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MYOCARDIAL ENERGY AND PLASTIC METABOLISM AFTER IRRADIATION OF THE RABBIT THYROID GLAND WITH DECIMETER WAVES

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Application of decimeter electromagnetic fields to the region of the thyroid gland is used to stimulate repair processes in various organs and tissues [3]. Since it has been shown that during the action of decimeter waves (DMW) on the thyroid region some degree of activation of the hormone-forming functions of the gland takes place [2], the question arises of the dosage of this agent, so as not to give rise to pathological changes either in the gland itself undergoing irradiation (the thyroid gland) and in the target organs for its hormones. From this standpoint, particular attention must be paid to the state of the heart muscle, for if thyroid function is intensified and, in particular in the presence of thyrotoxicosis, the energy metabolism of the myocardium and its supply of plastic materials are affected [4].

The aim of the present investigation was to assess the functional state of the mitochondria (MCH) of the myocardium and the glycogen and nucleic acid content of this tissue, in relation to the intensity of action of DMW on the thyroid gland, with the aim of choosing the conditions of irradiation which would not cause damage to the systems studied. A morphological study also was made of the state of the myocardial capillary network and on the

TABLE 1. Parameters of Respiratory and Phosphorylating Activity of Myocardial MCH during Irradiation of Thyroid Gland with DMW of Varied Intensity (oxidation substrate was a 5 mM solution of α-ketoglutarate, M ± m)

Time of investigation	Velocity of oxidation, nA O_2/min/mg protein				ADP/O	ADP/T
	V_c	V_{ADP}	V_4	V_{DNP}		
			DMW, 10 mW/cm^2			
After course	7,2±1,2	14,2±2,2	5,0±0,6	15,6±2,0	3,6±0,2	5,1±0,5*
After-period	7,0±1,3	14,5±2,5	6,2±1,3	20,2±2,6	3,1±0,3	5,0±0,55*
			DMW, 120 mW/cm^2			
After course	12,3±2,3*	21,5±3,1*	10,2±1,7*	24,2±3,7	2,6±0,15*	4,86±0,5
After-period	8,0±2,2	15,4±1,7	7,8±1,2**	22,2±1,5	2,7±0,3	4,2±0,6
			DMW, 240 mW/cm^2			
After course	15,6±1,5***	27,2±2,8***	17,7±3,1***	27,0±3,3***	2,4±0,2***	2,2±0,6***
After-period	12,3±1,0***	20,1±1,7	15,3±1,2***	22,3±2,1	2,5±0,2***	3,1±0,2
			Control			
	6,9±1,1	13,9±2,7	6,5±1,0	20,8±3,1	3,2±0,2	3,85±0,3

Legend. Isolation medium contained 0.3 M sucrose and 0.01 M versene; incubation medium contained 0.3 M sucrose, 10 mM KCl, 10 mM KH_2PO_4, 0.5 mM versene. *) Significance of differences compared with control, $p < 0.05$-0.01; **) significance of differences compared with course of DMW with PFD of 10 mW/cm^2, $p < 0.05$-0.01

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TABLE 2. Glycogen Concentration (in mg%) in Myocardium of Rabbits Exposed to DMW of Varied Intensity in Thyroid Gland Region (M ± m)

Exposure, dose, mW/cm^2	After course	After-period
DMW, 10	4,79±0,53	6,95±0,84
DMV, 120	4,94±0,80	9,6±1,63*
DMV, 240	6,2±0,57	10,1±2,0*
Control	5,44±0,61	5,44±0,61

*p < 0.05 compared with control.

TABLE 3. Nucleic Acid Concentration (in µg/mg wet weight of tissue) in Myocardium of Rabbits Exposed to DMW in Thyroid Gland Region (M ± m)

Exposure, dose, mW/cm^2	After course		After-period	
	RNA	DNA	RNA	DNA
DMW,10	7,74±0,45	11,49±0,75	8,52±0,53	11,63±0,63
DMW, 120	5,6±0,41**	11,26—0,68	6,37±0,41*	10,35±0,9
DMW, 240	5,84±0,27**	10,06±0,79	6,51±0,49*	10,01±0,79
Control	8,47±0,68	10,7±0,65	8,63±0,68	11,21±1,4

Legend. Significance of differences calculated compared with control: *p < 0.05-0.02, **p < 0.002-0.001.

structural elements of the cardiomyocytes (CMC).

EXPERIMENTAL METHOD

Experiments were carried out on 100 male chinchilla rabbits weighing 2.5-3 kg. A "Volna-1" generator with contact ceramic emitter 40 mm in diameter was used as the source of DMW (460 MHz). The thyroid gland region was irradiated by DMW with power flux density (PFD) of 10, 120, and 240 mW/cm for 6 min daily for 10 days. The animals were killed immediately after the course of 10 procedures and also 10 days after the end of the course (the after-effect period). Animals receiving mock procedures served as the control. Respiration and phosphorylating activity of the myocardial MCH were evaluated by a polarographic method [6], using the PA-2 polarograph (Czechoslovakia) and a demi-enclosed platinum electrode paired with a calomel electrode. The glycogen concentration in the myocardium was determined by the method in [9] and nucleic acids by a dual-wave spectrophotometric method [8]. Morphometric [1, 7] and histochemical methods [5] were used for the morphological investigations.

EXPERIMENTAL RESULTS

The study of the myocardial energy metabolism revealed a regular feature: with an increase in the intensity of DMW there was a gradual decrease in the phosphorylating activity of MCH (Table 1) and accumulation of glycogen in the myocardium (Table 2). The differential effect of different doses of DMW also was found when the structural metabolism of the myocardium was investigated. Whereas after irradiation with DMW with PFD of 10 mW/cm^2 the nucleic acid content in this tissue was unchanged, increasing the PFD to 120 or 240 mW/cm^2 led to a fall of the RNA level (Table 3). However, the tendency toward recovery noted during the aftereffect period of irradiation and the results of morphometric investigations (Table 4) indicate that these changes may be regarded as functional.

Thus the intensities of action of DMW on the thyroid gland region gave rise to certain functional shifts affecting energy and structural metabolism in the myocardium, but they had no damaging action on the heart muscle of the experimental animals. At the same time,

TABLE 4. Morphometric Parameters of Cardiomyocytes (CMC) and Capillary Bed or Rabbit Heart during Exposure to Various Doses of DMW in Thyroid Gland Region (M ± m)

Exposure, dose, mW/cm^2	Number of CMC per standard area	S of CMC, μ^2	S of CMC nuclei, μ^2	S of capillary bed, μ^2	Blood supply index
DMW, 120	16,8±0,41	134,0±5,2	40,2±0,8**	15,9±0,62**	0,39±0,06
DMW, 240	18,3±0,54**	116,5±4,3**	36,7±0,93***	11,9±0,71**	0,35±0,05*
Control	15,7±0,37	146,3±3,6	46,6±0,9	18,8±0,67	0,53±0,05

Legend. Significance of differences calculated compared with control: *$p < 0.05$, **$p < 0.02$-0.01; ***$p < 0.001$.

it was shown that the greatest changes in the parameters studied (reduction of the phosphorylating activity of MCH, glycogen accumulation, changes in the myocardial microcirculation, certain modifications of the structural elements of the cardiomyocytes) became more marked if the intensity of exposure was increased to 240 mW/cm^2.

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