FOLLOW UP MEASUREMENTS OF ^{131}I THYROID ACTIVITY IN 54 GERMAN CHILDREN AFTER THE CHERNOBYL ACCIDENT

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INTRODUCTION

In the first days after the Chernobyl accident the uptake of ^{131}I was a primary matter of concern with respect to the internal radiation exposure. In the body, nearly all iodine is stored in the thyroid. Especially in children the incorporation of radioisotopes of iodine may result in high organ doses, because of the small thyroid masses.

The thyroid dose can only roughly be estimated from a single measurement of the thyroid activity or from the activity in the air or in foodstuffs. The accurate calculation of the dose, however, requires follow up measurements of the time course of the ^{131}I activity during the whole period of incorporation. In order to get detailed information on the radiation dose to the thyroid in Germany after the Chernobyl accident, the time course of ^{131}I activity was measured in 54 children during May and June 1986 and the individual organ doses were calculated.

SUBJECTS AND METHODS

In 53 healthy children (29 boys, 24 girls; age: 1 - 16 years) and in an eight years old girl with a hyperfunction of the thyroid gland, the time course of the ^{131}I activity in the thyroid was followed by up to 6 measurements performed in May and June 1986. The counting time ranged between 1 and 5 minutes. A 3" by 3" NaI(Tl)-crystal in a lead shielding was applied as thyroid monitor. The distance between the crystal and the neck surface is fixed by an adjustment device to 12.5 cm. A multichannel pulse height analyzer was applied for the spectrum collection. The count rate in the energy window from 0.31 to 0.41 MeV was used as a measure of ^{131}I activity. The transformation of the obtained count rates into activity requires a careful calibration of the system with several thyroid phantoms (1). These measurements showed that the volume of the thyroid has only little influence on the counting efficiency, but there is a strong dependence of the measured count rate on the distance from the detector to the thyroid. The calibration factor which was used to calculate the ^{131}I activity in the thyroid of children corresponds to a thickness of the tissue over the thyroid of 10 mm (2). After the decay of ^{131}I the individual background count rates were measured. Net count rates were converted into thyroid activities A_T and individual retention functions $A_T(t)$ were evaluated to calculate the cumulated activity $\tilde{A}_T$ in the thyroid:

$$\tilde{A}_T = \int_0^\infty A_T(t)\, dt$$

It was assumed that the earliest uptake of ^{131}I in the thyroid was on the 3rd of May, because no or only very low ^{131}I activity was measured in four adults on the 2nd of May 1986 (1). The thyroid dose D_T is calculated from

$$D_T = \frac{\tilde{A}_T}{m_T} \left(\bar{E}_\beta + a(m_T,E)\, \bar{E}_X + b(m_T,E)\, \bar{E}_\gamma \right)$$

with: m_T: mass of the thyroid

$\bar{E}_\beta$: mean emitted energy of ß-particles per decay

$\bar{E}_X$: mean emitted energy of X-rays per decay

$\bar{E}_\gamma$: mean emitted energy of gammarays per decay

a,b: absorbed fractions of photon energy

Absorbed fractions of the photon energy were determined from values published in MIRD-Pamphlet No 8 (3). In 31 children the thyroid volumes were determined sonographically, for all other children the values were interpolated corresponding to their age.

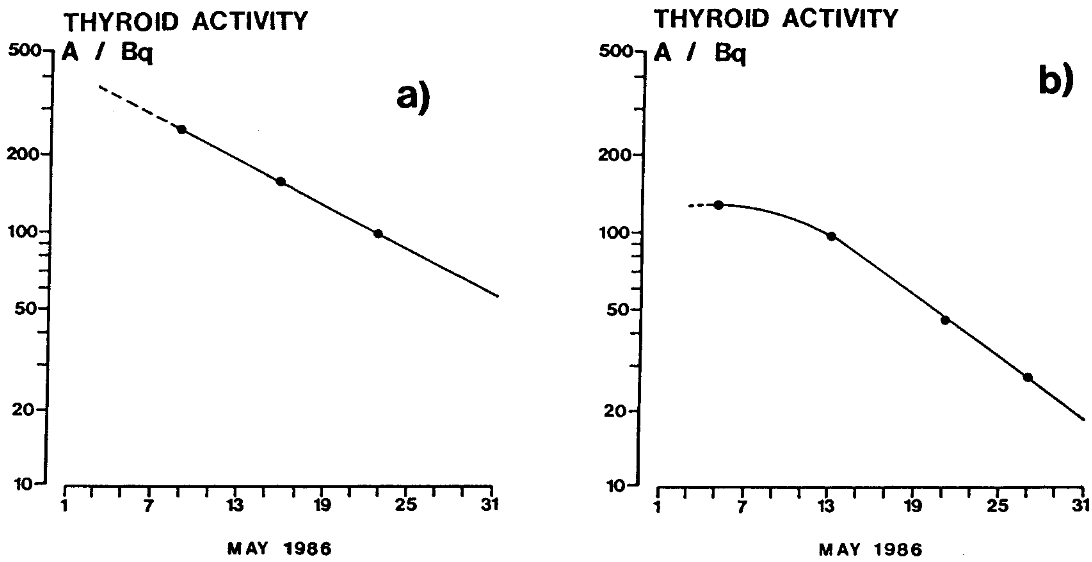

Figure 1: Time courses of ^{131}I thyroid activity in an 11 years old boy (a) and in a 5 years old girl (b)

RESULTS AND DISCUSSION

As examples, the figure 1 shows the time courses of ^{131}I thyroid activity of an 11 years old boy and of a five years old girl. For the calculation of the cumulated activity this time course could mostly be described as a monoexponential function. In those cases where no monoexponential decrease was observed, $\tilde{A}_T$ was determined by linear interpolation of the activity values. Since in the Rhein-Main-region it was not raining before May, 5th, most of the radioactive iodine was inhaled during the first days in May. But part of the ^{131}I must have been ingested, because the half life of the monoexponential decrease of the activity was higher than the physical half life time of ^{131}I.

The sonographically determined thyroid volumes ranged between 2 and 21 ml. Values of the calculated doses are given in figure 2. Radiation doses to the thyroid were between 0.3 and 2.1 mSv. According to the age dependent thyroid volumes, a decrease

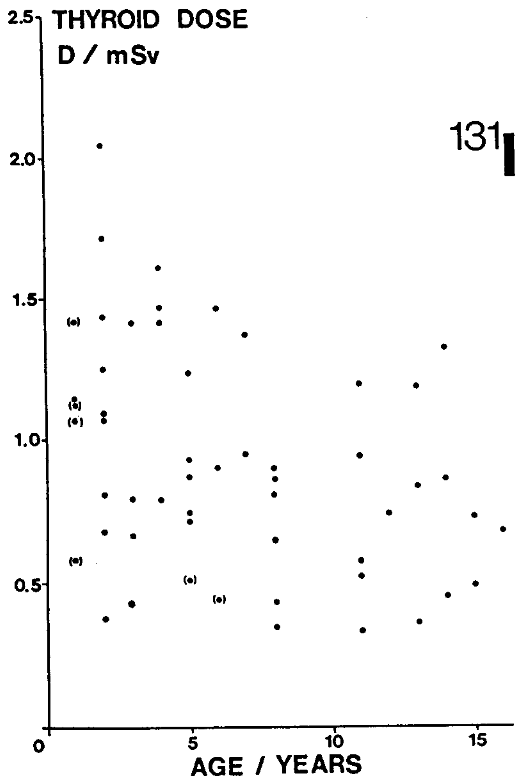

Figure 2: Thyroid doses in 54 German children

of the thyroid dose with increasing age was observed. The girl with the hyperfunction of the thyroid showed no deviation in thyroid activity and dose from the other children of comparable age.

These values are representative for nearly all parts of Germany except Southern Bavaria. For that region higher values have been reported (4). Thyroid doses can be assumed to increase to the south east corner of Germany (Berchtesgaden), corresponding to the higher fallout and washout. Nevertheless these data show that even about 1500 km from the site of the accident significant thyroid doses due to radioactive iodine were observed.

LITERATURE

1. Ch. Hansen, P. Roth, E. Werner
   Verlauf der ^{131}I-Aktivität in der Schilddrüse bei Erwachsenen und Kindern aus dem Rhein-Main-Gebiet nach dem Reaktorunglück in Tschernobyl
   7. Fachgespräch zur Überwachung der Umweltradioaktivität, 16.-17.11.1987, Neuherberg

2. W.S. Snyder (Chairman)
   Report of the Task Group on Reference Man
   ICRP Publication 23, Pergamon Press, New York, 1975

3. W.H. Ellett, R.H. Humes
   Absorbed fractions for small volumes containing photon-emitting radioactivity
   MIRD Suppl. No 5, Pamphlet No 8 , J. Nucl. Med. 12, 1971

4. H. Schmier
   Ganzkörpermessungen an ausgewählten Personengruppen
   GSF Mensch + Umwelt, Radioaktivität und Strahlenfolgen, 1986