FUNCTIONALIZED GOLD NANOPARTICLES AS DAMAGE-SPECIFIC X-RAY COMPUTED TOMOGRAPHY CONTRAST AGENTS IN BONE TISSUE

Abstract

By

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The accumulation of microdamage has been linked to clinical bone fragility and increased fracture susceptibility. Damage is normally repaired by a cellular remodeling process. However, a fracture may occur if damage accumulates faster than it can be repaired. Current methods for imaging microdamage are inherently invasive, destructive and two-dimensional. The development of a targeted, deliverable X-ray contrast agent would allow for specific and three-dimensional imaging of microdamage *in vitro* and potentially *in vivo*. Therefore, the objective of this research was to investigate the use of surface functionalized gold nanoparticles as damage-specific X-ray contrast agents. Gold nanoparticles were synthesized and functionalized with carboxylate, phosphonate, or bisphosphonate molecules for targeting calcium. Functionalized gold nanoparticles were characterized and compared based on their colloidal stability and binding affinity to both a synthetic bone mineral analog and damaged bone tissue. Bisphosphonate functionalized Au NPs exhibited the most rapid binding kinetics and highest binding affinity. Bisphosphonate functionalized Au NPs of varying particle diameter were also prepared to investigate nanoparticles size effects on X-ray attenuation and

deliverability. Damaged bone tissue labeled by bisphosphonate functionalized Au NPs was able to be detected using absorption edge subtraction in X-ray tomography. Other novel X-ray imaging methods were also to potentially improve the detection of nanoscale contrast agents. In summary, the ability to utilize functionalized gold nanoparticles as targeted X-ray contrast agents for microdamage in bone tissue was found be to feasible with improved X-ray imaging techniques.