BIOEFFECTS OF CONTINUOUS EXPOSURE OF EMBRYOS AND YOUNG CHICKE TO ELF DISPLAYED BY DESK COMPUTERS: PROTECTIVE EFFECT OF TECNO AO ANTENNA

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Introduction

Previous experiments performed in our laboratory demonstrated that in the chicken, immune and adrenocorticotropic systems synergistically respond to antigenic stimulation (1, 2). Now we report that continuous exposure of embryos and young chickens to electromagnetic fields (EMFs) emitted by video display units (VDUs: TV or computer) increases embryonic mortality, alters humoral immunity and its hormonal control and reduces body weight; on the other hand, an electromagnetoprotective device termed TECNO AO antenna effectively prevents these adverse biological effects. TECNO AO antenna (8-12 Hz; 100-150 fT; patent registration number: PCT/FR 93/00546) is an autonomous magnetic oscillator made up of oscillating paramagnetic solution contained in a syntonised double antenna. The following parameters were measured: embryonic mortality; plasma corticosterone, plasma melatonin and serum specific antibody titers after antigen challenge; body weight.

Materials and methods

The exposure system was either TV set (Thompson, D 55 cm, 55M x P83, 75 Watts/50 Hertz) or computer (Goupil G5 286 10, 220 V, 50 Hz). Three experiments were performed: experiment-1(1993); experiment-2 (1995); experiment-3 (1996). During each experiment, the monitor's screen was hidden with a black tissue to avoid exposure to visible spectrum. TVs and computers give off the same assortment of electromagnetic waves ranging from X-rays to ELF, but ELF and VLF fields are quantitatively the most important (3, 4).

• In the first experiment, eggs and chickens were 0.5-0.8 m in front of the TV set. In the incubation room, ELF intensity measured 0.8 and 0.5 m from TV switched off was 0 and 12 nT respectively; in the same room, with the exposure device on, the values measured at 0.8 and 0.5 m were 135 and 270 nT respectively. In the hen house, no ELF field was detected in front of the switched off TV; when the latter was switched on, the levels of ELF at 0.8 and 0.5 m distance were 135 and 260 nT respectively. No VLF could be measured either in the

incubation room or the hen house in front of the switched off TV;VLF intensity measured 0.8 and 0.5 m in front of the switched on TV was 0 and 25 nT respectively. Three groups of 30 eggs each were incubated in the incubation room and treated as follows: sham-exposed (control group) with TV switched off (C); electromagnetic field-exposed group with TV on (E); electromagnetic field-exposed group with TV on but equipped with TECNO AO antenna (P). Fertilized eggs were purchased from Couvoir des Cévennes (Lédenon, France). Incubation was carried for 21 days under 38 ± 1°C, 45-50% humidity and permanent darkness. The eggs were turned manually during the incubation period until embryonic day 19. Embryonic death was noticed by candling the eggs on day 3, 5, 7, 7, 11 and 13. After the 13 th day, the eggs became so opaque that the embryos could no longer be observed through the shell. For this reason, embryonic death from 13 to 21 days of incubation was evaluated by opening the eggs from which the chicks did not hatch after the 21 st day of incubation. After hatching, each group of chicks was continuously exposed until the end of the experiment, under the exposure schedule applied to the corresponding embryos. Newly-hatched chicks from each experimental group were collectively housed in cages (50 x 40 x 40 cm) under controlled photoperiod [12 h light (0800-2000), 12 h dark] and the temperature in the cages was progressively reduced 1°C per day from 38°C to 22°C. Two weeks after hatching, the chicks were transfered in a hen house and were distributed 3 per cage. The animals had free access to feed and water. Young chickens were immunized subcutaneously three times with porcin thyroglobulin (125 µg/ 100 g bw) at the age of 21, 30 and 39 days; blood samples were collected at the age of 20, 29, 38 and 47 days and blinded. Serum titers of specific anti-thyroglobulin antibodies (expressed as titer log) were determined by an indirect ELISA technique whereas plasma levels of corticosterone (ng/ml) were measured by radioimmunoassay. All the animals were weighted on day 47. Statistical analysis was performed by the Mann-Whitney test.

• In the second and third experiments, eggs and chickens were 0.5-0.8 m at the side of the computer. In the incubation room, ELF intensity 0.8 and 0.5 m from the computer switched off was 0 and 27 nT respectively; when the computer was switched on, ELF intensity at the same distances was 140 and 660 nT respectively. In the hen house, no ELF field could be detected around the exposure system switched off; when the latter was switched on, ELF intensity was 120 nT at 0.8 m and 560 nT at 0.5 m. The distribution of the ELF field in the cages was not measured. In the hen house no VLF emission could be detected when the exposure device was switched off; with the computer switched on, the levels of VLF were 0 and 4 nT at 0.8 and 0.5 m respectively. Three groups of eggs identical to those considered in the first experiment were used (C, E, P). During each experiment, an additionnal group of non exposed eggs (reference group) was simultaneously incubated in a Maino incubator (0.5 x 0.4 x 0.4 m) (L.A.D.I France). In the turned off incubator, no detectable ELF field could be

measured; when the incubator was switched on, the magnitude of the ELF field measured at the level of eggs, 0.4 and 0.3 m from the top side, was 150 and 650 nT respectively. No VLF field could be detected when the incubator was turned off; in the turned on incubator, the levels of VLF were 0 and 19 nT at 0.4 and 0.3 m respectively. In the second and third experiments, each group comprised 30 and 60 eggs respectively. Incubation and rearing conditions were similar to those defined in the first experiment. Embryonic mortality was also assessed as in the first experiment. Immunization was performed only in the second experiment, according to a slightly modified schedule. This modification was aimed at refining the profile of hormonal responses between day 29 and day 38: young chickens were immunized subcutaneously three times with porcin thyroglobulin (125 µg/ 100 g bw) at the age of 21, 30 and 36 days; blood samples were collected at the age of 20, 29, 35 and 38 days and blinded. Serum titers of specific anti-thyroglobulin antibodies (IgG) were determined by an indirect ELISA technique, whereas plasma levels of corticosterone (ng/ml) and melatonin (pg/ml) were measured by radioimmunoassay. All the animals were weighted on day 38. Statistical analysis was performed by the Mann-Whitney test.

Results

• The number of dead embryos in the Maino incubator was taken as reference for the evaluation of embryonic mortality in the incubation room. In the control group (C), total embryonic mortality evaluated on day 21 was 27% (exp. 1), 33% (exp. 2) and 10% (exp. 3). The death rate in the exposed group (E) reached 57% (exp. 1), 47% (exp. 2) and 67% (exp. 3). On the other hand, embryonic loss was significantly reduced in the TECNO AO antenna-protected group (P): 33% exp. 1), 38% (exp. 2) and 27% (exp. 3).

• Antibody and hormonal data reported here are those obtained in the second experiment; comparable data were found in the first experiment (5, 6). Irrespective of experimental groups, anti-thyroglobulin IgG titers increased throughout the experimental session. However, exposed chickens exhibited significantly lower titers of IgG (10,175 ± 3,437) than their Control and Protected counterparts whose antibody production were comparable (122,500 ± 17,128 and 151,458 ± 29,964 respectively). From the first to the third immunization, control chickens exhibited progressively rising corticosterone and melatonin levels reaching a maximum value on day 38 (corticosterone: 9 ± 0.4 ng/ml; melatonin: 70 pg/ml). Conversely in the exposed group, hormonal concentrations remained steadily low at baseline values on day 38 (corticosterone: 4 ± 0.1 ng/ml; melatonin: 5 pg/ml). On the same day, the levels of corticosterone and melatonin in the protected chickens were normal: 9 ± 0.6 ng/ml and 66 pg/ml respectively.

• Electromagnetic field exposure led to significant reduction in body weight ($p < 0.05$), and striking sex differences were recorded with males appearing more sensitive than females. Conversely, in the TECNO AO antenna-protected group, normal body was restored.

Conclusion

Taken together, these results suggest that continuous embryonic and post-hatching exposure to electromagnetic emissions issued from VDUs (TV or computer) is associated with increased embryonic mortality, altered humoral immunity and its hormonal regulation and reduced body weight in chickens. Much more striking, the TECNO AO antenna effectively conteracts all these biological disruptions. Embryonic phase seems to be the most sensitive to electromagnetic emissions as witnessed by data reported elsewhere (7).

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