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Article

Nanodiamond Effects on Cancer Cell Radiosensitivity: The Interplay between Their Chemical/Physical Characteristics and the Irradiation Energy

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Abstract: Nanoparticles are being increasingly studied to enhance radiation effects. Among them, nanodiamonds (NDs) are taken into great consideration due to their low toxicity, inertness, chemical stability, and the possibility of surface functionalization. The objective of this study is to explore the influence of the chemical/physical properties of NDs on cellular radiosensitivity to combined treatments with radiation beams of different energies. DAOY, a human radioresistant medulloblastoma cell line was treated with NDs—differing for surface modifications [hydrogenated (H-NDs) and oxidized (OX-NDs)], size, and concentration—and analysed for (i) ND internalization and intracellular localization, (ii) clonogenic survival after combined treatment with different radiation beam energies and (iii) DNA damage and apoptosis, to explore the nature of ND–radiation biological interactions. Results show that chemical/physical characteristics of NDs are crucial in determining cell toxicity, with hydrogenated NDs (H-NDs) decreasing either cellular viability when administered alone, or cell survival when combined with radiation, depending on ND size and concentration, while OX-NDs do not. Also, irradiation at high energy (γ-rays at 1.25 MeV), in combination with H-NDs, is more efficient in eliciting radiosensitisation when compared to irradiation at lower energy (X-rays at 250 kVp). Finally, the molecular mechanisms of ND radiosensitisation was addressed, demonstrating that cell killing is mediated by the induction of Caspase-3-dependent apoptosis that is independent to DNA damage. Identifying the optimal combination of ND characteristics and radiation energy has the potential to offer a promising therapeutic strategy for tackling radioresistant cancers using H-NDs in conjunction with high-energy radiation.