Characterisation and transmissibility of α-particle-induced chromosome aberrations

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The evaluation of the health risks associated with low dose radiation exposure relies on the verification of exposure history. Retrospective biodosimetry based on frequencies of chromosome translocations is well established for exposure to low LET radiation and has proved a valuable tool for validating doses in epidemiological studies. For high LET irradiation, such as that from internally deposited α-emitting radionuclides, the relationship between chromosome aberration frequencies in blood lymphocytes and dose is more difficult to establish. In recent years, in vitro studies have highlighted the complexity of chromosome aberrations induced by α-irradiation. Moreover, exposure to densely ionising radiation is predicted to result in a lower ratio of inter- to intra-chromosomal exchanges (F ratio) than exposure to low LET radiation. However, the majority of cells with complex aberrations will be unstable and will not undergo cell division to give viable descendant cells. Therefore, the quantification of chromosome biomarkers of α-irradiation must take into account the distribution and transmissibility of the different aberration types if it is to provide information that is relevant to the interpretation of in vivo frequencies. The profile of chromosome damage induced by α-particle irradiation was examined using sFISH and mBAND. Lymphocytes in their first in vitro division following exposure to 213Bi α-particles were analysed by sFISH and genomic aberration frequencies derived. Cell stability status was established by analysing the whole genome for unstable aberrations. The majority of aberrant stable cells contained a single simple translocation. The dose response for translocations in stable cells for doses up to 200mGy was 7.90 $\pm$ 0.98 x 10-2 per Gy. Aberrations involving the number 5 chromosomes were identified using mBAND. Exchanges involving aberrant chromosomes 5 were classed as inter- or intrachanges and further classified into simple and complex. F ratios were 1.4 and 2.4 for 0.2 and 0.5Gy α-particles and 5.5 for 1.5Gy γ-rays. Although α-particles induced more intrachanges, their association with complex exchanges, which are likely to be unstable and nontransmissible through cell division, will limit their applicability as a marker of past in vivo exposure. This work has failed to demonstrate a unique chromosome biomarker which would discriminate between different qualities of radiation in workers with historical exposures but has confirmed that stable cells with a single translocation do arise in significant numbers in a dose dependent fashion following α-particle irradiation.

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