COMPARED DEPOSITION OF RADON-222 AND RADON-22O (THORON) PROGENY AND NUCLEAR ABERRATIONS IN THE RESPIRATORY TRACT OF RATS AFTER EXPOSURE UNDER DIFFERENT AEROSOL CONDITIONS.

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INTRODUCTION

The inhalation of airborne short-lived radon decay products occured from the two main isotopic forms of radon, ^{222}Rn and ^{220}Rn (thoron), which are ubiquitous in the human environment and contributed to the greatest part of the natural radiation exposure. The laboratory rat has been particularly used to estimate the hazard to human health following exposures to radon and progeny (1). These data on lung cancer risk in rats are consistent with the epidemiological findings for uranium miners in all exposure categories considered and in typical aerosol characteristics, so that the exposure-dose conversion factor estimated by lung modelling are comparable in the two species (2). It has been shown that measurements of deposition of ^{214}Pb in excised lungs and nuclear aberrations in alveolar macrophages allow us to estimate the dose delivered to the deep lung after radon progeny inhalation (3). In contrast, experimental data for thoron and thoron progeny are quite limited. The aim of this study was to develop an experimental device suitable for the exposure of few rats to thoron, - to measure the deposition of thoron progeny within the excised lung of rats by gamma spectrometry of ^{212}Pb and to compare this deposition for a similar cumulative exposure with the incidence of micronuclei and binucleated alveolar macrophages observed after radon progeny inhalation in well characterized atmospheres.

EXPERIMENTAL METHODS

An available and convenient source of thoron gas is ^{228}Th, involatile at room temperature, which decays rapidly via thoron gas in ^{216}Po and ^{212}Pb. It is possible to increase dramatically the rate of emanation by heating. Such a small experimental design was performed for nose-only animal exposures (Algade-Cogéma, France). It consists in a small glass volume (15 liters) in which the heated generator was previously located and where the rats were restrained in specially designed tubes so that only the noses of the animals protruded into the chamber. Due to its very short half-live, ^{216}Po is in equilibrium with thoron so that the activities are comparable. A smoke aerosol was introduced to allow the attachment of ^{212}Pb and limit its plate-out on surfaces. Six rats were exposed in a single session to thoron and progeny for 3 hours under these experimental conditions.

Two animals were euthanazied to determine the gross deposition in the excised lungs by gamma spectrometry of the emission of ^{212}Pb at 239 keV. The retention of ^{212}Pb was measured within an annulus shaped NaI detector (Crismatec, France). All these measurements were performed according to the recommendations decided between the European laboratories involved in animal studies on radon (4).

Two of the remaining rats were euthanazied 6 days after thoron exposure and the two last ones, 12 days after the end of thoron exposure. Micronuclei and binucleated cells were scored in alveolar macrophages extracted by bronchoalveolar lavage, 8 days after exposure. Cytospins of cell suspension were air-dried, fixed in ethanol-ether (1/1 v) and stained with Giemsa before light microscopic observation.

RESULTS AND DISCUSSION

Table 1 shows the inhalation parameters measured in exposure chambers and lead deposition measured in excised lungs of thoron exposed rats compared to those previously measured in rats exposed to radon (^{222}Rn) in the inhalation facility of Razès under different aerosol atmospheres and using a quite similar potential alpha energy concentration (PAEC).

Table 1. Inhalation parameters of radon and thoron exposures and Pb retention in the deep lung of rats under different conditions and for a similar potential alpha energy concentration (PAEC).

RADON INHALATIONS			THORON INHALATION	
Aerosol parameters	High equilibrium	Low equilibrium	Aerosol parameters	High equilibrium
^{222}Rn activity	4632 kBq/m3	9925 kBq/m3	^{220}Rn activity	1268 kBq/m3
^{218}Po activity	2408 kBq/m3	7146 kBq/m3	^{216}Po activity	1100 kBq/m3
^{214}Pb activity	1713 kBq/m3	1488 kBq/m3	^{212}Pb activity	330 kBq/m3
^{214}Bi activity	1667 kBq/m3	397 kBq/m3	^{212}Bi activity	< 1 kBq/m3
Equilibrium factor	0.36	0.16	Equilibrium factor	0.30
PAEC	9.3 mJ/m3 450 WL	8.9 mJ/m3 429 WL	PAEC	15 mJ/m3 720 WL
Cumulative dose (after 3 hours)	27.9 mJ/m3.h 7.9 WLM	26.7 mJ/m3.h 7.5 WLM	Cumulative dose (after 3 hours)	43 mJ/m3.h 12 WLM
^{214}Pb activity in 3 excised lungs	5.0 ± 2.9 kBq/g	5.3 ± 3.2 kBq/g	^{212}Pb activity in 2 excised lungs	0.36± 0.2 kBq/g

Table 2 shows the percentage of micronucleated and binucleated alveolar macrophages recovered from the rats exposed to radon and euthanazied 8 days later. The controls corresponded to 5 unexposed rats killed at the same age.

Table 2. Percentage of micronucleated and binucleated alveolar macrophages (AM) one week after radon and thoron exposures (mean value ± SD).

	% of micronucleated AM	% of multinucleated AM
Controls	0.19 ± 0.10	1.34 ± 0.69
radon at high equilibrium	1.22 ± 0.26	2.91 ± 0.74
radon at low equilibrium	1.47 ± 0.42	2.30 ± 0.78
thoron at high equilibrium	0.59 ± 0.06	2.64 ± 0.98

If the micronuclei index is similar for radon inhalations under different aerosol characteristics, the number of micronuclei after thoron is lower as regards the level of concentration but higher than that found spontaneously in unexposed rats. However it is now possible to expose rats to an aerosol mixture of thoron and progeny inducing an increased incidence of alveolar cell nuclei aberrations. Further studies are still in progress to improve the measurements of the aerosol characteristics, thoron progeny deposition and dose distribution compared with radon progeny exposures.

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