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Development of targeted cytoplasmic irradiation for normal human fibroblasts with monochromatic X-ray microbeams

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Introduction

We reported about the chromosomal damage induced by cytoplasmic irradiations with He-ion microbeams at the Radiological Research Accelerator Facilities of Columbia University [1]. The data indicated that when 10% of normal human cells in the population were irradiated with 8 He ions through the cytoplasm, the level of the induced chromosomal damage in the irradiated population were significantly higher than that of the non-irradiated control population. Furthermore, the profile of the induced chromosomal damage was quite similar to that in which 100% of the cells in the population were irradiated (Fig.1). The result suggests that biological data for targeted cytoplasmic irradiation is very important for evaluating radiation risk of low-dose irradiations.

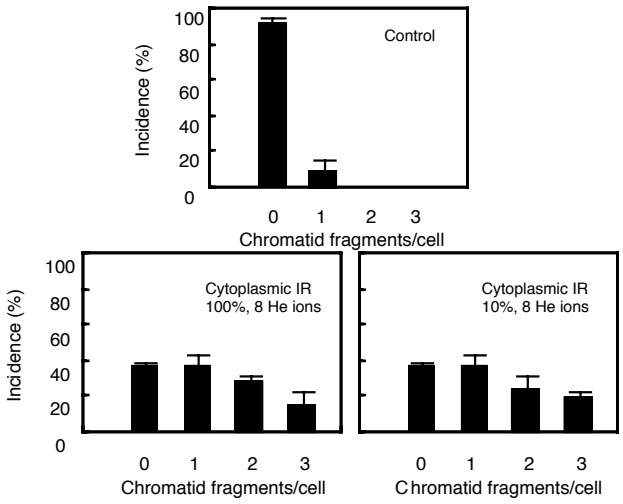

Fig.1 Cytoplasmic irradiation of He-ion microbeams induced chromosomal damage in normal human cells.

Targeted irradiations using microbeams enable us to examine biological responses, such as bystander effects, genomic instability and radioadaptive response, in detail. These biological responses should be essential for evaluating radiobiological effects for human body, especially low-dose or low-dose-rate exposures as the accident of Fukushima Daiichi Nuclear Power Plants. However limited studies for targeted irradiations using microbeams were available. In this study we have been carrying out cellular biological effects on normal human fibroblasts induced by targeted nucleus/cytoplasmic irradiations with X-ray microbeams. This year, we developed the X-ray microbeam cell irradiation system at BL27B into targeted cytpolasmic irradiations for normal human fibroblasts.

Materials and Methods

Targeted cytoplasmic irradiations of monochromatic X-ray microbeams (5.35keV) were carried out at BL27B. Briefly, we made two kinds of microbeams covering the areas of 60 and 30 square micrometers in which the center of the microbeams the gold-made mask was set in order to shield the nucleus [2]. Approximately 600 exponentially growing normal human fibroblasts were inoculated into the centre of each microbeam dish, which was stretching a 2.5μm-thick Mylar film over the bottom of the hole for X-ray window, the day before irradiation. Each cell nucleus stained by Hoechst 33342 was captured by the computerized cell irradiation system and irradiated 40R in the microbeam areas, involving each cytoplasm.

Results

In the targeted cytoplasmic irradiation system, the captured cell nuclei of normal human fibroblasts were successfully shielded and irradiated 40R in the areas of two kinds of microbeams (Fig.2). We have begun to examine cell-killing effect, which was detected with a colony-forming method.

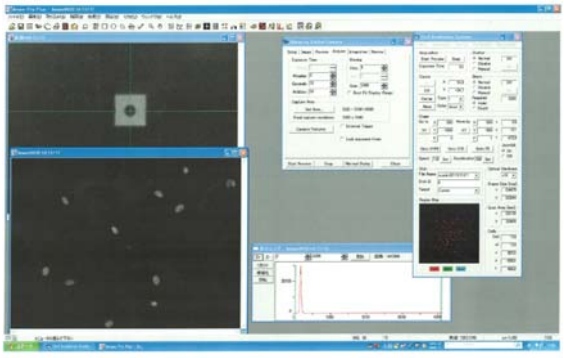

Fig.2 The computerized targeted cytoplasmic irradiation system of X-ray microbeams (60 square micrometers).

References

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