RENAL THORIUM AND URANIUM EXCRETION IN NON-EXPOSED SUBJECTS: INFLUENCE OF AGE AND GENDER

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1. Introduction

Monitoring for occupational incorporation of ²³⁸U and ²³²Th is usually carried out by urinary excretion analysis. The interpretation of a measured value of a worker requires the knowledge of the natural uranium and/or thorium excretion and its dependence e.g. on age, gender and residential area. Up to now, these factors are not satisfactorily known since the commonly used analytical methods such as alpha ray spectrometry are hardly useful to investigate non-exposed subjects (Dang et al. 1992).

Inductively coupled plasma mass spectrometry (ICP-MS) provides a tool for rapid measurement of very low concentrations of uranium and thorium in biological fluids (Gladney et al. 1989, Allain et al. 1991, Karpas et al. 1996, Schramel et al. 1997). This technique enables studies even on larger groups of non-exposed subjects since the measurements can be carried out on unprocessed urine.

The present study was aimed at the assessment of the variation of renal ²³⁸U and ²³²Th excretion with age and gender in non-exposed subjects.

2. Subjects and methods

A total of 63 healthy volunteers were included in the study. Of these, 33 were females (mean age 43 ± 21 years (mean ± SD), range 11 to 84 years) and 30 males (mean age 41 ± 18 years, range 7 to 73 years). None of them had a history of previous occupational exposure to uranium or thorium. Subjects were asked to collect total urine for 24 hours under normal living habits in polyethylene bottles.

After addition of 50 ml. l⁻¹ conc. nitric acid (subboiling distilled) the urine was kept at 4°C until measurement by ICP-MS (ELAN 5000, Perkin-Elmer, Sciex). The method has been described in detail elsewhere (Schramel et al. 1997). The quality criteria (precision as well as detection limits) are summarised in Table 1. In a total of 15 samples data of urinary ²³⁸U concentration obtained by ICP-MS were intraindividually compared to results of conventional alpha spectrometric analysis (Fig. 1). In general a good agreement was obtained but part of the uranium concentrations were below the detection limits of the alpha spectrometry.

3. Results

The ²³²Th excretion in urine in relation to the age is shown in Fig. 2. The geometric mean of all 63 subjects investigated is 34 μBq.day⁻¹ (SD 1.90). For the 33 females it is 30 μBq.day⁻¹ (SD 1.78) and for the 30 males 40 μBq.day⁻¹ (SD 2.01). The difference between males and females is statistically not
significant. There is some increase in 232-Th excretion with age. But assuming a linear relationship, the correlation coefficient (r = 0.19) is statistically not significant (p > 0.05).

**Table 1. Precision and detection limits (3 SD of background signal) for measurement of 232-Th and 238-U in urine by ICP-MS**

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Detection limit μBq. l⁻¹</th>
<th>Precision</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>same day</td>
</tr>
<tr>
<td>232-Th</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>238-U</td>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>

The 238-U excretion in urine in relation to the age is shown in Fig. 3. The geometric mean of all subjects is 237 μBq.day⁻¹ (SD 2.50). For the 33 females it is 200 μBq.day⁻¹ (SD 2.81) and for the 30 males 287 μBq.day⁻¹ (SD 2.09). The difference between males and females is statistically not significant. 238-U excretion increases with age although even at ages above 60 years low values are obtained. Assuming a linear relationship, the correlation coefficient of r = 0.35 is statistically significant (p < 0.01).

**Fig. 2. Relationship between data of daily urinary excretion of 232-Th and age in non-exposed subjects**

**Fig. 3. Relationship between data of daily urinary excretion of 238-U and age in non-exposed subjects**

In two of the subjects, 232-Th excretion and 238-U excretion were followed for up to 17 consecutive days (Fig. 4 and Fig. 5). There is a remarkably high day-to-day fluctuation both for thorium and uranium. But, whereas the mean values for thorium are quite congruent there is a significant deviation in the uranium excretion.

**4. Conclusions**

ICP-MS provides a tool for rapid and sensitive determination of long-lived radioisotopes in biological materials. Especially, measurements of 232-Th and 238-U in urine may be carried out on unprocessed samples of a few ml with low detection limit but high precision and accuracy. Therefore, ICP-MS can be considered as an alternative technique for routine monitoring of workers regarding excretion analysis of long-lived radionuclides.

Data obtained in this study for 238-U excretion in urine of non-exposed subjects are somewhat less than those given in ICRP-Publication No. 23 for the reference man (600 to 6,000 μBq.day⁻¹) but they are in quite good agreement with more recent results of Dang et al. (1992).
Fig. 4. Day-to-day variations in urinary excretion of $^{232}$Th in two male non-exposed subjects (52 and 55 years) for a period of up to 17 days.

Fig. 5. Day-to-day variations in urinary excretion of $^{238}$U in two male non-exposed subjects (52 and 55 years) for a period of up to 17 days.

5. References

- E. S. Gladney, W. D. Moss, M. A. Gautier, M. G. Bell, Health Phys. 57 (1989) 171
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