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Electrohypersensitivity: Observations in the Human Skin of a Physical Impairment

by

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An ever increasing number of studies have clearly shown various biological effects at the cellular level of electromagnetic fields, including powerfrequent and radiofrequent ones as well as microwaves. Such electromagnetic fields are present in your everyday life, at the workplace, in your home and at places of leisure.

Recently, a new category of persons with a physical impairment (electrohypersensitivity; EHS) has been described in the literature, namely those that claim to suffer from subjective and objective skin- and mucosa-related symptoms, such as itch, smarting, pain, heat sensation, redness, papules, pustles, etc., after exposure to visual display terminals (VDTs), mobile phones, DECT telephones, as well as other electromagnetic devices. Frequently, symptoms from internal organ systems, such as the heart and the central nervous system, are also encountered.

Persons claiming such adverse skin reactions after having been exposed to computer screens or mobile phones very well could be reacting in a highly specific way and with a completely correct avoidance reaction, especially if the provocative agent was radiation and/or chemical emissions -- just as you would do if you had been exposed to e.g. sun rays, X-rays, radioactivity or chemical odours. The working hypothesis, thus, early became that they react in a cellularly correct way to the electromagnetic radiation, maybe in concert with chemical emissions such as plastic components, flame retardants, etc., something later focussed upon by professor Denis L. Henshaw and his collaborators at the Bristol University [This is also covered in great depth in Gunni Nordström's new book "The

Invisible Disease - The Dangers of Environmental Illnesses caused by Electromagnetic Fields and Chemical Emissions" (O Books, 2004, ISBN 1-903816-71-8).]

Very soon, however, from different clinical colleagues, and in parallel to the above, a large number of other 'explanations' became fashionable, e.g. that the persons claiming EHS only were imagining this, or they were suffering from post-menopausal psychological aberrations, or they were old, or having a short school education, or were the victims of classical Pavlovian conditioning or a journalist-driven mass media psychosis. Strangely enough, most of the, often self-made, 'experts' who proposed these explanations had themselves never met anyone claiming EHS and these 'experts' had never done any investigations of the proposed explanatory models.

The aim of our own studies has been to investigate possible alterations, in the cellular and neuronal systems of these persons' skin. As controls, age- and sex-matched persons without any subjective or clinical symptoms or dermatological history, have served. Immunohistochemistry using antisera to the previously characterized marker substances of interest has been utilized. Among many discoveries, the following may be mentioned:

We have investigated the presence of intraepidermal nerve fibers in normal human skin from healthy volunteers using the new marker PGP 9.5 (Wang et al., 1990; Hilliges et al., 1995; Johansson et al. 1999). The intraepidermal nerve fibers are found as close as 20-40 μm from the surface, which makes it highly possible that weak electromagnetic fields may affect them.

In facial skin samples of electrohypersensitive persons, the most common finding is a profound increase of mast cells. Nowadays we do not only use histamine, but also other mast cell markers such as chymase and tryptase, but the pattern is still the same as reported previously for other electrohypersensitive persons (Johansson and Liu, 1995). From these studies, it is clear that the number of mast cells in the upper dermis is increased in the EHS group. A different pattern of mast cell distribution also occurred in the EHS group, namely, the normally empty zone between the dermo-epidermal junction and mid-to-upper dermis disappeared in the EHS

group and, instead, this zone had a high density of mast cell infiltration. These cells also seemed to have a tendency to migrate towards the epidermis (=epidermotrophism) and many of them emptied their granular content (=degranulation) in the dermal papillary layer. Furthermore, more degranulated mast cells could be seen in the dermal reticular layer in the EHS group, especially in those cases which had the mast cell epidermotrophism phenomenon described above. Finally, in the EHS group, the cytoplasmic granules were more densely distributed and more strongly stained than in the control group, and, generally, the size of the infiltrating mast cells was found to be larger in the EHS group as well. It should be noted, that increases of similar nature later on were demonstrated in an experimental situation employing normal healthy volunteers in front of visual display units, including ordinary house-hold television sets (Johansson et al., 2001).

In one of the early papers (Johansson et al., 1994) we made a sensational finding when we exposed two electrically sensitive individuals to a TV monitor. When we looked at their skin under a microscope, we found something that surprised us. In this article, we used an open-field provocation, in front of an ordinary TV set, of persons regarding themselves as suffering from skin problems due to work at video display terminals. Employing immunohistochemistry, in combination with a wide range of antisera directed towards cellular and neurochemical markers, we were able to show a high-to-very high number of somatostatin-immunoreactive dendritic cells as well as histamine-positive mast cells in skin biopsies from the anterior neck taken before the start of the provocation. At the end of the provocation the number of mast cells was unchanged, however, the somatostatin-positive cells had seemingly disappeared. The reason for this latter finding is discussed in terms of loss of immunoreactivity, increase of breakdown, etc. The high number of mast cells present may explain the clinical symptoms of itch, pain, edema and erythema.

We have compared facial skin from electrohypersensitive persons with corresponding material from normal healthy volunteers (Johansson et al., 1996). The aim of the study was to evaluate possible markers to be used for future double-blind or blind provocation investigations. Differences were found for the biological markers calcitonin gene-related peptide (CGRP), somatostatin (SOM), vasoactive intestinal polypeptide (VIP), peptide

histidine isoleucine amide (PHI), neuropeptide tyrosine (NPY), protein S-100 (S-100), neuron-specific enolase (NSE), protein gene product (PGP) 9.5 and phenylethanolamine N-methyltransferase (PNMT). The overall impression in the blind-coded material was such that it turned out easy to blindly separate the two groups from each other. However, no single marker was 100% able to pin-point the difference, although some were quite powerful in doing so (CGRP, SOM, S-100). However, it has to be pointed out

that we cannot, based upon those results, draw any definitive conclusions about the cause of the changes observed. Blind or double-blind provocations in a controlled environment (Johansson et al., 2001) are necessary to elucidate the underlying causes for the changes reported in this particular investigation.

I and my collaborator, dr. Shabnam Gangi, in two recently published papers of theoretical nature (Gangi and Johansson, 1997, 2000), have put forward a model for how mast cells and substances secreted from them (e.g. histamine, heparin and serotonin) could explain sensitivity to electromagnetic fields. The model bounces off from known facts in the fields of UV- and ionizing irradiation-related damages, and use all the new papers dealing with alterations seen after e.g. power-frequent or microwave electromagnetic fields to propose a simple summarizing model for how we can understand the phenomenon of electrohypersensitivity.

In the first paper, in the journal *Experimental Dermatology* (Gangi and Johansson, 1997), we describe the fact that an increasing number of persons say that they get cutaneous problems as well as symptoms from certain internal organs, such as the central nervous system and the heart, when being close to electric equipment. A major group of these persons are the users of video display terminals, who claim to have subjective and objective skin- and mucosa-related symptoms, such as pain, itch, heat sensation, erythema, papules, and pustules. The central nervous system-derived symptoms are, e.g. dizziness, tiredness, and headache. Erythema, itch, heat sensation, edema and pain are also common symptoms of sunburn (UV dermatitis). Alterations have been observed in cell populations of the skin of electrohypersensitive persons similar to those observed in the skin damaged due to ultraviolet light or ionizing radiation. In electrohypersensitive persons a much higher number of mast cells have been

observed. It is known that UVB irradiation induces mast cell degranulation and release of TNF-alpha. The high number of mast cells present in the EHS group and the possible release of specific substances, such as histamine, may explain their clinical symptoms of itch, pain, edema and erythema. The most remarkable change among cutaneous cells, after exposure with the above-mentioned irradiation sources, is the disappearance of the Langerhans' cells. This change has also been observed in electrohypersensitive persons, again pointing to a common cellular and molecular basis. The results of this literature study demonstrate that highly similar changes exist in the skin of electrohypersensitive persons, as regards the clinical manifestations as well as alterations in the cell populations, and in skin damaged by ultraviolet light or ionizing radiation.

In the second publication (Gangi and Johansson, 2000), from the journal *Medical Hypotheses*, the relationship between exposure to electromagnetic fields and human health is even more in focus. This is mainly because of the rapidly increasing use of such electromagnetic fields within our modern society. Exposure to electromagnetic fields has been linked to different cancer forms, e.g. leukemia, brain tumours, neurological diseases, such as Alzheimer's disease, asthma and allergy, and to the phenomenon of electrohypersensitivity/screen dermatitis. There is an increasing number of reports about cutaneous problems as well as symptoms from internal organs, such as the heart, in people exposed to video display terminals. These people suffer from subjective and objective skin and mucosa-related symptoms, such as itch, heat sensation, pain, erythema, papules and pustules (cf. above). In severe cases, people can not, for instance, use video display terminals or artificial light at all, or be close to mobile telephones. Mast cells, when activated, release a spectrum of mediators, among them histamine, which is involved in a variety of biological effects with clinical relevance, e.g. allergic hypersensitivity, itch, edema, local erythema and many types of dermatoses. From the results of recent studies, it is clear that electromagnetic fields affect the mast cell, and also the dendritic cell, population and may degranulate these cells. The release of inflammatory substances, such as histamine, from mast cells in the skin results in a local erythema, edema and sensation of itch and pain, and the release of somatostatin from the dendritic cells may give rise to subjective sensations of on-going inflammation and sensitivity to ordinary light. These are, as mentioned, the common symptoms reported from persons suffering from electrohypersensitivity/screen dermatitis. Mast cells are

also present in the heart tissue and their localization is of particular relevance to their function. Data from studies made on interactions of electromagnetic fields with the cardiac function have demonstrated that highly interesting changes are present in the heart after exposure to electromagnetic fields. Some electrically sensitive have symptoms similar to heart attacks after exposure to electromagnetic fields. One could speculate that the cardiac mast cells are responsible for these changes due to degranulation after exposure to electromagnetic fields. However, it is still not known how, and through which mechanisms, all these different cells are affected by electromagnetic fields. In this article (Gangi and Johansson, 2000), we present a theoretical model, based upon the above observations of electromagnetic fields and their cellular effects, to explain the proclaimed sensitivity to electric and/or magnetic fields in humans.

In summary, it is evident from our preliminary data that various biological alterations are present in the electrohypersensitive persons claiming to suffer from exposure of electromagnetic fields. In view of recent epidemiological studies, pointing to a correlation between long-term exposure from power-frequent magnetic fields or microwaves and cancer, our data ought to be taken seriously and to be further analyzed.

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