Spectrum of complex DNA damages depends on the incident radiation

M. Hada (1,2), B.M. Sutherland (1)

(1) Biology Department, Brookhaven National Laboratory, USA, (2) Present address, NASA/JSC, USA (bms@bnl.gov/ Phone: +1-631-344-3380)

Ionizing radiation induces clustered DNA damages in DNA-two or more abasic sites, oxidized bases and strand breaks on opposite DNA strands within a few helical turns. Clustered damages are considered to be difficult to repair and therefore potentially lethal and mutagenic damages. Although induction of single strand breaks and isolated lesions has been studied extensively, little is known of factors affecting induction of clusters other than double strand breaks (DSB). The aim of the present study was to determine whether the type of incident radiation could affect yield or spectra of specific clusters.

Genomic T7 DNA, a simple 40 kbp linear, blunt-ended molecule, was irradiated in non-scavenging buffer conditions with Fe (970 MeV/n), Ti (980 MeV/n), C (293 MeV/n), Si (586 MeV/n) ions, or protons (1 GeV/n) at the NASA Space Radiation Laboratory or with 100 kVp X-rays. Irradiated DNA was treated with homogeneous Fpg or Nfo proteins (or without enzyme treatment for DSB quantitation), then electrophoresed in neutral agarose gels. DSB, Fpg-OxyPurine clusters, and Nfo-Abasic clusters were quantified by number average length analysis.

The results show that the yields of all these complex damages depend on the incident radiation. Although LETs are similar, protons induced twice as many DSBs than did X-rays. Further, the spectrum of damage also depends on the radiation. The yield (damage/Mbp/Gy) of all damages decreased with increasing linear energy transfer (LET) of the radiation. The relative frequencies of DSBs to Abasic- and OxyBase clusters were higher for the charged particles—including the high energy, low LET protons—than for the ionizing photons.

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