Induction of DNA Damage by Low Dose PET scans

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This research is focused on assessing the radiation risk associated with positron emission tomography (PET) scans. It has been suggested that low dose medical imaging, such as PET scans, carry an added biological risk because they expose the patient to ionizing radiation. PET scanning is an increasingly used nuclear medicine procedure that requires the administration of isotope ^{18}F-fluorodeoxyglucose (^{18}F- FDG, E=250 keV β and 511 keV γ) and results in an effective dose to the patient ranging from 7-22 mSv.

The radiation induced DNA damage associated with a PET scan was studied in 7-9 week old female wild type Trp53 +/+ mice. Mice were given a PET scan with ^{18}F-FDG and the biological response was assessed in bone marrow using the micronucleated reticulocyte (MN-RET) formation assay. Mice were injected with 0, 20, 40, 100 or 400 μCi of ^{18}F- FDG corresponding to a total body dose of 0.0 mGy, 11.7 mGy, 23.3 mGy, 58.3 mGy, and 233.2 mGy, respectively. There was a significant elevation (dose response) in the MN-RET frequency at and above 100 μCi ^{18}F-FDG. A mouse given a 20μCi injection is similar to the dose that a patient might receive during a PET examination with ^{18}F-FDG and there was no measurable effect in mice. However, radiation exposure from a PET scan is non uniform and some estimates report that a 20uCi injection could result in 400mGy to the bladder, so effects in bladder are under investigation. It has been hypothesized that oxidative stress, such as that caused by exposure to low dose radiation from a PET scan, stimulate a radioadaptive response. In a second set of PET experiments, mice were injected with 0, 20, 100 or 400 μCi of ^{18}F- FDG and then challenged *in vivo* with 1 Gy at a high dose rate, 24 hours after the PET scan. A single PET injection at any dose did not cause *in vivo* sensitization or protection for MN-RET formation after the challenge dose and no adaption was seen.

The possibility of a PET scan inducing an adaptive response was further examined in lymphocytes specifically by assessing gamma-H2AX foci formation *in vitro*. Mice were injected with 0, 20, 100 or 400 μCi of ^{18}F- FDG. Mice were sacrificed and their bone marrow was challenged *in vitro* with acute 0, 1, 2 or 4 Gy doses, 24 hours after the PET injection. A single PET scan did not appear to modify the response of bone marrow to any of the challenge doses except at the 400uCi PET scan where there was a reduced number of foci compared to non-injected mice indicating some type of adaption.

Effects of PET diagnostic exposures can induce effects in bone marrow in mice. Depending on the endpoint they may also induce an adaptive response that modifies the effects of larger radiation exposures, but the timing between the two exposures and the magnitude of the challenge dose seems to be important. These studies will be useful to help interpret the meaning of short-term biological endpoints such as MN-RET and gamma-H2AX foci formation with actual long-term cancer risk.