Retrospective biodosimetry of an occupational overexposure - case study

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Study Goal: The purpose of this study was to provide retrospective biological dose assessments for an individual who had a suspected occupational exposure to an industrial radiography source four years previously. Doses were estimated using both the frequency of dicentrics in Giemsa stained metaphase cells using the dicentric chromosome assay (DCA) and translocation frequency measured by Fluorescent In Situ Hybridization (FISH).

Abstract: The DCA is the standard assay for biodosimetry when samples are available shortly after exposure. When sampling is delayed for more than a few months, however, FISH allows for the visualization of stable translocations. In 2015, Health Canada (HC) was approached by the Canadian Nuclear Safety Commission to conduct a dose assessment for a possible overexposure. The scenario involved a 35 year old male who was suspected of having been exposed to industrial 192Ir radiography in 2011. A blood sample was shipped to HC and processed for both DCA and FISH analysis. For the DCA, 1004 first metaphase cells were analyzed with 9 dicentrics observed. FISH translocation analysis was performed using 3 colour whole chromosome probes for chromosomes 1, 2 and 4. 8001 cells were analyzed with 35 simple translocations detected in apparently stable cells.

Due to the time elapsed between the event and sampling, analysis for the DCA was carried out by adjusting the measured frequency of dicentrics to the expected number which would have been observed immediately following irradiation, assuming a half-life (t½) for dicentrics in circulating lymphocytes of 36 months. This number was then compared to the calibration curve to calculate dose, standard error, 95% confidence limits, adherence to the Poisson model, and minimum detectable dose for this assay, using the Dose Estimate software. The t½ adjusted dose was 0.21 ± 0.05 Gy (95% CI: 0.13 - 0.31 Gy), with no evidence of departure from Poisson and a minimum detectable dose of 70 mGy for 9 dicentrics. For the FISH assay, the translocation results were adjusted for age-related background to allow calculation based on excess radiation induced translocations by comparison with the age-background adjusted HC calibration curve. The translocation-based dose was found to be 0.09 ± 0.05 Gy (95% CI: 0 - 0.19 Gy). No statistical significant difference between the doses estimated using the DCA and FISH analysis was demonstrated.

Conclusion: When a half-life of 3 years for dicentrics was taken into consideration, the dose estimates from both assays were in agreement. Due to the time delay between exposure and analysis, there was no possibility of determining whether the exposure was partial- or whole-body. Due to the uncertainty in the half-life for the DCA, the FISH translocation assay is considered to be more reliable as a technique for retrospective dosimetry.