

Mechanism of short-term ERK activation by electromagnetic fields at mobile phone frequencies

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FROM ABSTRACT:

The exposure to non-thermal microwave electromagnetic fields generated by mobile phones affects the expression of many proteins.

This effect on transcription and protein stability can be mediated by the MAPK (mitogen-activated protein kinase) cascades, which serve as central signalling pathways and govern essentially all stimulated cellular processes.

Indeed, long-term exposure of cells to mobile phone irradiation results in the activation of p38 as well as the ERK (extracellular-signal-regulated kinase) MAPKs.

In the present study, we have studied the immediate effect of irradiation on the MAPK cascades, and found that ERKs are rapidly activated in response to various frequencies and intensities.

Using signalling inhibitors, we delineated the mechanism that is involved in this activation.

We found that the first step is mediated in the plasma membrane by NADH oxidase, which rapidly generates ROS (reactive oxygen species).

These ROS then directly stimulate MMPs (matrix metalloproteinases) and allow them to cleave and release Hb-EGF [heparin-binding EGF (epidermal growth factor)].

This secreted factor activates the EGF receptor, which in turn further activates the ERK cascade.

Thus this study demonstrates for the first time a detailed molecular mechanism by which electromagnetic irradiation from mobile phones induces the activation of the ERK cascade and thereby induces transcription and other cellular processes.

THESE AUTHORS ALSO NOTE:

“The intensive use of mobile or cellular phones in the last 20 years has aroused concern about possible health problems that may be caused by the microwave irradiation which is associated with these phones.”

"The current safety standard for the use of mobile phones takes into consideration mainly heating, which is induced by their electromagnetic field."

"According to these parameters, which are measured by SARs (specific absorption rates; the amount of energy delivered is too low to trigger biological effects; however, it has been shown that electromagnetic fields can affect living tissues by energies that are much lower than those causing changes in the temperature of tissues." These are known as "temperature-insensitive responses."

It is documented that transcription can be induced by short exposures to low-frequency electric and magnetic fields.

"The higher-frequency (approx. 900 MHz) electromagnetic irradiation emitted from mobile phones also induces expression of proteins in various cells."

"The elevated expression of these proteins may participate in the induction of various cellular processes that appear to be affected by mobile phones, which include replication, cell-cycle progression and apoptosis."

"A major mechanism that regulates transcriptional activity in response to extracellular stimuli is the activation of the MAPK (mitogen-activated protein kinase) cascades. These cascades are a group of signal transduction pathways which mediate the effects of various stimuli to regulate essentially all stimulated processes, including proliferation, differentiation, metabolism and the stress response."

There are 5 MAPK cascades:

- 1) ERK (extracellular-signal-regulated kinase)
- 2) JNK (c-Jun N-terminal kinase)
- 3) SAPK1 (stress-activated protein kinase 1)
- 4) p38MAPK (SAPK2)
- 5) BMK1 (big MAPK1; also known as ERK5)

Lengthy exposure to mobile phone irradiation can activate the p38MAPK, JNK and ERK cascades.

"These changes in activity of the MAPKs can consequently regulate the physiological response of the exposed cells and organisms, and therefore are major regulators of the effects of electromagnetic fields at mobile phone frequencies."

This study shows that rat ERKs are rapidly activated in response to mobile phone irradiation at various frequencies and intensities. "This activation is mediated by ROS (reactive oxygen species) that are produced upon irradiation."

RESULTS

ERKs are phosphorylated in response to mobile phone irradiation.

"A group of enzymes that are known to rapidly respond to extracellular stimuli are the MAPKs and therefore their phosphorylation was used to determine the acute effect of mobile phone irradiation."

Rat cells were subjected to mobile phone irradiation at an intensity well below the average intensity of mobile phones.

Irradiation-induced phosphorylation of ERK is mediated by ROS.

Using the ROS (reactive oxygen species) scavenger NAC (N-acetyl-cysteine), cell phosphorylation was inhibited. **[Very Important]**

"Irradiation for 2 min was enough to exert the full effect on the phosphorylation of ERKs"

"Taken together, these data indicate that the phosphorylation of ERKs following mobile phone irradiation include production of ROS that activate MMPs."

DISCUSSION

"We found that the ERK cascade was activated within 5 min, and the peak activity was within 10–15 min of irradiation."

These results indicate that "mobile phone irradiation induces an immediate effect in the cytoplasm which activates ERK signalling to induce further transcription of a variety of genes."

"The phosphorylation of ERKs is induced through several steps," and the first step in the processes is cell phone irradiation-induced generation of ROS.

Production of ROS by mobile phone irradiation is "induced by the activation of NADH oxidase, which appears to be an early acceptor of mobile phone irradiation." "These events appear to occur within seconds and initiate the subsequent activation of the pathway that leads to the phosphorylation of ERKs."

This study indicates that the early acceptor of cell phone irradiation is NADH oxidase, which is localized in the plasma membrane and converts the irradiation into ROS, which subsequently activate MMPs.

"In summary, we have shown in the present study that ERKs are rapidly activated in response to mobile phone irradiation at various frequencies and intensities."

"This activation is mediated by ROS that are produced by NADH oxidase upon irradiation, and directly activate MMPs."

Only ten minutes on a mobile could trigger cancer, scientists believe
By DAVID DERBYSHIRE August 30, 2007

THIS AUTHOR NOTES, IN PART THE FOLLOWING CONCERNING THE ABOVE ARTICLE:

"Mobile phones can take as little as ten minutes to trigger changes in the brain associated with cancer, scientists claimed yesterday."

"They found even low levels of radiation from handsets interfere with the way brain cells divide. Cell division encourages the growth of tumours."

The new study by the Weizmann Institute of Science in Israel suggests "nonthermal" cell phone radiation could pose a risk.

"The Israeli scientists exposed human and rat cells in a laboratory to low-level radiation at 875 megahertz - a similar frequency to the one used in many mobile phones. Although the radiation was far weaker than emissions from a typical handset, it began to switch on a chemical signal inside the cells within ten minutes, the researchers report in the Biochemical Journal."

KEY POINTS FROM DAN MURPHY

- 1) Thus this study demonstrates for the first time a detailed molecular mechanism by which electromagnetic irradiation from mobile phones induces a cascade of cellular responses that may cause cancer.
- 2) "The intensive use of mobile or cellular phones in the last 20 years has aroused concern about possible health problems that may be caused by the microwave irradiation which is associated with these phones."
- 3) "The current safety standard for the use of mobile phones takes into consideration mainly heating, which is induced by their electromagnetic field." "However, it has been shown that electromagnetic fields can affect living tissues by energies that are much lower than those causing changes in the temperature of tissues." These known as "temperature-insensitive responses."
- 4) This study shows that the electromagnetic irradiation emitted from mobile phones increase the production of reactive oxygen species free radicals (ROS) that initiate a cascade of cellular responses that may cause cancer.
- 5) This cell phone irradiation induced production ROS (reactive oxygen species) is inhibited by administration of the free radical scavenger NAC (N-acetyl-cysteine).
[Very Important]

- 6) Adverse cellular effects could be noted within 2 minutes of cell phone radiation exposure. Increased effects were noted within 5 minutes of exposure, and the "peak activity was within 10–15 min of irradiation."
- 7) The first step in the processes is cell phone irradiation-induced generation of ROS (reactive oxygen species) free radicals.
- 8) This study indicates that the early acceptor of cell phone irradiation is NADH oxidase, which is localized in the plasma membrane and converts the irradiation into ROS, which subsequently activate MMPs.
- 9) "Mobile phones can take as little as ten minutes to trigger changes in the brain associated with cancer."
- 10) "They found even low levels of radiation from handsets interfere with the way brain cells divide. Cell division encourages the growth of tumours."

COMMENT FROM DAN MURPHY

This is one of several articles we have reviewed that suggests cell phones may be hazardous to our health. This is also the reason I use the FCC (Federal Communication Commission) certified and SAR (Standard Absorption Rate) tested radiation attenuation device on my cell phone, the "RF Raider" from Erchonia. Erchonia's number is (888) 242-0571, or (214) 544-2227.