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EFFECT OF X-RAYS ON LIVER METABOLISM

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Abstract: The greatest issue facing our century is environmental contamination on a global scale. Research has unequivocally demonstrated that radioactive rays are a significant contributor to environmental pollution. The primary causes of the rise in the intensity of radioactive radiation in the atmosphere nowadays are thought to be the fast development of industry, the ongoing construction of new power plants, and other things.

Many modern devices are being assessed as potential sources of radioactive radiation, particularly those utilized in manufacturing and in the medical field. Along with the patients who are in contact with these devices, the medical personnel are also exposed to radiation. In light of this, one of the top priorities in the fields of medicine and biology is elucidating how X-rays affect the liver's metabolism, which is thought to be an essential organ. For this purpose, experiments were conducted on 20 white rats. Enzymatic and non-enzymatic liver markers were measured in the blood of the experimental animals after they were exposed to radiation using the "RUM-17" device.

Keywords: white rats, X-rays, enzymatic and non-enzymatic metabolism of the liver.

1. The relevance of the subject

The physiological functions of an organism are regulated by the metabolic processes in the body. Thus, the primary physiological processes of the body are either in a normal state or take a pathological direction based on alterations in metabolism (1).

It has been determined that the liver is the most important organ regulating metabolism in the body. Through liver metabolism, endogenous intoxication factors that are already present in the body and exogenous ones that are ingested from the environment are neutralized (2, 3). Numerous studies have proven that liver metabolism disorder is a polyetiological pathology. Long-term medication use, bad habits, environmental pollution, and radioactive radiation are some of these factors (4, 5, 6).

Taking this into account, we studied the alterations in the enzymatic and non-enzymatic metabolism of the liver of white rats exposed to X-rays.

2. Materials and methods of research

Twenty white rats weighing between 140 and 180 grams were used in the studies. Depending on the purpose of the study, the experimental animals were divided into 4 groups of 5 animals each.

Group 1 is the control group, where the experimental animals were examined in an intact state.

Group 2 included white rats exposed to radiation through an X-ray device.

White rats included in the 3rd group were examined 3 days after being exposed to radiation and the state of liver metabolism was studied.

Group 4 involved the determination of markers that characterized the liver's enzymatic and non-enzymatic metabolism in white rats ten days after irradiation.

The tests were carried out in accordance with the European Bioethics Commission's (Strasbourg, 1986) guidelines for the treatment of experimental animals. The experimental animals were selected according to their gender (male and female) and kept in the vivarium under normal conditions (at a temperature of 20–220 °C) and fed according to the standard food ration.

The opinion of the authors was taken as a basis when selecting enzymes reflecting liver metabolism in the blood (7, 8) and reflecting non-enzymatic markers (9,10). So, in order to evaluate the enzymatic metabolism, aspartate transaminase (AST), alanine aminotransferase (ALT), creatine phosphokinase (CPK), lactate dehydrogenase (LDH), alkaline phosphokinase (ALP), creatinine, urea (U), total bilirubin (TB), the amount of residual nitrogen (N), and total protein (TP) were determined.

The reagent kits made by the Human Company were used to conduct the necessary biochemical tests on the fully automatic BioSkreen MS-2000 analyzer, which is made in the USA.

Using the RUM-17 device, radiation was applied to the experimental white rats. During irradiation, the voltage was 180 kV, the current strength was 15 m, the focal length was 3, the filters were 0.5 mm Cu+1.0 mm Al, and the dose rate without a tube was 0.86 g/sec. A single dose of 4 g was administered during the irradiation of experimental animals in accordance with A.U. Eminov's (2014) recommendation.

Using a program created in accordance with current standards, parametric and non-parametric techniques were used to examine quantitative indicators derived from experiments (12, 13, 14). Using the Brave-Pearson approach for correlational analysis, a high correlation link was verified when r>0.07.

3. Results and Analysis

The minimum, maximum, and average quantitative indicators of each marker we examined were established and recognized as the norm based on the outcomes in experimental animals (table 1).

Table 1

The results of the determination of markers specifying liver metabolism in the blood of intact white rats.

No.	Stat. indic.	AsT	AlT	LDH	CPK	AlP	Creat.	U	TB	N	TP
1	Min.	25	30	270	243	150	0.7	16	0.3	6	66
2	Max.	33	40	440	275	300	1.2	45	1.1	18	85
3	M	29.4	35.2	368	260.4	234	0.92	33	0.8	12.2	75.4
4	m	1.50	1.85	28.53	6.00	27.13	0.09	5.08	0.14	2.06	3.47

In the blood of experimental animals exposed to X-rays (group 2), the concentration of markers characterizing the enzymatic metabolism of the liver increased sharply. Thus, compared to the level in the intact state, the average concentration of the AST, AlT, glutamyl transferase, LDH, CPK, and alkaline phosphatase enzymes increased, respectively, by 27% (P<0,05), 28% (P<0,05), 17%, 31% (P<0,05), 52% (P<0,001), and 29% (P<0,05). However, in a certain proportion of the experimental animals, the concentrations of the other enzymes were found to be within the normal range, with the exception of the CPK enzyme concentration. Thus, in 40% of the experimental white rats, the average concentration of the liver's primary functioning markers, AST and ALT, remained at a normal level. The blood concentration of the alkaline phosphatase enzyme, in contrast to that of the AST and ALT enzymes, was comparatively greater in the experimental animals that stayed within the normal range. They made up 60% of the experimental animals. Nonetheless, the proportion of white rats exhibiting normal LDH enzyme concentration dropped precipitously to 20%. In all experimental animals, the concentration of the CPK enzyme, which is the primary indicator of the reparative process, was higher than usual.

According to an examination of the experiment results, X-ray exposure causes disorders in the liver's enzymatic metabolism. As a manifestation of this, the concentration of enzymes characterizing liver metabolism in the blood increases and rises to a higher level than the norm. The CPK enzyme, however, had a higher blood concentration than the other enzymes among the experimental animals. Only 20% of the experimental animals had normal LDH concentrations due to the enzyme's increased sensitivity to X-rays (table 2).

The following alterations have been noted in markers that characterize non-enzymatic metabolism in the blood.

Compared to the intact state, the amount of creatinine, urea, total bilirubin, and residual nitrogen in the blood increased, respectively, by 43.5%, 72.1%, 70%, and 51%. The amount of total protein decreased by 7%. However, despite this change, 80% of the experimental animals had a normal amount of creatinine, and 60% of them had a normal level of residual nitrogen and total protein. The amount of urea and total bilirubin remained at a normal level in the small number of animals, which made up 20% of the experimental animals.

Table 2

Results of the determination of markers evaluating liver metabolism in the blood of intact white rats

No.	Statis. indic.	AsT	AlT	LDH	CPK	AlP	Creat.	U	T/B	N	T/P
1	Max	28	33	320	315	280	1	32	1.1	10	59
2	Min	50	57	590	463	330	1.7	74	1.5	27	81
3	M	37.4	45.8	482	394.8	302	1.32	56.8	1.36	18.4	70.2
4	m	3.78	4.53	45.54	24.25	8.60	0.12	7,60	0.09	2.80	4.71
5	P	<0.05	<0.05	<0.05	<0.001	<0.05	<0.05	<0.05	<0.05	=0.05	=0.05

Examinations of the experimental animals included in the 3rd group were performed 3 days after stopping X-ray irradiation. As a result of the blood examination, it was determined that 3 days after stopping X-ray irradiation, the average concentration of the AST, ALT, LDH, CPK, and alkaline phosphatase enzymes in the blood increased, respectively, by 27%, 30%, 31%, 52%, and 29% compared to the intact state.

Of the experimental animals, 40% had normal levels of both transaminases, 20% had LDH, and 60% had alkaline phosphatase. However, unlike these enzymes, the concentration of the CPK enzyme in the blood remained higher than normal in 100% of the white rats. Pathological changes were found in the non-enzymatic metabolism as well as the enzymatic metabolism of the liver. Even three days after the experimental animals were taken out of the radiation field, there was still an increase in blood levels of creatinine, urea, total bilirubin, and residual nitrogen, which were 43.5%, 72%, 70%, and 51%, respectively. The amount of total protein decreased by 7%. However, this increase was not recorded in all the experimental animals. The blood levels of creatinine in 80% of the experimental animals, total protein and residual nitrogen in 60%, and urea and total bilirubin in 20% of the animals all remained normal.

Table 3 presents the findings derived from the experimental animals.

Ten days following X-ray irradiation, the experimental animals in the fourth group were decapitated, and blood samples were obtained to assess biochemical markers indicative of liver metabolism.

Table 3

Results of the determination of markers evaluating liver metabolism in the blood of white rats 3 days after stopping X-ray irradiation

No.	**Statis. indic.**	**AsT**	**AlT**	**LDH**	**CPK**	**AlP**	**Creat.**	**U**	**T/B**	**N**	**T/P**
1	Max	28	33	320	315	280	1.0	32	1.1	10	59
2	Min	50	57	590	463	330	1.7	74	1.6	27	81
3	M	37.4	45.8	482	394.8	302	1.32	56.8	1.36	18.4	70.2
4	m	3.78	4.53	45.54	24.25	8.60	0.12	7.60	0.09	2.80	4.71
5	P	<0.05	<0.05	<0.05	<0.01	<0.05	<0.05	<0.05	<0.01	=0.05	=0.05

It was determined that the concentration of AST, AlT, LDH CPK, and alkaline phosphatase enzyme in the blood increased by 22%, 23%, 27%, 41%, and 22%, respectively. Alkaline phosphatase enzyme concentration in 80% of experimental animals, AlT enzyme concentration in 60%, AST enzyme concentration in 40%, and LDH enzyme concentration in 20% remained within normal limits. However, unlike these enzymes, the concentration of the CPK enzyme was higher than the normal level in 100% of the experimental animals.

Even after stopping the X-ray irradiation 10 days ago, the number of markers that describe the liver's non-enzymatic metabolism did not go back to normal; instead, it remained elevated.

This difference is 39% for creatinine, 68% for urea, 62.5% for total bilirubin, and 40% for residual nitrogen. The amount of total protein in the blood was reduced by 5% compared to intact animals.

Despite the fact that the amount of creatinine, total protein, and residual nitrogen in the blood was higher than the normal level, the vast majority of the subjects (60%) remained at a normal level.

In contrast to creatine, only 20% of the experimental animals' levels of urea and total bilirubin remained normal.

Thus, in white rats exposed to X-rays, the enzymatic and non-enzymatic metabolism of the liver is disturbed, and although it partially recovers within 10 days, it does not decrease to the normal level but is higher than it.

This finding leads us to infer that abnormalities related to liver metabolism underlie a number of diseases that arise in the body as a result of radiation exposure.

Table 4

Results of the determination of markers evaluating liver metabolism in the blood of white rats 10 days after stopping X-ray irradiation

No.	Statis. indic.	AsT	AlT	LDH	CPK	AlP	Creat.	U	T/B	N	T/P
1	Max	28	30	315	286	260	1.0	32	1.1	10	61
2	Min	46	56	575	415	330	1.7	74	1.5	25	81
3	M	35.8	43.2	467	366.6	286	1.28	56.8	1.3	17.8	71.4
4	m	3.38	4.75	43.09	21.80	12.08	0.12	7.60	0.07	2.46	4.27
5	P	=0.05	=0.05	<0.05	<0.01	=0.05	<0.05	<0.05	<0.05	<0.05	=0.05

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РЕНТГЕНОВСКИЕ ЛУЧИ И ИХ ВЛИЯНИЕ НА МЕТАБОЛИЗМ ПЕЧЕНИ

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Резюме: Глобальное загрязнение окружающей среды является важнейшей проблемой нашего столетия. Проведенные исследования убедительно доказали, что радиоактивные лучи занимают важное место среди факторов, загрязняющих окружающую среду. Сегодня основной причиной увеличения интенсивности радиоактивного излучения в атмосфере считают бурное развитие промышленности, постоянное увеличение количества электростанций и другие факторы.

Сегодня ряд устройств, используемых на производстве и особенно в медицинской практике, также можно считать источниками радиоактивного излучения. Наряду с пациентами, контактирующими с этими устройствами, облучению подвергается и медицинский персонал. В связи с этим выяснение влияния рентгеновских лучей на метаболизм печени, считающейся жизненно важным органом организма, является приоритетной задачей медицинских и биологических наук. С этой целью были проведены эксперименты на 20 белых крысах. Подопытных животных облучали на приборе «РУМ-17» и определяли в крови ферментативные и неферментативные маркеры печени.

Ключевые слова: белые крысы, рентгенологические исследования, ферментативный и неферментативный метаболизм печени.

RENTGEN ŞÜALARININ QARACİYƏR METABOLİZMİNƏ TƏSİRİ

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Xülasə: Ətraf mühitdə baş vermiş qlobal çirklənmə yaşadığımız əsrin ən mühüm bəlasıdır. Aparılan tədqiqatlar birmənalı şəkildə sübuta yetirmişdir ki, ətraf mühitini çirkləndirən amillər sırasında radioaktiv şüalar mühüm yer tutur. Bu gün sənayenin sürətli inkişafı, elektrik stansiyalarının sayının durmadan artması və digər amillər atmosferdə radioaktiv şüalanmanın intensivliyinin artmasının əsas səbəbi kimi dəyərləndirilir.

Bu gün istehsalatda və xüsusilə tibbi praktikada istifadə edilən bir sıra cihazlarda radioaktiv şüa mənbəyi kimi dəyərləndirilir. Bu cihazlarla təmasda olan pasiyentlərlə yanaşı tibb personalı da şüalanmaya məruz qalır. Bu baxımdan rentgen şüalarının orqanizmin həyati vacib üzvü sayılan qaraciyərin metabolizminə təsirinin aydınlaşdırılması tibb və biologiya elmlərinin prioritet problemi olaraq diqqət mərkəzində durur. Bu məqsədlə təcrübələr 20 baş ağ siçovul üzərində aparılmışdır. Təcrübəyə götürülən heyvanlar “RUM-17” cihazı vasitəsilə şüalandırılmış və qanda qaraciyərin fermentativ və qeyri-fermentativ markerləri təyin edilmişdir.

Açar sözlər: ağ siçovullar, rentgen şüaları, qaraciyərin fermentativ və qeyri-fermentativ metabolizmi.