Oxidative stress in normal cells exposed to carbon ions

C. Laurent, I. Testard, A. Leduc and J.-L. Lefaix
CEA, LARIA, CIRIL-GANIL, Bd Henri Becquerel, BP 5133, 14070 Caen, France
laurentc@ganil.fr

The high efficiency of carbon ions versus photons, with an RBE (Relative Biological Efficiency) of 2 to 3, to treat various tumours was demonstrated in the main hadrontherapy centers (GSI, Germany and HIMAC, Japan). However, few extensive studies were performed in order to evaluate the impact of high-LET exposure on healthy tissues. In spite of a better accuracy of a carbon beam as compared to photons, normal cells could also be irradiated in vicinity of the tumours treated. Thus, in order to evaluate the possible secondary effects of a carbon treatment, we compare the exposure of normal human cells to carbon ions (75 MeV/u) and to photons (X-rays). Survival curves were performed to select irradiation doses in both cases, X- or C-exposure. Oxidative stress was assessed in these cells to observe induced early and long-term cellular responses following radiation exposure (hours, days and weeks). Since exposure to high-LET ions is known to create DNA damage that are difficult to repair and that often lead to cell death, DNA damage were measured using global or cell level techniques as comet assay and γ-H2AX immunostaining. These measurements were performed soon after the exposure and also after different periods of recovery (1 and 3 hours). The evaluation of micronuclei in the cell cultures up to 21 days after irradiation was also a good indicator of the global management of DNA injury. Then, lipid peroxidation products (MDA, 4-HNE) were quantified as well as reactive oxygen species production (by flow cytometry using DCFH-DA and HE probes). Enzymatic defence systems (catalase, superoxide dismutase and glutathione peroxidase activities) and non-enzymatic defence systems (vitamin E, reduced/oxidized gluthatione) were also investigated. First results indicated an increased efficiency in producing oxidative damage after carbon ions exposure compared to X-rays.

Article published by EDP Sciences and available at http://www.radioprotection.org
or http://dx.doi.org/10.1051/radiopro:2008670