Effect of acute exposure to low-level CW and GSM-modulated 900 MHz radiofrequency on synaptic transmission and plasticity in the rat perirhinal cortex

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Summary — We are studying non-thermal effects of continuous wave (2 W/kg) and GSM-modulated (2 or 4 W/kg) 900 MHz radiofrequency (RF) electromagnetic field exposure on synaptic transmission and plasticity in rat perirhinal cortex slices. Preliminary results, still under elaboration, indicate that the exposure to both RF signals may cause small changes in synaptic plasticity in our experimental conditions.

INTRODUCTION

The extensive use of mobile telephone technology has raised public concern about possible effects associated to radio frequency (RF) electromagnetic fields (EMFs) exposure, particularly because the mobile phone handset operates in the proximity of the head. In addition, the concern is sustained by the controversial reports found in scientific literature. Regarding the possibility that RF EMFs can interfere with learning and memory, the results obtained in both animal models and humans are discordant, some of them showing a correlation between global system mobile communication (GSM) signal exposure and memory deficits, and some others not supporting this hypothesis [1].

In an attempt to give a contribution to the identification of possible molecular targets of RF effects able to modify neuronal activity, we have recently studied the effect of CW and GSM 900 MHz RF acute exposure on neuronal voltage-gated calcium channels. No significant effects were found in our experimental conditions: 1–3 periods of 90 s exposure; specific absorption rates (SAR): 2 W/kg and 2 W/kg (time average value) for CW and GSM-modulated signals, respectively [2].

In order to move the investigation to a more complex scale, in the present study we are studying the effect of RF EMFs at the neuronal circuit level in the rat brain, in an area that lies in the medio-temporal lobe of the cerebral cortex, the perirhinal cortex. We evaluate RF effects on the amplitude of the synaptic component of the extracellular field potential recorded during and following RF exposure. The advantage of this methodological approach is to provide a real time estimation of an electrophysiological parameter which is strictly dependent on the functional integrity of neuronal connectivity. Moreover, we evaluate the effect of the same exposure on long-term potentiation of synaptic transmission (LTP), a form of synaptic plasticity (i.e. activity-dependent change in synaptic strength) which underlies memory formation [3]. The exposure system consists of a coplanar wave guide especially designed for these experiments [4]. The SAR values (2 W/kg and 2 or 4 W/kg - average time value) for CW and GSM-modulated RF, respectively) have been chosen according with the limits proposed by the European Community (Council Recommendation on the limitation of exposure of the general public to electromagnetic fields 0Hz - 3000GHz, 1999/519/CE, GU 199/59 of 30/7/1999).

MATERIALS AND METHODS

Experiments are carried out in horizontal brain slices including the perirhinal cortex, prepared from Sprague Dawley male rats aged 23 to 50 days. Rats are deeply anaesthetized with halothane and sacrificed; brains are quickly removed and immersed in cold (4°C) artificial cerebro-spinal fluid (ACSF), gassed with 95% O₂ and 5% CO₂ at pH 7.4. Horizontal slices (400 µm thick) are cut using a microtome (WPI, inc., USA). After recovery, a single slice is transferred to a submersion recording chamber perfused (3 ml/min) with a warm (34°C) ACSF. Extracellular field potentials evoked by horizontal fibres stimulation (by means of a stimulating concentric bipolar electrode, 70-80 KOhm) are applied to evoke the basal synaptic response; the stimulus intensity is adjusted to produce 50% of the maximal FP amplitude (of the order of 70 µA, Fig. 2). LTP is induced by 100 Hz “theta burst” stimulation, consisting of four sets of stimulations delivered 15 s apart, each one consisting of 10 bursts of five pulses at 100 Hz with inter-burst intervals of 150 ms [3]. After 30 min of...
stabilization of synaptic response, slices are exposed either to 
CW RF (900 MHz, 2W/Kg) for 5 min, or to GSM signal 
(900MHz, 2 or 4W/Kg, average peak value) for 5 min.

RESULTS

Preliminary results, still under elaboration, indicate that 
the exposure to both RF signals may cause small changes in 
synaptic plasticity in our experimental conditions.

Fig. 1. A brain slice during extracellular field potential recording (A); 
the coplanar waveguide (B).

Fig. 2. Representative traces of extracellular field potentials evoked by 
afferent pathways stimulation at different intensities.

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