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The Minimum Dose of X-rays Able to Alter *in vivo* Intestinal Absorption of Glucose *

by

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In previous articles (6-9) the effect of X-radiation on the rat intestinal absorption of glucose was studied along with the good radioprotective action of cysteamine. After irradiation with 600 r the absorption diminished initially (at 2 to 8 hours), then increased (at 24 hours), and finally showed a progressive falling off until the end of the experiment (at 96 hours). We were interested in knowing the degree of radiosensitivity of the intestinal absorption of glucose during the 96 hours experimental period. With this gool in mind we ascertained the minimum dose of X-rays necessary to have some effect on the process of intestinal glucose absorption.

Material and Methods

The experiments were carried out on white rats employing the succesive absorption technique of SOLS and PONZ (10) and using the same materials and methods described in a previous publication (9). The absorption was observed at 8, 24 and 96 hours following the varied dose of irradiation on the whole rat body. As in former works (7, 9) the glucose concentration was 2.77mM; this implies a flux toward the blood in active transport conditions.

Results

From Table I it can be seen that a 50 r dose does not effect the glucose absorption during the experimental period. An increase in radiation to 100 r produces no statistically significant changes at 8 hours nor at 24 hours, but at 96 hours there is a definite increase in the active transport of glucose of about 45 %. For the sake of comparison the results at 600 r are also listed in Table I (9).

Cysteamine has shown itself an effective radioprotector for doses of 600 r. It was interesting to see if the same amount of cysteamine could eliminate the increase in

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TABLE I

Effect of total body irradiation on the active transport of glucose through the intestine of rat.
Glucose 2.77 mM with ClNa at 9 °/₀₀ (154 meq Na^+/l). Absorption time: 20 minutes. Irradiation on animal without anaesthesia.

N.° animals	Dose r	Post-Irrad. hours	Successive absorptions (μM/cm)			
			1st Abs.	2nd Abs.	3rd Abs.	4th Abs.
12	—	—	0.33 ± 0.04	0.33 ± 0.03	0.31 ± 0.07	0.32 ± 0.04
6	600	8	0.22 ± 0.01	0.22 ± 0.01	0.23 ± 0.02	0.24 ± 0.01
6	600	24	0.43 ± 0.02	0.45 ± 0.02	0.43 ± 0.01	0.44 ± 0.02
6	600	96	0.19 ± 0.02	0.18 ± 0.02	0.19 ± 0.02	0.18 ± 0.02
12	100	8	0.38 ± 0.01	0.38 ± 0.02	0.36 ± 0.02	0.36 ± 0.01
10	100	24	0.33 ± 0.02	0.32 ± 0.02	0.32 ± 0.03	0.31 ± 0.02
12	100	96	0.48 ± 0.02	0.48 ± 0.02	0.46 ± 0.03	0.47 ± 0.03
10	50	8	0.30 ± 0.02	0.30 ± 0.02	0.29 ± 0.02	0.29 ± 0.02
8	50	24	0.32 ± 0.01	0.31 ± 0.03	0.31 ± 0,01	0.31 ± 0.02
8	50	96	0.30 ± 0.02	0.30 ± 0.02	0.30 ± 0.01	0.29 ± 0.04

glucose absorption at 96 hours when 100 r were applied; this would provide an indirect proof that the increase was due precisely to radiation. Cysteamine administered intraperitoneally at 10 mg/100 g and 10 minutes before irradiation effectively eliminated any increase thereby showing a complete radioprotective effect (Table II). In these experiments the absorption of glucose was measured only at 8 and 96 hours after irradiation.

Discussion

The minimum dose of X-rays able to alter the intestinal absorption of sugars during the following 96 hours is between 50 and 100 r, revealing a notable radiosensitivity previously unknown. A dose of 50 r is already too low. Various other observations have manifested the effects of small quantities of irradiation on intestinal physiology (1-5).

TABLE II

Radioprotective effect of cysteamine. Intestinal absorption of glucose in total body irradiated rats (100 r).
Glucose 2.77 mM with NaCl at 9 °/₀₀ (154 meq Na^+/l). Absorption time: 20 minutes. Intraperitoneal cysteamine (10 mg/100 g), 10 minutes before irradiating. Irradiation on the animal without anaestesia.

N.° animals	Post-Irrad. hours	Successive absorptions (μM/cm)			
		1st Abs.	2nd Abs.	3rd Abs.	4th Abs.
6	—	0.32 ± 0.02	0.30 ± 0.03	0.33 ± 0.01	0.31 ± 0.03
8	8	0.30 ± 0.01	0.30 ± 0.02	0.30 ± 0.01	0.31 ± 0.03
8	96	0.30 ± 0.02	0.31 ± 0.02	0.32 ± 0.02	0.32 ± 0.02

With 100 r the effect at 96 hours is opposite that of 600 r at 96 hours, the former stimulating and the later inhibiting active transport. The stimulation observed with 100 r is similar to that seen with 600 r at 24 hours.

The increase in glucose absorption at 96 hours after 100 r is eliminated by the injection of cysteamine before irradiation. This confirms the radioprotective capacity of cysteamine with respect to changes in intestinal absorption already observed using larger doses (7, 9), and at the same time demonstrates that the increase in absorption is due precisely to effects of irradiation.

The results obtained at 24 hours after irradiation with 100 r aren't statistically significant. The faint increase in absorption observed at 8 hours has an insufficient probability. However the fact that the presence of cysteamine completely eliminates the increase suggests that it is really produced by the radiation.

Summary

The minimum dose of X-rays necessary to alter the intestinal absorption of glucose within 96 hours after irradiation is between 50 and 100 r. With 100 r absorption increases 45 % at 96 hours, white with 600 r at 96 hours there is a decrease of the same magnitude. Cysteamine is seen to be an effective radioprotector, eliminating the aforementioned increase in glucose absorption.

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