Lymphocyte cell death following thermal neutron exposure

L.C. Paterson[1], J. Atanackovic[2], C. Boyer[3], S. El-Jaby[1], N.D. Priest[1], R.B. Richardson[1]

[1] Canadian Nuclear Laboratories, Chalk River, ON Canada
[2] Ontario Power Generation, Whitby, ON, Canada
[3] Canadian Neutron Beam Centre, Canadian Nuclear Laboratories, Chalk River, ON, Canada

To date, there is little experimental data that describes the cellular effects of thermal neutron exposure and no published data specifically pertaining to cell death – a common endpoint used in quantitative detriment assessments of absorbed radiation dose.

Blood from three healthy male volunteer blood donors (ages 25 to 65) was irradiated with either ^{60}Co gamma rays or thermal neutrons. Following irradiation, lymphocytes were isolated, and cultured for 48 hours according to standard biological dosimetry protocol [1]. Cells were harvested and prepared for either apoptotic or dicentric chromosome assay (DCA) analysis, as described previously [2].

Thermal neutron irradiations were performed at the Canadian Neutron Beam Centre at the National Research Universal (NRU) reactor. Test tubes containing 1.5 mL of blood were suspended in front of the N5 Triple-Axis Spectrometer beam port that was adjusted to a beam dimension of 1" × 2". The thermal neutron doses delivered ranged between 0.03 Gy and 2.6 Gy at a dose rate of 2.33 Gy h^{-1}. The neutron dose was indirectly determined using the Monte Carlo N-Particle (MCNP 5) radiation transport code to model the neutron beam and target geometry [3]. The composition of blood was input using elemental compositions given in ICRP Publication 23 [4]. The thermal neutron fluence rate at the sample holder was calculated to be 2.80×10^{8} neutrons cm^{-2} s^{-1}. Fluence to kerma conversion coefficient for thermal neutrons, which in this particular situation is equivalent to dose absorbed, was calculated to be 2.31×10^{-13} Gy cm^{2}. This neutron kerma factor is well aligned with published values [5, 6].

Gamma irradiation was completed using CNL's ^{60}Co GammaCell 200 and GammaCell 220 irradiators.

No correlation between thermal neutron dose and apoptotic induction was observed (Fig. 1b); however, a dose response was evident when chromosome aberrations were examined (Fig. 2). Following gamma radiation exposure, a dose-dependent increase in apoptosis was observed (Fig. 1a), and similarly dose-dependent increases in chromosome aberrations are well documented following gamma exposures. These results are in contrast to apoptotic induction responses following fast neutron exposures [7-9], however the chromosome aberration results align with published data thermal neutron data [6]. Additional biological endpoints are currently being examined.

References

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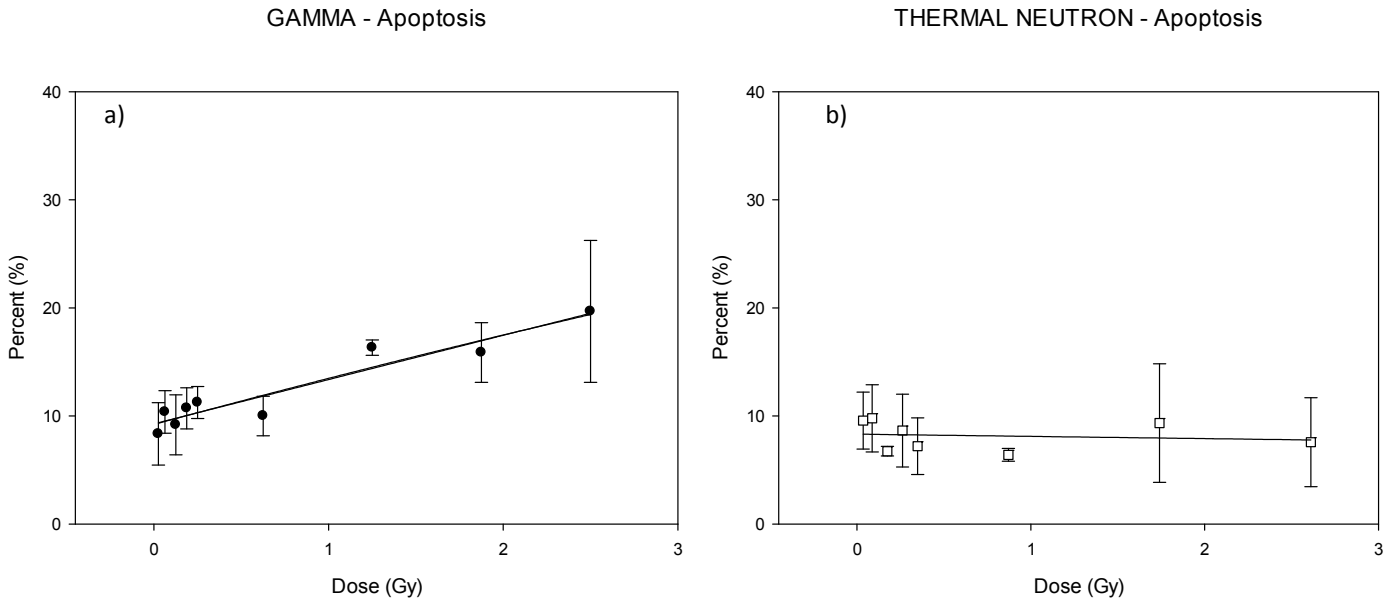

Figure 1 Percentage of apoptosis versus dose (Gy) for (a) gamma rays and (b) thermal neutrons. Error bars represent standard error.

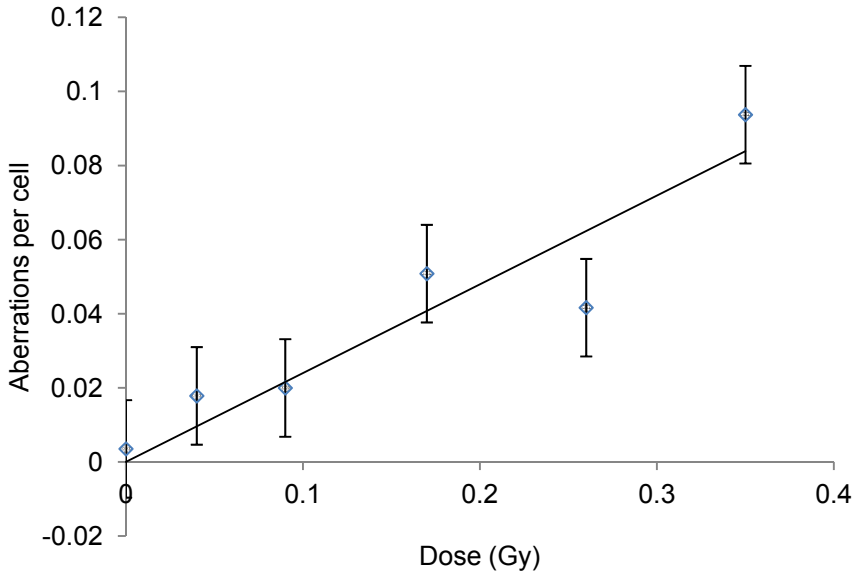

Figure 2 Dicentric chromosomes aberrations per cell following thermal neutron exposure. Error bars represent standard error.