

Establishment of the dicentric assay and production of a X-ray dose-response curve

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Abstract

Intending to carry out biological dosimetry after accidental or occupational radiation exposure a dose-response curve was established by conventional analysis of dicentric chromosomes in human lymphocyte metaphase spreads after in vitro 240 kV X-ray exposure of peripheral blood samples. A total of 7672 first-division metaphases of three healthy volunteers was analyzed after exposure to doses ranging from 0.2 to 4.0 Gy at a dose rate of 1.0 Gy min⁻¹. The background level of aberrations at zero dose was determined by the analysis of 10085 metaphases obtained from unirradiated blood samples of seven healthy volunteers. The calibration curve follows a linear-quadratic equation, $Y = c + \alpha D + \beta D^2$, with the coefficients $Y_{Dic} = ((0.788/1000) \pm 0.000279) + (0.0454 \pm 0.00632) \times D + (0.0632 \pm 0.00406) \times D^2$. Thereafter, we performed an in vitro experiment, in which whole body exposures within a range of 0.2 to 4.0 Gy were simulated. The calibration curve was applied to derive dose estimations by scoring the typical 500 to 1000 metaphase spreads per subject for routine analysis. Our data show a Poisson distribution for dicentrics for all doses except for 4 Gy ($-1,96 < u < +1,96$). However, a Poisson distribution is observed for this dose, when trivalent chromosomes are included in the analysis. Acentrics show overdispersion in three of six doses, which is consistent with published findings from others (Lloyd et al., 1986, Schmid et al., 1984). Comparing the α and β coefficients with those from similar published studies (Schmid et al., 1984, Lloyd et al., 1986, Baraquinero et al., 1997, Prasanna et al., 2002) good general agreement can be observed. However, some inter-laboratory variations exist, which could result from the energy of irradiation, the dose rate, methodical/technical differences, scoring criteria and the experience of the technicians. With the establishment of this dose response calibration curve we now have the prerequisite to carry out biological dosimetry with the dicentric assay after accidental or occupational radiation exposures.