

A STUDY ON THE INFLUENCE OF 50-Hz MAGNETIC FIELDS  
ON THE CYTOTOXIC ACTIVITY OF HUMAN NATURAL KILLER CELLS

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ABSTRACT

The effect of exposure to 50-Hz sinusoidal magnetic fields on the cytotoxic activity of fresh human natural killer cells has been investigated. Either effector or target cells were exposed to a homogeneous magnetic flux density ranging from 0.1 to 10 mT. The experimental results do not show evidence of an effect for any of the exposure conditions, suggesting that magnetic fields do not inhibit significantly the cytotoxic activity of peripheral blood lymphocytes.

INTRODUCTION

In the last years, a continuously increasing attention has been devoted, inside both the scientific community and the public opinion, to the biological effects of extremely low frequency (ELF) magnetic fields. The results of some epidemiological studies<sup>(1)</sup> have in fact indicated a possible association between long-term exposure to the magnetic fields generated by large electrical plants, in particular power lines, and the development of some kind of tumors.

In order to hypothesize a causal link between magnetic fields and cancer, a plausible biological mechanism of interaction is to be identified, which should account for the promoting action of the magnetic field.

Taking into account the present hypotheses on the potential carcinogenicity of power frequency magnetic fields, the study of possible effects on the *in vitro* immune response is deemed of uppermost interest.

In the light of the important role of the immunosurveillance system, we investigated the effect of power-frequency magnetic fields on the cytotoxic activity exerted by a small population of peripheral blood mononuclear cells, named natural killer (NK) cells. These cells have recently become the subject of extensive laboratory investigation.

NK cells are operationally defined as cells capable of mediating spontaneous *in vitro* cytotoxicity against a variety of target cell populations without apparent prior sensitization. They are involved in a large number of different immunological functions including cytotoxicity against tumor cells and virally transformed cells, resistance to some microbial, fungal, and parasitic agents, regulation of some lymphokine secretion, regulation of hemopoiesis, and natural resistance to allogeneic grafts.

In this study, the effect of 50-Hz sinusoidal magnetic field is investigated on the allogeneic cytotoxicity reaction conducted *in*

vitro by peripheral blood lymphocytes (PBL) effector cells acting on K562 target cells (specially sensitive to NK lysis).

#### EXPERIMENTAL

A sinusoidal 50-Hz magnetic field was generated inside coils of 18 cm diameter and 50 cm height, with a winding of 6 turns/cm. That allowed a quite homogeneous field in all the central region of the coil, where the samples were located. The current intensity was controlled by a Variac potentiometer, so that the magnetic flux density could be varied up to about 10 mT. The actual value of the magnetic field density was continuously monitored by the narrow Hall-probe of a gaussmeter, which was inserted in the coil at the sample location.

Although the magnetic flux density could be set within a precision of 2%, variations of the order of 5% generally occurred throughout the exposure period, due to instability in the electric network.

Through a Variac potentiometer, the magnetic flux density was varied between 0.1 and 10 mT, i.e. of the same order of magnitude of exposure limits for workers and population recommended by the recent IRPA/INIRC guidelines<sup>(2)</sup>.

PBL from fresh human blood, freed of adherent cells, were divided into two samples at  $10^6$ /ml concentration and suspended in culture medium. One sample was exposed to the magnetic field, while the other was sham-exposed.

All the exposure system was included in an incubator at 37 °C and 5% CO<sub>2</sub>. Exposure lasted the whole incubation time (70 h).

Cytotoxicity was then assayed by mixing effector cells to <sup>51</sup>Cr-labelled cells with effector-to-target (E/T) ratios ranging between 50:1 and 6.25:1. The reaction mixture was incubated for 3 h at 37 °C. All groups were tested in triplicate.

The percent <sup>51</sup>Cr release  $R_s$  was calculated as:

$$R_s = 100 (R_t - R_s) / (R_m - R_s)$$

where  $R_t$ ,  $R_s$ , and  $R_m$  are the test, spontaneous, and maximum release, respectively.

#### RESULTS AND DISCUSSION

Results of 3-hour <sup>51</sup>Cr-release cytotoxicity tests are reported, for three different magnetic flux densities, in Figs. 1-3. Data relative to other exposure levels exhibit the same behaviour.

It has been suggested<sup>(3,4)</sup> that the cellular plasma membrane may be a major target for ELF magnetic fields. Possible effects on cell-mediated lysis might therefore be related to action on either the effector or target cell membrane.

The experimental data do not show any significant change of the cytotoxic activity by NK cells after exposure of either effector cells (Fig. 1), or target cells (Fig. 2), or both (Fig. 3).

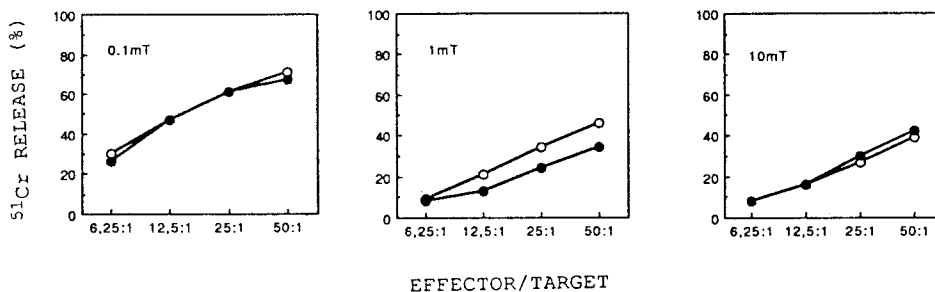


Fig. 1. Comparison of cytotoxic activity of exposed (●) and non-exposed (○) NK effector cells on K562 target cells.

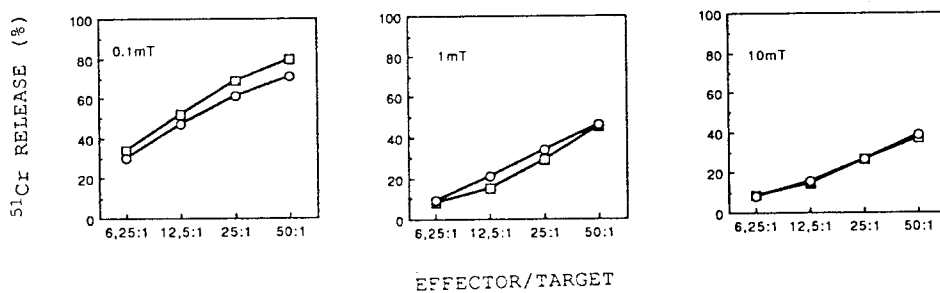


Fig. 2. Comparison of cytotoxic activity of NK effector cells on exposed (■) and non-exposed (○) K562 target cells.

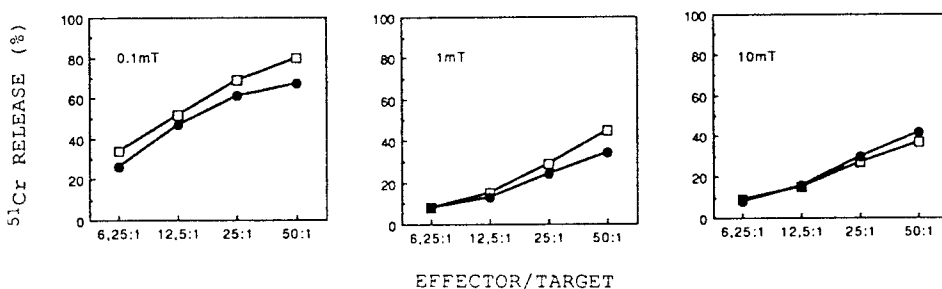


Fig. 3. Comparison of cytotoxic activity of exposed NK effector cells on exposed K562 target cells (●) and non-exposed NK effector cells on non-exposed and non-exposed K562 target cells (■).

Repeated experiments on blood from different donors show the same behaviour, independently on the individual variability.

Our findings therefore suggest that the exposure to 50-Hz sinusoidal magnetic fields do not have relevant effect on the behaviour of NK cells. In contrast, Lyle et al.<sup>(5)</sup> reported a significant inhibition of allogeneic cytotoxicity by murine T-lymphocyte line CTLL-1 exposed to 60-Hz electric field, suggesting a possible effect on activated cells.

To test this hypothesis, research is in progress on activated lymphocytes. Preliminary results seem to indicate a significant inhibition of the cytotoxic activity when activated effector cells are exposed to 50-Hz sinusoidal magnetic fields.

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