

EFFECT OF INHALATION OF THORON ON MITOTIC ACTIVITY IN THE KIDNEYS

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Inhalation of an air-thoron mixture for 2 h by rats leads to increased mitotic activity in the kidneys (48 h after inhalation), followed by a decrease (4-8 days after inhalation).

During work with radiothorium preparations in hospitals where α -ray therapy is given [9, 10, 14], during inhalation of air enriched with thoron for therapeutic purposes [16], during the working of radioactive deposits containing thorium, and also in factories where thorium ores and materials are processed [4, 5, 15], and so on, radioactive thoron gas (Rn^{220}) always enters the body to a certain extent via the respiratory passages. Breaking down there with a half-life of 54.5 sec, it gives rise to a series of fission products. These are isotopes of various chemical elements (ThA, a polonium isotope ^{216}Po ; ThB, a lead isotope ^{212}Pb ; ThC, a bismuth isotope ^{212}Bi , etc.), and they must therefore behave differently in the various organs and tissues of the living body.

The object of this investigation was to study the effect of inhalation of an air-thoron mixture on the mitotic activity of kidney cells in rats.

EXPERIMENTAL METHOD

Three series of experiments were carried out on 77 male albino rats whose mean weight was 200 g. The animals were kept in an inhalation chamber where they breathed air enriched with thoron. The thoron concentration in the air was kept constant ($2.5 \cdot 10^{-5}$ Ci/liter). The electrometer constant for thoron under these conditions was calculated by Baranov's formula [3]. The concentration of thoron fission products in the air was determined by the method of Andreev and Tadzhikov [2]. Its mean value was $1.28 \cdot 10^{-8}$ Ci/liter for ThB and $1.72 \cdot 10^{-11}$ Ci/liter for ThC.

In the experiments of series I the character of accumulation of ThB and ThC in the rats' kidneys was investigated in relation to the duration of inhalation. To do this, after inhalation for periods of 10, 20, 40, 60, 90, 120, 180, 240, and 300 min, the rats were immediately sacrificed by decapitation. The content of ThB and ThC in the kidneys at the moment of stopping inhalation was determined separately by Tadzhikov's method [8].

In the experiments of series II the behavior of the thoron fission products in the kidneys was studied at the end of inhalation for 2 h. Rats were sacrificed 0.5, 1, 2, 3.5, 4, 5, 6, 12, 16, and 24 h after inhalation, and, as in series I, the content of ThB and ThC per gram of renal parenchyma was determined separately.

The absorbed energy and dose of radiation were calculated on the basis of their relationship to the area below the curve of change in content of ThB and ThC per gram kidney tissue with time [1, 7, 8], the difference in energies of α -particles from ThC and ThC' [6], and also the difference in relative biological effectiveness of α - and β -particles and γ -quanta emitted by these isotopes. Calculations showed that during inhalation of the air-thoron mixture by a rat for 2 h, the absorbed dose received by the kidneys on account of Th (C + C') was 26.6 rem. The absorbed dose received by the kidneys on account of thoron can be calculated

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TABLE 1. Changes in Mitotic Activity of Epithelium of Convolted Tubules and Collecting Tubules of Rats' Kidneys after Inhalation of Air Enriched with Thoron

Series of experiments	Duration of inhalation (in h)	Time after end of inhalation (in days)	number of animals	Cortex			Medulla		
				Number of cells	No. of mitoses	MI (in ‰)	Number of cells	No. of mitoses	MI (in ‰)
Control 1 (C ₁)	—	—	5	60 957	35	0,57±0,03	40 513	13	0,31±0,05
Control 2 (C ₂)	2	2	4	49 272	20	0,40±0,04	30 805	9	0,28±0,04
I	2	2	4	48 887	44	0,89±0,10	32 497	21	0,63±0,09
II	2	4	5	65 111	33	0,51±0,04	42 579	21	0,44±0,10
III	2	8	3	36 335	13	0,37±0,06	25 296	8	0,32±0,09

on the assumption that its concentration in the kidneys is the same as in the blood, and that as with radon, it is 30% of the concentration in the inspired air [17, 18]. In an experiment lasting 2 h this dose is equal to 3.8 rem.

In the experiments of series III the effect of a single inhalation of air containing thoron for 2 h on mitotic activity of the kidneys (convoluted tubules of the cortex and collecting tubules of the medulla) was studied.

Since the study of the diurnal rhythm of mitosis in the rat kidney [11, 13] showed that the number of mitoses is greatest from 9 A. M. to noon, the experimental and control animals were sacrificed at noon, at different times after the end of inhalation.

The kidneys were fixed in 10% neutral formalin and embedded in paraffin wax. Sections were cut to a thickness of 6 μ and stained with hematoxylin-eosin.

The method of counting the number of cells and the number of mitoses in the various phases, and of calculating the mitotic index was described previously [13].

EXPERIMENTAL RESULTS

Data for the mitotic activity of epithelial cells of the renal tubules are given in Table 1. In control animals (C₂) inhaling pure air but kept, like the experimental animals, fixed in the chamber, the mitotic activity of the cortical cells was rather lower than that in control rats (C₁) taken directly from the animal house. This difference is statistically significant ($P < 0.02$).

In the experimental animals which inhaled thoron for 2 h, well defined stimulation of mitotic activity in the epithelium of the convoluted tubules was observed 48 h after the end of exposure. It was increased to twice the level in the C₂ rats and to 1.5 times the level in the C₁ rats. The difference is significant ($P < 0.02$) in the first case but not significant ($P > 0.05$) in the second.

In the later stages after exposure, mitotic activity in the convoluted tubules at first (4 days) returned to normal, but later (8 days) it was depressed. The decrease in the number of dividing cells from the 2nd to the 4th and 8th days is statistically significant (in both cases $P < 0.05$).

Table 1 also shows that in the control animals (C₁ and C₂) mitotic activity of the epithelial cells of the medullary collecting tubules was generally lower than in the convoluted tubules. A similar picture was observed previously [12]. Mitotic activity of the epithelium of the collecting tubules was increased 48 h after inhalation of thoron for 2 h.

Comparison of the mitotic activity of the epithelium of the collecting tubules in the C₂ animals with that in the experimental animals shows that after 48 h the latter was 2.2 times higher. The differences between the numerical data are statistically significant ($P < 0.05$). The increase in mitotic activity was temporary, and was followed by a gradual decrease. Four days after inhalation of thoron the mitotic activity was 1.5 times higher than in the control, but on the 8th day it had returned to normal.

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