

BIOCHEMICAL CHANGES IN THE BLOOD SERUM
AND MYOCARDIUM AFTER LOCAL IRRADIATION
OF THE RABBIT HEART WITH HARD BREMSSTRAHLUNG

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A sharp increase in the activity of lactate dehydrogenase (1.1.1.27), aldolase (4.1.2.13), aspartate aminotransferase (2.6.1.1), and creatine kinase (2.7.3.2), accompanied by marked morphological changes in the myocardial tissue, were found 60 h after local irradiation of the region of the rabbit's heart on a linear accelerator (dose 10,000 rad). The enzyme activity of the sarcoplasmic proteins of the myocardium was the same as in the control. Changes were also found in the isoenzyme spectrum of lactate dehydrogenase in the blood serum of the irradiated animals. The composition of the myocardial protein fractions and the isoenzyme spectrum of lactate dehydrogenase of the sarcoplasmic proteins of the myocardium were unchanged after irradiation.

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The study of biochemical changes following local exposure of individual organs, and especially the heart muscle, to large doses of ionizing radiation has recently assumed great importance.

In the present investigation the fractional composition and enzyme activity of proteins of the myocardium and blood serum were studied after local irradiation of the rabbit's heart with hard bremsstrahlung.

EXPERIMENTAL METHOD

Experiments were carried out on adult male chinchilla rabbits. The animals received local irradiation with hard bremsstrahlung with an energy limit of 4.3 MeV on a Mullard linear accelerator. Dose 10,000 rad, dose rate 330 rad/min, field 3 × 3 cm, exposure 30 min. The animals were sacrificed by decapitation 60 h after irradiation.

The blood serum and myocardium were investigated. The fractional composition of the heart muscle was determined by the method of Ivanov and co-workers [1]. The activity of the following enzymes was determined in the blood serum, sarcoplasmic proteins, and proteins of fraction T obtained from the left ventricle: lactate dehydrogenase (LDH), aldolase (ALD), alanine aminotransferase (ALT), aspartate aminotransferase (AST), acetylcholinesterase (CE), and creatine kinase (CK). The protein content in the samples was estimated by Lowry's method. The isoenzyme spectrum of LDH in the blood serum and sarcoplasmic proteins of the myocardium was studied by Hellmann's method.

EXPERIMENTAL RESULTS AND DISCUSSION

Histological investigation of specimens of the heart muscle revealed the presence of reactive inflammatory changes, degenerations, and necrosis of the myocardial tissue: foci of hemorrhage and necrosis along the course of the small veins and arteries, interstitial and perivascular edema of the connective tissue, single fibers or groups of fibers with degenerative changes, and foci of infiltration with leukocytes close to the foci of necrosis of these fibers.

The enzyme activity of the serum, sarcoplasmic proteins, and proteins of fraction T of the myocardium is given in Table 1.

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TABLE 1. Enzyme Activity of Blood Serum, Sarcoplasmic Proteins, and Proteins of Fraction T of the Myocardium (in μ moles substrate per mg protein/h incubation)

Material; group of animals	LDH	ALD	ALT	AST	CK	CE
Serum*:						
control	5,57 \pm 0,47	6,68 \pm 0,40	3,34 \pm 0,10	0,87 \pm 0,05	272 \pm 19	37,7 \pm 2,6
experiment	15,35 \pm 2,01 $P<0,001$	12,32 \pm 0,66 $P<0,001$	3,60 \pm 0,34 $P>0,05$	1,34 \pm 0,14 $P<0,01$	668 \pm 30 $P<0,001$	37,8 \pm 2,7 $P>0,05$
Sarcoplas- mic proteins						
control	6,50 \pm 0,59	13,03 \pm 1,64	8,87 \pm 0,98	20,63 \pm 2,35	3182 \pm 235	0,15 \pm 0,01
experiment	5,91 \pm 0,52 $P>0,05$	13,68 \pm 1,30 $P>0,05$	9,03 \pm 1,18 $P>0,05$	21,06 \pm 3,18 $P>0,05$	3427 \pm 424 $P>0,05$	0,17 \pm 0,01 $P>0,05$
Proteins of fraction T :						
control	1,51 \pm 0,09	5,83 \pm 0,41	0,38 \pm 0,02	0,84 \pm 0,02	403 \pm 22	0,39 \pm 0,03
experiment	2,05 \pm 0,18 $P<0,05$	8,15 \pm 0,61 $P<0,01$	0,42 \pm 0,03 $P>0,05$	1,13 \pm 0,10 $P<0,02$	370 \pm 36 $P>0,05$	0,61 \pm 0,05 $P<0,01$

*Activity given in μ moles substrate/ml serum/h incubation.

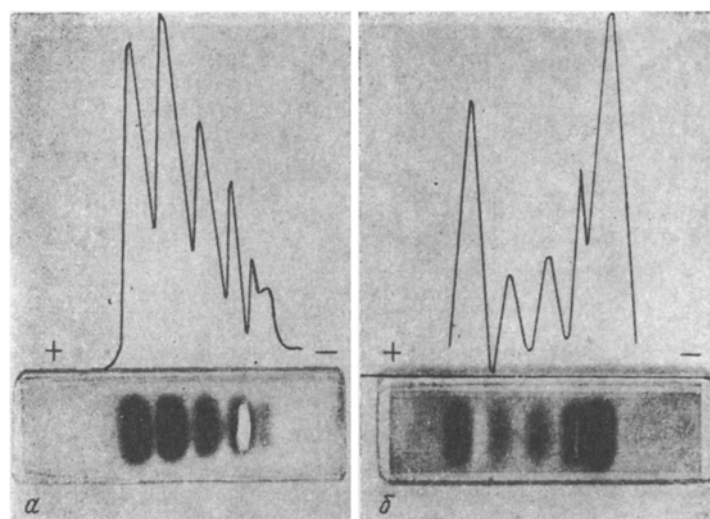


Fig. 1. Isoenzyme spectrum of LDH in blood serum. a) Control; b) experiment.

As Table 1 shows, after local irradiation of the heart region by hard bremsstrahlung in a dose of 10,000 rad, the activity of LDH, ALD, AST, and CK in the blood serum rose sharply. Meanwhile, the enzyme activity of the sarcoplasmic proteins remained unchanged. An increase was also observed in the LDH, ALD, AST, and CE activity in the proteins of fraction T of the myocardium.

The LDH isoenzyme spectrum of the blood serum is shown in Fig. 1. After a single local irradiation of the heart region (dose 10,000 rad) a statistically significant decrease was observed in the activity of LDH₁, LDH₃, and LDH₄ in the blood serum, accompanied by a sharp increase in LDH₅ activity.

No differences were found in the isoenzyme spectrum of the sarcoplasmic proteins of the heart muscle in the control and experimental animals.

The composition of the protein fractions of the myocardium from the irradiated rabbits was not significantly different from normal.

Hence, as these results demonstrate, the morphological changes in the myocardium after local irradiation (dose 10,000 rad) were accompanied by marked biochemical changes. An increase in the activity of LDH, ALD, AST, and CK – enzymes specific for muscle tissue in general and for the myocardium in particular, was observed in these experiments. The activity of these enzymes is known to rise especially sharply in myocardial infarction, when foci of necrosis arise in the heart muscle [3]. However, no significant decrease in the enzyme activity of the sarcoplasmic proteins of the myocardium could be detected. This may indicate the existence of a more complex mechanism of the increase in activity of the serum proteins both in myocardial infarction and after local irradiation of the heart [2, 4].

LITERATURE CITED

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