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Perspective

Development and Applications of Metal-Containing Nanomaterial in Cancer Therapy

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ABOUT THE STUDY

Due to the wide range of potential applications and their rich compositional and structural diversity, metal-containing nanomaterial have drawn significant research attention. The majority of metal-containing nanomaterial, however, is typically primarily exploited as novel delivery systems in the field of biomedicine and lack biological activity on their own. One folate-nickel nanotube is coated with dendritic polyethylene glycol, producing a new class of metal-containing nanotubes called PEG-FA-Ni NTs. Excellent *in vitro* and *in vivo* anticancer activity comparable to that of the effective medicines doxorubicin and cisplatin has been demonstrated by the discovered PEG-FA-Ni NTs. This research suggests that PEG-FA-Ni NTs may produce more effective anti-tumor effects by causing DNA damage, obstructing cell cycle, and finally triggering apoptosis.

A global danger to public health is malignant tumour illness. Although traditional chemotherapeutic drugs are widely used to treat cancer, their high toxicity limits their therapeutic efficacy. Therefore, the creation of medications with minimal toxicity and great efficacy is crucial for the treatment of tumours. A wide range of nanomaterial have been utilised in the treatment of tumours and have had positive curative effects and ongoing development of nanotechnology. A new class of nanomaterial called metal-containing materials typically consists of a coordination polymer with metal ions acting as the junction and an organic or inorganic ligand providing support to create a spatial 3D extension. Due to the variety of their structural makeup and prospective applications, these materials have garnered a great deal of scientific attention.

The biological use of metal-containing nanoparticles is the focus of significant contemporary research efforts. Researchers discovered that [Gd@C_{82}(OH)$_{22}$]n nanoparticles with metal Gd atoms inserted in the fullerene carbon cage display low toxicity and high antineoplastic action. A water soluble ligand bridged cobalt(II) coordination polymer of 2-oxo-1,2-dihydroquinoline -3- carbaldehyde (isonicotinic) hydrazine, which has strong radical scavenging potency against different radicals and demonstrated good anticancer activity, is one of the mechanisms involved in immune enhancement, G0/G1 phase arrest, angiogenesis inhibition, and antioxidant effect. These studies demonstrate that metal-containing nanomaterials can be directly generated into nano-metal medicines and have a wide range of potential applications in the biomedical field.

Hydrophilic alteration of FA-Ni NTs is necessary to increase their solubility and lengthen the duration that blood circulates through the body. Polyethylene Glycol (PEG), one of many chemical modifiers, has been employed frequently to enhance the solubility of nanoparticles because of its superior biocompatibility, non-immunogenicity, and few adverse effects. Dendritic Polyethylene Glycol (arm-PEG), as compared to other PEG derivatives, has the advantages of much better dispersion and lower immunogenicity in the body than linear PEG. To achieve greater dispersity, the FA-Ni NTs modified with the arm-PEG (PEG-FA-Ni NTs) were obtained in this work. Additionally, in order to further broaden the anticancer spectrum of FA-Ni NTs, we examined their efficacy against a number of representative tumour cell lines *in vitro* and *in vivo*. Additionally, its antitumor mechanisms were also initially investigated.

We modified FA-Ni NTs, which are biomolecule-based metal-containing nanotubes, with dendritic PEG to further reduce aggregation, increase solubility, and lengthen the blood circulation time *in vivo* in order to address the issues of easy agglomeration and poor solubility. The obtained PEG-FA-Ni NTs demonstrated a broad spectrum of antitumor activity both *in vitro* and *in vivo*. The overall antitumor activity was comparable to that of the effective anticancer drugs DOX and cisplatin, while the toxic side effects on normal cells were noticeably less severe than those of the effective anticancer medications. Additionally, *in vitro* apoptosis, cell cycle, and DNA damage assays were used to look into the anti-tumor mechanism of PEG-FA-Ni NTs. We discovered that PEG-FA-Ni NTs can enter tumour cells without difficulty and cause apoptosis by disrupting DNA and stopping the cell cycle. This work's research broadens the use of PEG-FA-Ni NTs in the treatment of cancer and offers a potential type of metal-containing nanomedicine for chemotherapy.

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