

Title : A simulation study on the radiosensitization properties of gold nanorods

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Abstract: Gold nanorods (GNRs) have emerged as versatile nanoparticles with unique properties, holding promise in various modalities of cancer treatment through drug delivery and photothermal therapy. In the rapidly evolving field of nanoparticle radiosensitization (NPRS) for cancer therapy, this study assessed the potential of gold nanorods as radiosensitizing agents by quantifying the key features of NPRS, such as secondary electron emission and dose enhancement, using Monte Carlo simulations. *Approach.* Employing the TOPAS track structure code, we conducted a comprehensive evaluation of the radiosensitization behavior of spherical gold nanoparticles and gold nanorods. We systematically explored the impact of nanorod geometry (in particular size and aspect ratio) and orientation on secondary electron emission and deposited energy ratio, providing validated results against previously published simulations. *Main results.* Our findings demonstrate that gold nanorods exhibit comparable secondary electron emission to their spherical counterparts. Notably, nanorods with smaller surface-area-to-volume ratios (SA:V) and alignment with the incident photon beam proved to be more efficient radiosensitizing agents, showing superiority in emitted electron fluence. However, in the microscale, the deposited energy ratio (DER) was not markedly influenced by the SA:V of the nanorod. Additionally, our findings revealed that the geometry of gold nanoparticles has a more significant impact on the emission of M-shell Auger electrons (with energies below 3.5 keV) than on higher-energy electrons. *Significance.* This research investigated the radiosensitization properties of gold nanorods, positioning them as promising alternatives to the more conventionally studied spherical gold nanoparticles in the context of cancer research. With increasing interest in multimodal cancer therapy, our findings have the potential to contribute valuable insights into the perspective of gold nanorods as effective multipurpose agents for synergistic photothermal therapy and radiotherapy. Future directions may involve exploring alternative metallic nanorods as well as further optimizing the geometry and coating materials, opening new possibilities for more effective cancer treatments.

Keywords: TOPAS; dose enhancement; gold nanorod; nanoparticle radio sensitization.

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