Caffeine-Induced Hematological Changes after Whole-Body Irradiation in Rat

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1. Introduction

Recent research indicated dietary antioxidants were useful radioprotectors to protect organisms against radiation-induced tissue lethality and other deleterious effects [1]. Radioprotective effects of vitamin C have been demonstrated in certain cells and animals, which would result from scavenging free radicals [2]. Moreover, the previous studies indicated that caffeine had been shown to potently act the radioprotector in irradiated mice [3,4]. However it is not clear exactly about effects of caffeine treatments chronically after irradiation. So the present studies were designed to identify the hematological effect of caffeine treatments chronically one month after whole-body gamma irradiation.

2. Methods and Results

2.1 Changes of organ indices

The rats (4 weeks old, male, F344 strain) were allocated randomly into six groups of five rats each. Irradiated groups were exposed to λ-irradiation using a ^{60}Co source with a total dose of 6.5 Gy, and a dose rate of 12.8 Gy/hr [5]. After irradiation, antioxidant-treated groups were treated ascorbic acids (250 mg/ml) or caffeine (80 mg/ml) in drinking water until ends of experiments [4].

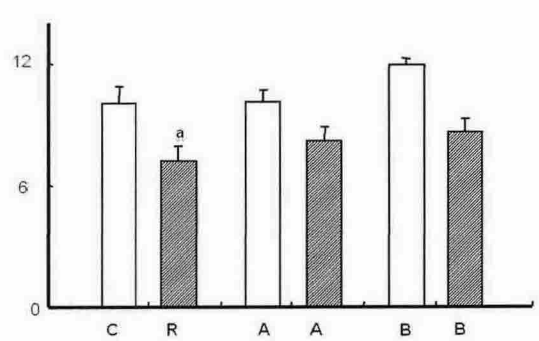

Figure 1. The increase-rate of body weight (g) in the experimental groups. Data was represented by mean± SEM (a, $p<0.05$).

All the rats were euthanized one month after irradiation. Body weights of radiation group showed a 25% decrease compared with the weight of the control (Figure 1). Body weights of ascorbic acid-treated irradiated group (AR) and caffeine-treated irradiated group (CR) showed 18.3% and 13.5% decrease, respectively, compared with those of control (CT). In other words, AR and CR showed 9.1% and 14.1% increase, respectively, compared with body weights of irradiated control (RC). Organ indices were summarized at Table 1. Liver indices did not changed significantly between the experimental groups. However testis and spleen indices showed a significant decrease in irradiated groups (RC, AR, and BR) compared with those of control. Testis and spleen in AR and BR, the rate of weight decrease did not show any distinguished differences compared with those of RC. Calculated values of testis and spleen in BR showed higher than values in AR.

2.2 Measurements of blood components

Level of white-blood cells (WBC) and red-blood cells (RBC) and serum-outflow of lactate dehydrogenase (LDH) and alkaline phosphatase (ALP) were measured by using the automatic analyzer (Hitach, 747/200 type), which is based on the spectrophotometric quantification of NADPH loss using lactic dehydrogenase as a coenzyme [6]. Table 1 indicates the levels of WBC and RBC in the experimental rats. Relative potency of RC (52.5%) was significantly recovered in AR and BR groups (71.1% and 68.4 %, respectively). Table 2 indicated the amount of serum-outflow of LDH and ALP in the experimental groups. Both LDH and ALP enzymes in the RC group showed significant increase 26% and 34% respectively compared with those of the control levels.

Table 1. Levels of WBC and RBC in the experimental groups

	WBC		RBC	
	Values	%	Values ($\times 10^4$)	%
CT	5663.3 ± 262	1	850 ± 9.7	1
RC	2973.3 ± 49	52.5	727 ± 35	85.6
A	5563.3 ± 354	98.2	820 ± 20	0.96
AR	4026.6 ± 339	71.1	744 ± 21	0.87
B	4866.6 ± 178	86.9	793 ± 14	0.93
BR	3873.3 ± 199	68.4	719 ± 10	0.85

Table 2. Amounts of ALP and LDH in the experimental groups

	ALP	LDH

	Values	%	Values	%
CT	241 ± 1.45	1	6500 ± 314	1
RC	301 ± 10.9	1.26	8748 ± 427	1.34
A	251 ± 16.2	1.04	6901 ± 330	1.06
AR	245 ± 5.19	1.02	7437 ± 291	1.14
B	270 ± 8.96	1.12	6866 ± 365	1.05
BR	231 ± 10.2	0.96	7621 ± 243	1.17

Levels of ALP in the AR and BR group did not show the differences significantly. However levels of LDH in both groups decreased 20% and 17% respectively compared with levels of the RC group. These results were indicated that ascorbic acids and caffeine affected the defense for irradiation-induced liver damages.

3. Conclusion

The present studies were evaluated the effects of ascorbic acid and caffeine posttreatments-induced hematological components after whole-body irradiation. Reduction of RC was well again ascorbic acid or caffeine posttreatments. The levels of WBC and amounts of serum-flowout ALP showed improvement in the AR and BR group. Taken together, these results suggested that ascorbic acids and caffeine may assist the recovery of damage after whole-body irradiation.

REFERENCES

[1] M.R.L. Stratford, R.J. Hodgkiss and R.R. Watfa, Studies on the role of antioxidants in radioprotection, Pharmacol Therap., **Vol.39,** p.389, 1988.
[2] M.K. O'Connor, J.F. Malone, M. Moriarity and S. Mulgrew, A radioprotective effect of vitamin C observed in Chinese hamster ovary cells, Br J Radiol., **Vol.50**, p.587, 1977.
[3] T. P. Devasagayam, and P.C. Kesavan, Radioprotective and antioxidant action of caffeine: mechanistic considerations, Indian J Exp Biol., **Vol.34(4)**, p.291, 1996.
[4] J. K. Kim, J. H. Kim, and Y. D. Yoon, Evaluation of caffeine as a radioprotector in whole-body irradiated male mice, In Vivo, **Vol.17(2)**, p.197, 2003.
[5] C. J. Lee, H. H. Park, B. R. Do, Y. D. Yoon, J. K. Kim, Natural and radiation-induced degeneration of primordial and primary follicles in mouse ovary, Animal Reprod Sci., **Vol.59**, p.109, 2000.
[6] S. Fukuda, S. Tsuchikura, H. Iida, Age-related changes in blood pressure, hematological values, concentrations of serum biochemical constituents and weights of organs in the SHR/lzm, SHRSP/lzm and WKY/lzm, Exp Anim., **Vol.53(1)**, p.67, 2004.