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BRIEF COMMENTARY

Potential health effects of radiofrequency electromagnetic fields exposure

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ABSTRACT

There are diverse effects in consequence of exposure to radiofrequency electromagnetic fields (RF-EMF). The interactions of fields and the exposed body tissues are related to the nature of exposure, tissue comportment, field strength and signal frequency. These interactions can crop different effects.

Keywords: RF-EMF; Exposure Health Effects; Multiple Sources; Indirect Interactions

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1. Direct effects of exposure to a simple source of RF-EMF

1.1 Biological thermal effect

The greatest customary category of such effects is the thermal biological effect where tissues are physically heated by absorbed electromagnetic energy produced by an EMF. This energy could be controlled by the specific absorption rate (SAR) in (W/kg) that multiplied by the exposure interval in (s) gives the corresponding energy in (J/kg). Regarding biological effects in general, the case of exposure to excessive EMF (intensity and interval) can be dangerous to living tissues. Standards thresholds fixed by health-safety authorities[1,2] could verify this. Remark that these thresholds are established accounting for different body parts (different tissue behaviors) and different exposure conditions (relative to exposed person relation with exposure), involving: workers, fabricating, testing, installing …, users and nearby persons, animals …. These thresholds involve induced EMF as well as SAR and exposure interval, in the tissues. Such exposure may guide to tissue heating, in particular for high frequencies (RF), causing a growing in temperature, which can origin tissue damage[3–5]. Two features strengthen such incidence. One relates to the capacity of RF energy to quickly heat tissues. The other corresponds to the body's failure to endure or dissipate the inconsistent heat that can be created. Note that the fragments of the tissues least defended from RF-EMF heating are those presenting deficiency in blood circulation, which is the key way of dealing with severe heat. Note that disproportionate forte fields can exhibit non-thermal effects.

1.2 Non-thermal effects

Further types of interactions can also be more complicated, creat-

ing non-thermal effects connecting diverse biochemical or bioelectrical consequences that disturb cellular, molecular and chemical arrangements in living tissues[6]. These effects can be fashioned due to long-term exposures or extreme short-term exposure relating high SAR values. Actually, electromagnetic fields of modest intensity generally have no non-thermal effects on living tissue cells. In contrast, extreme strength fields can exhibit non-thermal effects such as membrane electroporation. Remark that non-thermal effects can be exercised clinically for tumor handling by operating RF-EMF with moderate strength (100–200 V/m) without risk.

1.3 Atypical symptoms effects

The last category of effects consequently of exposure to RF-EMF concerns exposed people endangering atypical symptoms. This is the circumstance of two different groups of people. The first exhibits diverse non-specific symptoms due to unimportant exposures even for a negligible duration; those are supposed hypersensitive to field exposure. The second shows cognitive functioning troubles for long-term exposure to fields. Regarding the effects in this category, several investigations have been reported in literature[7,8].

At this point, in these two classes of atypical symptoms, which look real, their existence is actually connected with EMF even if their biological effect appears non-existent. Thus, the exposure provokes indirectly via an undisclosed link (for the instant) with the influences at the source of the symptoms. Constantly with such a contradiction, one can believe that electromagnetic consequences disregarded now could possibly come into sight and interpret these symptoms. Undeniably, it is scientifically problematic to negate the existence of a danger. Such ambiguity can always rationalize a cautious attitude[9]. Because of this challenging circumstance, and awaiting extra research and enhanced valuation, individuals with these symptoms could commonsensically be handled clinically as a persisting disease, conceding that the principal cause stays the EMF ambiance.

2. Intricate effects of exposure to multiple sources of RF-EMF

The extensive usage of wireless communication appliances in one application necessitates estimation of interfaces reflecting all these devices taking into account possible exposure effects on each. Thus, we require considering, from one side, the possible anomalies of neighboring electronic devices caused by RF-EMF exposures and from the other side the amalgamation of all proximate wireless communication devices. The situation of combined devices needs a global SAR assessment in the diverse tissues for the conforming concerned situation concerning tissue characteristic behaviors and assets of the different sources[10]. Examples of malfunction and combined consequences are given e.g. in the study of Karpowicz *et al.*[11]. This problematical question looks not slight particularly if the frequencies of the sources are dissimilar. Thus, the calculation by mathematical modeling (supposed most adequate) of such kind of problem presents multifaceted difficulties[12,13].

This problem could become serious in several real circumstances related mainly to indoor cases such as medicinal centers, and shopping malls. Different approximate experimental approaches exist for the evaluation of such complex effects[11]. A future investigative challenge could be to establish a mathematical electromagnetic model involving “n” different frequencies without performing “n” successive solutions. The latter requires excessive computation time and leads to “n” non-superimposable SAR values because the interaction of the sources has not been taken into account. Only specific digital developments can solve this problem.

3. Indirect effects of EMF exposures

We have examined in above lines the different interactions relating to direct effects on body living tissues. There are other secondary indirect types of interactions relative to EMF exposure on medical tools and appliances[14–16]. These devices are generally in direct connection with the body tissues and often using EMF in their functioning and hence have potential troubles due to external EMF. Such devices include imagers, interventional instruments,

embedded mechanisms and wearable appliances. The impacts of such interactions can origin significant consequences for health safety. Such impacts can be predicted, evaluated and controlled through EM compatibility (EMC).

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Conflict of interest

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