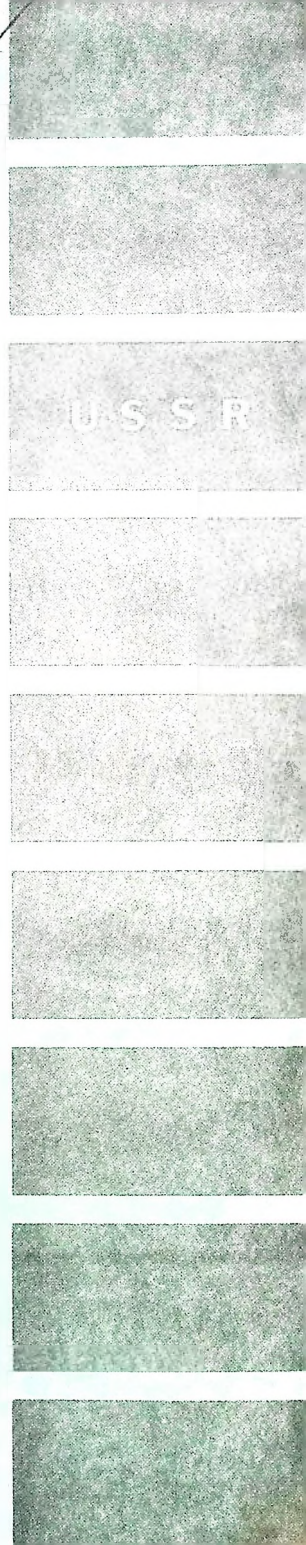


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CHANGES IN PERMEABILITY OF HISTO-HEMATIC BARRIERS
UNDER THE EFFECT OF MICROWAVES

By

L. V. POLYASHCHUK



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CHANGES IN PERMEABILITY OF HISTO-HEMATIC BARRIERS
UNDER THE EFFECT OF MICROWAVES

(Presented by E. B. Babsky, Member Academy of Sciences Ukrainian SSR)

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For the last few years microwaves have been used in treatment of diseases of the nervous system, digestive organs, and serous membranes (1-9). Microwaves are used successfully in the treatment of various diseases of the muscles (10-11).

The effect of the microwaves on the permeability of organisms had not been studied until now. The literature contains only scattered data on the effect of microwaves on the permeability of the ophthalmic barrier.

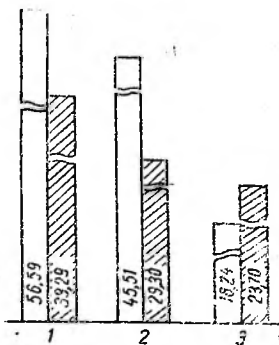
The effect of microwaves on the permeability of the hemato-encephalic and hematic barriers has not been investigated. In connection with this, we decided to do an investigative study on the effect of high-frequency electromagnetic fields in the centimeter range (microwaves) of different power and duration of action on the permeability of the hemato-encephalic and hematic barriers of the organism.

The experiments were conducted on 92 rabbits. For the study of permeability of the hemato-encephalic and histo-hematic barriers, we used the method of radioactive indication. Radioactive phosphorus in the form of a dibasic phosphate salt was injected into the experimental rabbits intraperitoneally from a theoretical basis of 45 microcuries per kg of animal weight. Sixty minutes after the injection of the concentration of radioactive phosphorus, the rabbits were killed by electric current; batches of samples were taken from cerebrum (vermis, cerebral hemispheres, grey and white matter of the cerebrum, optic chiasma, four colliculi, olfactory bulb, medulla oblongata, epiphysis and hypophysis), various parts of the spinal cord (cervical, thoracic, and lumbar), and also from the femoral and thoracic muscles of the parenchymatous organs. The radioactivity of the tissues studied was determined by apparatus PP-16. Microwaves were generated by a Luch-58 apparatus with a frequency of 2307 megacycles and electromagnetic wave length of 12.3 cm.

Figure 1. Accumulation of P^{32} in the hypophysis, epiphysis, and lungs under the effect of SHF of 75W power and 10 min. exposure of the head region

Key:

1. Epiphysis
2. Hypophysis
3. Lungs



Microwaves with an intensity of 30-50-75W were directed on the head area for 10 and 20 min. and on a part of the frontal abdominal wall.

For the study of the reflex effect of microwaves on the permeability of the histo-hematic barriers, we exposed the region of the hind appendage of the rabbit with microwaves of 50W for 10 min. The distance from the electrode of the generator to the surface of the animal body was constantly 7-8 cm; power of the electromagnetic field was controlled with the apparatus PO-1 [transliteration]. The experiments were conducted simultaneously. The results obtained were calculated statistically.

The experiments proved that under the effect of microwaves of 30W with 10 min. exposure, there is some increase of permeability of the hemato-encephalic and hematic barriers.

A marked increase in the accumulation of P^{32} was observed in the four colliculi, in the olfactory bulbs, at the same time the spinal cord and the muscles did not show any deviation from the normal in P^{32} accumulation. So, for example, in the four colliculi the accumulation of P^{32} expressed by the percentage of absorption is an average of 1.69, and under the effect of microwaves of 30W is 2.3 percent (T-2.2; $P < 0.05$). In the olfactory bulb, the accumulation of P^{32} increases from 1.96 to 2.45 percent (T-2.2; $P < 0.05$). In the cerebral hemispheres the accumulation of P^{32} does not change and is an average 1.68 percent (standard value - 1.67 percent).

Microwaves of 50W for 10 min. produce an increase in the permeability of P^{32} through the hemato-encephalic barriers. So, for example, the accumulation of P^{32} (in the percentage of absorption) in the vermis equals an average of 3.21 (standard value - 1.81, T-2.2; $P < 0.05$), in the hypophysis 60, 65 (standard values - 45, 51, T-2.8; $P < 0.01$).

The electromagnetic field of microwaves with power of 75W and 10 min. duration on the head area produces an increase of the permeability of P^{32} through the hemato-encephalic barrier. The accumulation of P^{32} in the brain

tissues, in the cerebrum and spinal cord increases noticeably; while at the same time, in the hypophysis and epiphysis the accumulation of P32 decreases noticeably, as compared with the normal values.

The accumulation of P32 in the lungs and in the studied muscles increases as compared with normal values (Fig 1).

Increasing the duration of microwave action of 30W to 20 min. on the head area, we observed a greater increase of permeability of P32 through the hemato-encephalic and histo-hematic barriers into the brain tissue and the muscles than with 10-minute exposure (table).

Table:

Effect of the microwaves of 30W and 20 min. duration of the action on head area

(1) Назва	(2) Прод. вполювання P ³² в нормі		(3) Прод. вполювання P ³² в досліді		t	P
	M	±m	M	±m		
(4) Черв'ячок	1,81	±0,1	2,41	±0,2	4,3	<0,001
(5) Півкулі мозочка	1,67	±0,06	2,28	±0,2	3,1	<0,05
(6) Сіра речовина	1,92	±0,1	2,31	±0,2	2,5	<0,05
(7) Біла речовина	1,63	±0,1	2,15	±0,1	2,9	<0,05
(8) Чотирибугір'я	1,69	±0,1	2,47	±0,3	3,8	<0,05
(9) Ньюхові цибулини	1,96	±0,1	2,67	±0,2	3,5	<0,05
(10) Довгастий мозок	3,55	±0,2	3,97	±0,4	1,9	<0,1
(11) Епіфіз	56,59	+2,5	65,32	±0,6	29,2	<0,001
(12) Гіпофіз	45,51	±2,4	48,43	±0,4	8,4	<0,001
(13) Зорові бугри	2,17	±0,3	3,34	±0,2	2,1	<0,05
(14) Спинний мозок (шийна частина)	2,04	±0,4	2,53	±0,3	1,9	<0,1
(15) Спинний мозок (грудна частина)	2,94	±0,06	3,07	±0,3	0,8	<0,1
(16) Спинний мозок (поперекова частина)	2,57	±0,1	2,90	±0,1	1,2	<0,1
(17) Легені	18,24	±0,9	19,09	±0,5	2,7	<0,05
(18) Стегновий м'яз	2,40	±0,008	2,71	±0,2	2,4	<0,05
(19) Передній грудний м'яз	8,32	±0,7	11,11	±0,3	5,6	<0,001

Key:

- | | |
|---|---------------------------------|
| 1. Name | 10. Medulla oblongata |
| 2. Percent of P32 absorption standard values | 11. Epiphysis |
| 3. Percent of P32 absorption experimental results | 12. Hypophysis |
| 4. Vermis | 13. Optic chiasma |
| 5. Cerebral hemispheres | 14. Spinal cord (cervical part) |
| 6. Grey matter | 15. Spinal cord (thoracic part) |
| 7. White matter | 16. Spinal cord (lumbar part) |
| 8. Four colliculi | 17. Lungs |
| 9. Olfactory bulb | 18. Femoral muscle |
| | 19. Pectoral muscle |

The electromagnetic field strength of microwaves at 50W and 20 min. exposure on the head area produces greater permeability of P^{32} through the hemato-encephalic and histo-hematic barriers than the field strength of superhigh frequency (SHF) at 30W with the same duration of action. So, for example, in the vermis the amount of P^{32} in percent of incorporation is an average of 4.2 (T-3.2; $P < 0.001$), in the olfactory bulb 3.98 (T-2.9; $P < 0.01$), in the four colliculi 3.39 (T-2.6; $P < 0.01$), in the hypophysis - 64.37; (T-2.8; $P < 0.01$).

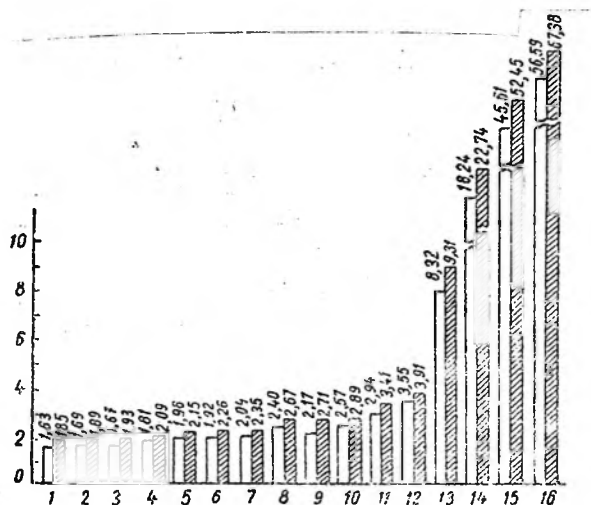
The effect of microwaves of 50W and 10 min. duration on the epigastric area increases the permeability of the hematic barriers, and increases the accumulation of P^{32} in the spinal cord; while at the same time, the permeability of the hemato-encephalitic barrier remains almost the same.

For example, in the grey matter of the spinal cord the amount of P^{32} in percentage of absorption is an average of 1.99 (normal, 1.92), in the olfactory bulb 1.56 (normal value 1.96). In the cervical part of the spinal cord P^{32} increases on the average to 4.91 percent (normal value 2.04), in the thoracic - to 4.51 percent (normal value 2.94) and in the lumbar area of the spinal cord 3.25 percent (normal value 2.57). The accumulation of P^{32} in the lungs increases to 32.89 percent (normal value 18.24, T-3.6; $P < 0.001$), and in the pectoral muscle - 13.21 (average normal values 8.32, T-2.4; $P < 0.05$).

The action of microwaves of 50W with 10 minutes exposure on the region of the right hind appendage of the rabbit increases the permeability of the histo-hematic and hemato-encephalitic barriers, but less than during the action of the same power on the head area (Fig 2).

Our experiments proved that under the influence of microwaves, the penetrability of the hemato-encephalic and histo-hematic barriers in the rabbit organism is changed. These changes in the penetrability of the natural barriers for P^{32} , as can be seen from our data, depends upon the intensity of the SHF of the electric field and the duration of the action on organism.

Figure 2. Accumulation of P^{32} in brain, spinal cord, muscles and lungs under the effect of microwaves of 50W with 10 min. exposition of right hind appendage of a rabbit



Key:

- | | |
|--------------------------------|---------------------------------|
| 1. White matter | 9. Optic chiasma |
| 2. Four colliculi | 10. Spinal cord (lumbar part) |
| 3. Grey matter | 11. Spinal cord (thoracic part) |
| 4. Vermis | 12. Medulla oblongata |
| 5. Olfactory bulbs | 13. Pectoral muscle |
| 6. Cerebral hemispheres | 14. Lungs |
| 7. Spinal cord (cervical part) | 15. Hypophysis |
| 8. Femoral muscle | 16. Epiphysis |

Our data agree with the observations of the other authors, who recorded the permeability of the serous barriers under the action of the electromagnetic fields (12, 13). They also agree with our previous observations during the study of the influence of ultrasound waves upon the permeability of histo-hematic and hemato-encephalic barriers.

The optimal dosage which produces the maximum increases of the permeability of P32 through the natural barriers, is an SHF field intensity of 50W and 75W with 10 minutes exposure, which corresponds with the date from a number of clinicians, who studied the influence of this physical agent upon functional ability of the nervous system (13-15).

We established, that the microwaves have a distinct reflectory effect on the penetrability of the barriers, which were studied with P32. This is proved by our experimental study of the microwave effect, which acts on the area of the hind right appendage of the rabbits, on the permeability of the histo-hematic, and on the hemato-encephalic barriers. The reflex character of the effect of microwave on other physiological processes was described in the literature (16-18).

Our results proved that the intensive action of the microwaves lowers the accumulation of P³² in the endocrine glands (epiphysis and hypophysis), but in other areas of the cerebrum the accumulation of P³² increases.

The obtained results are explained on the basis of the functional level of endocrine glands under the effect of microwave, and by the stress mechanism of this effect. These observations can be used by clinicians in a form of dosage-like prescription with the aim of regulating the permeability of the hemato-encephalic and histo-hematic barriers of medical substances.

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