THE EFFECT OF IONIZING RADIATION ON THE NUCLEIC ACID CONTENT OF RAT LIVER MITOCHONDRIA

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The influence of ionizing radiation on the nucleic acid content of various organs has been widely investigated in the modern literature. However, the work has been carried out with tissue homogenates or with individual cells and has dealt mainly with the nuclei and the whole cytoplasm. Much less attention has been given to examining the effect of ionizing rays on the nucleic acid content of the specific organelles in the cytoplasm. Investigation of this problem has become of greater importance in view of the theory, proposed by a number of workers, that the destructive action of radiation upon the synthetic and other biochemical processes may not be uniform in its effect upon the various subcellular structures [2-4].

Special interest is attached to the action of high ionizing radiation doses on the RNA content of the mitochondria during the first hours after exposure. We have been able to find no information concerning this in the literature. The available data relative to the effect of radiation on the RNA content in the homogenate is of great interest but it does not answer the question at hand, namely, whether it is possible that there are a variety of different changes induced in the different cytoplasmic organelles and that the sum total of these are reflected in change in the RNA content of the whole homogenate. It is pertinent in this connection to bear in mind that the content of RNA in the microsomal fraction is close to that of the mitochondrial fraction. Thus, according to some work [8, and others] 38% of the RNA of the rat liver homogenate is in the form of microsome RNA, and the mitochondrial fraction makes up 28% of the total. The literature indicates that RNA content of the homogenates rises in the early hours following radiation with sublethal as well as with higher doses. It was shown [1] that 6 h after a 2000 r dose of irradiation in the rat there was a rise in the liver RNA level.

The problem undertaken in the present work was a study of the effect of high roentgen radiation dosage (1500-2000 r) on the RNA content of rat liver mitochondria 2 h after exposure.

EXPERIMENTAL METHOD

The experiments were carried out on 12 male albino rats weighing 140-160 g; the animals were exposed to radiation in the RUM-3 apparatus. Mitochondria were isolated by differential centrifugation in 0.25 M sucrose under refrigeration at 2-4°. The purity of the isolated fraction was verified by electron microscopy and by means of the qualitative reaction for DNA with differentiation according to the Barton [6] modification. Nucleic acids were determined by the A. S. Spirin [5] method. The quantity of nucleic acid was calculated per mg of protein in the mitochondrial fraction. The results were treated statistically.

EXPERIMENTAL RESULTS

Experimental series I provided data on the RNA content of liver mitochondria from control animals. The average value was 20.6 ± 1.02 μg per mg protein. This value is in close agreement with published data. It was observed [7] that mitochondria contain 15-20 μg of RNA per mg of protein. According to other data [9] the RNA per mg of mitochondrial protein is 17 μg.

The animals in experimental series II were exposed to radiation doses of 1500 and 2000 r. The changes induced at both dosage levels were identical (the RNA content per mg of mitochondria protein was 38.9 ± 5.68 μg).

Thus, radiation significantly raises the level of RNA per mg of mitochondrial protein (in the average by 88.8%). Statistical treatment of the data established the significance of the difference between control and irradiated subjects ($t = 3.17$; $P < 0.01$). It should also be noted, as additional evidence of significance, that the lowest RNA level in the mitochondria of the irradiated animals was higher than the highest value obtained on the healthy controls.

The results we have obtained are constant with published information [1] concerning the increased RNA in rat liver homogenates in the early hours after irradiation. It is specifically of interest to compare the data we have obtained on the RNA increase in the early hours after irradiation with the data in the literature concerning the rate of protein synthesis in the mitochondria during this same period after exposure to ionizing radiation. It has been reported [10] that 2 h following a 1000 r radiation dose no significant rise occurred in the incorporation of C^{14}-glycine and C^{14}-lysine into the proteins of the mitochondria and microsomes in rat liver. Considering the limited number of investigations which have been directed toward this problem, it should be pointed out that the question concerning the relationship between nucleic acid metabolism and intensity of protein synthesis in specific cytoplasmic organelles in the early hours after irradiation requires further investigation.

SUMMARY

The object of study was the influence of high doses of ionizing radiation (1500-2000 r) on the RNA content of mitochondria of the liver in albino rats. Mitochondria were isolated 2 h after the irradiation of animals. A significant increase in the RNA level was discovered in comparison to the mitochondria of the liver in healthy animals (by 88% on the average).

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