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EMF EFFECTS ON VIRAL REPLICATION: A POSSIBLE EXPLANATION FOR THE CONFLICTING REPORTS REGARDING PROTEIN SYNTHESIS.

J. Staczek*, H.E. Gilleland, Jr.*, L.B. Gilleland*, and A.A. Marino
Louisiana State University Medical Center in Shreveport, Louisiana 71130, USA.

Whether EMFs affect transcription and translation is disputed, based on published reports that suggest opposite answers. Our ultimate aim is to develop and exploit a simple model system amenable to the study of EMF effects at the molecular level. In the experiments reported here, both transient and steady-state EMF-induced effects were considered.

OBJECTIVE

To evaluate the effect of EMFs on virus replication as a function of time.

METHOD

Cells

Replication of the bacterial virus (bacteriophage) MS2 (ATCC 15597) in *E. coli* (ATCC 15597-B1) was studied. The MS2 genome is RNA and codes for 4 proteins; at 50–100 min after infection, one MS2 phage can result in the release of 100–200 phages from each infected *E. coli* cell. *E. coli* and MS2 were mixed at multiplicities of infection (MOI) of 0.2–2.0 plaque-forming units (PFU)/bacterium in Tryptic Soy Broth (TSB; Difco). The phage was permitted to adsorb in the cold for 15 min, then was pelleted and resuspended 4 times in the cold to reduce the level of unadsorbed phage. The final pellet was resuspended in TSB, placed in borosilicate glass tubes (4.5 ml/tube), and then randomized to exposed or sham-exposed conditions, both of which occurred in an incubator at 37°C. At the beginning of the experiment (t=O) and at 5-min intervals beginning at t=40 min after commencement of exposure, the mixture was resuspended and 100 µl was removed from each tube and assayed for phage titers by plaque assay. The results were expressed relative to the sham-exposed control (E/C); in some experiments, as an additional control, the EMF was not applied (C/C).

Exposure Apparatus

Two identical solenoids were wound on acrylic pipes 13 cm high and 5 cm in diameter; the tubes containing the infected bacteria were centered in the vertical mid-plane of the solenoid at a radius of 2.5 cm from its axis. The solenoids were mounted on an acrylic plate at an axis-to- axis separation of 25 cm. One solenoid was energized to produce 5 gauss, 60 Hz, and the second was short-circuited to provide sham exposure (residual 60-Hz field, 12 mG). The solenoid inductance, resistance, and power dissipated were 219 mH, 7.8 Ω, and 5.6 mW, respectively. The data was evaluated using two-way repeated-measures ANOVA and analysis of simple effects.

RESULTS

The appearance of MS2 in the medium lagged significantly in the EMF-exposed cultures compared with the sham-exposed cultures, but the final phage concentrations did not differ (Fig. 1A). The difference was not an artifact of the exposure system or procedure (Fig. 1B).

DISCUSSION

In studies published by others, EMF exposure could have affected the rate but not the amount of product synthesized. If so, field-induced differences would be expected in the measured variable, followed by a return to control level at a time characteristic of the system and the conditions of study. Differences in results between different laboratories could then be explained on the basis of

differences in timing of observations. If the lag in phage concentration (Fig. 1A) were mediated by an effect on protein synthesis, our results would support the hypothesis that EMFs affect rate but not total product because the results demonstrated a significant effect 50–60 min after commencement of exposure, with subsequent attainment of control levels. An effect involving transcription can be excluded (because it does not occur in the *E. coli-MS2* system), but processes not involving protein synthesis (such as an effect on viral penetration, RNA replication, or bacterial-cell lysis) could have mediated the observed effect.

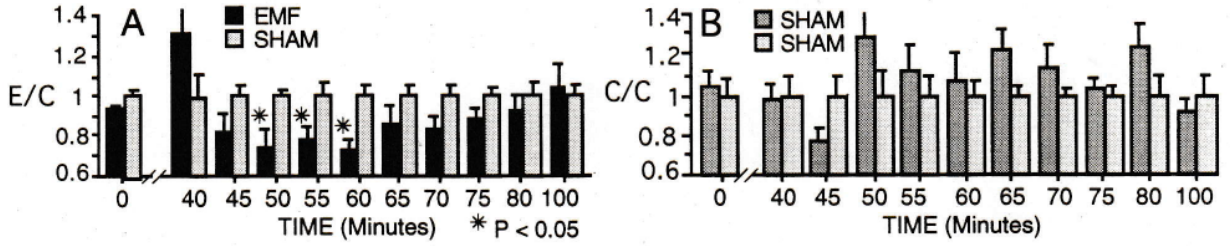

Fig. 1 A. Effect of 5 G, 60 Hz on virus concentration (Mean ± SE). Exposure of *E. coli* with adsorbed MS2 commenced at *t*=0. The change in PFU in the medium beginning at *t*=40 min was measured. Results from different days were combined by normalizing with the mean of the control cultures (N=10). B. Results of a procedure as described in Fig. 1A, except that the EMF was not applied in either solenoid (N=8).

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