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PEGylated palladium nanocubes as nanomaterials sensitizing glioblastoma cells to proton irradiation

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INTRODUCTION & AIM

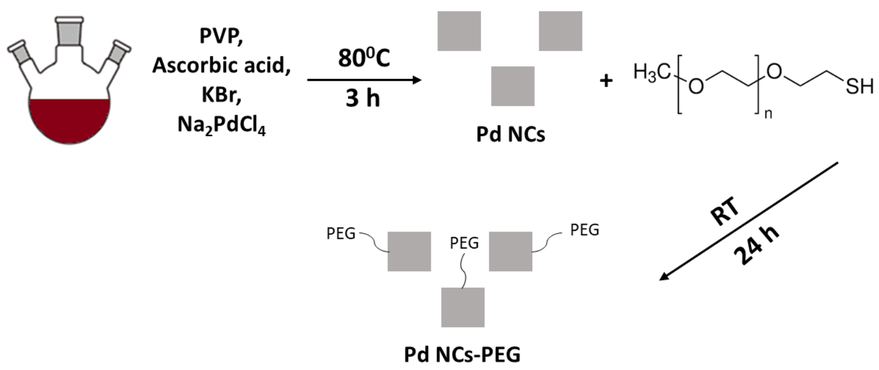
The search for innovative strategies to combat cancer remains one of the major scientific challenges of the 21st century. In this context, a nano-system based on cubic ≈ 14 nm palladium nanoparticles (Pd NCs) has been developed for use as a radiosensitizer in proton radiotherapy (PR). The application of these nanosystems enhances the sensitivity of tumor cells to subsequent proton beam irradiation. Additionally, a successful modification of Pd NCs with thiolated polyethylene glycol (Pd NCs-PEG) was carried out. The therapeutic potential of the prepared Pd NCs/Pd NCs-PEG was evaluated *in vitro* on selected glioblastoma multiforme cell lines (LN229 and U118).

Why nano-palladium?

- **High surface to volume ratio,**
- **Possibility of large-scale production avoiding organic solvents,**
- **Ease of the surface functionalization in order to obtain the desired properties,**
- **Cheaper production cost compared to more popular gold nanoparticles.**

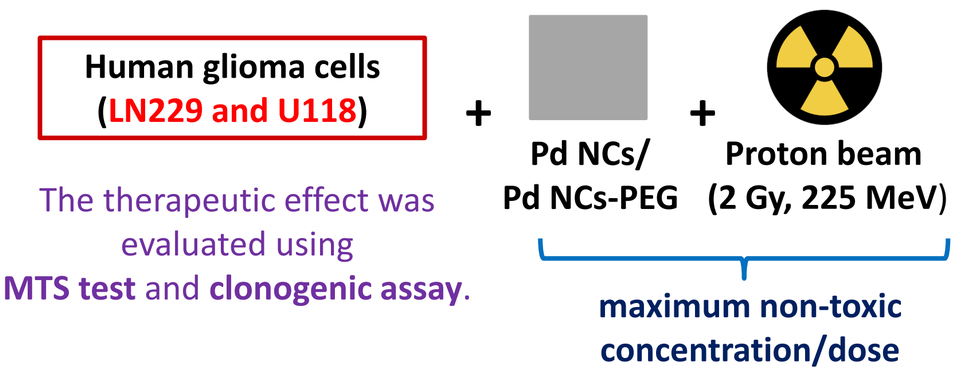
METHOD

A. Synthesis and physicochemical characterization of Pd NCs/Pd NCs-PEG



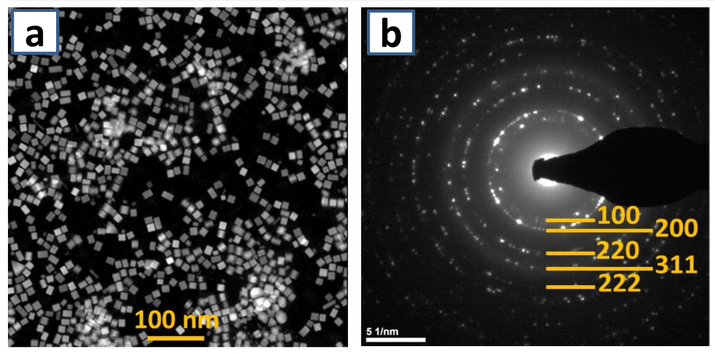
- Scanning Tranmission Electron Microscopy STEM (***morphology of NPs***)
- Selected Area Electron Diffraction SAED (***local crystallinity***)
- Microelectrophoresis (***zeta potential***)
- Fourier-Transform Infrared Spectroscopy F-TIR (***evaluation of NCs biofunctionalization***)

B. Biological tests *in vitro* – Pd NCs/Pd NCs-PEG as radiosensitizers



The therapeutic effect was evaluated using **MTS test** and **clonogenic assay**.

RESULTS & DISCUSSION



c

	Zeta potential
Pd NCs	- 20.6 mV
PEG-Pd NCs	- 1.6 mV

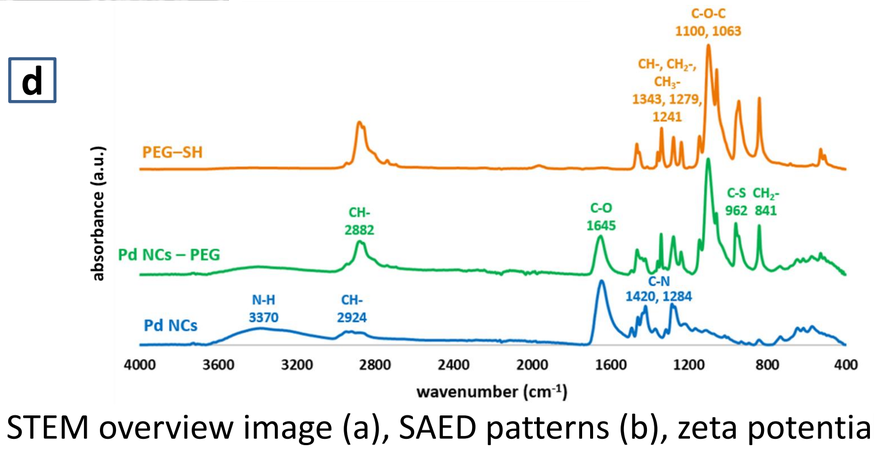


Figure 1. STEM overview image (a), SAED patterns (b), zeta potential values of the Pd NCs/Pd NCs-PEG (c) and F-TIR spectra of Pd NCs/Pd NCs-PEG and PEG-SH (d)

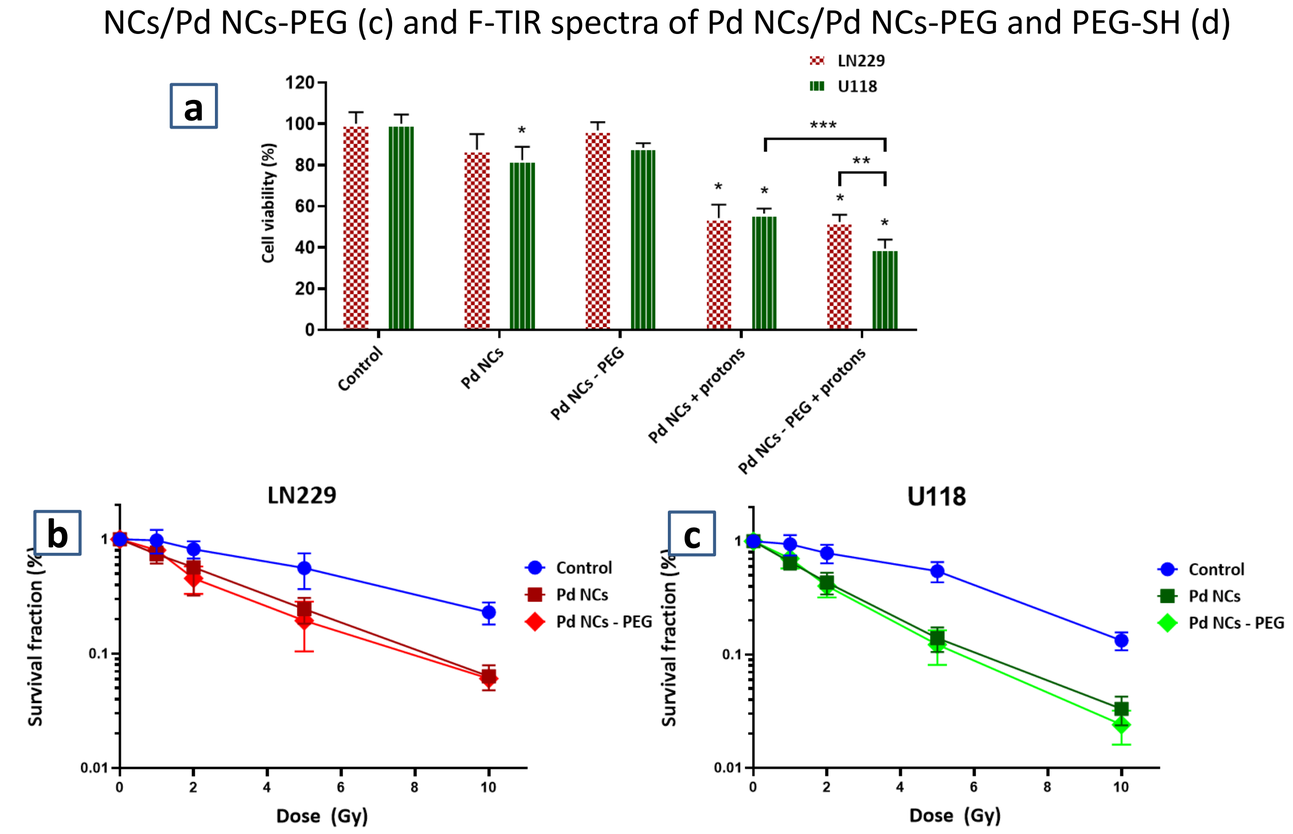


Figure 2. The MTS assay results of glioblastoma cells after 3 h incubation with NCs and irradiated with proton beam (a). Clonogenic cell survival curves of LN229 (b) and U118 (c) cells.

CONCLUSION

Both Pd NCs and Pd NCs-PEG demonstrate strong potential as radiosensitizers in proton therapy. Although their radiosensitizing effects appear comparable under the tested conditions, it is important to note that identical nanoparticle concentrations were used to enable a fair assessment of their intrinsic radiosensitizing capabilities. However, Pd NCs-PEG exhibit significantly lower cytotoxicity (data not shown), which means that higher therapeutic doses could be safely administered. Therefore, Pd NCs-PEG may serve as a “Trojan horse” system: relatively harmless on their own, yet capable of inducing a markedly enhanced therapeutic effect when combined with proton irradiation.

REFERENCES AND ACKNOWLEDGEMENTS

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