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TIME DEPENDENT DISTRIBUTION, ACCUMULATION AND LOSS OF LEAD-210 IN VARIOUS ORGANS OF RATS*

T. ENGIZEK

University of Istanbul, Faculty of Science, Radiobiology Department, Istanbul

ABSTRACT

The hard tissues (bones, especially the part between proximal end of femur and anterior intertrochanter line, tooth, etc.) were found to accumulate Pb-210 the most, soft tissues (brain, tongue, and etc.) the least. The biological half-life of Pb-210 was found to be the longest in the part between proximal end of femur and anterior intertrochanter line, and the shortest in the liver. The tooth and tail retained Pb-210 constantly independent of time.

ÖZET

Pb-210 en fazla sert dokular (kemikler, özellikle femurun proximal ucu ile anterior intertrochanter çizgisi arasındaki kısım, diş v.b.) en az ise yumuşak dokularda (beyin, dil v.b.) birikmiştir. Pb-210'un biyolojik yarı-ömrü, femurun proximal ucu ile anterior intertrochanter çizgisi arasındaki kısımda en uzun, karaciğerde ise en kısa olarak bulunmuştur. Diş ve kuyruk Pb-210 miktarını zamana bağlı olmaksızın sabit tutmuşlardır.

INTRODUCTION

The lead which is a heavy metal, and one of the trace elements, plays an important role in environmental pollution.

Since lead may play an effective role in the function of cell organelles /1/, of the organs /2/ and of the hereditary materials /3/, in the regulation of protein, RNA and DNA amount in the brain /4/, in the development of the animal behaviour and intelligence /5/, in the ebmryonal development /6/, in the environmental pollution /7/, and in toxicity of food, it has been a point of interest for biologist, physicians, agriculturists and veterinarians.

Pb-210 used in the experiments was in sterile lead nitrate form provided from "The Radiochemical Centre, Amersham" having a specific activity of 21-60 mCi/mg.

Albino rats, whose average weights ranged from 40-50 grams, were injected 0.05 cc 30 μCi lead nitrate once subcutaneously.

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After injection, for 5 weeks duration of time, at the end of each week, one group of rats were sacrificed, their organs were removed and kept under laboratory conditions about 48 hours to reach a specific balanced humidity.

The relative lead concentration and the affinity coefficients to lead were obtained from the equation,

$$a_i = A_i/\Sigma A_i/n = nA_i/\Sigma A_i$$

in the equation,

a_i = Relative lead concentration of an organ,
A_i = Activity per gram of an organ,
$A_i/\Sigma A_i$ = The affinity coefficient of an organ to lead,
n = Number of organs used in the experiment.

In the living animal, "the correction factor" was calculated from the biological half-life graph by considering the per cent of activity to the initial Pb-210 activity administered and detected randomly.

RESULTS

We can summarise the results obtained from our experiments as follows (Table-1);

1. During the experimental period, the hard tissues (such as femur, especially the part between proximal end of femur and intertrochanter line, thinnest part of femur and the tooth) accumulated Pb-210 significant more in comparison to the soft tissues (such as tongue, heart and the brain).

2. In the thinnest part of femur and in the biceps brachii, activity of Pb-210 increased continuously.

3. The tooth and the tail retained Pb-210 almost at the same level, which is accumulated independently of time.

4. Organs such as the kidney and the stomach accumulated high amounts of the Pb-210 in a very short time and then the amount of Pb-210 decreases in a regular way.

5. The biological half-life of Pb-210 was found to be the longest in the part of the femur, between its proximal end and its anterior intertrochanter line (61.3 ± 14.0 days) and the shortest in the liver (3.7 ± 0.1 days) (Table-2).

6. Thinnest part of femur in 50.8 ± 22.7 days and biceps brachii in 21.0 ± 7.1 days double the initial amount of Pb-210 they contained (Table-2).

7. The biological half-life of Pb-210 in the living rat body was found to be 60.0 ± 5.9 days (Fig. 1).

In some types of organs such as skin, brain, spleen and blood, that showed marked differences in the amount of Pb-210 they contain, it was impossible to detect any biological half-life during the whole experimental period (Table-2).

TABLE-1. The affinity coefficients of lead-210's in different proportions depending on time

Dissection period	1 week	2 weeks	3 weeks	4 weeks	5 weeks
Individual number	21	8	9	10	7
Correction factor	7.4	6.8	6.2	5.7	5.3
Organs	Af.Co.(3)	Af.Co.	Af.Co.	Af.Co.	Af.Co.
1. Femur (1)	1879 ± 6.7(4)	1645 ± 26.2	1173 ± 32.6	1458 ± 9.2	1327 ± 12.9
2. Femur (2)	1074 ± 7.5	1977 ± 29.6	1695 ± 34.2	1841 ± 11.2	1413 ± 14.0
3. Tooth	933 ± 9.5	1769 ± 63.7	1784 ± 40.7	1478 ± 10.4	938 ± 11.1
4. Tail	221 ± 2.1	283 ± 4.4	171 ± 7.2	239 ± 1.5	233 ± 1.9
5. Kidney	747 ± 2.7	440 ± 18.0	236 ± 30.0	191 ± 2.1	119 ± 0.3
6. Biceps femoris	100 ± 3.4	203 ± 11.6	128 ± 14.4	103 ± 2.1	46 ± 2.4
7. Biceps brachii	30 ± 5.7	29 ± 22.0	85 ± 29.4	26 ± 4.7	105 ± 6.6
8. Pectoralis	212 ± 4.7	25 ± 13.2	83 ± 26.6	42 ± 2.6	117 ± 4.8
9. Tongue	30 ± 3.8	29 ± 26.9	69 ± 34.4	26 ± 6.2	16 ± 8.1
10. Heart	31 ± 2.5	16 ± 9.0	37 ± 12.4	17 ± 2.6	16 ± 4.7
11. Blood	1200 ± 14.4	106 ± 8.3	79 ± 13.6	54 ± 5.5	742 ± 10.0
12. Stomach	138 ± 1.1	26 ± 2.3	23 ± 12.4	9 ± 0.9	7 ± 1.6
13. Small intestine	119 ± 3.0	8 ± 10.3	63 ± 13.6	18 ± 1.9	7 ± 1.6
14. Large intestine	192 ± 6.2	73 ± 7.8	53 ± 42.4	35 ± 0.6	26 ± 1.3
15. Liver	141 ± 1.0	49 ± 2.4	34 ± 3.3	12 ± 0.6	10 ± 0.5
16. Spleen	178 ± 8.1	63 ± 30.2	246 ± 34.0	91 ± 15.2	108 ± 16.5
17. Skin	95 ± 1.2	12 ± 4.1	91 ± 6.4	29 ± 0.9	21 ± 1.6
18. Lung	66 ± 4.7	34 ± 16.6	70 ± 24.9	17 ± 3.6	32 ± 5.2
19. Brain	181 ± 2.0	14 ± 8.8	83 ± 16.7	17 ± 1.9	16 ± 2.6

(1) The part between femur's proximal end and anterior intertrochanter line.
(2) Thinnest part of femur.
(3) Affinity coefficient.
(4) Standart error.

TABLE-2. The biological half-life of lead-210 in various organs and it's accumulation's doubling time.

Half-life Organs	T_b(1) (days)	T(2) (days)
1. Femur	61.3 ± 14.0(5)	(6)
2. Femur	——	(7)50.8 ± 22.7
3. Tooth	∞(3)	——
4. Tail	∞	∞
5. Kidney	11.9 ± 0.4	——
6. Biceps femoris	N.D(4)	N.D
7. Biceps brachii	——	21.0 ± 7.1
8. Pectoralis	N.D	N.D
9. Tongue	N.D	N.D
10. Heart	7.0 ± 1.4	——
11. Blood	N.D	N.D
12. Stomach	7.5 ± 0.6	——
13. Small intestine	10.2 ± 3.0	——
14. Large intestine	11.4 ± 0.9	——
15. Liver	3.7 ± 0.1	——
16. Spleen	N.D	N.D
17. Skin	N.D	N.D
18. Lung	18.0 ± 4.6	——
19. Brain	N.D	N.D

(1) Biological half-life.
(2) Doubling time of lead-210's accumulation.
(3) The organs where the amount of lead-210 remain fixed independent of time.
(4) Not determined.
(5) Standart error.
(6) The part between femur's proximal end and anterior intertrochanter line.
(7) Thinnest part of femur.

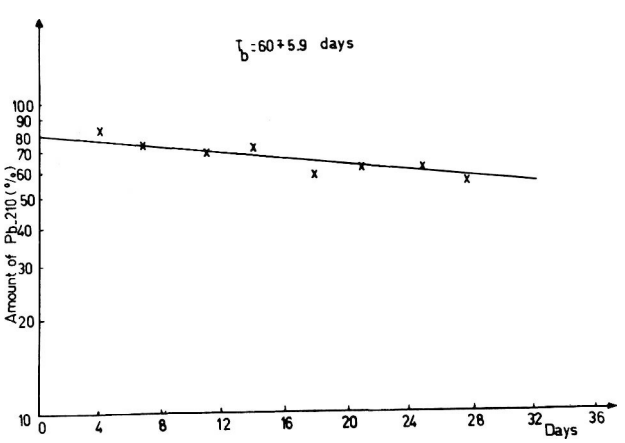


Fig. 1. The change in amount of Pb-210 dependent of time in whole body.

CONCLUSION

In the experiments, Pb-210 was injected subcutaneously, for it is reported that when lead is bound to certain compounds, its transport through the intestines may be prevented /8/.

In our experiments, generally the part between proximal end of femur and intertrochanter line always accumulated more Pb-210 in comparison to other investigated region of the femur and to other organs. The reason for this finding is not known clearly. If the internal structure of the bones which accumulate lead in different amount was investigated, differences between them could be observed, for instance, the bone-cells in the thinnest part of femur are more packed while ones in the epiphyseal region have a more or less spongish structure. In this second region, there is obviously more water which may play a role in the amount of Pb-210.

Even though, lead is found in a low concentration in the brain, it is hardly understandable why it exerts the highest damage to the brain cells. The only explanation could be that the brain cells do not regenerate at all, and the cells of the other organs renew themselves very often.

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