Clinical Significance of Low-Level Radiation Exposure in Mammalian Radiobiology Investigated by Radon (Rn^{222}) Dissolved Water Intake in a Dog

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Abstract: To establish the clinical significance of low-level radiation exposure, this study was conducted under the artificial radioactive circumstances, such as internal exposure of alpha-ray with radon (Rn^{222}) dissolved water (RDW) intake, and its production method is uncomplicated and presented as public property by the third party. Here, we report that this method provides the wide range of availabilities in radioactivity. This 1-year experimental study investigated the effect of RDW on a dog as a mammal model, resulted in no biochemical harmfulness. To acquire the accuracy of this consequence, the accumulation of more data in mammal models is indespensable with consistent radioactive backgrounds.

Keywords: Alternative treatment, radiation hormesis, linear non-threshold theory, uranium-238, gamma-spectrometer.

INTRODUCTION

We have previously reported the bio positivity of low-level radiation in human being under various artificial experimental conditions, in which external exposure of beta- and predominant gamma-ray contact with the radioactive meterials and internal exposure of alpha-ray with inharing radon (Rn^{222}) gas [1, 2]. However, the confirmative study has not been carried out sufficiently because the process for radioactive preparation is not presented. Since our previous study described the experimental radioactive conditions [2], this study focused on the manufacturing process of Rn^{222} dissolved water (RDW) in detail and examined the biochemical effect of internal exposure to alpha-ray by oral RDW intake in our family dog as a mammal model.

SUBJECTS AND METHODS

The Manufacturing Process of RDW and Measurement of Radioactivity

Generally, the radioactive minerals are provided at the private market organized by the private stone dealers, so-called the old-collectors, have collected the radioactive minerals as an ornament before the Second World War. At present, the possession of radioactive minerals over 370Bq/g uranium is legally restricted within 300g or 900g thorium in Japan. Therefore, it is quite difficult to obtain them in bulk through the ordinary commercial channel without the permission of the public organization. When selecting an objective radioactive mineral, the following specific features are often observed: 1) superficially black color; 2) relatively heavy because of higher specific gravity than iron ore; and 3) we sorted an mineral with nearly or higher than 1m SV/hr radioactivity by a radioactivity counter (Radiation Alert Inspector, S.E. International INC.); then, we selected the uranium-238 related minerals using a gamma-spectrometer (TA100 TECHNOAP INC.). The image is shown in Figure **1**. The following procedure was repeated several times while RDW was being prepared: collecting the precipitates after centrifuging the water with milled mineral resources (1-2 mm in diameter). After the purification and dry-up, the resources are pounded into powder with pestling by hand as fine as possible in the mortar, accordingly radon could be efficiently emitted. Rn^{222} concentration in RDW (Bq/ml) is measured using scintillation cell (ALPHA-SCINT-1-117, TRACERLAB INC.). The 10-gram powder described above packed in a commercially available tea-bag and left in distilled water (1.5 litter) for 1 hour at 18.5 Celsius degree, which was measured twice at 6 hours (sample 1) and 12 hours (sample 2) after sinking the tea-bag into the distilled water.

RDW Intake in a Dog and Biological Influence

As a mammal model of this study, our family dog was selected. It was born in 2014, male and his weight

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ISSN: 1929-2260 / E-ISSN: 1929-2279/18

was10 kg right before the study initiation. He had no abnormalities in physical findings. The commercially available water dispenser attached to the cage was used to give RDW (Sample 2) to the dog without any restrictions on RDW intake, including time and dose. After 1-year observation, both peripheral blood and biochemistry data (at initiation and after 1 year) were juxtaposed for assessing the biological effect of RDW.

Figure 1: The image of radioactive mineral.

At initial concentration of radioactive minerals, superficially black color can provide macroscopic useful information.

RESULTS

The results of Rn^{222} concentration in RDW is shown in Table **1**. The average of Rn^{222} concentration at 6 and 12 months during the observation period were 165.9 Bq/L and 710.1 Bq/L. The laboratory data of RDW intake in the dog is shown in Table **2**.

RDW intake period was 1-year and the blood samle was obtained at the initiation and the final point. No abnormalities in both samples or general conditions were observed.

DISCUSSION

This study demonstrated the simple way to prepare RDW. The acquired radioactive level depends on each mineral resource and it is difficult to prepare the sample water with the fixed radioactive level in advance. However, the large amount of material resources with high purity (e.g uraninite) allows to obtain the higher radioactive levels; the support by the public research is indispesnable. The Japsanese hot-spring law requires the level of 111Bq/L Rn^{222} concentration and more as the alternative treatment.

The linear-non-threshold theory (LNT) has long been accepted as a basic concept of self-protection against radioactive exposure as small as possible, and the guidelines based on LNT have suggested that the use of computed tomography particularly in small children should be carefully considered [3]. However, in the low-level radioactivity, whether LNT is trustworthy is still controversial [4-6]. Accordingly, the definition of “low-level” or threshold has not been established yet. This study indicated the method to prepare RDW which was roughly regulated at the different Rn^{222} concentration levels by diluting the same lot samples with high radioactivity and to provide comparative samples. Concerning the internal alpha-ray exposure

Table 1: Rn222 Concentration (Bq/l) in Sample Water

Sample 1: at 6 hours after sinking the tea-bag with 10 g powder into saline water	
1	164.11
2	169.39
3	157.16
4	172.85
Mean	165.9
Sample 2: at 12 hours after sinking the tea-bag into saline water	
5	721.26
6	721.98
7	680.13
8	690.9
Mean	736.16

Table 2: Laboratory Anlyses Performed on Blood Samples

	normal range	pre-	post-
red blood cell	5.39 - 8.70 M/μL	7.06	7.77
hematocrit	38.3 - 56.5%	54.3	54.1
hemoglobin	13.4 - 20.7 g/dL	16.6	18.8
mean corpuscular hemoglobin	59 - 76 fL		70
mean cellcorpuscular hemoglobin	21.9 - 26.1 pg		24.2
man corpuscular hemoglobin concentration	32.6 - 39.2 pg/dL		34.8
reticulocyte	10.0 - 11.0 K/μL		9
white blood cell	4.9 - 17.6 K/μL	8.9	6.6
neutreoleukocyte	2.94 - 12.67 K/μL	6.46	4
lymphocyte	1.06 - 4.95 K/μL	1.41	1.79
monocyte	0.13 - 1.15 K/μL	0.39	0.09
eosioncyte	0.07 - 1.49 K/μL	0.63	0.71
basophilic cell	0 - 0.1 K/μL	0	0.01
platelet	143 -448 K/μL	264	19.5
glucose	60 - 123 mg/dL	111	119
creatinine	0.5 - 1.4 mg/dL	0.8	0.9
blood urea nitrogen	9 - 30 mg/dL	6	15
phosphorus	2.2 - 5.9 mg/dL	3.4	3.1
calcium	9.0 - 11.4 mg/dL	10.6	10.2
sodium	141 -156 mmol/L	145	146
potassium	3.9 - 5.5 mmol/L	4.3	4.5
chlorine	109 - 121 mmol/L	115	115
total protein	5.1 - 7.5 g/dL	6.9	6.5
albumin	2.6 - 3.9 g/dL	3.2	3.4
globulin	3.7 g/dL	3.7	3.1
A/G ratio		0.86	1.09
alanine aminotransferase	18 - 93 U/L	27	39
aspartate aminotransferase	17 - 45 U/L	20	23
alkaline phosphatase	15 - 162 U/L	151	56
gamma-glutamyl transepeptidase	0 - 9.0 U/L	7.6	6.9
total bilirubin	0 - 0.4 mg/dL	<0.1	<0.1
total cholesterol	132 -344 mg/dL	108	
triglyceride	31 - 92 mg/dL	51	143
amylase	401 - 1,395 U/L	989	815
lipase	137 - 721 U/L	324	430

pre, laboratory analysis performed on a blood sample at the initiation of 1-year study period; post, laboratory analysis performed on a blood sample at the end of 1-year study period.

through the gastrointestinal mucosa or respiratory system using ultrasonic distrubuter [2], its clinical significance should be fully investigated in the basic mammal models. The accumulation of experimental

data with standardized backgrounds will be foothold to resolve the long-term debate in terms of LNT.

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Received on 08-06-2018 Accepted on 20-10-2018 Published on 23-10-2018

DOI: http://dx.doi.org/10.30683/1929-2279.2018.07.04.4