New Evidence for Existence of Biological Windows

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Recent advances in biological and clinical research on the effects of magnetic and electromagnetic fields once again raise the questions of dosimetry in respect of evaluation of the relationship between the strength of the applied magnetic field and the biological response. This issue becomes even more important when the effects of relatively weak magnetic fields (less than 100 mT) are considered. It is now well accepted that the effects of magnetic and electromagnetic fields do not follow "dose-response" dependence, as is the case with ionizing radiation. In 1975-1976 three laboratories (Loma Linda, USA; Sofia, Bulgaria and Rostov, USSR) independently introduced the idea of "biological windows". In general, this idea considers the existence of certain ranges of amplitude of the applied magnetic fields that are more favorable for the initiation of biological responses. Until now, three biological windows have been suggested: 0.2-0.5 mT, 15-20 mT, 45-50 mT. The intermediate window (15-20 mT) has been insufficiently investigated.

Therefore, we designed an experiment to investigate the biological response to applied magnetic fields with amplitude in the range of 5-25 mT. As a test system we used the well established model of cell-free myosin phosphorylation. The system and assay are described in detail elsewhere. A brief description of the system includes 5 μM Ca^{2+}, 70 nM calmodulin, 160 nM myosin light chains, and 2 nM myosin light chain kinase. A pulsating semi-sinusoidal magnetic field (120 pps) generated by a therapeutical device (EMF Therapeutics, Inc., Chattanooga, TN, USA) was applied for 5 min to the reaction mixture at well controlled temperature conditions (37° C).

The results clearly indicate a statistically significantly increase in the phosphorylation rate over the entire range (5-25 mT) of applied magnetic fields. While the increase is only 16% at 5 mT, and 29% at 10 mT, the maximum effect is seen at 15 mT with a 96% increase. The value of the effect at 20 mT is 46% and 35% when magnetic field amplitude was 25 mT. A typical course of the dependence is shown at Figure 1.

In conclusion, the experimental data strongly confirm the existence of an intermediate biological window with the most probable maximum effect at 15 mT. These results are in a good correlation with our animal data (in publication) which indicate that magnetic field of 15 mT most significantly inhibits angiogenesis in a murine tumor model. If further research confirms these findings, this will be a significant step toward optimizing the use of magnetic fields in clinical settings.

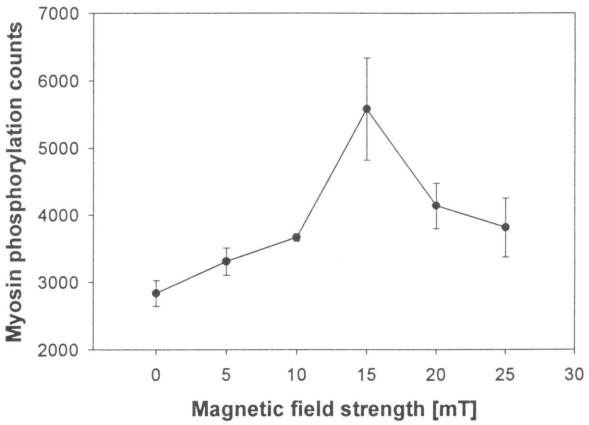

Figure 1: Myosin phosphorylation as a function of magnetic field strength