Low dose diagnostic radiation exposure and cancer risk in Trp53+/- mice

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The cancer risk associated with exposure to low doses of ionizing radiation has traditionally been extrapolated from effects observed at high doses and high dose rates using a linear no threshold model. Based on this approach, it has been postulated that human exposure to medical imaging involving low doses of x-rays and gamma rays increase an individual's risk of developing cancer throughout their lifetime. Conversely, there is evidence that low doses of gamma radiation increase the latency period of cancer depending upon genotype, cancer type, and the magnitude of the radiation exposure. There is however very little research directly measuring the association between cancer risk and diagnostic radiation qualities.

We have tested whether a single 10 mGy CT scan (75kVp, 200µA) or PET scan (^{18}F-FDG, 250 KeV β^+, 511keV γ) modified cancer risk in Trp53+/- female mice (n=200). Cancer risk was defined by changes in the latency period and frequency of specific cancer types (lymphoma, carcinoma, and sarcoma) relative to unirradiated controls. Mice received the CT scan or PET scan at 7-8 weeks of age and were monitored daily for the development of symptoms consistent with these cancer endpoints. CT doses were verified using repeat measurements with TLDs implanted at various points within a mouse carcass. Current models of absorbed doses from small animal PET with ^{18}F-FDG estimate that a 20 µCi injection delivers an effective whole body dose of 10-12 mGy in a 20g mouse. Cancer diagnoses were confirmed via histological analysis. Significant differences in the frequencies of tumours between groups were tested for using a chi-squared test or Fischer's exact test. Overall survival and tumour specific survival, corrected for competing causes of death, were assessed using a Kaplan Meier model and specific differences in survival between groups were evaluated using a log rank test. We also investigated whether a single CT scan or PET scan is capable of inducing an adaptive response. Mice were exposed to an acute 4 Gy γ dose at 7-8 weeks of age (n=200). Other groups received a single CT scan or PET scan 24 hours prior to this 4 Gy dose (n=200). In another group of mice, additive risk was investigated. Mice received the acute 4 Gy dose followed 4 weeks later by weekly CT scans administered over a course of 10 weeks (100 mGy total).

At the time of this abstract, this study was nearing completion. Our preliminary analysis indicates that a single CT scan significantly extends overall lifespan relative to controls. There was no significant difference in lifespan between mice that received a 4 Gy dose and those that received an adapting exposure with a CT scan or PET scan. We anticipate tumour specific differences between the various treatment groups.