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Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans

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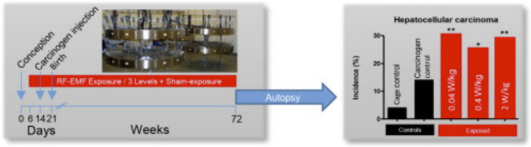
Highlights

- Tumor-promoting effects of RF-EMF exposed mice have been reported in 2010.
- We have replicated the study with higher numbers of mice per group.
- We could fully confirm the previous results, thus the effects are reproducible.
- Apparently, no clear dose–response relationship is evident.
- We hypothesize that metabolic changes are responsible for the effects observed.

Abstract

The vast majority of *in vitro* and *in vivo* studies did not find cancerogenic effects of exposure to electromagnetic fields (RF-EMF), *i.e.* emitted by mobile phones and base stations. Previously published results from a pilot study with carcinogen-treated mice, however, suggested tumor-promoting effects of RF-EMF (Tillmann et al., 2010). We have performed a replication study using higher numbers of animals per group and including two additional exposure levels (0 (sham), 0.04, 0.4 and 2 W/kg SAR). We could confirm and extend the originally reported findings. Numbers of tumors of the lungs and livers in exposed animals were significantly higher than in sham-exposed controls. In addition, lymphomas were also found to be significantly elevated by exposure. A clear dose–response effect is absent. We hypothesize that these tumor-promoting effects may be caused by metabolic changes due to exposure. Since many of the tumor-promoting effects in our study were seen at low to moderate exposure levels (0.04 and 0.4 W/kg SAR), thus well below exposure limits for the users of mobile phones, further studies are warranted to investigate the underlying mechanisms. Our findings may help to understand the repeatedly reported increased incidences of brain tumors in heavy users of mobile phones.

Graphical abstract



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Keywords

Electromagnetic fields; Cancer; Tumor promotion; Mice

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Introduction

The increased use of mobile phones during the last two decades was accompanied with fears that their emission of radiofrequency electromagnetic fields (RF-EMF), sometimes also called “radiation”, may have adverse health effects. So far, no biophysical mechanism has been identified which would speak in favor of such effects since the quantum energy in the frequency range used for mobile communication is far too low to break chemical bonds. The only accepted mechanism by which RF-EMF could be harmful is heating which is prevented at the current exposure limits for the general population (specific absorption rate (SAR) 0.08 W/kg whole body; 2 W/kg local exposure) [1]. Some epidemiological studies, however, have found increased incidences of brain tumors in heavy users of mobile phones [2], [3]

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[2], [3].

In 2010, a study was published [4] showing tumor-promoting effects of life-long exposure to RF-EMF (Universal Mobile Telecommunication System, UMTS) at moderate exposure levels in mice treated with a carcinogen (ethylnitrosourea, ENU) *in utero*. Those results were potentially influenced by an unexpected infection with *Helicobacter hepaticus* (which may have had an influence on the pathological findings in the liver, as suggested by the authors). Nevertheless the data showed clear effects of RF-EMF exposure on the incidences of lung and liver tumors. We have replicated this study with higher numbers of animals per group, but otherwise under similar conditions, in order to clarify whether the previously reported results could be confirmed. In addition, two additional SAR levels of exposure (low and high) were included in order to investigate possible dose–response relationships. Furthermore, we ensured that we did not have any infection with Helicobacter species in our animals.

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Experimental design

The experiment was performed according to the German Animal Welfare Act and approved by the local authorities (city state of Bremen). Special care was taken to repeat the study by Tillmann et al. [4] as accurately as possible. Male C3H/HeNCrl (n=43) and female C57Bl/6N (n=290) mice were purchased in a staggered design from Charles River Germany, Sulzfeld, Germany, at an age of 8–9 weeks. After acclimatization, at the age of 12 weeks (females), the males and 128 females were mated for one …

Results

Our study confirms and extends the previously published observations of tumor-promoting effects of life-long RF-EMF exposure. The numbers of both adenomas and carcinomas were significantly increased in the lungs, and carcinomas were significantly elevated in the livers of RF-EMF exposed animals (Fig. 1, Table 1). As compared to the sham-exposed control mice, numbers of animals with bronchiolo-alveolar adenomas (lungs) were doubled at low and moderate SAR levels, and hepatocellular carcinomas …

Discussion

The fact that both studies found basically the same tumor-promoting effects at levels below the accepted (and in most countries legally defined) exposure limits for humans is worrying. Although animal experiments are generally not easily transferable to the situation in humans, the findings are a very clear indication that – in principal – tumor-promoting effects of life-long RF-EMF exposure may occur at levels supposedly too low to cause thermal effects. The basis for defining safety …

Acknowledgments

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