

DETECTION OF C- AND C_x-REACTIVE PROTEIN IN THE BLOOD SERUM
AFTER EXPOSURE TO VERY HIGH FREQUENCY ELECTROMAGNETIC WAVES

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With the introduction of radioelectronic techniques on a wide scale into the national economy, increasing importance is attached to studies of the biological action of electromagnetic waves of various ranges of frequency at present being undertaken. Particular attention is being concentrated on the biological effectiveness of microwaves or waves in the very high frequency range (λ ranging from 1 mm to several tens of centimeters).

Several clinical, physiological, biochemical, and immunological changes and also morphological changes in certain tissues have been observed in persons exposed to very high frequency electromagnetic waves—and also in experimental conditions. However, the threshold intensities of energy of electromagnetic waves producing organic changes (inflammation and destruction), together with functional changes, have not yet been clearly defined. To study this question, it seems desirable to use the reaction of determination of C-reactive protein in man and C_x-reactive protein in rabbits, a technique increasingly used in clinical and experimental investigations. This reaction is nonspecific, and for this reason it may be compared with tests such as the ESR, the leukocyte formula, the ratio between the blood protein fractions, and so on, but at the same time it has at least two important advantages over these others: first, in the healthy organism C- and C_x-reactive protein is absent and, second, its high sensitivity—C- and C_x-reactive protein can usually be detected before changes developed in the ESR, the leukocyte formula, and the other nonspecific indices of a pathological state of the organism.

C-reactive protein, also known as the protein of the acute phase, discovered in 1930 [4] in the sera of patients with pneumonia, is widely used for diagnostic purposes as a test of inflammatory and destructive changes in the organism arising under the influence of various biological, physical, and chemical agents [1-2]. In 1943, a protein of the acute phase (C_x-reactive protein) was discovered in rabbits.

The authors have determined C-reactive protein in human subjects and C_x-reactive protein in rabbits exposed to graded doses of very high frequency electromagnetic waves in the decimeter and centimeter range.

EXPERIMENTAL METHOD

Investigations on human subjects were carried out only with radiation of low intensity, whereas in animals the effectiveness of energies with different levels of power flux density (PFD) was determined.

Investigations were carried out on four persons, two of whom were irradiated with electromagnetic waves of decimeter range at a PFD of 2-3 mW/cm² in the course of their work for periods of ten days, for 1 h daily, while the other two were in similar conditions but not exposed to radiation. The blood serum was investigated twice before and three times during irradiation (on the second, third, and ninth days) and four days after its ending. The blood serum was obtained from these subjects in the usual way. The reaction was carried out by the capillary method, with antiserum to C-reactive protein made by the Leningrad Research Institute of Vaccines and Sera, 24 h after taking the blood.

For the experiments on rabbits, antiserum to C_x-reactive protein prepared by the authors themselves at the Leningrad Research Institute of Vaccines and Sera was used in the reaction.

Presence of C_X -Reactive Protein in Rabbits Following a Single Irradiation with Very High Frequency Electromagnetic Waves

| PFD (in mW/ cm ²) | No. of animals | Number of positive reactions for C _X - reactive protein | | | | | Total number of ani- mals with positive reaction | P (during compari- son with control) | Severity of reaction |
|--|-------------------|---|------------------------|-------|--------|--------|--|---|-------------------------|
| | | imme- diately after irradia- tion | time after irradiation | | | | | | |
| | | | 3 h | 1 day | 3 days | 5 days | | | |
| 120 | 3 | 0 | 1 | 3 | 2 | 0 | 3 | 0.025 | 3x |
| 50 | 8 | 0 | 3 | 6 | 3 | 0 | 6 | 0.025 | 2x-4x |
| 10 | 6 | 0 | 1 | 4 | 0 | 0 | 4 | > 0.025 | 2x-3x |
| 3 | 12 | 0 | 1 | 4 | 1 | 0 | 4 | > 0.025 | 2x-3x |
| con- trol | 12 | 0 | 0 | 2 | 0 | 0 | 2 | — | 2x-1x |

C_X -reactive protein was determined in 379 experiments on 55 rabbits. Altogether two series of investigations were carried out: I—with a single exposure, and II—with repeated exposures (5-30 irradiations, given once daily) to very high frequency electromagnetic waves. The animals were irradiated with very high frequency electromagnetic waves of centimeter range given either as separate pulses or continuously at PFD values of 3, 10, 50, and 120 mW/cm². The duration of irradiation at PFD 3 and 10 mW/cm² was 1 h daily. With a PFD of 50 and 120 mW/cm², the duration of exposure was limited to 30 and 15 min respectively.

Since no marked differences could be found in the biological effect when this test was used between continuous and pulsed irradiation, the results were considered together and differentiated only as regards PFD.

EXPERIMENTAL RESULTS

No C -reactive protein was found in the blood serum of the human subjects, whether irradiated or not.

The results of the investigations of series I on rabbits (exposed once to irradiation) are shown in the table.

The table shows that following irradiation of rabbits by electromagnetic waves with a PFD of 50 mW/cm² for a period of exposure of 30 min, C_X -reactive protein appeared in the blood of most animals, and when the PFD was 120 mW/cm², C_X -reactive protein was found in all animals. Significant differences were found between the results obtained in the experimental groups and the controls in accordance with the tables of V. S. Genes (1964) ($P=0.025$). In the groups of animals irradiated at a PFD of 3 and 10 mW/cm², the value of P in relation to the number of positive reactions was greater than 0.025, so that the difference between the results in the experimental and control groups cannot be considered significant. However, taking into account the much longer duration and severity of the positive reactions in the experimental animals and in the controls, it is permissible to speak of a tendency towards the appearance of C_X -reactive protein during the action of electromagnetic energy of these low intensities.

This effect appeared more clearly in those cases (not included in the table) when C_X -reactive protein was actually present in the blood at the moment of irradiation, i.e., when the animal had some pathological process at this time: the content of C_X -reactive protein in the blood was increased as a result of the action of a VHF field of low intensity.

The appearance of small quantities of C_X -reactive protein for a short period in individual control animals was evidently due to the preliminary taking of the blood and the infliction of slight trauma (incision of the vein).

In the investigations of series II—when the animals were irradiated for the same exposure, but daily for 5-30 days—the results obtained were similar to those in series I: with an increase in PFD the severity and frequency of the reaction for C_X -reactive protein increased. However, repeated exposures did not always cause increase in the content of C_X -reactive protein in the blood; often the C_X -reactive protein appearing after the first irradiation subsequently disappeared from the blood although the sessions of irradiation continued. The reason for this phenomenon is uncertain, but it may be suggested that it is due to antibodies against C_X -reactive protein appearing after some time, in the conditions of adaptation of the organism to the stimulus, when they facilitate removal of C_X -reactive protein from the blood.

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