CHANGES IN THE EXCITATION OF THE OPTIC ANALYZER IN MAN BY MICROWAVES

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Microwaves are widely used nowadays in industry and medicine. By far the great majority of papers published so far deal with the thermal action of microwaves, and so far as the nonthermal action is concerned, this has not been studied. Some authors [7] assert that, in doses not causing heating of the tissues, microwaves do not in general possess biological activity. The views of these authors were not subsequently confirmed.

It was shown in animal experiments that, with a power flux density of an ultrahigh frequency electromagnetic field (uhf) of 5 milliwatt/cm^2 (the lower limit of thermal activity is accepted to be 10 milliwatt/cm^2), changes occur in dogs not only in the conditioned reflexes [5] but also in the electrocardiogram [6] and the electroencephalogram [1].

In the present research we studied the reactions of the human body, and primarily the central nervous system, to nonthermal doses of microwaves.

Since the optic analyzer in man is the most highly "corticalized" (K. M. Bykov), we judged the character of the effect of these waves on the central nervous system by changes in the functional state of the organ of vision arising as a result of the action of microwaves on man.

EXPERIMENTAL METHOD

In order to ascertain the functional state of the visual analyzer during the action of the microwaves, the functional mobility of the light-perception apparatus of the fundus of the retina and the optic rheobase and chronaxie of the dark-adapted organ of vision were studied.

As an index of the functional mobility of the retina, the area of projection fo the blind spot was determined by means of a scotometer, which we constructed jointly with S. F. Libikh [2].

The optic chronaxie and rheobase were determined by means of an attachement to a sensory chronaximeter, constructed by G. B. Smolyanskii and S. F. Libikh*.

Observations were made on two human subjects aged 23 and 24 years. Both were apparently healthy and had normal vision.

The scotometer, with a white screen and black indicator, was placed before a microwave source with a pulse action. The subjects were seated before the scotometer screen with their back to the source. The illumination of the scotometer screen (70 lux) was constant for all the investigations. In order to determine the area of projection of the blind spot, the subjects were adapted to the brightness of the screen for 5 minutes. After determination of the area of projection of the blind spot, the microwave generator was switched on at $\lambda = 10$ cm. Immediately before the end of 10 minutes of continuous action of the microwaves, the area of projection of the

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blind spot was again determined. The area of projection was determined on two further occasions, 10 and 45 minutes after cessation of the action of the microwaves.

In 2 observations on each subject, the area of projection of the blind spot was also studied 120 and 150 minutes after switching off the generator. In view of the fact that the circumstances of the investigation, and in particular the noise of the generator, etc., may affect the opticanalyzer, control observations were made, in which in some cases the source was screened, and in others the subjects wore protective clothing.

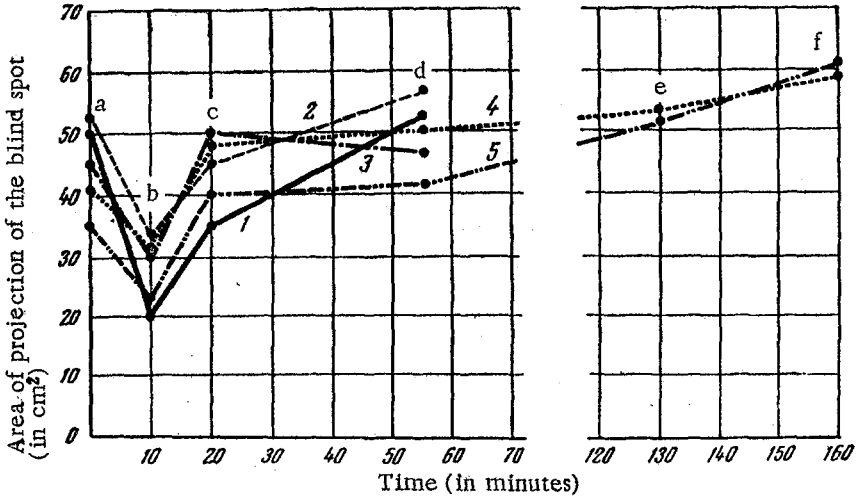

Fig. 1. Changes in the area of projection of the blind spot in the subject N. I. M. during the action of the uhf field. a) Before the action of the microwaves; b) at the end of the action; c) 10 minutes after the end of the action of the microwaves; d) 45 minutes after; e) 2 hours after; f) 2½ hours after; 1, 2, 3, 4, 5) investigation numbers.

This clothing consisted of a cotton combination suit and helmet, and between the outer layer and the lining of the helmet there was a metal net with a fine mesh. Protective spectacles contained the same net instead of glass lenses. The combination suit was worn over the underclothing.

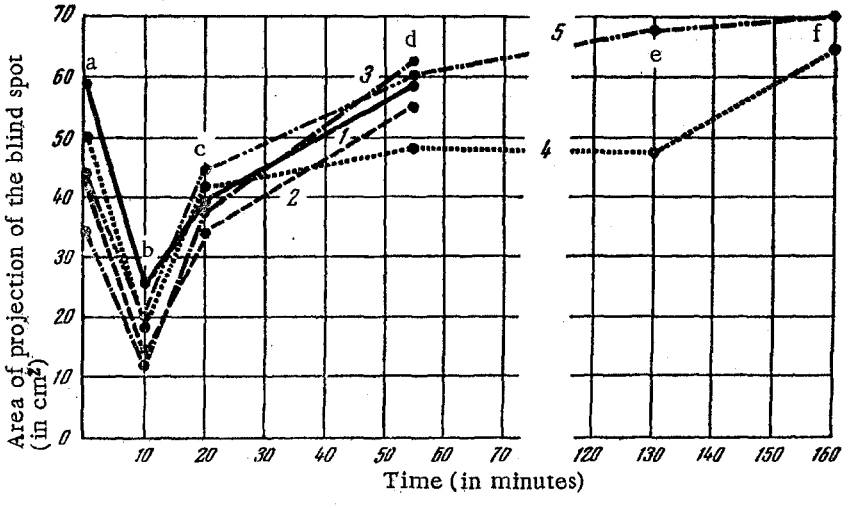

Fig. 2. Changes in the area of projection of the blind spot in the subject I. I. R. during the action of the uhf field. Legend as in Fig. 1.

Determination of the optic rheobase and chronaxie was carried out in a dark room. After adaptation to the dark for 30 minutes a standard exposure to light was given. When 30 minutes had elapsed after the standard exposure to light, the optic rehobase and chronaxie were determined twice at 5-minute intervals. If the results of the two successive determinations were identical, the dark-adaptation was regarded as complete. The uhf generator was then switched on. At the 10th minute of action of the microwaves the determination of the rheobase and chronaxie was repeated, after which the microwave source was switched off.

In the period after the action of the microwaves, the optic rheobase and chronaxie were determined twice: 10 and 15 minutes after switching off the generator. The investigations were repeated every 7-14 days in the period between 2 P.M. and 6 P.M.

The power flux density of the uhf field was 1 milliwatt/cm^2. From data published in the foreign literature the permissible limit of intensity for microwaves of λ=10 cm in industrial conditions is 1 milliwatt/cm^2.

Changes in the Value of the Optic Rheobase and Chronaxie during the Action of Microwaves

Subjects tested	Time	First investigation		Second investigation	
		rheobase (relative figure)	chronaxie (sigma)	rheobase (relative figure)	chronaxie (sigma)
I. I. R.	Before the action of the microwaves	10.4	32	12	30
	At the end of the action of the microwaves	6.2	26	6	27
	10 minutes after the end of the action of the microwaves	10.6	33	11.6	38
	15 minutes after the end of the action of the microwaves	10.2	36	12.4	35
N. I. M.	Before the action of the microwaves	10	38	11	45
	At the end of the action of the microwaves	6.4	26	8	37
	10 minutes after the end of the action of the microwaves	8	30	8.6	25
	15 minutes after the end of the action of the microwaves	15.6	38	13.4	44

EXPERIMENTAL RESULTS

In all, 22 photometric observations were carried out, 10 of which were during the action of microwaves and 12 controls (in 6 the source was screened and in 6 protective clothing was worn). In this way 97 determinations were made of the area of projection of the blind spot.

In order to study the character of the effect of the uhf field on the organ of vision, adapted to dark, 2 investigations were carried out on each subject (4 in all). In these investigations the optic rheobase and chronaxie were determined 20 times.

The results of the determination of the area of projection of the blind spot during the action of the microwaves are shown in Figs 1 and 2.

As may be seen from Figs. 1 and 2, the reaction to the microwaves was clear and almost identical in type in every case, and consisted of a decrease in the area of projection of the blind spot. This decrease demonstrated that during the action of a low intensity uhf field for a short period of time, mobilization of the light-sensitive elements of the retina took place.

From 10-30 minutes after the cessation of the action of the microwaves, the area of projection of the blind spot returned to its original level, and then exceeded it. This increase in the area of projection of the blind spot had not come to an end 2-2½ hours after cessation of the uhf action.

The area of projection of the blind spot in man is known to decrease usually toward evening [4]. The figures given illustrate the opposite picture — increase in the area of projection of the blind spot in the period of action, i.e., toward evening, above the level estimated in the middle of the day.

It is quite possible that this excessive increase in the area of projection of the blind spot is a follow-up reaction, inductive in nature. The results of the determination of the area of projection of the blind spot before application of the microwaves show that the initial value of the area of projection in the subject N. I. M. diminished from investigation to investigation, thereby indicating the presence of a training effect. In the subject I. I. R., the largest area of the blind spot was the same as in the first investigation. We also observed the same effects in another investigation carried out jointly with S. F. Libikh and G. M. Smolyanskii [3].

The course of the curves in Figs. 1 and 2 also shows that neither signs of cumulation nor of increased resistance to the action of microwaves from investigation to investigation could be observed. The absence of such signs may be due to the fact that the action of the microwaves was weak and transient, and the intervals between the individual observations were relatively long. In the observations when the subjects were screened or wore protective clothing, it was found that when the circumstances of the investigation (the noise of the apparatus in action, the illumination and so on) remained as before, the area of projection of the blind spot either was unchanged or slightly increased. This finding was in agreement with the results of the action of noise on the area of projection of the blind spot which we had obtained earlier [2]. The values of the optic rheobase and chronaxie (see Table) under the influence of the microwaves were also diminished, but after cessation of their action, they very quickly (after 10-15 minutes) regained their original level. In the subject N. I. M. in the period after action of the microwaves, the rheobase was even increased above the original level, i.e., the same follow-up reaction took place as with scotometry. It may be concluded from the results obtained that the level of excitation of the organ of vision when dark adapted was raised by the action of the microwaves.

Since the intensity of action of the microwaves in our investigations was clearly within the limits of non-thermal doses, the alterations found in the optic analyzer may be associated with the specific action of these waves. The nature of this action has not yet been determined.

SUMMARY

A considerable decrease of the area of projection of the blind spot, shortening of the adequate optic chronaxia and reduction of the rheobase were observed in 2 persons at the end of a 10-minute period of microwave exposure ($\lambda = 10$ cm with the power flux density of 1 milliwatts/cm^2).

During the aftereffect the above shifts, at first, would come back to their initial level, surpassing it later on in a number of cases.

The intensity of the microwave action excluded the warming of the tissue and, therefore, the changes in the optic analyzer are attributable to the specific effect of the waves.

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