RADAR OCCUPATIONAL EXPOSURE: INTERFERENCES WITH THE FUNCTION OF THE NERVOUS SYSTEM

Răzvan Dănulescu, Violeta Borza, Gheorghe Bălăceanu, Doina Popa, Eugenia Dănulescu,

Public Health and Medical Research Institute, Iaşi, Romania

INTRODUCTION

In the modern life and work environment the electromagnetic pollution is obviously increased and therefore the knowledge of its level and effects constitutes a major priority and challenge for the scientific community (4,11,12). In this international context the estimation of the health status of the microwaves exposed people colligated with the evaluation of the exposure have an important role not only for the scientific knowledge but especially for the improvement of the protection standards (7,13). Therefore the case of pulsed microwaves which seems to have peculiar biological effects (1,3), especially on the nervous system (10), has determined us to try to study in a clinical and epidemiological approach the occurrence of such effects upon chronic exposed humans.

OBJECTIVE

To assess the possible impairment of the nervous system function due to the chronic occupational exposure to low and medium levels of pulsed microwaves.

STUDY DESIGN

Cross-sectional study in 60 occupationally exposed people in radar maintenance activity, compared to matched controls, followed by a long-term survey of the main findings.

METHODS

Assessment of microwaves exposure (frequencies, power densities, SAR estimations, ergonomic investigations, questionnaires).

Assessment of the nervous system function few days after the cessation of the work: questionnaires, careful psychiatric and neurological examinations, psychological tests and electrophysiological investigations (EEG, short-latency evoked potentials, electroneuromyography - EMG, excitability, H-index as a measure of the sensitive conduction velocity, motor conduction velocity). Medical investigations in order to eliminate other causes of central or peripheral neuropathia have also been done. Yearly assessments of microwaves and of the nervous system (NS) function have subsequently been performed.

The exposed lot has included 60 electronic and electrotechnical technicians and engineers with the mean age of 39.7±3.6 years and the length of service in radar maintenance of 15.9±5.3 years. The control lot has comprised 36 people with the same electronic and electrotechnical training and activity, from the same factory, but which were never been exposed to microwaves. The age, the length of service and the other characteristics of the controls are matched with those of the exposed.

RESULTS

The investigation of the occupational exposure to pulsed microwaves has shown frequencies in the range 0.2-10 Ghz, average power densities of 0.01 - 5 - 10 mW/cm^2 and great variations of partial and total exposures to complex field distribution, with extremely various power densities and frequencies, generated in a close and small workspace by multiple unshielded generators. By using the methods and diagrams from the "Radiofrequency Radiation Dosimetry Handbook (Fourth Edition)", CH Durney, 1986, (5,11), we have estimated the Specific Absorption Rates (SARs). Various whole body SARs have been estimated: 0.01 - 2 W/kg. The local SARs, even more difficult to estimate, were greater for the head (neck) and hands (wrists).

The NS investigations has shown neurasthenia at 80% of the exposed versus 8.3% at the controls, the difference being statistically significant ($p<0.0005$); the relative and the attributable risk calculations have shown that pulsed microwave exposure is a risk factor and even a determinant factor for the neurasthenia. Significant changes of psychological tests (increase of the reaction time, decrease of the intellectual efficiency, impairments of the recent memory, attention, mood and behaviour) that support the higher and significant prevalence of neurasthenia have also been found. The mean age of the neurasthenic subjects is equal with the age of the whole lot, but the length of service of these subjects is statistically different (16.3±5.2 years vs. 11.6±5.7 years, $p<0.001$). This also means that the exposure in the above mentioned conditions could be a determinant factor for the neurasthenia. The prevalence of this finding is the same at the engineers and at the technicians, although the first group has a much more intense intellectual work. This also could be an evidence for the microwaves role in neurosis. The frequency and the severity of the neurotic symptoms are more intense when the length of service and/or the exposure are greater. Amplitude and frequency changes of EEG has revealed hypovoltages at 67% of the neurasthenic subjects and also decrease of the alpha waves index and increase of the theta and delta waves percentage. The auditory evoked-potentials have especially shown an increase of the latency of the second wave, which may reflect a possible long term stimulation of the Varolio pons as a structure of the acoustic way.

At the peripheral nervous system level we have found decreases of the peripheral nerves conduction velocity, especially sensitive, in 46.7% of the exposed people vs. 16% at the exposed, the difference being statistically significant ($p<0.001$). Slight neurological signs of polineuropathia have also been found. The relative and the attributable risk calculations have shown that pulsed microwave exposure is also a risk factor and even a determinant factor for the impairment of the conductibility on the studied nerves. The analysis of these changes has shown the followings: 30% of the exposed have a decrease of the sensitive conduction velocity (20% having only an aspect of incipient sensitive polineuropathia and the others - 10% - having also a decrease of motor conduction velocity, so they display an aspect of incipient sensitive-motor polineuropathia). 13.33% presents nervous conduction speeds at the lower limit of the normal and 3.33% have typical changes of motor polineuropathia. We have calculated the correlation index between the length of service and the H-index (sensitive conduction velocity) in all the exposed lot and we have found an inverse correlation: $r = -0.68$, which shows that the sensitive conduction velocity significantly decreases when the length of service increases. The calculation of the regression has found that an increase with

0.88 years of the length of service decrease the H-index with 0.52, relation considered as a signal and a stimulus towards further studies.

It is to be mentioned that the yearly revaluation of these findings showed similar aspects, but the people which worked less showed a slight improvement of some parameters.

CONCLUSIONS

The long time exposure at pulsed microwaves with average power densities rather small in comparison with the IRPA guidelines (7,11,13) on limits of exposure to RF seems to determine various degrees of neurasthenia, behavioural changes and peripheral polineuropathia aspects.

These changes with statistical significance, correlated with the length of service and exposure levels, the persistence at the exposed people of these impairments as well as, the absence of other neurotrop agents, have determined us to state the possible persistent interference of the pulsed microwaves with the electroneurophysiological phenomena.

It is to be mentioned that the findings concerning the long term pulsed microwaves effects on the peripheral nervous system in humans as well as the chronic changes of the auditory evoked potentials may contribute, if confirmed, to a better understanding of the interaction mechanisms of the electromagnetic fields and radiations with the nervous system and, of the significance for the human health and well-being of this interaction (2,6,8,9,14). So, we consider that this kind of studies must be continued as a complement to the experimental ones and that they could be really useful for the scientific knowledge.

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