discussed in various texts [11] so the serum levels of adrenaline and corticosterone in the groups were studied. The obtained information from these examinations has been displayed in figures 4 and 5. In these figures the serum levels of both

hormones have been calculated and reported on percentage compared with the previous phases. As it is deducted from figure 4, the adrenaline changes percentage during the day 7 has been decreased intensely, but the changes in this hormone during the first day are not significant, compared with the control group. Therefore, in conformity with the behavioral changes arising from the radiation effect in the days 1 and 7, it seems that the effective mechanism in the behavioral change in the day 7 is coupled with the change in the adrenaline rate. In the other words, the radiation in the first day has no effect on the interaction in the serum levels of adrenaline. On the contrary, this fact is not seen concerning corticosterone.

In figure 5 it is shown that the corticosterone percentage rate in the day 1 has remarkable changes. It is expected that the behavioral changes (movements) of the rat, coupled with the hormonal changes, have different patterns. It is possible sometimes that hormones change in a synergic or on the contrary manner. There are such reports in the scientific texts [23-27]. It is obvious that changes in the hormone levels of blood have a close relation with the rate of the receptor of that hormone and the rate of the receptors' coding gene expression.

In fact, there is a close and known relation between the hormone level and the amount of receptors and the gene expression and regulation [28-31].

The rate of adrenaline in blood has been measured to confirm the hormonal changes and to study the alpha 1 receptors of blood. Considering the decrease in the blood adrenaline, it is expected that the compensatory mechanisms such as the coding gene expression of these receptors show a remarkable increase. Such information has been propounded in various scientific reports [32-36].

In the figure 6 the rate of the changes percentage in the adrenaline alpha 1 receptors has been displayed during the day 7 compared with the control group. According to the figure 6 the amounts of the adrenaline receptors has been increased about 70% after radiation during the day 7, that confirms the shortage of adrenaline in blood. Since the adrenaline role in the muscular and physical system is known, adrenaline shows different effects by connecting to the different receptors. For example, while it is connected to the beta receptors, it causes increase in heartbeat, while connecting to the alpha 1 receptors it can interfere with the smooth muscle contraction. Since the effect of the 5Hz electromagnetic wave has increased the muscular mobility, it seems that the decrease in the serum levels of adrenaline and subsequently the increase in the alpha 1 receptor have been occurred along with decrease in muscular mobility and preserving the balanced position of the living being.

Therefore, it is important to perform further complementary research along with the examination of the mechanism of radiation effects on increase in the muscular mobility.

CONCLUSION

Radiation of 5Hz electromagnetic wave on the rats in the form of a determined pattern such as one hour per day and during one or seven successive days, it will cause an over 70% increase in the muscular mobility. These changes can also be observed and examined in the hormonal level.

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