Name(s)

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Project Number

S2107

Project Title

Electromagnetic Fields Inhibit Cancer Proliferation: An Interdisciplinary Approach to Improve Treatment

Abstract

Objectives

We aimed to explore the effects of low-frequency EMFs on selective inhibition of cancer cells, associated biological/molecular responses and cell-death pathways. Our in vitro study serves TWO major purposes: 1. Given the prevalence of cancer deaths worldwide (especially in developing countries), treatment efficacy and affordability must be improved. We hypothesize that EMFs may demonstrate potential for such treatment. 2. Despite being ubiquitous in everyday life and widely debated in public health, EMFs remain one of the most unexplored fields of biological research. We intend to validate the impact of EMFs in biological phenomena and emphasize the need for further scientific exploration.

Methods

Novel EMF-Apparatus: developed two inexpensive solenoids + smartphone-controlled electrical setup for EMF-exposures (60 Hz, 1-2 mT, 12 hr/day, 3-5 days)
Cellular/Molecular Changes: cultured multiple cancer cell lines (HCT116, SH-SY5Y, RAW 264.7) and non-cancer cells (HEK293); conducted MTS Assay post-EMF to quantify reduced cell viability/proliferation; Ca^{2+}/reactive oxygen species (ROS) inhibitors pre-EMF; fluorescent evaluation of Caspase-3 (apoptosis)

Results

2mT EMF induces >90% cell-death in multiple cancers (effective). 1.0-1.25 mT EMF induces ~60% cell-death in HCT116 and no statistically significant non-cancer cell-death (selective). Cancer-cell death localized to EMF-targeted areas. ~30% cancer cell-death mitigated by both Ca^{2+} and ROS inhibition. No statistically significant involvement of Caspase-3 in EMF-based cancer cell-death.

Conclusions

We engineered a novel, low-cost IoT EMF-apparatus and determined that it is selective, localized and effective against various cancers (unprecedented in previous literature). In addition, we have shown that Ca^{2+}/ROS are involved in EMF-based molecular changes, and that EMF-induced cell-death is independent of apoptosis. These exciting findings demonstrate that EMFs have the potential to improve treatment efficacy and affordability. While further testing is required to fully develop EMF-based cancer therapy, an immediate and important takeaway from our current study is that EMFs can have profound biological implications, thus demanding significant attention in modern biological research.

Summary Statement

In our study, we developed a first-of-its-kind EMF-apparatus, discovered novel therapeutic properties of EMFs in cancer and helped validate the need for further EMF-based research in modern biology.

Help Received

(Intel ISEF Form C completed). We thank Dr. Salvesen at SBP Institute for providing resources (cell culture, assays) and training (equipment, safety). All research/plans for executing project were developed independently. We carried out all experiments and data analysis ourselves under appropriate supervision.