INTERACTION BETWEEN ELECTROMAGNETIC WAVES AND AUDITORY ORGANS

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The Authors report their experience on the effect of electromagnetic waves on the ear (cochlea) and the auditory function. In particular, the use of electromagnetic sources (radio, TV, mobile telephones etc.) probably cause hyperthermia in the coclea capable of producing physiological variations of the answer to stimulus in relation to the inactivation and/or progressive modification of enzymatic activity, variations of trans-membrane ionic exchanges and modifications of the cellular metabolism of calcium. Following studies will be supported by epidemiological validation of this cause-effect relationship.

The increasing technological growth that characterizes modern society is not always synonymous of progress because it can sometimes cause conditions of risk for the health of individuals (1).

In fact, the researches carried out to prove any noxious consequences of electromagnetic waves on man are today of particular interest.

The widespead use of electromagnetic fields is a recent phenomenon. Their use has greatly increased over the past decade and to many they are now an essential part of business, commerce and society. The use of such waves for communications has caused the intensification and the optimization of interpersonal exchanges of information but it has also exposed humanity to phenomenon detrimental to health, considering that human beings have not been able to adapt themselves to these new conditions from an evolutionary point of view (2).

In fact, in the past, the natural magnetic field produced by Earth did not interfere with man's health; today, instead, the quantity of electromagnetic waves in the environment has notably increased due to both the massive use of these waves for communications and to many other electromagnetic sources (electric transport power-lines, radar plants, radio and television transmitters, mobile telephony repeaters, railway systems) (3).

In a family household, the use of such tools, either by direct contact or at a brief distance from the body, cause an electromagnetic matching between the human body and generated field with an interaction between the ions present in human tissues and electricity.

This causes an alteration of the electrolytic conditions present in tissues with consequential thermal damages, due to electrical input and its conversion into heat (local or general thermal elevation), or non-thermal damage, by means of modifications of the molecular mechanisms and of cellular membrane potential.

It is manifest that any damage caused by electromagnetic wave absorption is related to both the source and the target of radiation. In the first case the extent of the alterations depends on:

- the power of the radiations;
- the spectral features;
- the exposure time.

In the second case, in relation to the target organ, the damage is related to:

- the irradiated area;
- the tissue vascularization.

EFFECTS ON THE EAR

The vascular system of the cochlea (centre of the organ of Corti) is of a terminal type, lacking in collateral branches: this anatomic factor makes the ear particularly sensitive to the small heat variations caused by electromagnetic waves.

This condition can cause hyperthermia in the cochlea capable of producing

physiological variations of the answer to stimulus in relation to the:
- inactivation and/or progressive modification of enzymatic activity (4);
- variations of the trans-membrane ionic exchanges (5);
- modifications of the cellular metabolism of calcium (6).

The alterations of the intracellular enzymatic system, in the ciliated cells at the plasmatic membrane level, of the endoplasmic reticulum of mitochondrion, influence fundamental cytoplasmatic activities of cellular functionality, namely, energy production, ionic transport and protein synthesis. It is known that the variations of the ionic trans-membrane exchanges can alter the regulation of membrane potential and therefore the processes that allow the translation of sound stimulus in the cochlea, that is, the transformation from a mechanical to an electric event. In coclear pathogenesis the variations of the cellular metabolism of calcium could also assume particular importance; ions modulating cellular contractile activities, intervene in the regulation of the electrotonic processes of the external ciliate cells (ECC) of the cochlea. The ECCs are provided with a canalicular system in their cytoplasmatic membrane that permits the release and assumption of calcium ions. The calcium ions mediate contractile activity that allows the ECCs to intervene in determining the oscillations of the tectorial membrane and the regulation of the activity of the inner ciliate cells (ICC). It has also been observed that the partial destruction of the ECCs causes a modification of the sensitivity of the ICCs, above all for the middle-high frequencies, hence presuming the presence of a real phenomenon of intermodulation. The mechanical translation of the ECCs carried out by means of contractible dynamics allows the approach of the tectorial membrane to the reticular lamina with consequential moving of the endolympha and refolding of stereocilia toward the inside spiral sulcus, phenomenon that involves the activation of the inner ciliate cells. Considering the above reported phenomena, the existence of a particular tropism to electromagnetic radiations can be hypothesized in the cochlear compartment that, composed by delicate neurosensorial structures, can highly suffer the metabolic and biofunctional variations.

It is must be emphasized that such phenomenon may depend on variables such as individual predisposition, existence of past cochlear diseases and quantitative and qualitative formalities of exposure to the waves of mobile telephony.

In such a context, the existence of a subjective thresholding factor must be considered; beyond this "threshold" metabolic and vascular variations caused by electromagnetic irradiation, could irreversibly compromise cochlear functionality.

Although there is no evidence that electromagnetic waves cause cancer or other illnesses, there are results suggesting that their emissions have a variety of strange effects on living tissue, and, in this work, we have pointed out the cause-effect relationship between exposure to electromagnetic radiations and appearance of cochlear disease. Following studies will be supported by epidemiologic validation of this cause-effect relationship.

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