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Can the adaptive response to ionizing radiation detect by the cytokinesis-blocked micronuclei assay?

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1. Introduction

Many studies have been performed to assess the development and application of potentially useful biodosimetry. At present, although chromosome dicentric assay is a sensitive method for dose estimation, it is laborious and requires enough experience for estimation. Therefore, we need an alternative cytogenetic dosimetry to estimate the absorbed dose of victims after low dose exposure such as radiation accidents in hospital workers and workers of radiation related facilities[1]. An alternative and simple cytogenetic technique is the measurement of the micronucleus frequency in cultured human lymphocytes. The reliability of conventional micronucleus (MN) assays is diminished owing to the inclusion of non-dividing cells in the estimate, but this problem has been overcome by the development of the cytokinesis-blocked (CB) MN assay. The reliable and ease assays of the cytokinesis blocked-approach are obvious advantages in biological monitoring, but there are no developed recognizable and reliable techniques for biological dosimetry of a low dose exposure until recently[2].

Adaptive response is important in determining the biological responses at low doses of radiation and has the potential to impact the shape of the dose-response relationship.

We analyzed the frequency of both spontaneous and *in vitro* ^{137}Cs γ-rays-induced MNs in the low dose radiation-exposed workers to estimate the cytokinesis-blocked (CB) MN assay is proper assay or not as a screening the adaptive response.

2. Methods and Results

The subject: Ten subjects were composed of the low dose radiation-exposed workers aged between 26 years and 46 years. These subjects were all hospital workers and their life style was disregarded in MN data.

Irradiation condition: The blood samples were irradiated with 0 - 2Gy of ^{137}Cs γ-rays was 98.2cGy/min.

Cell culture and cytokinesis-block methods: Whole blood was cultured in RPMI 1640 containing a Hepes buffer, 15 % heat inactivated fetal calf serum, L-glutamine and antibiotics. Cytochalasin-B was added 44 h after commencement of the culture at a concentration of 3.0μg/ml. After an incubation period of 72 h, the cells were collected by centrifugation. Collected samples were resuspended in KCl hypotonic solution and a mixture of methanol and glacial acetic acid. The fixed cells were air-dried and stained with 10% Giemsa for 10 min.

Scoring of the MN and data analysis: The MNs were scored in 500~1000 binucleated CB cells using a 1000X magnification. All the statistical analyses were performed using a Graph PAD in a Plot computer program and Excel program.

Results: For the study of the adative response of the MN frequency, 10 low dose radiation-exposed workers

were selected. Micronucleus per 1000 binucleated cells was counted for the low dose radiation-exposed worker.

Table 1. Micronucleus frequency of peripheral lymphocytes according to irradiated dose, respectively.

Age	exposed dose during last 1 year	Dose (Gy)	0.00	0.10	0.25	0.50	0.75	1.00	2.00
34.5	10.54	average	0.064			0.169		0.338	0.820
40	5.38	**A**	0.056			0.156		0.330	0.804
26	11.78	**B**	0.077			0.155		0.295	0.725
46	1.48	**C**	0.049			0.128		0.315	0.749
29	3.64	**D**	0.055			0.175		0.304	0.869
33	24.79	**E**	0.068			0.173		0.300	0.748
26	6.83	**F**	0.060			0.203		0.405	0.946
35	24.38	**G**	0.091			0.171		0.368	0.866
31	5.28	**H**	0.050			0.180		0.338	0.778
43	15.36	**I**	0.071			0.177		0.385	0.835
36	6.44	**J**	0.068			0.169		0.340	0.878
Standard			0.002	0.006	0.016	0.032	0.067	0.114	0.460
Low			0.000	0.002	0.010	0.019	0.049	0.088	0.352
High			0.003	0.009	0.023	0.045	0.085	0.140	0.567

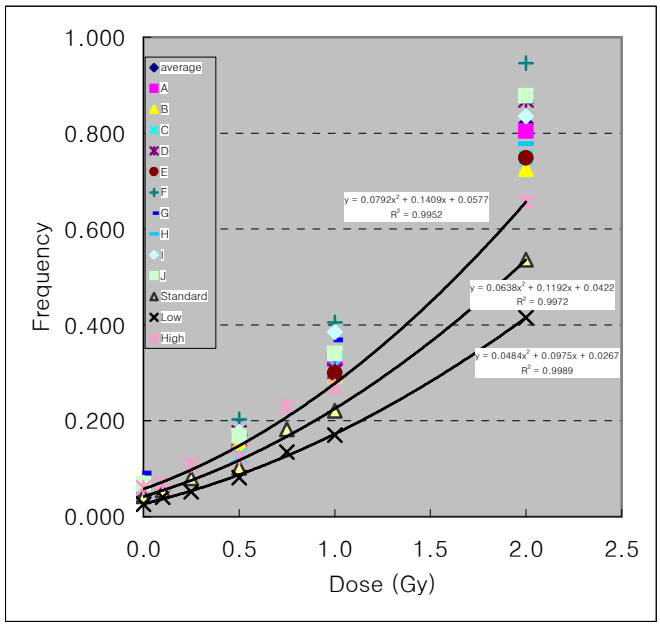

Figure 1. Dose-response relationship in micronucleus frequency of peripheral lymphocytes according to irradiated dose, respectively.

The frequency was not followed with age in the spontaneous MN frequency of low dose radiation-exposed workers as shown in Table 1. And the effect of low dose radiation-exposed was not shown in dose-dependent MN frequency, either, as shown in Figure 1.

3. Conclusion

We think that in estimating the genetic hazards of environmental mutagens there are major problems in applying them from the epidemiological data to a biodosimetry in the low dose radiation exposed person. The occupational, medical and population exposures of various forms of ionizing radiation may have the ability to alter DNA without affecting other cellular functions and these toxic effects are deterministic or stochastic effects. Therefore, if genetic effects are to be manifested from very low-dose exposure to ionizing radiation through epidemiological and *in vitro* studies, the risks have to be considerably larger than the risks from non-ionizing radiation or other environmental mutagens. In this experiment, we could not observed the adaptive response of low dose radiation and the cytokinesis-blocked (CB) MN assay is maybe not proper assay as a screening the adaptive response, although the subject number is only 10. In next research, we will try out the MN assay and dicentric assay together in low dose radiation-exposed workers with age, sex and life-style factors.

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