Studies on Bioelectric Effects of Intense Ultra Wideband Radiation

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Applications of nanosecond pulsed electric field effects on biological cells and tissues have gained considerable notice over the last several years and continue to be of great interest based on results that demonstrate actions mimicking hormones, enhancing gene expression, and inducing apoptosis in tumors and tissues (K.H. Schoenbach et al., Proc. IEEE, 92, 1122 (2004)). While these effects will continue to be investigated, a new domain of pulsed electric field interactions with cell structures and functions opens up when the pulse duration is reduced to values such that membrane charging becomes negligible. For mammalian cells, this holds for pulse durations of one nanosecond and less. In addition to entering a new domain of electric field-cell interactions, this new approach will ultimately allow applications for pulsed electric fields without invasive electrode delivery, using antennas instead.

We plan to explore electric field–cell interactions in the 1 ns range. The effect of these pulses on biological cells will first be studied *in vitro*, using plate electrodes as pulse delivery systems, so that threshold values for nonlethal and lethal effects on cells can be determined. Among these effects are calcium release from subcellular structures, reversible membrane poration, phosphatidylserine externalization, and DNA damage. Knowing the electric field threshold values for these biological effects will allow us to design a wideband antenna that will deliver electric fields of this magnitude locally. The design of the antenna will utilize an optical principle: rays emitted from one focal point in an ellipsoidal reflector are focused at the second one, as shown in Fig. 1 (C. Baum, Note 501, August 2005). Support in antenna design and construction will be obtained from scientists at the Air Force Research Laboratory in Albuquerque, who have strong expertise in high power, wideband antenna design.

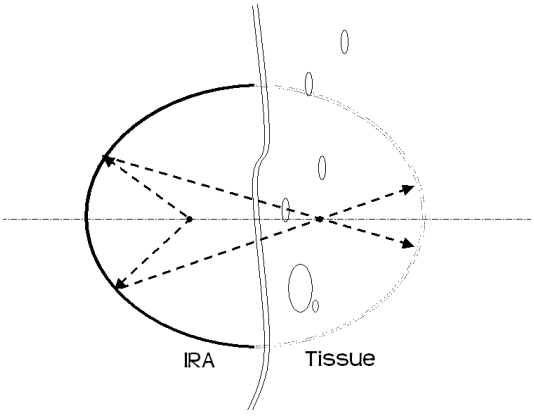

Fig. 1. Schematics of a focusing antenna (left) delivering electromagnetic energy to a focal point in tissue (right)

A synergistic approach using modeling, engineering, and biology will resolve the effects of very intense pulsed electric fields on cells and tissues in the new domain of field-cell interactions. The goal is to use this technology for non-invasive biological and medical therapies as well as in environmental applications.

Acknowledgement

This work is supported by Bioelectrics, Inc. and by an Air Force Office of Scientific Research Multidisciplinary University Research Initiative (MURI) grant on subcellular responses to narrowband and wideband radio frequency radiation, administered through Old Dominion University.