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Abstract

Thermal therapy is a very promising method for cancer treatment, which can be combined with chemotherapy, radiotherapy and other programs for enhanced cancer treatment. In order to get a better effect of thermal therapy in clinical applications, optimal internal temperature distribution of the tissue embedded with gold nanoparticles (GNPs) for enhanced thermal therapy was investigated in present research. The Monte Carlo method was applied to calculate the heat generation of the tissue embedded with GNPs irradiated by continuous laser. To have a better insight into the physical problem of heat transfer in tissues, the two-energy equation was employed to calculate the temperature distribution of the tissue in the process of GNPs enhanced therapy. The Arrhenius equation was applied to evaluate the degree of permanent thermal damage. A parametric study was performed to investigate the influence factors on the tissue internal temperature distribution, such as incident light intensity, the GNPs volume fraction, the periodic heating and cooling time, and the incident light position. It was found that period heating and cooling strategy can effectively avoid overheating of skin surface and heat damage of healthy tissue. Lower GNPs volume fraction will be better for the heat source distribution. Furthermore, the ring heating strategy is superior to the central heating strategy in the treatment effect. All the analysis provides theoretical guidance for optimal temperature control of tissue embedded with GNP for enhanced thermal therapy.

Keyword: Thermal therapy; gold nanoparticle; two-energy equation; optimal temperature control