The Efficacy of Near Infrared-activated Gold Nanoparticles to Treat Atherosclerosis: A Simulation Study

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Cardiovascular disease is the leading cause of death and is typically caused by atherosclerosis, or arterial plaque buildup. Photothermal gold nanoparticles are emerging in medical studies to induce targeted hyperthermia, killing cells and clearing clots. This study investigated near-infrared activated gold nanoparticles (AuNPs) as a minimally invasive photothermal treatment for atherosclerosis, which could generate localized hyperthermia to soften plaque and improve flow through a simulated stenosed artery. It was hypothesized that the NIR-activated gold nanoparticles would increase blood flow, and greater AuNP concentrations would enhance photothermal heating and flow. To complete experimentation, gold nanoparticles were synthesized using citrate reduction and characterized using UV-Vis spectroscopy to confirm plasmon resonance. Aspirin-functionalized AuNPs were also prepared and similarly analyzed. Simulated stenosed arteries were constructed using vinyl tubing with an internal plaque blockage. Simulated blood with varying concentrations of AuNPs was added to an artery and exposed to NIR light. Temperature was recorded at 0, 5, and 10 minutes, and flow performance was evaluated by measuring the time required for 1 mL to drip out of the tube. This process was repeated 3 times for each of the 3 controls and 4 samples. The results supported the hypothesis and demonstrated that gold nanoparticles, when activated by near-infrared light, increase temperature and improve flow rate, with higher concentrations producing greater effects. Additionally, aspirin modification did not significantly reduce the photothermal properties of the gold nanoparticles. These findings are an innovative approach that supports research for a minimally invasive treatment for atherosclerosis.

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