Long-term Exposure to Extremely Low Frequency Electromagnetic Field and Melatonin Production by Blood Cells

H Seifpanahi-Shabani[1], M Abbasi[2], I Salehi[3], Z Yousefpour[4], A Zamani[4]

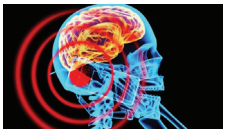
Study of circadian rhythms is important in many areas of occupational medicine. Melatonin has immunomodulatory effects and regulates circadian rhythms in vertebrates.[1] Recent growth in exposure to extremely low frequency electromagnetic field (ELF-EMF) has stimulated concerns about its adverse effects on circadian rhythms. Melatonin may be a good biomarker for assessing the biological effects of ELF-EMF.[2]

It is assumed that melatonin is mainly secreted from the pineal gland. However, it can also be produced *de novo* by bone marrow cells.[3,4] In addition, in an *in vitro* experiment, it was shown that mitogen activation of human lymphocytes can cause melatonin release.[5] The capability of the bone marrow and the immune system cells to produce melatonin supports the idea that the immune system, itself, would produce melatonin that may be beneficial to its regulatory functions. Although, the effect of ELF-EMF on the production of melatonin from the pineal gland has been investigated during past decades,[2,6] to the best of our knowledge, there is no document on the effect of ELF-EMF on the production of melatonin by the bone marrow and immune system cells. We therefore, conducted this experimental study to investigate the effect of long-term ELF-EMF on the production of melatonin by blood cells *in vitro* to differentiate it from the pineal gland source.

Forty Wistar adult male rats were divided into "test" (n=20) and "control" (n=20) groups. The test group rats were exposed to the maximum acceptable limit of ELF-EMF (100 μT), at a frequency of 50 Hz, 2 h/day from 10:00 to 12:00 am, for three months. The control rats were placed in the exposure unit, while the electricity was switched off, from 12:00 to 14:00.[7] Levels of melatonin in serum and supernatant of the whole blood culture activated with 5 μg/mL of phytohemagglutinin (PHA) were determined by sandwich enzyme-linked immunosorbent assay (ELISA).

Exposure of rats to ELF-EMF had no significant effect on melatonin levels of serum (p=0.963) and whole blood culture (p=0.249) in the test group compared with the control group (Fig 1). Comparing serum with the whole blood cultures melatonin levels in both groups showed that although the blood sample was diluted by RPMI medium during culture, the melatonin levels in the blood culture supernatant was still roughly 2.5 times its level in the

[1]Students Research Center, Hamadan University of Medical Sciences, Hamadan, Iran
[2]Department of Internal Medicine, School of Medicine, Hamadan University of Medical Sciences, Hamadan, Iran
[3]Department of Physiology, School of Paramedical Sciences, Hamadan University of Medical Sciences, Hamadan, Iran
[4]Department of Immunology, School of Medicine, Hamadan University of Medical Sciences, Hamadan, Iran



Correspondence to
Dr. Alireza Zamani,
Department of Immunology, School of Medicine, Hamadan University of Medical Sciences, Hamadan, Iran
Tel: +98-81-3838-0583 ext 338
Fax: +98-81-3838-0208
E-mail: a_zamani@umsha.ac.ir
Received: Mar 10, 2016
Accepted: Jun 1, 2016

Cite this article as: Seifpanahi-Shabani H, Abbasi M, Salehi I, *et al*. Long-term exposure to extremely low frequency electromagnetic field and melatonin production by blood cells. *Int J Occup Environ Med* 2016;**7**:193-194.

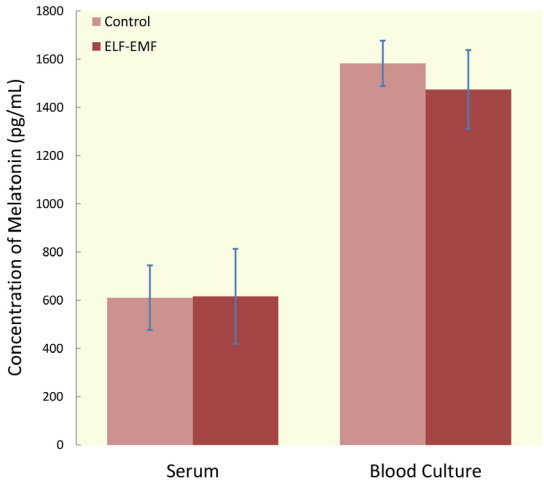


Figure 1: Mean melatonin levels in the serum and the supernatant of whole blood culture of ELF-EMF exposed and control rats. Error bars represent 95% CI for the mean.

serum (Fig 1).

We found that exposure of rats to 100 μT ELF-EMF for two hours a day for three months, could not change the melatonin levels in their serum and the supernatant of the whole blood culture. Touitou, *et al*, also demonstrated a lack of effect of ELF-EMF on melatonin secretion in humans sera who had been exposed to EMF for up to 20 years.[6] In addition, in a study by Cakir, *et al*, they found that ELF-EMF has no effect on lymphocyte count.[8] In contrast, another study shows that exposure of male Wistar rats to 50-Hz sinusoidal magnetic field of 100 μT intensity for 18 h/day for 30 days, decreases plasma concentrations of melatonin by 30%.[9] At the moment, for presence of too many variables—different animal species, exposure conditions such as frequency, polarization, exposure duration, strength of magnetic fields on the results, and limited data—it is difficult to come to a definite conclusion about the effect of ELF-EMF on melatonin production.[2,10] Furthermore, the observation that PHA stimulation of whole blood cells can result in significant melatonin production,[5] could challenge the historical assumption that the pineal gland is the main source of melatonin in vertebrates.

Conflicts of Interest: None declared.

References

1. Haddadi GH, Fardid R. Oral administration of melatonin modulates the expression of tumor necrosis factor-alpha (TNF-alpha) gene in irradiated rat cervical spinal cord. *Rep Pract Oncol Radiother* 2015;**20**:123-7.
2. Touitou Y, Selmaoui B. The effects of extremely low-frequency magnetic fields on melatonin and cortisol, two marker rhythms of the circadian system. *Dialogues Clin Neurosci* 2012;**14**:381-99.
3. Conti A, Conconi S, Hertens E, *et al.* Evidence for melatonin synthesis in mouse and human bone marrow cells. *J Pineal Res* 2000;**28**:193-202.
4. Tan DX, Manchester LC, Reiter RJ, *et al.* Identification of highly elevated levels of melatonin in bone marrow: its origin and significance. *Biochim Biophys Acta* 1999;**1472**:206-14.
5. Carrillo-Vico A, Calvo JR, Abreu P, *et al.* Evidence of melatonin synthesis by human lymphocytes and its physiological significance: possible role as intracrine, autocrine, and/or paracrine substance. *FASEB J* 2004;**18**:537-9.
6. Touitou Y, Bogdan A, Lambrozo J, Selmaoui B. Is melatonin the hormonal missing link between magnetic field effects and human diseases? *Cancer Causes Control* 2006;**17**:547-52.
7. Zamani A, Vahidinia A, Ghannad MS. The effect of garlic consumption on Th1/Th2 cytokines in phytohemagglutinin (PHA) activated rat spleen lymphocytes. *Phytother Res* 2009;**23**:579-81.
8. Cakir DU, Yokus B, Akdag MZ, *et al.* Alterations of hematological variations in rats exposed to extremely low frequency magnetic fields (50 Hz). *Arch Med Res* 2009;**40**:352-6.
9. Selmaoui B, Touitou Y. Sinusoidal 50-Hz magnetic fields depress rat pineal NAT activity and serum melatonin. Role of duration and intensity of exposure. *Life Sci* 1995;**57**:1351-8.
10. Jahandideh S, Abdolmaleki P, Movahedi MM. Comparing performances of logistic regression and neural networks for predicting melatonin excretion patterns in the rat exposed to ELF magnetic fields. *Bioelectromagnetics* 2010;**31**:164-71.