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CLINICAL ASPECTS OF THE EFFECT OF METRIC RANGE ELECTROMAGNETIC FIELDS

A. I. Kleĭner, et al

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By

A. I. KLEYNER, ET AL.

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[Article by A.I. Kleyner, D.K. Abramovich-Polyakov, V.M. Makotchenko, V.P. Malinina-Putsenko, Ye. P. Nedbaylo, V.N. Panova and N.I. Marchenko, Khar'kov Scientific Research Institute of Labor Hygiene and Vocational Diseases and the Institute of Advanced Medical Studies]

[Text] The widescale use of electromagnetic fields (EMP) of radio frequencies in many sectors of industry, modern science and technology is drawing the attention of hygienists and occupational pathologists. A study of the functional state of the many systems of the organism makes it possible to identify the potential specific biological effect of radio-frequency EMP (Z.V. Gordon, 1968; G.G. Lysina and coauthors, 1968, etc.). At the same time, the clinical manifestations of the unfavorable effect of EMP, particularly in the metric range frequency, are not yet sufficiently studied.

Comprehensive clinical studies were made of 50 woman welders of plastic items who were exposed to metric range EMP. The force of the field at the work places (N.N. Goncharova) fluctuated from 45 to 160 v/m, exceeding the maximum permissible level (20 v/m) 100-700 percent. The meteorological conditions in the shop were satisfactory, and the level of the maximum acoustical pressure of the noise at the welders' work places did not exceed the maximum permissible values.

Young workers predominated (41 under 40 years of age and 9 above 40), with a relatively brief period of vocational service (20 -- under 3 years, and 30 persons -- from 3 to 5 years). Examined at the same time was a control group of woman workers from the machine shop (50 persons), who were not exposed to harmful production factors. The age composition was identical to that of the women in the basic group.

A considerable number($69\pm8\%$) of those examined from the basic group indicated that in the second half of the work day they did not feel physically well (headache with a feeling of pressure, general weakness, tiredness and somnolence). In addition to this, $44\pm7\%$ of the workers in the basic group complained of increased irritability, $22\pm6\%$ -- of tearfulness, $10\pm4\%$ -- of

depression, 22±6% -- of frequent headaches, even outside of work, 28±6% -- reduction in memory, 22±6% -- insomnia, 14±5% -- constant feeling of general weakness and 20±6% -- parasthesia in the distal parts of the arms. Among the people in the control group, the complaints listed were either entirely absent or were recorded with statistically reliable less frequency.

The complaints of increased nervousness, tiredness and depression grew as the production service period of the welders examined increased.

A neurological examination of the welders drew attention to the changes which were observed considerably less often or were completely absent among the persons in the control group. These were emotional lability (among 20±6%), anisocoria (among 10±4%), a reduction in tendon (16±5%) and sole (44±7%) reflexes, general hyperhidrosis (24±6%), intensive falling out of the hair during work time (46±7%) and a rapid weight gain (10±4%) or noticeable loss of weight (10±4%).

With an increase in the length of production service of those examined in the basic group, there was an increase in the number of changes in the emotional sphere, tendon and sole reflexes and body weight.

When the complaints of the workers in the basic group and the data on the neurological status were summarized, 42±7% (in the control group, 21±6% $R<0.05$) were diagnosed as having functional disorders of the nervous system (neurasthenic syndrom in 32%, vegetative-vascular dysfunction -- 10%).

In the overwhelming majority of the workers, the functional disturbances in the nervous system developed gradually, during work in contact with the EMP, with no obvious extraproduction causes for their onset.

A clinical-physiological study revealed the instability of the reactivity of both divisions of the vegetative nervous system (pulse rate, Aschner test). Also detected were asymmetry of various indicators of arterial oscillography in the upper and lower extremities (in 2/3 of those examined), asymmetry of the blood pressure in the digital arteries, with a tendency to a rise in it (in over half the welders) asymmetry of the blood pressure in the temporal arteries and the temporal-brachial coefficient, with a tendency toward their reduction (in 1/3 of the workers) and asymmetry of the skin temperature (in half of those examined).

The changes enumerated indicate the presence of general vascular-vegetative dystonia in the welders examined. It should be noted that the change in most of the clinical-physiological indicators occurred primarily when the length of service in production was over three years, which may indicate a relationship between these changes and the unfavorable effect of EMP in the welders examined.

Pathological changes were revealed in the condition of the cardiovascular system and partially in the digestive organs. For example, complaints of

pain in the area of the heart and tachycardia were encountered relatively more often among persons in the basic group than among those in the control group (respectively, 38±7% and 20±6% of the cases, R=0.05).

Electro- and mechanocardiograph studies were undertaken in order to study the cardiovascular system more thoroughly. The changes in the electrocardiograms were not as a rule sharply marked and were encountered in a comparatively small number of those examined. They amounted to a reduction in the voltage of the tooth T at two and more thoracic points of contact (among 27±7%). In a number of cases there were disturbances in the function of automatism (sinusal bradycardia and Tachycardia among 7±4%) and the functions of conductivity (a retardation of the intraventricular conductivity in 23±6%).

The changes in the peripheral link of the circulatory system were more significant. Heightened resistance in the precapillary system (in 60±8% of those examined) and an increase in the elastic properties of the walls of muscular-type vessels (in 80+6%) were frequently noted. It must be assumed that the reduction of the MO circulation observed in this case was a compensatory reaction, ensuring the necessary level of hemodynamics.

The changes discovered were primarily of a functional nature, which permits them to be related mainly to a disturbance in the extracardial regulation of the cardiovascular system.

Some of the welders examined evidenced complaints of a dyspeptic nature and complained of pain in the epigastric area, but not to a strongly marked degree.

A study of the gastric secretion in the interdigestive period revealed no notable disturbances. When food stimulus was used (7% cabbage broth), a tendency to hyposecretion proved characteristic. For example, the hourly secretion intensity was less than 50 ml among 41%, and proved to be reduced (less than 40 titration units among 1/3). A tendency toward hypoacidity increased parallel to the length of work service (with work service up to three years -- among 20%, and after three years -- among 42%).

In spite of the fact that the clinical manifestations of disease of the liver and viliary tracts were not characteristic of the group examined, a study of the functional state of the liver attested to a disturbance in a number of its functions, primarily protein and carbohydrate formation. A moderate reduction in the albumin content (less than 50%) and an increase in globulins, basically by virtue of the gamma globulin fraction, were relatively frequent, which caused a reduction (less than 1.1%) in the albumino-globulin coefficient in almost half of those examined (44.5%). A disturbance in the carbohydrate function, according to the data from a test with a glucose load, was shown by changes (increase and decrease) in the hyperglycemic (GGK) and postglycemic (PGK) coefficients in 60% of the subjects.

Disorders in the carbohydrate function of the liver increased in relation to the length of service in an area of exposure to EMP. Particularly, a rise

in the GGK of over 1.7 in workers with a service period up to three years occurred only among 11.8%, but with a service period of over three years -- among 24%.

The content of bilirubin in the blood serum and of urobilin in the urine was within the range of physiological fluctuations.

Moderate disturbances in the functional state of the pancreas were also discovered among workers in the basic group. For example, the level of amylase in the blood on an empty stomach proved to be heightened (over 3.5 mg) in 1/3 of those examined. Pathological types of the so-called "diastatic curve" were noted among 55% when the A.A. Shelagurov test was made (rise in the level of amylase in the blood after a double load of glucose instead of a reduction, as is characteristic for healthy people). The results of the Staub-Traugott test indicated a disturbance in the incretory function of the pancreas. A double hump nature was noted in the sugar curve of half of those examined and 60% proved to have a heightened postglycemic coefficient (over 1.1). An absence of any noticeable clinical manifestations of disease of the pancreas permits us to regard the disturbances mentioned in its exocrine and incretory activity as being functional in nature.

In studying the organon visus, with biomicroscopy, eight workers revealed pulverulent cloudiness of the crystalline lens, located near the equator, without a reduction in the sharpness of the vision. A pathological elasto-curve was detected in 12 persons with normal values for the intraocular pressure. Most of those examined proved to have reduced darkness adaptation, mainly due to its finite values.

An analysis of the hematological indices revealed some stimulation of the erythroblastic growth with a normal content of erythrocytes and hemoglobin in the peripheral blood. Slight reticulocytosis (over 1.1%) occurred in 36%, and in 1/5 of the observations -- an increased amount of basophilic-granular erythrocytes. A tendency toward thrombocytopenia (less than 150,000 in 1 mm^3 of blood) and leucopenia (from 4 to 5,000 in 1 mm^3) was also noted in 20% of those examined.

Disturbances in the neuro-hormonal regulation and especially disturbances in the activity of the hypothalamus-hypophysial-adrenal system play a large part in the mechanism of the pathogenic effect of electromagnetic fields of the radio-frequency range, as was shown by studies of a number of authors (V.N. Gur'yev, 1955; B.F. Murashov, 1966; F.N. Kolesnik and V.M. Malyshev, 1967; Ye. V. Yermakov, 1969).

We judged the functional condition of the adrenal cortex by the content of total 17-oxycorticosteroids (17-OKS) in the daily urine, which were determined by the Sil'ber-Porter method in the modification by M.A. Krekhova. The daily excretion of catecholamines (adrenaline and noradrenaline), which reflect to a great extent the functional condition of the sympatho-adrenal system, was determined by the fluorometric trioxyndol method of V.O.'Osinskaya (1957) in the modification of A.M. Baru (1962).

The daily excretion of 17-OKS among the welders examined was reliably reduced (4.5±0.35 mg, R<0.05) as compared with healthy people (5.5±0.32). The catecholamine content in the daily urine was also statistically noted as being reduced (A -- 7.6±0.80 μg and NA -- 22.3±1.5 μg, and in the control group -- 11.4±1.5 μg and 31.0±2.4 μg; R<0.05).

To ascertain the condition of the functional reserves of the adrenal cortex in some of those examined, a test was made with an AKTG [adrenocorticotrophic hormone] load. When the AKTG was administered, the daily excretion of 17-OKS increased 4-5 times, which indicates the state of preservation of the reserve function of the cortical substance.

Consequently, a disturbance in the glucocorticoidal function of the adrenal glands and the tonus of the sympatho-adrenal system, with preservation of the reserves of the cortical substance, was characteristic for workers exposed to metric range EMP.

Thus, comprehensive clinical investigations revealed changes in the state of health of women welding plastic items, in many ways caused by the exposure to electromagnetic fields of metric range. This pertains primarily to the disorders discovered in the functional state of the nervous system. The uniformity of the changes in the health of the workers in the dynamics of the work day and the increase in disorders of the nervous system revealed in connection with the length of vocational service attested to the role of EMP in their onset. Disorders of the cardiovascular system were chiefly characterized by changes in the peripheral link of the circulation, were of a functional nature, and were caused by disorders in the extracardial regulation. Changes in the digestive system were relatively frequent, and were manifested in a tendency to gastric hyposecretion, a disturbance in the protein and carbohydrate forming functions of the liver and a disorder in the functional state of the pancreas. Changes in ophthalmotonus and the transparent media of the eyes (pulverulent cloudiness), like the slight hematological changes, may also rightfully be related to the adverse effect of EMP. Disturbances in the functional activity of the hypophysial-adrenal and sympatho-adrenal systems were regular, and apparently play a certain role in the pathogenesis of "radio wave" sickness.

The clinical manifestations of disorders in the systems studied were not sharply marked, were primarily of a reversible nature and as a rule did not result in loss of working capacity.

The data from the clinical observations indicate a need for further improvement in the work conditions for women welding plastic articles who are exposed to metric range EMP.

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