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TWENTY-TWO YEARS LATER: CONSISTENT DOSE ESTIMATION OF AN ACCIDENTAL OVEREXPOSURE BY RETROSPECTIVE BIOLOGICAL DOSIMETRY

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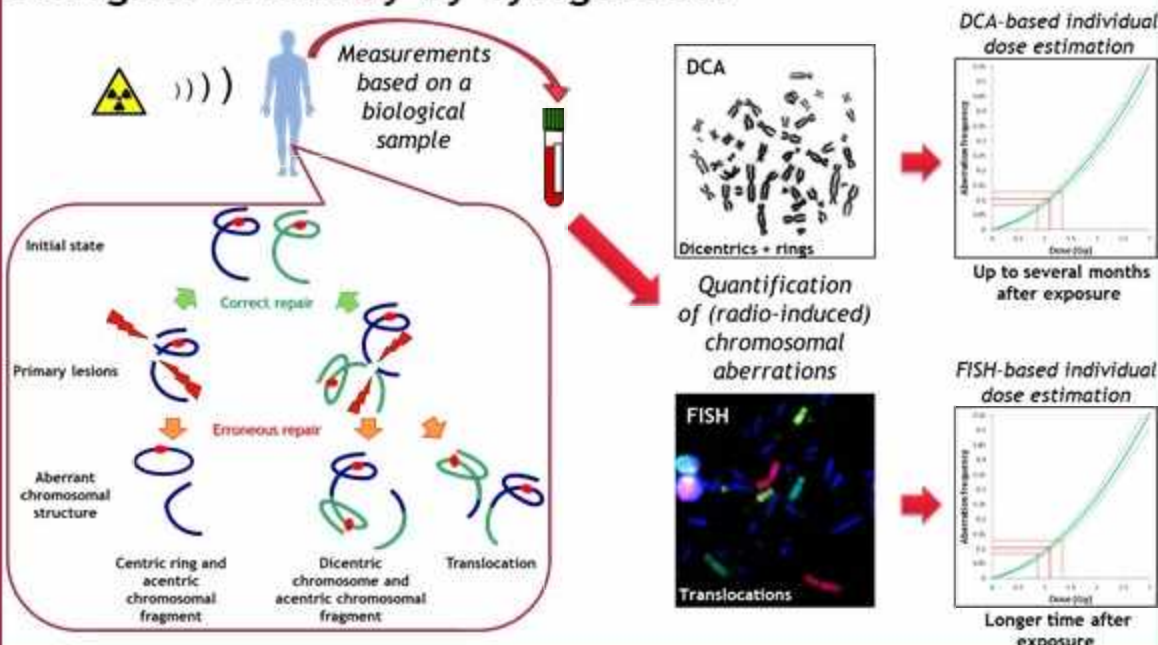
ABSTRACT

As the chromosomal translocation rate increases with age in the non-exposed population, the translocation-based dose estimation of an external radiation exposure victim needs to take into consideration such background. We sought to retrospectively estimate the dose of exposure of a victim from the Lilo radiological accident in Georgia twenty-two years afterwards and compare it to the original biological dosimetry-based dose calculation performed in our laboratory. Similar types of studies have retrospectively estimated a radiation dose, notably involving victims of the Chernobyl, Goiânia and Tammiku accidents¹⁻³. Nevertheless, their estimations were done after shorter periods of time post-exposure and in some cases, the exposure might not have been exclusively of an external nature^{1,2}.

In this study, we used Fluorescence In Situ Hybridization (FISH) to detect and score chromosomal translocations in lymphocytes from a recent blood sample of the victim. We performed the analysis using our laboratory's updated FISH dose-effect curve and taking into account translocation data from a large panel of unexposed individuals. We found the mean exposure dose to be similar to the original assessment obtained by the dicentric chromosome assay (DCA) more than 22 years ago. Furthermore, the confidence interval from the DCA analysis was contained within our FISH confidence interval, which as expected, was slightly larger. Altogether, these observations confirm a comparable dose estimation, suggesting that our current dose-effect curve is suitable for analyses long time after external exposure.

Keywords: Retrospective biological dosimetry; FISH; Chromosomal translocations; Accidental overexposure.

Biological dosimetry by cytogenetics



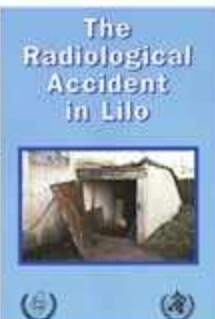
The radiological accident in Lilo⁴

- Former Soviet training center in Georgia used by Georgian troops. Many different radiation sources (¹³⁷Cs, ⁶⁰Co and ²²⁶Ra) were abandoned with no inventory by the previous military owners of the site.

- In 1997, local radiation-related skin lesions appeared on 11 frontier guards. Some developed further lesions and severe symptoms.

- They were transferred to Specialized hospitals in Germany, Russia and France for treatment and surgery.

- As part of the IAEA assistance mission, cytogenetic analyses were performed on the victims.



Cytogenetic analysis after the accident (1997)

A biological dosimetry assessment was performed in our laboratory for one of the victims using both DCA and FISH, as the exposure was suspected to have taken place continuously for more than a year^{4,5}. We recently re-analyzed the original aberration frequencies observed using our up-to-date methods in order to increase precision and reduce uncertainty.

Type of analysis	Estimated whole-body dose	95% confidence interval
DCA	0.58 Gy	0.33 - 0.87 Gy
FISH	0.41 Gy	0.11 - 0.88 Gy
FISH (age-adjusted)	0.41 Gy	0.12 - 0.88 Gy

Analysis 22 years after exposure

During a recent medical follow-up, we analyzed a sample of the victim by FISH. As expected, the translocation frequency was higher than that of the age-corresponding background population.

	Mean value of the non-exposed population ⁶	Threshold value ^{7**}	Observed
Translocations for 1646 metaphases	4.4 (Int'l, n = 293) 4.1 (EU, n = 100)	7.8 7.3	17

We performed a dose assessment and found that the result was comparable to the estimation linked to the 1997 data.

Type of analysis	Mean whole-body dose	95% confidence interval
FISH	0.41 Gy	0.10 - 0.86 Gy
FISH (age-adjusted)	0.40 Gy	0.08 - 0.87 Gy

CONCLUSION AND PERSPECTIVES

Retrospective biological dosimetry by FISH allowed us to estimate a dose that is consistent with the original assessment 22 years prior. This suggests that our current dose-effect curve is suitable for relative dose estimations long time after external exposure. As we pursue a continuous improvement of the precision of our FISH calibration curve, we are developing analytical methods that will allow us to incorporate several confounding factors of an individual (age, sex, lifestyle factors, etc.) when performing a dose assessment by FISH.

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 ** Value above which a difference is statistically significant