Lorem Calor: Photothermal Cancer Therapeutics Using Noble Metallic Nanoparticles

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Abstract

Current clinical methods to treat tumors with hyperthermia often employ high power laser light, with a narrow intensity and poor cell type selectivity. This nonspecificity of laser light, combined with the need for high power output (on the scale of tens to hundreds of watts), can expose and kill off normal, healthy cells in the path of the source. Plasmonic nanoparticles have been proposed as tunable photothermal agents to enhance the localized temperature capacity of surrounding tissue while minimizing the damage to healthy tissue. Given the multitude of nanoparticle functionalization methods, sizes, and shapes of plasmonic nanoparticles, tailoring SPR wavelengths to the NIR region is possible, which may allow for deeper penetration, more selective photothermal capacity, and a higher potential for active binding to tumors. Initial clinical and preclinical studies show promising results for the shrinkage of targeted tumors, however, there is still cause for concern towards topics such as toxicity, thermal breakdown of the nanoparticle itself, undesired side effects of localized necrosis, and of missed metastases during photothermal treatment. Combination therapies, such as chemotherapy combined with photothermal therapy, have attempted to maximize synergistic therapeutic effects, and may act as a valuable solution to the limitations produced by PTT alone. Large animal studies and clinical trials will also be necessary to tune the parameters for optimal tumor destruction with minimal necrosis, especially for deep tissue tumors.

1. Background

1.1 The Rise of Photothermal Treatment For Cancer Therapy

Cancer is the second leading cause of death in the United States, killing an estimated 595,000 citizens in 2016 alone [1]. The main lethal cancer types include metastasis of the lungs and bronchus, colon and rectum, the prostate, and the breast [1] (fig.1). The cost of care for treatment is projected to reach $157 billion by 2020, largely due to population growth and aging [2]. Current methods for cancer treatment include chemotherapy, invasive surgery, immunotherapy, and more targeted methods, including small molecule drugs and monoclonal antibodies [3]. Given the wide-reaching systemic response to some of these treatment methods, novel site-specific approaches are being sought out to treat cancer in the absence of significant healthy tissue death.