Contribution ID: **88** Type: **poster preferred**

Establishment of an 192 Ir γ-ray calibration curve for lymphocyte dicentric assay in case of occupational or accidental exposure in industrial radiography

Tuesday, 16 October 2012 16:12 (1 minute)

The analysis of dicentric chromosomes in human peripheral blood lymphocytes is the most reliable and accurate method for estimating a recent absorbed dose following external exposure to ionising radiation. The frequencies of dicentrics per grey vary depending on the variations in both the linear energy transfer (LET) and the relative biological effectiveness (RBE) of any particular radiation. Therefore, the conversion of an observed dicentric frequency into dose with reference to an in vitro calibration curve established for the type of radiation, which is the same to that of the radiation being studied, significantly improves accuracy of dose reconstruction by the dicentric assay. Since the most common radiation incidents are in industrial radiography using iridium sources, the aim of this study was to establish the calibration curve for 192Ir γ-rays as a reference in the Central Laboratory for Radiological Protection (Warsaw, Poland) for estimating the absorbed dose in case of undesired occupational or accidental radiation exposure. The conventional metaphase-spread chromosome technique was used to study the dose-response effects in irradiated in vitro lymphocytes of two healthy donors. The irradiation was performed with the Gammamat TSI-3 industry standard γ-ray projector containing the 192Ir source with an activity 2 644 GBq at that time. The dicentric data obtained for eight different doses of 192Ir γ-rays were fitted to a linear-quadratic model of chromosome aberration formation by low-LET radiation: Y=c+bD+aD2.To determine the best-fit coefficients the computer program CABAS and the maximum likelihood method were used. The coeficients obtained were: c=0,0010±0,0006; b=0,0322±0,0102 Gy-1; c=0,0541±0,0055 Gy-2. Established dose response curve was used for valuation of the dose for a worker accidentally overexposed to γ 192Ir industrial radiography source which, have become detached and must have been returned to the shielded container. The estimated mean dose was equal to 0,10 Gy, with the 95% confidence interval of 0,03-0,21 Gy, whereas the mean dose received on the basis of physical reconstruction of the accident was found to be 0,09 Gy. If the 60Co calibration curve was used, the obtained dose was 0,18 Gy with the 95% confidence interval of 0,06-0,32 Gy.

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Session Classification: Poster Session 1

Track Classification: Biological and Physical Dosimetry