8. A. A. Shvedova, K. N. Novikov, V. A. Grigor'ev, et al., in: Bioantioxidants [in Russian], Moscow (1975), p. 104.
9. R. E. Anderson, R. M. Benolken, P. Dudley, and D. Lendis, Exp. Eye Res., 18, 205 (1974).
10. N. C. Nielsen, S. Fleischer, and D. G. McConnel, Biochim. Biophys. Acta, 211, 10 (1970).
11. R. Olenescu and S. Nita, Rev. Roum. Biochim., 10, 119 (1973).
12. W. A. Pryor and J. P. Stanely, Lipids, 11, 370 (1976).
13. B. Sameulsson, Trends Pharmacol. Sci., 1, 227 (1980).
14. T. P. Stossel, R. G. Mason, and A. L. Smith, J. Invest., 54, 638 (1974).
15. L. G. Valenta, H. Bode, A. L. Vickery, and G. B. Caulfield, J. Clin. Endocrinol., 54, 638 (1974).

EFFECT OF A PULSED MAGNETIC FIELD ON PERMEABILITY OF THE CORNEA AND SORPTION PROPERTIES OF THE TISSUE STRUCTURES AND REFRACTIVE MEDIA OF THE EYE

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KEY WORDS: pulsed magnetic field; permeability; sorption.

One of the special features distinguishing the action of magnetic fields (MF) on biological objects is their ability to change the permeability of biological barriers and cell membranes [1, 3, 6]. The study of the effect of MF on permeability of the tissue structures of the organ of vision is of great interest.

Motivation for the present investigation was provided by the results of electron-microscopic and radiologic investigations, which yielded indirect evidence in support of increased permeability of the cornea under the influence of a pulsed MF [4, 5]. The writer has attempted to obtain direct proof of increased permeability of the cornea and enhanced sorption properties of the tissue structures and refractive media of the eye under the influence of a pulsed MF, which may be of great importance to clincial ophthalamology.

EXPERIMENTAL METHOD

Experiments were carried out on four groups of rabbits (57 animals, 114 eyes), two of which were experimental and two control. In the course of the investigation the method of radioactive indication of two substances (^{35}S-streptomycin and ^{75}Se-methionine), widely used in ophthalmologic practice, was used. The working solution of the preparations (2 ml), with radioactivity of 300,00 cpm in 0.1 ml, was poured into a lid-retracting bath which, after preliminary local anesthesia, was introduced beneath the animal's eyelids. The system thus formed (the eye with the lid-retracting bath and the radioactive substance poured into it) in the experimental series was exposed for 10 min to the action of a pulsed MF. In the control only the radioactive substances were applied, with the same exposure as in the corresponding experiment. A pulsed MF (pulse duration 0.02 sec) with maximal magnetic flux density in the pulse of 8.5 mT was used, as having the greatest effect on permeability of the cornea in experiments *in vitro* [4].

Changes in permeability of the cornea were assessed on the basis of changes in radioactivity of the aqueous humor. To determine the time of maximal saturation of the aqueous with radioactive substance, samples of aqueous humor were collected immediately after exposure to MF, and 5, 15, and 50 min later.

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TABLE 1. Changes in Radioactivity ^{35}S-Streptomycin and ^{75}Se-Methionine in Aqueous Humor after Exposure to Pulsed MF (M ± m)

Time of observation	^{35}S-streptomycin		^{75}Se-methionine	
	Relative units	%	Relative units	%
Immediately after exposure	0,075±0,006 / 0,042±0,004	78,5*	0,151±0,009 / 0,124±0,011	21,8*
5 min later	0,040±0,004 / 0,033±0,004	21,2	0,185±0,010 / 0,152±0,012	22,6*
15 min later	0,052±0,006 / 0,045±0,008	15,5 15,5	0,654±0,017 / 0,625±0,021	4,7
50 min later	0,115±0,010 / 0,111±0,012	4,5	1,101±0,050 / 1,068±0,070	3,0

Legend. Here and in Table 2: numerator gives radioactivity of aqueous in experiment, denominator gives same in the control; *P < 0.05 compared with corresponding value in control, taken as 100.

TABLE 2. Changes in Radioactivity of Tissues and Refractive Media of the Eye and Peripheral Blood after Exposure of the Eye to Pulsed MF (M ± m)

Test substance	Radioactivity of ^{75}Se-methionine	
	Relative units	%
Cornea	0,54±0,08 / 0,90±0,05	64,8*
Aqueous humor	0,31±0,03 / 0,53±0,05	72,3*
Iris	0,16±0,01 / 0,19±0,02	18,7
Lens	0,17±0,03 / 0,13±0,01	30,7*
Vitreous body	0,06±0,003 / 0,05±0,004	20,0
Retina and vascular membrane	0,08±0,002 / 0,06±0,003	33,5*
Peripheral blood	0,047±0,010 / 0,021±0,001	123,3*

To study the effect of MF on the sorption properties of the media and tissues of the eye, besides the aqueous humor, the lens vitreous body, cornea, iris, and also the retina and its vascular membrane taken together (because of the impossibility of separating them), were investigated. As a control of elimination of the radioactive substance from the eye into the blood stream, the blood also was investigated.

After the appropriate time the substrates for study were removed, dried in an incubator, and used in the form of dry weighed samples for measurement of their radioactivity. The values of radioactivity obtained (in cpm) were calculated per mean weight of test substrates, and the content of radioactive substance was determined in per cent. The numerical results were subjected to statistical analysis.

EXPERIMENTAL RESULTS

Under the influence of the pulsed MF the permeability of the cornea was found to increase appreciably (Table 1).

It will be clear from Table 1 that the concentration of ^{35}S-streptomycin in the aqueous humor of the animals immediately after exposure to MF was significantly higher than in the control ($P < 0.001$). At subsequent times of observation, the level of radioactivity of the aqueous humor in the experiment also was higher than in the control, but the difference was not significant.

Analysis of permeability of the cornea for ^{75}Se-methionine also showed increased penetration of radioactivity into the aqueous. A significant increase in the ^{75}Se-methionine concentration was observed not only immediately after exposure to MF, but also 5 min later. The results are evidence of the greater penetrating power of ^{75}Se-methionine, and it was this which determined the choice of indicator for subsequent investigations (Table 2).

It will be clear from Table 2 that the pulsed MF had a marked effect on the sorption propeties of the tissue structures and refractive media of the eye. For instance, 50 min after exposure a significant decrease in the concentration of the radioactive substance in the cornea and aqueous humor was observed compared with the control. The decrease in its concentration in the iris was not significant. Meanwhile, in the other tissues and media studied, the ^{75}Se-methionine concentration was increased, especially in the lens, the retina, and the vascular membrane, and a smaller but significant increase was observed in the vitreous body.

Toward the end of the experiment a marked increase in radioactivity of the peripheral blood (by 123.3%) took place compared with the control.

The results thus indicate a marked influence of the pulsed MF on permeability of the cornea, which was particularly pronounced immediately after exposure and in the early period of observation. Under the influence of the pulsed MF the sorption properties of the lens, retina, and vascular membrane were enhanced. During exposure of the eye to MF, with a magnetic flux density in the pulse of 9.5 mT, permeability of the structures of the cornea and their metabolic activity were increased, and this was accompanied by increased penetration of the radioactive substance into the eye. This effect, and also the immediate effect of MF on the structures tested, can explain the greater accumulation of radioactive lebel in the lens, vitreous body, retina, and vascular membrane of the eye. The decrease in the concentration of radioactive substance in the cornea and aqueous humor taking place immediately afterward was evidently due to the effect of MF on the drainage system of the eye and on the blood-eye barrier. Evidence in support of this conclusion is given by results showing a marked increase in concentration of the radioactive substance in the peripheral blood of animals whose eyes were exposed to MF, and also by the results of investigations by other workers [2].

It must be emphasized that the pulsed MF, under the conditions of exposure which were used, ruling out any possibility of injury to the cornea, can be used in clinical practice in order to increase the concentration of thereaputic substances in the tissues of the eye and to enhance their therapeutic action.

LITERATURE CITED

1. P. G. Bogach and T. L. Davydovskaya, in: Clinical Use of Magnetic Fields [in Russian], Izhevsk (1977), p. 9.
2. B. N. Zhukov et al., in: Biological Action of Electromagnetic Fields [in Russian], Pushchino (1982), p. 126.
3. V. M. Kulitskii, in: Problems in Experimental and Clinical Pathology [in Russian], Moscow (1974), p. 311.
4. R. K. Marmur, A. V. Skrinnik, N. E. Dumbrova, and T. I. Genessina, Oftal'mol. Zh., No. 4, 231 (1981).
5. A. V. Skrinnik and N. E. Dumbrova, Oftal'mol. Zh., No. 6, 331 (1981).
6. Z. Karni, J. Am. Osteopathol. Assoc., 76, 132 (1976).

SOME PRINCIPLES GOVERNING MONOMERIC ^{239}Pu ELIMINATION FROM THE SKELETON AND LIVER BY LIPOSOME-ENCAPUSLATED PENTACIN

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The problem of removal of ^{239}Pu, deposited in the organs, still remains unsolved. We know that the complexone calcium-trisodium salt of diethylene-triaminepenta-acetic acid (DTPA), or pentacin, which is used to eliminate some radionuclides and toxic metals from the body, passes with difficulty through cell membranes and is ineffective in eliminating ^{239}Pu from cells [1, 9]. Meanwhile, when the complexone is used encapsulated in liposomes, it can enter the cells of organs in which the radionuclide is deposited much more readily, and the effectiveness of the compound as a means of eliminating ^{239}Pu from the liver and skeleton is enhanced [2-4, 7, 8]. To discover the principles governing the action of the compound and its rational usage, it is necessary to know how the action of the lysosomal form of pentacin (LP) depends on dose. This problem has not been studied in detail as regards the liposomal form both of complexones and of other thereapeutic substances.

The aim of this investigation was to study the effectiveness of LP as a means of eliminating monomeric ^{239}Pu from the liver and skeleton and to determine how the effect depends on dose and the concentration of the complexone in the liposomes.

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