## Analgesic-antiinflammatory effect of a 100 Hz variable magnetic field in RA

Sir,

For more than 20 years electromagnetic fields (PEMF) have been employed in medical practice, essentially for analgesic purposes. There are numerous studies which report that PEMF are capable of eliciting *in vitro* and *in vivo* bioeffects, but a well-accepted biophysical mechanism which quantitatively describes the PEMF coupling to biological systems still remains elusive (1).

The aim of this study was to examine some of the physiological effects of a weak magnetic field modulated by a low frequency sinsoidal law, employed for analgesic purposes. We selected 10 patients (5 males and 5 females, mean age 40 ± 3.8 years) affected by rheumatoid arthritis (RA), diagnosed according to the ARA criteria (2) and in a relapsing phase of the disease. These patients (group A) were compared with 10 normal subjects (group B) (5 males and 5 females, mean age 39 ± 4 years).

The subjects, after giving their informed consent, were treated with a sinusoidal magnetic field (frequency 100 Hz oscillation) for 30 minutes (the length of time commonly used for analgesic treatment), in accordance with the literature (3, 4). In the RA patients antiinflammatory agents were stopped 7 days before the start of the study. Erythrocyte sedimentation rate (ESR) and C reactive protein (CRP) were evaluated under basal conditions and 60 minutes after PEMF treatment. In addition, before and 30 and 60 min. after PEMF application, the following biochemical parameters were measured: plasma cyclic adenosine monophosphate (cAMP) levels (125 RIA kit, Incstar Corporation, Stillwater, USA), β-endorphins (125 RIA kit, DiaSorin, Stillwater, USA), oxygen free radicals (OFR) (colorimetric method, d-ROMs test, Diacron Srl, Grosseto, Italy), the E2 prostaglandin (PGE2) (3H RIA kit, Seragen Inc., Boston, USA), cortisol (125 RIA kit, DPC, Los Angeles, USA) and adrenocorticotropic hormone (ACTH) (Immunoradiometric Assay, Incstar Corporation, Stillwater, USA).

ESR and CPR were in the normal range in group B (Table I), but were significantly increased in group A (Table I), thus confirming that the rheumatoid inflammatory process was not yet over. In group B, the basal values for plasma cAMP, beta-endorphins, OFR, PGE2, cortisol and ACTH were in the normal range. In contrast, the basal values for cAMP, OFR and PGE2 were significantly higher in group A (Table I), owing to the activation of inflammatory cells.

Statistical analysis (Student's paired t-test) showed a significant difference between groups A and B in terms of cAMP, OFR and PGE2 activation. After PEMF treatment, β-endorphins, OFR, PGE2, cortisol and ACTH were constantly in the normal range in group B, while cAMP levels showed a significant increase at 30 min. and much more at 60 min. In group A, β-endorphins, cortisol and ACTH did not show significant changes at 30 and 60 min., nor did ESR and CPR at 60 min. Moreover, plasma cAMP showed a significant increase with respect to the already high basal values, while OFR and PGE2 presented significant decreases.

The increase in plasma cAMP suggests that second messenger-dependent processes, due to the interaction of PEMF with the cytoplasmatic membrane, are involved in the effect of the electromagnetic field. In fact, cAMP is synthesized by adenylate cyclase, which is attached to the inner face of the cytoplasmatic membrane, thus representing a sensitive indicator of electromagnetic field action at the cell membrane site (1, 5). The significant decrease in OFR and PGE2 seen in group A suggests that PEMF can interfere with some of the fundamental agents of the inflammatory process. Probably, PEMF interact with the polymorphocyte and macrophage cell membranes, resulting in changes in the ion permeability and capacitive reactance of these membranes (1). The increase in cAMP induced by PEMF in both groups confirms experimental evidence of the inhibition of OFR production by PEMF activity (5, 6). The lack of a decrease in ESR and CPR in group A after PEMF is probably due to the short length of the study period. Finally, the lack of effect of PEMF on ACTH, cortisol and opioid secretion, also reported by other authors (7, 8), seems to demonstrate that the analgesic-anti-inflammatory properties of PEMF are linked to their antagonist activity towards the peripheral mechanisms of pain, and not towards the central agents of pain, in particular the endorphin system.

**Table I.** Basal values of ACTH, cortisol, β-endorphins, cAMP, OFR, PGE2 ESR and CPR in RA patients and control subjects (expressed as means ± SD).

| | RA pts. (n = 10) | Controls (n = 10) |
|---|---|---|
| ACTH | 34.5 ± 14.3 | 36.1 ± 16.07 |
| Cortisol | 167.7 ± 25.8 | 160.7 ± 26.4 |
| β-endorphins | 5.7 ± 2.1 | 5.6 ± 1.9 |
| cAMP | $25.3 \pm 6.64^{+}$ | $8.4 \pm 1.06^{+}$ |
| OFR | 423.6 ± 78,5* | 260.2 ± 41.6* |
| PGE2 | 355.5 ± 145.17§ | 82 ± 10.2§ |
| ESR | $57 \pm 8^{+}$ | $15 \pm 3.9^{+}$ |
| CRP | 10.7 ± 5.6^ | 0.9 ± 1.3^ |

Normal values for ACTH < 70 pg/ml; cortisol 50 -200 ng/ml; β-endorphins 10.1 ± 1.8 pmol/L; cAMP 10.38 ± 0.8 nmol/L; OFR 300 - 340 UC; PGE2 50 - 110 pg/ml; ESR < 20 mm/1st hr; CPR < 1.0 mg/dl.
^p < 0.005; $^{+}$p < 0.0001; *p < 0.000017; §p < 0.000016.

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