Comparative Study of the Cancer Treatment Potential of Tumor-Treating Fields and Cold Atmospheric Plasma Treatment

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Introduction
Treatment of glioblastoma multiforme (GBM) continues to remain a challenge using conventional treatment. In this study we compare the efficacy of TTFields and CAP in GBM using human glioblastoma (U87) cells.

What is Cold Atmospheric Plasma?
Cold atmospheric plasma is a high-energy ionized state of matter that generates a spectra of reactive oxygen (and nitrogen) species. The generation of these species is maximized by using pure helium gas as the carrying gas to trigger the discharge process and form the CAP with a flow rate of 8L/min. The electrodes were connected to a high voltage resonant transformer (8 kV peak, frequency 12.5 kHz).

The Activation State

Plasma-Generated Emission Spectra

* N2/He (N2/H2 + He), * He/He (N2/H2 + He), ** N2/He (N2/H2 + He), *** He/He (N2/H2 + He)

Wavelength (nm)

Plasma-Generated Reactive Species in vitro

Treatment with cold atmospheric plasma results in the accumulation of intracellular reactive oxygen species, with peak ROS generation occurring at 60 seconds.

Plasma-Mediated Sensitization to Chemotherapy

** In Vitro Cell Viability

Treatment with TMZ treatment results in a cellular "activation state" that sensitzes cells to temozolomide treatment.

Conclusions & Future Directions
Glioblastoma multiforme (GBM) is the most common and aggressive form of primary CNS malignancy in adults. With a median survival time of 12 – 18 months with standard treatment (temozolomide + surgical resection + radiation therapy), treatment has thus far remained elusive. Cold atmospheric plasma has been shown in other oncological contexts to have a therapeutic benefit. In recent years, tumor treating fields (TTFields) has emerged as a non-invasive therapeutic option for solid tumors. TTFields utilize alternating low and intermediate frequency electric fields to induce cell cycle arrest and apoptosis of neoplastic cells through two possible mechanisms - anti-microtubule action and dielectrophoretic morphological changes within the cell. The specific frequency of the field is tuned according to tumor type (200 kHz for GBM) and delivered through four dermal transducer arrays (on a shaved head) over a median duration of 20 hours/day. In GBM, co-treatment with TMZ and TTFields has been shown to increase progression-free survival and overall survival, with treatment duration (hours per day) directly correlated to these metrics. In this study we compare the efficacy of TTFields and CAP in GBM using human glioblastoma (U87) cells. In both TTFields and CAP, an energy dose-dependent reduction in cell viability was seen. CAP achieved comparable cell death in 30 seconds and at a significantly lower energy dose than TTFields, indicating that CAP may be the more favorable treatment option.