A Novel Approach to Improving Photodynamic Therapy Through Analysis of the Effects of Induced Hypoxia and Utilization of Bioluminescence, Year Two

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Photodynamic therapy (PDT) is a form of cancer treatment that involves administering a photosensitizing drug and irradiating it with an external light source. Upon exposure, the photosensitizer produces reactive oxygen species (ROS) which are toxic to the macromolecules within cells and results in their death. This project focused on developing a novel approach to overcoming two major obstacles involved in PDT through the investigation of the effects of hypoxia induction and utilization of bioluminescence. These primary drawbacks are the low penetration depth of external light sources and the insufficient production of ROS due to hypoxic regions in large tumors. A cell viability assay was performed after culturing cancerous mammalian cells expressing luciferase under hypoxic and normoxic conditions when photosensitive and/or bioluminescent reagents were present. Both the Rose Bengal and hypericin photosensitizers at high concentrations were viable, with the external light source generating a greater statistically significant ($p<=0.0002$) decrease in cell viability than the bioluminescent reagent. When hypoxic conditions were generated using an enzymatic hypoxia induction system, the groups utilizing bioluminescence as a light source experienced a greater statistically significant ($p<0.0001$) increase in cell viability than the regular PDT trials. These results indicate that while external light is more powerful than luciferin as a light source, the beneficial impact of elevated oxygen levels is the most significant when implementing PDT with bioluminescence, supporting the experimental hypothesis. This research provides valuable knowledge in improving PDT treatment as a whole, paving the way for the development of a non-invasive, effective cure for cancer.