

THE EFFECTS OF TOTAL X-RADIATION ON THE GLYCOPROTEIN
CONTENT OF BLOOD SERUM IN NORMAL AND HYPOTHYROID ANIMALS

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Alterations of the glycoproteins in various disorders found in the clinic and produced in animals under experimental conditions have been the basis of numerous investigations. The findings have been reviewed by native [1, 4, 6, 7] and by foreign authors [10, 17, 19].

Relatively little study has been focused upon the effects of ionizing radiation on the quantitative and qualitative composition of the glycoproteins in the blood serum. Certain workers [18], using x-radiation on rats at a 700 r dose level, observed no change in the total amount of polysaccharides in the first 4-5 days, but on the sixth day they observed an elevated level. A 300 r dose had no effect on the serum polysaccharides.

It has been observed that the serum mucoid level remains rather stable in rats following a 700 r radiation dose [9]. In rabbits it has been observed that the serum glycoproteins increase in the first day after irradiation [20].

Numerous workers attribute a major role to the thyroid gland hormone in regulating the serum glycoprotein metabolism. Significant variations in the fractional composition of the serum glycoproteins in rats have been noted in connection with changes in the functional condition of the thyroid gland [3]. Data have been published showing changes in the serum hexosamine content in dogs and rats under treatment with thyroid hormone [12, 13, 14]. Abnormalities in the composition of the integumentary acid mucopolysaccharides have been found in hypothyroid rats [16].

We have investigated the effect of radiation upon the total level of serum glycoproteins and their individual electrophoretic fractions in normal rats and in rats with thyroid hypofunction.

METHODS

The experiments involved 120 male albino rats weighing 170-200 g. Experimental hypothyroidism was produced by daily administration per os of mercazole at the rate of 0.02 g per 100 g body weight for a 3 week period. The rats were irradiated in the RUM-3 apparatus under the following conditions: potential of 180 kv, current strength 15 ma, focal distance 60 cm, filter 0.5 mm Cu and 1 mm Al, output 20 r/min, exposure time 30 min. The total dose was 600 r. Glycoproteins were determined 88-90 h after irradiation.

The total glycoprotein was measured as the amount of hexoses (mannose and galactose) associated with the proteins using the anthrone method [15]. The values were calculated as milligrams of hexoses per 100 ml of serum. The glycoproteins in the individual serum fractions were determined by paper electrophoresis [5]. The color intensities on the electrophoresis strips were calculated after elution of the dye [8]. The results from each were expressed as percentages of the total glycoprotein content in the blood serum.

RESULTS

The results, which are presented in the table, show that hexoses associated with the serum proteins undergo a statistically significant increase ($P < 0.001$) in thyroid hypofunction. Irradiation alone causes no noticeable change in their level compared with normal rats, nor does irradiation together with thyroid hypofunction produce a different level than the hypothyroid state alone. Although irradiation failed to influence the total amount of glycoproteins, nevertheless, it produced substantial changes in distribution among the various fractions. Irradiation of normal rats

Glycoprotein Content of the Blood Serum in Normal and Hypothyroid Rats after Irradiation

Condi- tions of expt.	Hexoses as- sociated with proteins (in mg/per 100 ml)	Electrophoretic fractions (in %, M+m)				
		albumin	α_1 -globulin	α_2 -globulin	β -globulin	γ -globulin
Control	176,70 \pm 2,32	8,01 \pm 0,43	31,84 \pm 0,51	21,41 \pm 0,65	25,69 \pm 0,54	13,16 \pm 0,66
Hypo- thyroid	225,5 \pm 6,39 $P < 0,001$	6,59 \pm 0,39 $P = 0,012$	37,78 \pm 0,63 $P < 0,001$	17,74 \pm 0,45 $P < 0,001$	25,18 \pm 0,56 $P > 0,4$	12,64 \pm 0,55 $P > 0,4$
Irradi- ated	185,76 \pm 7,05 $P > 0,2$	8,94 \pm 1,0 $P > 0,4$	38,46 \pm 0,99 $P < 0,001$	18,87 \pm 0,78 $P > 0,023$	22,36 \pm 0,71 $P = 0,002$	11,34 \pm 0,77 $P > 0,08$
Hypothy- roid and irradi- ated	221,73 \pm 7,34 $P < 0,001$	6,66 \pm 0,82 $P > 0,1$	39,12 \pm 0,75 $P < 0,001$	19,09 \pm 0,76 $P < 0,03$	25,72 \pm 0,66 $P > 0,4$	9,44 \pm 0,80 $P = 0,002$

yielded a significant ($P < 0,001$) increase in the glycoproteins associated with the α_1 -globulins, and it decreased those attached to the α_2 -globulin ($P > 0,02$) and to the β -globulin ($P = 0,002$) fraction. Bergstermann [10] indicated that glycoproteins associated with the albumin and γ -globulin fractions are decreased after irradiation; however, he did not present any information concerning the radiation dose or the length of time required for such changes to occur. The decrease we observed in the γ -globulin glycoprotein was not statistically significant.

According to some reports [2, 3] the fractional distribution of the serum glycoproteins is significantly altered in the state of thyroid hypofunction. Results of our investigations agree with these findings.

It should be emphasized that the glycoproteins in the α -globulin fraction are elevated in hypothyroidism because of an increase in the α_1 -glycoproteins [2, 3]; simultaneously there is a statistically significant fall in the α_2 -glycoprotein fraction ($P < 0,001$).

When the hypothyroid rats were irradiated, an increase in the α_1 -glycoproteins and decreases in the α_2 - and γ -glycoproteins were observed which were statistically significant in comparison with the normal controls. However, in comparison with the values obtained on hypothyroid (non-irradiated) animals, substantial differences were not found; the only exception to this was the fall in γ -globulins, which was statistically significant ($P < 0,001$) when comparing the hypothyroid irradiated animals with the hypothyroid non-irradiated subjects.

In summarizing these observations, it may be stated that total x-radiation has no effect on the total glycoproteins of the serum in normal or in hypothyroid rats; it has no effect on their electrophoretic distribution in the hypothyroid animals except in the γ -globulin fraction; it produces significant changes in intact animals with respect to the distribution of glycoproteins among the electrophoretic fractions of serum even in early stages of the development of radiation injury.

At present it is difficult to state what brings the changes about. Many workers attribute the increased concentration of glycoproteins in the serum to a disturbance of tissue mucopolysaccharide metabolism, and especially to a disordered metabolism of the neutral heteropolysaccharides derived from the tissues [11]. Elucidation of this question, perhaps, will be possible through further investigation of changes in the tissue content of glycoproteins.

SUMMARY

A significant increase of α_1 -glycoproteins and reduction of α_2 - and β -glycoproteins was observed after 88-90 h in intact rats subjected to total single irradiation in a dose of 600 r. The level of hexoses associated with proteins (anthronic reaction) remained unchanged.

The irradiation of hypothyroid animals had no influence on the content of hexoses associated with proteins and on the electrophoretic distribution of blood serum glycoproteins with the exception of the fraction of γ -glycoproteins whose level tends to decrease.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
