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LETTER TO THE EDITOR

Magnetic Fields might be Used as Radiosensitizer for Cancer Radiation Therapy

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Abstract. Cancer treatment with the use of radiotherapy can produce many side effects, and in some cases the treatment response is far less than optimal, leading to apparition of metastases. As such, radiosensitization of tumors may improve the efficacy of radiation effects by minimizing the failure to radiation therapy. Here a hypothesis is suggested concerning the potential use of magnetic field exposure as a radiosensitizer during cancer treatment by increasing DNA damage.

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Abbreviations used: MFs, magnetic fields; DSB, DNA double-strand breaks

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Dear EDITOR:

Cancer is a major health problem in our society. Nowadays, it is treated with surgery, radiotherapy, and/or chemotherapy, with the ultimate goal of curing the patient and avoiding the dissemination of cancer cells into other parts of the body. These different treatments are available in all hospitals all over the world, but they have their own advantages and risks. Currently, there is a great need to improve cancer treatment by developing new drugs, discovering new drug targets, and using new radio- and chemosensitizing agents to improve cancer treatment outcomes and achieve higher patient survival.

Environmental exposure to electromagnetic fields is strongly increased in developed countries as a consequence of the distribution and use of electricity. Several in vitro investigations on the biological effects of magnetic fields (MFs) exposure were performed to study the potential genotoxicity of MFs and therefore to assess the MF-associated cancer risk. Genotoxic effects of MFs may occur directly by damaging the DNA and/or by altering DNA repair mechanisms [1].

The study of DNA strand breaks involves the investigation of one type of DNA damage highly associated with carcinogenic mechanisms, widely known for agents such as radiation. Among the agents associated with cancer are those that induce DNA damage, mainly DNA strand breaks. MFs do not have sufficiently high energy to directly produce a breakage in the covalent links in the DNA; nevertheless, an indirect effect could be the interaction mechanism between MFs and living organisms [2].

At present, there are a number of radiosensitizers (RS) (e.g., oxygen, hyperthermia, or chemical agents) that can increase the effect of radiation and thus improve the response to radiotherapy in cancer treatment. Still, there is a need to discover new RS agents to increase the effect of radiation, to optimize radiotherapy protocols, and to improve the survival of patients with cancer. It is well known that ionizing radiation causes cell death as a result of accumulation of DNA strand breaks. Recent studies reported that MFs (50 Hz, sinusoidal, 1-24 h, 0.02-1 mT) could result in a significant increase in DNA double-strand breaks (DSB) [1, 3]. In addition, other researchers also found that MFs (50 Hz, 0.23-0.7 mT) could alter the fidelity of repair of genomic lesions [4].

In this context, it is logical to hypothesize that MFs might induce therapeutic benefits by acting as RS in radiotherapy by increasing the formation of DNA DSB and by inhibiting its repair. This hypothesis is supported by the study by Miyakoshi et al. [5] which reported that exposure to X-rays (5 Gy) followed by exposure to MFs (50/60 Hz) at a dose of >50 mT for 30 min potentiated X-ray-induced DNA double-strand breaks [5]. In addition, Koyama et al. [2] found that the exposure to MFs (5 mT) and X-ray irradiation (10 Gy) enhanced the degree of DNA damage induced by ionizing radiation. This effect was seen when the exposure was done immediately before or after X-irradiation. In addition, Lai and Singh suggested that free radicals might play a role in MF-induced DNA damage and therefore, exposure to MFs might affect the production of free radicals or enhance the activity of hydroxyl radicals produced by X-rays [6]. These molecules can interact with DNA and form oxidative DNA adducts, resulting in strand breaks [6].

Although these studies are encouraging that provide credence to the proposed hypothesis of using combined exposure to MFs and ionizing radiation to increase DNA damage, it is necessary to conduct further studies both *in vitro* and *in vivo* to validate the effectiveness and therapeutic benefits of MFs as a RS agent in cancer radiotherapy.

References

1. **Ivancsits S, Diem E, Jahn O, Rüdiger HW** [2003] Intermittent extremely low frequency electromagnetic fields cause DNA damage in a dose-dependent way. Int Arch Occup Environ Health 76: 431-436.
2. **Koyama S, Nakahara T, Sakurai T, Komatsubara Y, Isozumi Y, Miyakoshi J** [2005] Combined exposure of ELF magnetic fields and X-rays increased mutant yields compared with X-rays alone in pTN89 plasmids.

J Radiat Res 46: 257-264.

3. **Du XG, Xu SS, Chen Q, Lu DQ, Xu ZP, Zeng QL** [2008] Effects of 50Hz magnetic fields on DNA double-strand breaks in human lens epithelial cells. Zhejiang Da Xue Xue Bao Yi Xue Ban 37: 9-14.
4. **Lloyd D, Hone P, Edwards A, Cox R, Halls J** [2004] The repair of gamma-ray-induced chromosomal damage in human lymphocytes after exposure to extremely low frequency electromagnetic fields. Cytogenet Genome Res 104: 188-192.
5. **Miyakoshi J, Yoshida M, Shibuya K, Hiraoka M** [2000] Exposure to strong magnetic fields at power frequency potentiates X-ray-induced DNA strand breaks. J Radiat Res 41: 293-302.
6. **Lai H, Singh NP** [1997] Melatonin and N-tert-butyl-alpha-phenylnitrone block 60-Hz magnetic field-induced DNA single and double strand breaks in rat brain cells. J Pineal Res 22: 152-162.