Biological Significance of the Exposure to Low Dose Radiation Revealed by Advanced Cytogenetic Methods

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There are several places in the world where natural background radiation is distinctively high. One of them is an area in the south of China where the natural background radiation is 3 to 5 times higher than in other areas. The high radiation comes from decay products of Th-232 and U-238 in the soil in this area. Habitants in this high background radiation area (HBRA) live in the same site for more than 6 generations. To know the cytogenetical effect of such low dose level radiation, we have been studying chromosomes of the lymphocytes of those people in collaboration with Chinese researchers. Advanced cytogenetic methods developed in our laboratory for detecting the effect of low dose radiation were applied to this Japan-China collaborative study.

Frequencies of dicentrics plus centric ring chromosomes (Dic+Rc) of 39 healthy family members (3 generations from 13 families) living in both HBRA (22 cases) and control area (17 cases) were studied. Dic+Rc were scored in 55,595 cells (2,527 cells/case) in HBRA and in 45,799 cells (2,694 cells/case) in control under a microscope equipped with an automated stage.

Translocations of 9 residents in HBRA and 8 residents in control were analyzed with a chromosome painting method. For translocations, totally 14,096 cells (1,566 cells/case) in the former and 17,522 cells (2,190 cells/case) in the latter were analyzed. It was found that the frequency of Dic+Rc increased with the dose but there was no dose effect detected in that of translocation.

According to Lloyd et al.(1992), induction rate of dicentrics per cGy by low LET radiation is 3 in 10,000 cells at the dose level below 5 cGy. The average dose to be received from natural circumstance is 0.24 mSv according to UNSCEAR report (1993). If so, since dicentrics and translocations are induced in the equal ratio, the frequency of translocations attributable to radiation at 60 year old person would be $(60\times0.24/0.876)\times(3/10000)=4.8/1000$ cells. However, the observed values in the normal population reported by Ramsey et al. (1995) are much more than 3 times higher than this value. The effect of radiation on the induction of chromosome aberrations, which have statistically a potential risk of causing malignant or congenital diseases, seems to be less significant than those of metabolic factors and/or mutagenic agents (excluding radiation) even if it were the exposure to the dose 3 times higher than the average dose mentioned above.