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Commentary

Recent Developments in Nanomedicine for Chemo Phototherapy

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DESCRIPTION

Photodynamic Therapy (PDT) is a minimally invasive, clinically approved treatment for solid cancers. PDT's antitumor impact is dependent on the photosensitizer, molecular oxygen (O_2), and a laser with a certain wavelength and intensity cooperating in a spatiotemporal manner. Singlet oxygen ($1O_2$) is formed as a result of photochemical interactions between the light activated photosensitizer and O_2. This produces therapeutic benefits. The heterogeneous solid tumour microenvironment, on the other hand, is already hypoxic in some areas. When PDT is used alone, hypoxia reduces the efficacy of oxygen-dependent PDT and can lead to partial tumour killing and disease recurrence. As a result, combining PDT with other therapeutic interventions, such as chemotherapy (referred to as chemo phototherapy), for improved outcomes, is fascinating and has recently attracted attention. In fact, nanotechnology-based multimodal synergistic therapy is gaining traction as a promising treatment option.

Researchers have devised a number of strategies to alleviate tumour hypoxia and improve PDT performance in order to circumvent the hypoxia bottleneck. For increased PDT, one technique is to administer Perfluorocarbons (PFCs) containing exogenous oxygen. However, the adverse effects of PFC in humans include decreased arterial pressure, lung damage, thrombocytopenia, and flu-like symptoms, as well as questions about dosage form stability. The other method is to produce oxygen by decomposing H_2O_2, which is typically increased in cancer cells compared to normal cells. Nanoparticle-based targeted administration of Catalase (CAT) has been established for this purpose, alleviating tumour hypoxia and improving PDT. However, being a 240 kDa bio macromolecule, it has poor stability and loading difficulties.

To overcome the constraints of natural enzymes, nanozymes (nanomaterials having enzyme like properties) with cheap cost, high stability, and mass manufacturing have recently been produced. Nanozymes may potentially have other multifunctional features, such as the capacity to image. Several CAT-like nanozymes, including those based on MnO_2 and platinum, have been created and shown to be oxygen-replenishing nanomaterials.

Platinum nanoparticles (nan opt) have a high level of cytotoxicity and can be used as a chemotherapeutic agent by releasing Pt ions. To the best of our knowledge, past research papers have focused solely on nano Pt's CAT mimicry or chemotherapeutic efficacy, with little attempts to utilize their combined actions for cancer treatment. Nan opt was anchored on the Nano carriers utilizing the in situ growing approach for typical loading. The chemotherapeutic effectiveness of nanoPt may be limited due to the carrier dimension constraint (90-130 nm), having reduced influence on tumour cells in the deeper tumour parenchyma, further away from blood arteries from which they extravasate.

We produced a unique nano Pt delivery technique in this study that took use of both CAT-like activity and chemotherapeutic efficacy to produce synergistic chemo phototherapy. It's a problem to retain nanoPt free for tumour penetration, therefore avoiding the limitations of the traditional in situ growth approach, while still achieving significant loading due to their ultra-small size (3-5 nm) and hydrophilicity. The reverse phase evaporation approach was used to successfully encapsulate nanoPt in the inner aqueous cavity of liposomes. The hydrophobic, clinical photosensitizer verteporfin was loaded into the lipid bilayer.

The nanoPt/VP@Lipo that resulted was subsequently hybridized with RAW 264.7 Macrophage (M) Cell Membrane (CM) to produce nanoPt/VP@MLipo. The liposome's biomimetic features, such as extended circulation and inflammatory endothelium (e.g., tumour vasculature) targeting, are likely to be enhanced by the use of M membrane proteins. Nan opt/VP@MLipo would hold the tumour site after intravenous (i.v.) injection, where nanoPt catalysis the breakdown of large levels of H_2O_2, delivers oxygen, and so increases the VP-based PDT effect. The ultra-small nanoPt liberated by O_2 synthesized in PDT will increase tumour penetration and treatment by disrupting the liposomal barrier. The physicochemical properties of nanoPt/VP@MLipo are examined, and the chemophototherapy effectiveness of nanoPt/VP@MLipo is proven *in vitro* and *in vivo*.

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