A Novel Nanomaterial as a Multifunctional Contrast Agent for Targeted X-ray and Fluorescent Biomedical Imaging

Jain, Arjun (School: Catlin Gabel School)

Rapidly evolving cellular imaging techniques deliver improved diagnostic specificity and complement the spatial visualization of x-ray CT imaging. Both types of imaging need contrast agents – CT scanning uses high atomic number elements to attenuate x-rays, and cellular imaging uses fluorescent molecules to visualize cellular targets under near-infrared (NIR) excitation. This research developed a commercially attractive contrast agent which functions effectively for both the imaging modalities, eliminating the need for two distinct agents. Multi-layer hybrid nanoparticles (NPs) were synthesized with a metal core, a silica shell to eliminate toxicity and allow for surface bioconjugation of ligands, and a lanthanide fluorophore to enhance photoluminescence. Bismuth, a heavy metal which is 1400 times cheaper than gold, was tested as an alternative to precious metals (gold and silver) used in current fluorescent agents. NPs with the bismuth core exhibited 2.8 times the x-ray attenuation of commonly used CT contrast agent iohexol, and were 21% more photoluminescent than gold NPs under NIR light excitation, proving their bimodality, i.e., effectiveness as an agent for both CT and photoluminescent imaging. In-vitro cellular imaging study with J774 murine macrophages proved the successful uptake of the contrast agent and resulted in highly differentiated cell images under NIR excitation. The NPs have a silica surface which can bind with ligands to target specific cells to be imaged. They are also viable candidates for in-vivo imaging since their excitation and emission wavelengths lie within the safe biological range. Therefore, the research has created an inexpensive, multifunctional contrast agent with effective surface plasmon resonance and x-ray attenuation properties.

Awards Won:
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