Integrating hyper-branched polyglycerol with gadolinium-iron nanozyme to achieve potent cascade superoxide dismutase-catalase activity for chemodynamic therapy

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Abstract:
Introduction
Nanozymes are nanomaterials with inherent enzyme-mimicking activities with fascinating potential in chemodynamic therapy. However, their stringent reaction conditions and limited catalytic activities remain a challenge. Herein, by integrating hyperbranched polyglycerol (hPG) with gadolinium-iron nanoparticles (GINPs), a novel hPG@GINPs nanocomposite was fabricated with enhanced catalytic activities.
Methods
The hPG was conjugated to the surface of GINPs by a ring-opening polymerization process to produce hPG@GINPs, thus facilitating the rapid electron transfer reaction with the active metal center. Cyclic voltammetry and electron impedance spectroscopic analysis of the hPG@GINPs. The uptake of hPG@GINPs in the MCF-7 and HEK 293 cells was observed through the darkfield CytoViva hyperspectral imaging system (HSI). The xCELLigence real time cell analysis (RTCA) system was used to assess cytotoxicity of the hPG@GINPs.
Results and Discussion
The hPG@GINPs showed catalytic reaction rates of about a hundred times greater than those without hPG with significant scavenging of reactive oxygen species (ROS). The enzymatic activity of the obtained hPG@GINPs nanocomposite showed excellent catalase-, peroxidase-, and oxidase-like activities. Notably, hPG@GINPs exhibited greater peroxidase-mimicking activity by mediating the decomposition of H_2O_2 into ·OH. Furthermore, the hPG@GINPs showed greater cytotoxicity towards MCF-7 cells and no toxicity towards HEK 293 cells. Moreover, the HSI system demonstrated how hPG@GINPs could enter the MCF-7 and HEK 293 cells.
Conclusion
Due to the cascade reactions, the hPG@GINPs nanozyme displayed remarkably chemodynamic therapy towards cancerous MCF-7 cells with no damage to normal HEK 293 cells, thus relieving oxidative stress-induced damage. This study presents a promising strategy for integrating hPG into GINPs with improved catalytic activity for antioxidant therapy.

Poster Presentation