Radiolabeled and biomimetic gold nanoparticles for photo-thermal therapy applications

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Cancer is one of the most significant diseases worldwide and remains a primary cause of death. Although extraordinary progresses in realizing innovative cancer treatments, we still face enormous challenges in the fight against cancer. Multitherapy is an innovative and efficient cancer cure that exploits the synergistic approach of two or more anti-tumor therapeutics. In this framework, the powerful combination of conventional cancer treatments, such as chemotherapy or radiotherapy and nanotechnology-based treatments, has provided exciting and unique opportunities in the never-ending battle against cancer. Inspired by the multitherapeutic treatments, we have realized a new generation of theranostic nanomaterials that use biomimetic, keratin-coated, gold nanoparticles (Ker-AuNPs) radiolabeled with ^{99m}Tc. The effective radiolabeling of Ker-AuNPs with ^{99m}Tc is achieved using the chelating agent Diethylenetriaminepentaacetic (DTPA), resulting in the ^{99m}Tc-DTPA-Ker-AuNPs nanoconjugate. The ^{99m}Tc-DTPA-Ker-AuNPs display a radiochemical purity of 90.7%, elevated biocompatibility (tested with healthy human embryonic kidney cells), and excellent photo-thermal property. The latter is used for testing the capability of implementing an innovative photo-thermal therapy (PTT)-based cancer cure that includes radio imaging capabilities (theranostic agent). A Lab-On-a-Chip (LoC) approach that makes use of a nephron-like microfluidic circuit, thus mimicking the renal filtering unit, is realized to localize and study the stability of ^{99m}Tc-DTPA-Ker-AuNPs under dynamic conditions. Combining the results obtained in this study and the potential future improvements, a sophisticated model of PTT against primary tumors can be achieved. This opportunity will produce a selective accumulation of ^{99m}Tc-DTPA-Ker-AuNPs to a specific tumor area, enabling active tracking, localizing, and PPT-assisted therapy or multitherapy.