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Selective Anticancer Effects of Cold Atmospheric Pressure Plasma Via RONS-Mediated Redox Dysregulation in Lung Cancer Cells

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ABSTRACT

Introduction: Cold atmospheric plasma (CAP) acts as a redox-modulating anticancer modality by generating reactive oxygen and nitrogen species (RONS). This process elevates lipid peroxidation (measured as malondialdehyde [MDA]), suppress superoxide dismutase (SOD) activity, and trigger oxidative stress-driven apoptosis. The integrated assessment of RONS, MDA, and SOD delineates the mechanistic basis of CAP-induced redox disequilibrium and cytotoxicity in lung cancer cells.

Materials and Methods: Human and murine lung cancer cells were exposed to helium-based CAP at voltages of 4 kV and 6 kV for 180 s using a flexible microplasma jet. Analyses were performed 24 h after the treatment. CAP-induced oxidative stress was analyzed by quantifying intracellular RONS, MDA, and SOD activity, while cytotoxicity was evaluated using the MTT assay.

Results and Discussion: CAP treatment markedly modulated the intracellular redox status in a voltage-dependent manner. At 6 kV, levels of intracellular RONS and MDA increased significantly, while SOD activity and cell viability (as measured by the MTT assay) decreased compared to 4 kV treatment. This outcome indicates that higher voltage led to greater disruption and induces apoptosis.

Conclusion: CAP treatment at 6 kV induced a marked rise in intracellular RONS and MDA levels, with a concurrent decline in SOD activity and cell viability, indicating a severe redox imbalance and apoptosis induction compared to 4 kV treatment.

Keywords: A549, Cold atmospheric pressure plasma, Helium, LL/2 cell lines, Lung cancer

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