DECORPORATION OF ^{241}Am AND ^{252}Cf BY Ca-DTPA FROM RAT, SYRIAN AND CHINESE HAMSTER

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1. INTRODUCTION

Considerable differences have been observed between animal species with regard to the retention of transuranium elements in the liver: They are retained with a very long biological half-life by Syrian and Chinese hamster (1), dog and man, whereas in rats, the most widely used laboratory animal for decorporation studies, an exceptionally rapid natural excretion from the liver takes place (references see 2) together with a very good mobilization of radionuclides by chelating agents. Our study deals with the question of the degree at which the results obtained with rats can be extrapolated to other animal species. In this respect, only few data exist (e.g. 3).

2. METHODS

Animals were 12 - 15 weeks old female rats (Heiligenberg strain, 175 - 205 g), Syrian hamsters (80 - 105 g) and Chinese hamsters (25 - 30 g). They were injected intraperitoneally with monomeric ^{241}Am- or ^{252}Cf-citrate. A single intraperitoneal injection of Ca-DTPA (diethylenetriaminepentaacetate) was administered 24 hours after the radionuclides; the chelate dosage is indicated in Table 1 and Figure 1. These animals were sacrificed 8 days after radionuclide administration. Repeated Ca-DTPA injections (30 $\mu mol \cdot kg^{-1}$ intraperitoneally) were given on the 4., 11., 18....... 81. day after ^{252}Cf injection and the animals were sacrificed on the 88. day. The radionuclides in the organs were assayed by liquid scintillation counting (4) and calculation of skeleton radioactivity by multiplying by 20, 23 and 34 the radioactivity in one femur of rats, Syrian and Chinese hamsters, respectively (5).

3. RESULTS

Deposition of ^{241}Am and ^{252}Cf in control animals on the 8. day and of ^{252}Cf on the 88. day can be seen in Tables 1 and 2; for comparison, deposition of ^{241}Am has also been determined in control animals on the 71. day: In skeleton, it amounts to 18, 30 and 19 % of the dose and in the liver to 2, 27 and 39 % for rats, Syrian and Chinese hamsters, respectively. Both radionuclides are retained in the skeleton with a long biological half-life with only minor differences between animal species, whereas in the liver the species differences already mentioned can be seen.

With few exceptions, more ^{252}Cf than ^{241}Am can be mobilized by DTPA (Table 1). The removal of both radionuclides from the skeleton is somewhat lower in Chinese hamster as compared to rats and Syrian hamsters. In the liver, the DTPA effectiveness is virtually the same for rats and Chinese hamsters but lower for Syrian hamsters (Table 1), though both hamster species behave similarly as far as radionuclide retention is concerned. The more detailed study of the dose effect

Species	Radio-nuclide	Chelate dose (µmol·kg^{-1})	Skeleton	n	Liver	n
Rat	^{241}Am	0	22.5 ± 1.1	7	40.4 ± 2.0	7
		30	18.0 ± 0.6 (80)	8	22.8 ± 3.5 (56)	8
		0	22.8 ± 0.9	7	35.3 ± 0.8	7
		1000	14.3 ± 0.7 (63)	7	3.8 ± 0.3 (11)	6
	^{252}Cf	0	43.5 ± 0.9	11	11.1 ± 0.5	11
		30	30.2 ± 0.8 (69)	4	3.7 ± 0.2 (33)	4
		1000	25.9 ± 0.6 (60)	6	1.7 ± 0.1 (15)	6
Syrian hamster	^{241}Am	0	32.4 ± 1.1	5	34.4 ± 1.2	6
		30	23.4 ± 1.0 (72)	8	24.7 ± 2.2 (72)	8
		0	26.6 ± 1.1	8	33.2 ± 2.2	7
		1000	19.9 ± 1.2 (75)	8	12.0 ± 2.2 (36)	8
	^{252}Cf	0	39.5 ± 1.2	9	9.8 ± 0.4	9
		30	27.4 ± 3.1 (69)	6	5.5 ± 0.7 (56)	6
		1000	23.7 ± 1.1 (60)	10	2.8 ± 0.6 (29)	10
Chinese hamster	^{241}Am	0	26.2 ± 1.2	6	38.4 ± 1.7	6
		30	24.5 ± 1.7 (94)	7	19.3 ± 1.3 (50)	7
		0	20.6 ± 2.0	5	35.8 ± 3.6	5
		1000	15.8 ± 1.3 (77)	6	5.8 ± 1.1 (16)	6
	^{252}Cf	0	29.1 ± 0.7	5	11.4 ± 1.5	5
		30	24.0 ± 1.1 (82)	6	3.9 ± 0.2 (34)	5
		1000	19.0 ± 0.03 (65)	6	1.7 ± 0.1 (15)	6

TABLE 1 Removal of ^{241}Am and ^{252}Cf from rodents by Ca-DTPA, injected 24 hours after radionuclides. Values in % of radionuclide dose, those in brackets represent % of control. Arithmetic means ± S.E.; n = number of animals per group, sacrificed 8 days after radionuclide injection.

Species	Skeleton 0.9 % NaCl	Skeleton Ca-DTPA	Liver 0.9 % NaCl	Liver Ca-DTPA
Rat	41.1 ± 1.3	20.9 ± 0.6 (51)	1.89±0.13	0.36±0.03 (19)
Syrian hamster	40.7 ± 1.7	23.7 ± 0.6 (58)	7.70±0.97	2.28±0.35 (30)
Chinese hamster	31.1 ± 0.9	16.4 ± 0.8 (53)	12.54±0.94	0.68±0.09 (5)

TABLE 2 Removal of ^{252}Cf from rodents by 12 Ca-DTPA doses (30 µmol·kg^{-1} on the 4., 11....81. day). Values in % of radionuclide dose, those in brackets represent % of control. Arithmetic means ± S.E., 5 - 8 animals per group, sacrificed 88 days after ^{252}Cf injection.

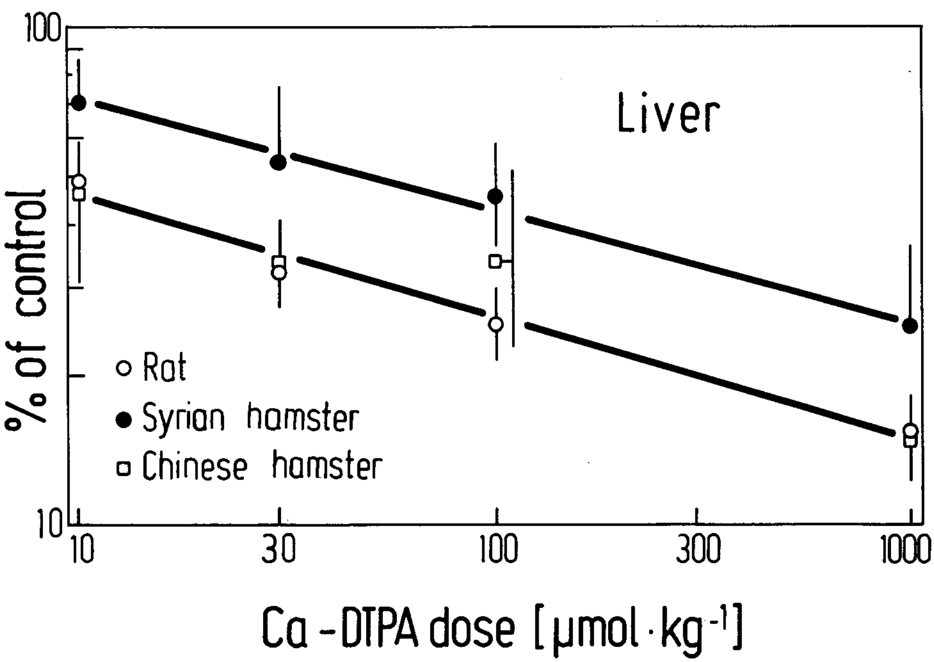

FIG. 1 Removal of ^{252}Cf from rodent liver by Ca-DTPA, injected 24 hours after ^{252}Cf. Geometric means with fiducial limits (P = 0.05), on the average 7 animals per group, sacrificed 8 days after ^{252}Cf.

function for the removal of ^{252}Cf confirms (Figure 1) that the response of rat and Chinese hamster liver is identical, whereas about ten times more DTPA must be administered in order to remove the same fraction of ^{252}Cf from Syrian hamster liver. It should be noted that in all species the dose effect functions are linear on the double-logarithmic scale and that their slopes are identical. There are only negligible species differences with regard to the removal of ^{252}Cf from skeleton by chronic DTPA administration (Table 2). However, the mobilization of ^{252}Cf from Chinese hamster liver is even higher than from rat liver.

4. DISCUSSION

Our data indicate that results of decorporation studies with rats can also be valid for other animal species. This holds for the skeleton and, which is surprising, also for the liver. In spite of the considerable differences between the rat and Chinese hamster with regard to the biological half-life of ^{241}Am and ^{252}Cf in the liver, the effectiveness of a single DTPA administration is the same in both animal species. As far as the dose effect function for the removal of ^{252}Cf from Syrian hamster liver is concerned, it is at least linear to that for rats and parallel to the latter on a double logarithmic scale. It might have been expected that radionuclide mobilization is especially easy from an organ with a rapid natural radionuclide excretion like rat liver; the results after chronic DTPA administration show, however, that the ^{252}Cf fraction, which can be mobilized from Chinese hamster liver is even higher than that from rat liver. Obviously, the assumption of an inverse proportionality between the biological half-life of a radionuclide in an organ and the degree of its mobilization by DTPA cannot be generalized. Almost complete removal of ^{241}Am by chronic DTPA administration has also been achieved from dog liver (3). Since the liver is one of the critical organs after incorporation of actinides, these and our findings support the usefulness of chronic DTPA treatment.

REFERENCES

(1) BROOKS, A.L., MEAD, D.K., PETERS, R.F., Lovelace Foundation Report LF-46 p. 240, Albuquerque (1973)
(2) ICRP Publication Nr. 19, Pergamon Press, Oxford (1972)
(3) LLOYD, R.D., McFARLAND, S.S., TAYLOR, G.N., WILLIAMS, J.L., MAYS, C.W., Radiat. Res. 62 (1975) 97
(4) SEIDEL, A., VOLF, V., Int. J. Appl. Radiat. Isotopes 23 (1972) 1
(5) SEIDEL, A., submitted for publication in Health. Phys.