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Development and molecular understanding of plasmonic photothermal therapy in combating cancer

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In cancer plasmonic photothermal therapy (PPTT), gold nanoparticles (AuNPs) are used to convert light energy into localized heat leading to cancer cell death. Among plasmonic nanoparticles, gold nanorods (AuNRs) have been widely used as they absorb near-infrared (NIR) laser light (safe to biological system). Herein, we developed a new AuNRs formulations technique, yielding better generation of AuNRs, enhanced cancer cell targeting and thus is more selective and efficient. On the other hand, the detailed mechanism of PPTT remains poorly understood. Thus, upon PPTT we used Surface Enhanced Raman Spectroscopy (SERS) to detect time-dependent changes in the intensities of the vibration frequencies of molecules. We complemented the study of changes in SERS spectra with metabolomics, proteomics and western blots through network analysis. It showed several apoptosis pathways (favorable death pathway compared to necrosis) were activated, which are consistent with the proposed role of altered phenylalanine metabolism in inducing apoptosis. We study the AuNPs' effect on mechanical properties of cancer cells using high-resolution three-dimensional imaging and atomic force microscope. Moving from cells to animals, in xenograft mice, we explored the death pathway using proteomic analysis and immunohistochemistry in mouse tumor tissues, indicated that PPTT trigger cancer death via apoptosis with no remarkable toxicity to mice, even after 15 months from treatment. Furthermore, the feasibility of PPTT has been verified on natural tumors in dogs and cats without any relapse or toxicity effects even after 1 year of treatment. In conclusion, together these data on cells, mice, cats and dogs demonstrated that our AuNR-PPTT inducing apoptosis is effective and safe for cancer therapy provides a strong framework for translation of this approach to the clinic.

Biography

Moustafa R K Ali has received his BS in Chemistry from Cairo University, Egypt. He is currently a PhD candidate in Prof. Mostafa A. El-Sayed's Lab in Chemistry & Biochemistry Department in Georgia Institute of Technology. His present research focuses on the nano-bio interaction and nanomedicine.

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