

THE EFFECT OF MICROWAVE RADIATION ON THE EYE LENS IN RATS

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The paper deals with the results of a study performed in three groups of rats exposed to microwave radiation. Eighteen rats were irradiated locally (the right eye), 16 were totally irradiated and 22 served as controls. The activities of enzymes aldolase, lactate dehydrogenase (LDH) and sorbital dehydrogenase (SDH) in rats' lenses were examined. In exposed rats the aldolase and LDH activities were found to be lower and that of SDH higher than in control animals.

Since World War II the radar microwave radiation has been increasingly used in air, river and sea transport. As a result of this an increasing number of people are exposed to microwave radiation.

In 1967 *Presman* (1) in USSR reported cataracts in persons permanently exposed to microwave radiation with the power of only few mW/cm² which otherwise does not cause major changes in the irradiated organism.

According to *Duke Elder* (2) the clinical picture of the lens exposed to microwave radiation, shows two degrees of opacity. The first degree of opacity occurs in the form of granular capsular spots in vacuolar formations of the hind cortex of the lens. These granulations, located on the periphery, could be joined to form a ring. The second degree is characterized by central planar opacity spreading from the centre to the periphery, which can change into a complete lens opacity.

In Yugoslavia *Đorđević and Kolak* (3) examined 322 radar station employees, and a control group of 220 persons. They did not find any difference in clinical or laboratory tests between the exposed and control group. The same authors (4) after having exposed rats to microwave radiation did not register any opacity in the lens (cataract).

The aim of our investigation was to establish a possible influence of microwave radiation on the enzymes in the rat's lens in which cataract was not clinically confirmed.

MATERIAL AND METHODS

Experimental animals: 30 female Wistar albino rats, 6 months old, with a mean body weight of 0—230 g. The animals were divided in three groups of ten rats each. The first group was irradiated locally — the right eye only. In the second the whole body was irradiated and the third served as control. All animals were clinically healthy without any ophthalmologic changes. As a source of microwave radiation a generator of microwaves with a frequency of 2 450 MHz and a wave length of 12.2 cm was used (Radiothera 306, Siemens).

The electromagnetic field power was measured with a »Narda« monitor, model 8 100 B. For the eye irradiation a local emitter with a maximum power of 24 W was used and for the whole body irradiation an emitter for longitudinal field with a maximum power of 200 W.

The eye of fixed animals was irradiated at a distance of 1—1.5 m from the emitter of microwaves with the outgoing generator power of 20 W. The measured power of the electromagnetic field at this distance was 4.5 to 5 mW/cm². The whole body irradiation of animals exposed free in a PVC tub was performed at a distance of 1 m with the outgoing generator power of 200 W. The measured power of the electromagnetic field (non-homogeneous) was 16—20 mW/cm².

The local irradiation of the eye lasted 15 minutes a day, for 12 weeks — a total of 900 minutes. Whole body irradiation of the second group took also 15 minutes a day, 5 days a week for 8 weeks: a total of 600 minutes.

During the experimental period the animals were ophthalmologically examined once a week, under the condition of maximal mydriasis after application of 1% atropine solution. The results of ophthalmologic examination were recorded for each animal individually.

The animals were killed by bleeding in ether narcosis and the lenses were taken for a histopathological examination immediately after killing.

»Non-thermic« doses were determined empirically. By preliminary measurement of the temperature of the eye globe (local irradiation) and of rectal temperature (total irradiation) we established that the above irradiation conditions produce a temperature increase of up to 1 °C. The temperature was measured in the eye, *in situ*, in decapitated animals and on the conjunctiva of healthy irradiated animals. The measurement was performed by a contact electric thermometer. Thermic effects of total irradiation were measured in the rectum by a mercury thermometer.

On the basis of these parameters, the irradiation doses under the above experimental conditions were established approximately as »non-thermic doses«. We suppose that the increase of body temperature, or that of the eye globe, of less than 1 °C could not produce significant effects

which could be expressed in the form of chronic irreversible pathologic changes. It is generally accepted that a dose below 10 mW/cm² is usually subthermic.

Biochemical analyses were performed after enucleation of the eye. The lens was carefully taken out with undamaged capsule and homogenized. The obtained homogenate was centrifuged at 4 °C. The activities of the enzymes sorbital dehydrogenase (SDH), aldolase and lactate dehydroge-nase (LDH) were determined in the obtained supernatant.

RESULTS AND DISCUSSION

After ophthalmologic examination in maximal mydriasis of all three groups of animals no evident morphologic changes in the lens were found. However, the results of biochemical investigations of the enzymes SDH, aldolase, LDH, show significant changes to have taken place (Table 1).

Table 1
Activity of enzymes in the lenses of irradiated rats

Group	SDH		ALDOLASE		LDH	
	X	± S.D.	X	± S.D.	X	± S.D.
A Local irradiation (n = 18)	112.0	44.1	600.9	241.2	33843.8	13462.6
B Total irradiation (n = 16)	158.2	70.1	351.5	170.0	29242.3	8865.7
C Control (n = 22)	222.5	84.5	352.7	159.7	20803.6	6234.7
Significance:	A : B	< 0.05	< 0.005	< 0.05		
	A : C	< 0.001	< 0.001	< 0.001		
	B : C	< 0.05	N.S.	< 0.005		

In the locally irradiated rats, the activities of aldolase and LDH were considerably higher than in control rats. On the contrary, the SDH activity was found to be considerably lower than in control rats.

In irradiated rats, clinically, we did not find any cataracts. However, the changes in enzyme activities in the lens were registered. These results suggest the need for further investigations of enzymes in the lens to be performed under the same experimental conditions.

From the point of view of occupational health these results suggest the necessity of undertaking follow up studies of persons extensively exposed to microwave radiation since this type of radiation could represent a co-factor in the development of presenile cataract.

References

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Sažetak

UČINAK KRATKOTALASNOG ZRAČENJA NA SOČIVO OKA U PACOVA

Autori opisuju rezultate istraživanja učinaka mikrotalasnog zračenja na sočivo oka pacova. Dvije grupe od po 10 ženskih pacova zračili su kratkotalasnim zrakama od 12,2 cm, 2 450 MHz, i to jednu grupu samo desno oko (maksimalna snaga 24 W), a drugu celo telo (maksimalna snaga 200 W). Treća je grupa služila kao kontrola. Životinje su bile eksponirane 15 minuta dnevno, pet puta nedeljno tokom 12 nedelja (prva grupa), odnosno 8 nedelja (druga grupa). Tokom eksperimenta sve su životinje oftalmološki pregledavane i merena im je temperatura tela i oka. Nakon završetka eksperimenta oči su enukleirane, sočivo odvojeno i homogenizirano te je u homogenatu merena aktivnost aldolaze, laktat dehidrogenaze i sorbitol dehidrogenaze.

Nisu utvrđene oftalmološke promene na oku. U ozračenih pacova utvrđeno je sniženje aktivnosti aldolaze i sorbitol dehidrogenaze, a aktivnost laktat dehidrogenaze bila je povišena, posebno izrazito u lokalno zračenih pacova.

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