Research Article

HEPATOLOGY FORUM

The effects of ELF-PEMF on liver

doi: 10.14744/hf.2024.2024.0005

Safety analysis of different intensities of elf-pemf in terms of apoptotic, inflammatory, and transcription factor NF-Kb expression levels in rat liver

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Abstract

Background and Aim: The purpose of this research was to ascertain how exposure to extremely low-frequency pulsed electromagnetic fields (ELF-PEMFs) at varying intensities affects apoptosis-related protein expression levels and liver morphology in rats.

Materials and Methods: In this experimental study, 40 Wistar albino rats were randomly divided into 4 groups, with 10 animals in each group: Control, Sham, 1 milli Tesla (1mT), and 5 mT groups. The control group did not expose any application during the experiment. Animals in the sham group were placed into the closed ELF-PEMF exposure environment, but the device was kept closed. The rats in the 1mT and 5mT groups were placed into a closed ELF-PEMF exposure environment, and the magnetic field application was applied 5 days a week for 4 hours a day for 8 weeks. At the end of the study, the animals were sacrificed, and their liver tissues were examined morphologically, and the expression levels of proteins related to apoptosis and inflammation in these tissues were analyzed.

Results: Our results indicated that ELF-PEMFs did not lead to any exact morphological alterations in the groups. Tissue apoptotic Bax and Caspase 3 expression levels in the 1mT and 5mT groups were similar ($p>0.05$) to the control group. Additionally, pro-inflammatory TNF-α and transcription factor NF-κB in the 1mT and 5mT groups were similar ($p>0.05$) to each other and the control group.

Conclusion: It is feasible to conclude that neither the administration nor the exposure design of this study is changing the immunoexpression of apoptosis-regulating protein expression levels or liver morphology exposed to ELF-PEMF in rats.

Keywords: Apoptosis; ELF-PEMF; inflammation; liver; NF-κB.

How to cite this article: Gokce Y, Seker U, Pekince Ozoner M. Safety analysis of different intensities of elf-pemf in terms of apoptotic, inflammatory, and transcription factor NF-Kb expression levels in rat liver. Hepatology Forum 2024; 5(4):178–183.

Received: February 13, 2024; **Revised:** March 04, 2024; **Accepted:** March 05, 2024; **Available online:** September 11, 2024

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Hepatology Forum - Available online at www.hepatologyforum.org

Introduction

Magnetic fields (MFs) produced by electrical or electronic devices used in our surroundings and electrical power lines have frequency ranges of 50 Hz in a large portion of the world and 60 Hz in North America.[1] The extremely low frequency (ELF) part of the electromagnetic spectrum is often defined as 0–300 Hz.[2] Extremely low-frequency electromagnetic fields (ELF-EMFs) are unable to break chemical bonds or have thermal effects on tissue because of their low energy values. They are also known to interact with human tissues and cause a small amount of electrical currents to flow.[3] Exposure to electromagnetic fields (EMFs) has become a necessary aspect of modern life, and it is expanding substantially as a result of growing needs and ongoing technological advancements. Because of this, a number of experimental and epidemiological studies that highlight the potential impacts of EMF exposure on biological systems have received international recognition.

The process of apoptosis via the elevation of intracellular reactive oxygen species (ROS) is considered to be the most likely mechanism explaining the anticancer effects of ELF-EMF. ROS, mainly from the mitochondria's electron transport chain during cell respiration, increase with dysfunction. Mitochondria, in the matrix (by MnSOD) or cytosol (by Cu/ZnSOD), are key sources of intracellular ROS during respiration. By devastating the equilibrium of the antioxidant defense system, overexpression of ROS results in oxidative stress, which damages the mitochondrial membrane and induces the release of cytochrome c.[4] Ding et al.'s[5] work showed that HL-60 leukemia cell lines could experience a potentiation of H_2O_2-induced apoptosis when exposed to 60 Hz, 5 milli Tesla (mT) ELF-EMF for a duration of 24 hours. A related study by Jian et al.[6] demonstrated that human hepatoma cell lines pretreated with low-dose X-ray radiation experienced a substantial increase in the rate of apoptosis with intermittent exposure to EMF. Short-term exposure of the human acute monocytic leukemia cell line to pulsed EMF, as demonstrated by Kaszuba-Zwoinska et al.,[7] markedly boosted the rate of apoptosis produced by colchicine and cyclophosphamide.

Notably, numerous additional research has placed a strong emphasis on ELF-EMF's anti-apoptotic properties in addition to its effects on ROS. A pretreatment of ELF-EMF exposure led to a 22% decrease in caspase 3-dependent apoptosis induced by anti-Fas therapy in Jurkat leukemic cell lines, according to Palumbo et al.[8] Another study revealed that the anti-apoptotic effect of melatonin on HepG2 cell lines was totally eliminated after 42 hours of intermittent exposure to EMF.[9] Brisdelli et al.[10] also demonstrated that, in comparison to quercetin treatment alone, simultaneous treatment of K562 cell lines with ELF-EMF and