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Cold Atmospheric Plasma: A Novel Therapeutic Modality for Breast Cancer

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ABSTRACT

Introduction: Breast cancer remains one of the most prevalent and challenging malignancies worldwide, driving the need for innovative and targeted therapeutic strategies. Cold atmospheric plasma (CAP), a partially ionized gas generated at room temperature and atmospheric pressure, has emerged as a promising anticancer agent.

Materials and Methods: CAP did not directly interact with cells through heat, but rather through the delivery of a complex mixture of reactive oxygen and nitrogen species, charged particles, and electric fields. When applied to breast cancer cells in vitro, CAP induced a series of biological effects, including oxidative stress-mediated apoptosis (programmed cell death), cell cycle arrest, and the inhibition of cell migration and invasion, key processes in metastasis.

Results and Discussion: A key advantage of CAP is its selectivity; several studies report that CAP treatment can selectively induce death in malignant cells while causing minimal damage to non-malignant mammary epithelial cells. Furthermore, CAP has shown promise in preclinical models for targeting cancer stem cells, a subpopulation implicated in tumor recurrence and resistance to therapy. In vivo studies using murine models have corroborated these findings, showing significant reductions in tumor growth with direct CAP application.

Conclusion: While the research in this area is still predominantly at the preclinical stage, these compelling results position CAP as a potent, multi-modal, and minimally invasive physical agent for the local and adjuvant treatment of breast cancer.

Keywords: Breast cancer, Cold atmospheric plasma, in vitro, in vivo

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