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Atmospheric Pressure Plasma jet for Biomedical Applications

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Atmospheric pressure non-thermal (i.e., cold) plasmas especially atmospheric pressure plasma jets are widely studied in plasma medicine and used for various therapeutic applications. These cold plasmas for tumor treatment or for skin infection etc. is promising and emerging field. Recently, the use of plasma in dermatology, cancer research and oncology are of particular interest. In this talk, an overview will be given about the activities performed in this field at Institute for Plasma Research in collaboration with different medical Institutes in India.
A low temperature atmospheric pressure plasmas like atmospheric pressure plasma jets (APPJ) operating with Helium/Argon gas as well as volume and surface dielectric barrier discharge (DBD) air plasmas are developed at Institute for Plasma Research (IPR). These atmospheric pressure plasmas have been explored for various applications like surface sterilization, cancer cell treatment, skin treatment, blood coagulation etc.
The treatment modality of oral cancers comprises of surgical resection of the tumor in conjunction with chemotherapy or radiation therapy which have limitations, such as, free flap reconstruction post-surgery, high radiation dose in radiotherapy and chemo-resistance in chemotherapy. To address these limitations, we have explored the effect of non-thermal / cold atmospheric plasma (CAP) in treatment of oral cancer cells lines. Here, CAP has shown to induce cancer cell death. We firstly established the in vitro efficacy of plasma treatment on GB-SCC, MCF7 and HEK293 cell lines using MTT assay. We observed a time dependent decrease in the cell viability on treatment with plasma jet. We further analysed its effect on in vivo hamster buccal pouch (HBP) model. Tumor was induced in hamsters and direct CAP treatment was initiated to observe CAP induced tumor regression over period of time.

Further helium-based CAP was applied on resected tumor specimens obtained from patients with glioma. The results show that CAP was effective in generating enhanced levels of RONS in glioma samples and CAP jet is more effective in thinner samples as compared to thick tumor samples. Our findings suggests that CAP could lead to RONS-mediated tumor cell death and can be potentially used as an adjunct therapy for treatment on the tumor bed, post resection of tumor in patients with glioma. The atmospheric pressure DBD air plasma was also used for sterilization and decontamination of the surfaces. The results showed that the air plasma effectively kills microbes likes bacteria, Fungus and virus on the different surfaces after treatment of few minutes.

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