This work describes a novel in vitro technique for cancer detection and treatment using X-ray radiation and nanoparticles. Surfaces of synthesized metallic nanoparticles have been modified with appropriate ligands to specifically target cancer cells and biomarkers in vitro. Characteristic fluorescence signals from the X-ray irradiated nanoparticles are then used for detecting the presence of cancer. The method enables simultaneous detection of multiple cancer biomarkers allowing accurate diagnosis and early detection of cancer. Circulating tumor cells, which are the primary indicators of cancer metastasis, have also been detected where the use of magnetic nanoparticles allows enrichment of rare cancer cells prior to detection. The approach is unique in that it integrates cancer detection and treatment under one platform because X-rays have been shown to effectively kill cancer cells through radiation induced DNA damage. Due to high penetrating power of X-rays the method has potential applications for in vivo detection of deeply buried cancers in humans.

Toxicity of bismuth nanoparticles on multiple cell types have been investigated using conventional cytotoxicity assays for both unmodified nanoparticles as well as nanoparticles modified with a variety of surface coatings. Appropriate surface modifications have significantly reduced inherent toxicity of the nanoparticles providing possibilities for future clinical applications.

To investigate cellular damages caused by X-ray radiation, an on-chip biodosimeter has been fabricated based on three dimensional microtissues which allows direct monitoring of responses to X-ray exposure for multiple mammalian cell types. An analytical approach is used to investigate the various parameters that affect the radiosensitizing properties of the nanoparticles. The results can be used to increase the efficacy of nanoparticle aided X-ray radiation therapy for cancer treatment by appropriate choice of X-ray beam energy, nanoparticle size, material composition and location of nanoparticle with respect to the tumor cell nuclei.

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The public is welcome to attend.