DNA DAMAGE IN MAMMALIAN CELLS BY NON-THERMAL ATMOSPHERIC PRESSURE MICROSECOND PULSED DIELECTRIC BARRIER DISCHARGE PLASMA IS NOT MEDIATED VIA LIPID PEROXIDATION

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Non-thermal dielectric barrier discharge plasma (DBD) is being widely developed for various applications ranging from wound healing to cancer therapy. It is very important that we understand how non-thermal DBD plasma interacts with mammalian cells.

Previously, we have shown that non-thermal DBD plasma has dose-dependent effects from increasing cell proliferation to inducing apoptosis and that these effects are primarily due to the formation of reactive oxygen species (ROS). It was also shown that non-thermal plasma treatment of mammalian cells submerged in a shallow layer of culture medium can result in dose dependent DNA damage. We specifically examined the induction of DNA damage by DBD plasma and showed that DNA damage is induced by organic peroxides formed as a result of ROS produced by neutral active species, which are generated by DBD plasma in cell culture medium [1]. In this sense plasma can create effects similar to ionizing radiation (IR). However, while IR penetrates through cell membranes creating ROS in the immediate vicinity of DNA, plasma treatment acts on cells through cell medium. The question arises: By what mechanisms do non-thermal plasma effects reach across cell membrane? There are several possibilities. One involves peroxidation of lipid membrane with malondialdehyde (MDA) as a by-product. The by-products of lipid peroxidation have been known to create bulky adducts on DNA [2] which is a form of damage requiring repair.

The goal of this work was to test the hypothesis that non-thermal plasma induced DNA damage in mammalian cells is mediated by plasma induced lipid peroxidation. We show that non-thermal plasma indeed induces lipid peroxidation, measured by release of MDA, in cells treated under medium and not under phosphate buffered saline (PBS). We further show that although non-thermal plasma induces lipid peroxidation in mammalian cells, plasma induced lipid peroxidation does not lead to DNA damage. Thus, one needs to consider other possible mechanisms for plasma induced DNA damage in mammalian cells such as ROS signaling or active transport of organic peroxides.

References:

[1] Kalghatgi S, et. al. 2009 Proc. 17th IEEE Pulsed Power Conference, Washington DC, pp 1133 - 1138
[2] Marnett, L. 1999 Mutation Research **424** pp 83 – 95