

Medical/biological Study (experimental study)**Mechanism of short-term ERK activation by electromagnetic fields at mobile phone frequencies.**

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Published in: Biochem J 2007; 405 (3): 559 - 568

Aim of study (according to editor)

To study the effect of electromagnetic fields at mobile phone frequency on the MAPK (mitogen-activated protein kinase) cascades.

Background/further details:

MAPK cascades (ERK1/2, JNK1-3, p38MAPK, BMK1) are a group of signal transduction pathways, which mediate the effects of various extracellular stimuli to regulate processes including proliferation, differentiation, metabolism and stress response.

Cells as well as isolated membranes of HeLa cells were used. Different inhibitors (reactive oxygen species inhibitor/scavenger, EGF receptor inhibitor, NADH oxidase inhibitor etc.) were used to identify mediators of irradiation-induced ERKs phosphorylation (signals are transmitted via phosphorylations of protein kinases and of regulatory proteins, for example).

Endpoint

- cell function: signal transduction pathways

Exposure

General category: digital mobile phone, microwaves

Field characteristics	Parameters
field 1: 875 MHz HeLa cells, rat cells exposure duration: 30 min	power flux density: 0.07 mW/cm ² power flux density: 0.23 mW/cm ²
field 2: 875 MHz rat cells, HeLa cells exposure duration: 10 min	power flux density: 0.1 mW/cm ² power flux density: 0.2 mW/cm ² power flux density: 0.31 mW/cm ²
field 3: 800 - 950 MHz rat cells exposure duration: 30 min	power flux density: 0.07 mW/cm ²
field 4: 875 MHz rat cells, HeLa Zellen exposure duration: 2 min, 12 min, 2 min exposure + 5 min in incubator without exposure, 2 min exposure + 10 min in incubator without exposure	power flux density: 17 mW/cm ²
field 5: 875 MHz HeLa cells exposure duration: 2 min, 5 min, 12 min, 20 min, 2 min exposure + 5 min in incubator without exposure, 2 min exposure + 10 min in incubator without exposure	power flux density: 0.31 mW/cm ²

field 6: 875 MHz HeLa cells exposure duration: 5 min	power flux density: 0.21 mW/cm ²
field 7: 875 MHz HeLa cells exposure duration: 5 min, 10 min, 15 min	power flux density: 0.344 mW/cm ²
field 8: 875 MHz HeLa cells exposure duration: 15 min, 30 min	power flux density: 0.2 mW/cm ²
field 9: 875 MHz HeLa membranes exposure duration: 5 min, 10 min	power flux density: 0.24 mW/cm ² power flux density: 0.2 mW/cm ²

Exposed system:

organelle/cell part (in vitro)

intact cell/cell culture (in vitro)

Rat1 cells, HeLa cells

membrane suspensions

Methods

Endpoint/Measurement parameters/Methodology

- molecular biosynthesis: detection and kinetics of phosphorylation of ERKs, JNKs, p38MAPKs (Western blot; densitometry); release of heparin-binding-epidermal growth factor (hb-EGF) and ERK activation by hb-EGF (Western blot)
- cell function: signal transduction pathways (detection of different molecules (see "molecular biosynthesis") and enzyme activity of NADH oxidase (spectrophotometry))

investigated material: isolated bio./chem. substance (in vitro), organelle/cell part (in vitro), cell homogenates/supernatants; membrane suspensions

time of investigation: after exposure

Main outcome of study (according to author)

This study delineate a detailed molecular mechanism by which electromagnetic fields at mobile phone frequency induces short-term MAPK activation and thereby transcription and other cellular processes. The data show that ERKs, but not JNKs or p38MAPKs, are rapidly activated in response to mobile phone exposure at various frequencies and intensities. The first step is mediated in the plasma membrane by NADH oxidase, which rapidly generates reactive oxygen species. The generated reactive oxygen species then directly activate matrix metalloproteinases to release heparin-binding (Hb)-EGF, which further activate the ERK cascade.

(Study character: medical/biological study, experimental study, full/main study)

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