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Peptide Conjugated Lipid Nanoparticles for Anti-Cancer Drug Delivery

Wei Xiao

State Key Laboratory of New-tech for Chinese Medicine Pharmaceutical Process, Jiangsu Kanion Pharmaceutical Co. Ltd., Lianyungang, 222001, China

ABSTRACT

Peptide Conjugated Lipid Nanoparticles and their role on Cancer Drug Delivery are reviewed here. The benefits of nanotechnology and combination style of medicine delivery are still hindered without the active ligands needed for treatment efficacy. This work analyzes the role of peptide ligands in different forms of cancer treatments targeting cells and tissues.

Keyword: Peptide-conjugated lipid nanoparticles, nanotechnology, angiogenesis, anti-angiogenesis, lung cancer, breast cancer

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***Address for Correspondence:**

Wei Xiao, State Key Laboratory of New-tech for Chinese Medicine Pharmaceutical Process, Jiangsu Kanion Pharmaceutical Co. Ltd., Lianyungang, 222001, China

Introduction

The process of self-assembly results in the formation of micro and nanoscale structures that find application in cancer therapy because of their unique and tunable nanostructures. While combination chemotherapeutics and nanotechnology are indeed useful for targeted drug delivery and improved treatment efficacy, a challenge continues to exist in the form of active targeting ligand that can be used[1-7]. This work is a review of peptides like the peptide conjugated lipid nanoparticles that are used in cancer treatment delivery.

Peptide-conjugated Lipid Nanoparticles

Sun et al. analyzed the effects of using peptide ligand structures for Doxorubicin DOX drug delivery in the case of breast cancer treatment and lymphoma treatment[8-14]. Traditionally, although DOX was effective for breast cancer treatment, the cardiotoxicity concerns necessitated the research into finding more suitable alternatives for drug delivery. Nanotechnology-enabled better ways of administration where drugs were directed to the tumor site. Selective accumulation at the site was possible because of how nanotechnology created better permeability and retention. Sun et al[15]. propose a solution for active targeting ligands in the form of an RGD peptide ligand. The peptide ligand assured safety and delivered DOX into the targeted cells efficiently[16-24].

Cheng et al. in their evaluation of peptide-conjugated lipid nanoparticles as DDS in lung and cervical carcinomas were able to identify that T7 peptide conjugating caused a more enhanced cellular uptake of the tumor cell targeting lipid nanoparticles (LNPs) than the non-targeted LNPs. Chemotherapeutic drugs are used to treat lung cancer. Drugs such as paclitaxel are used as part of an effective treatment plan. However, they have a range of side effects and limited efficacy[25]. The antisense oligonucleotides ASOs are particularly useful for target gene translation and for modulating programmed cell death. However, ASOs face challenges as well. Some of them suffer nuclease degradation or have a low permeability. Off-target effects result in increased cytotoxicity[15,26-30]. Target binding affinity is low which means more drug would be needed to ensure that the target cells are reached. In this context, the use of the T7 peptide helps in providing high affinity, and hence better tumor cell targeting is achieved. Cheng et al[21] assessed the efficiency rates of the drug in their studies. The authors conducted both in vitro and in vivo studies. They were able to identify that the T7 ligand attachment to the surface was efficient than non-conjugated LNPs. The overall anti-tumor activity of the conjugated peptides was hence stronger. More survival time was noticed in the mice considered as part of the study, and furthermore, the effective targeted action will be helpful in reducing cytotoxicity[31-34].

Peptide-conjugated nanoparticles are useful for the targeted imaging and therapy of prostate cancer. In the development of anti-cancer drugs, it has been identified that many medications are not that efficient. In-vitro biopanning helped Yeh et al.[35] to identify those peptide phages that will be useful as an anti-cancer treatment. Peptides are short-chain amino acid monomers. The peptide or the amide bond links the short chain monomers. As they form longer chains, the

protein structure is visible. On the other hand, as just short chains, they signal cells. This aspect of specific peptide phages is used for targeting prostate cancer cells. Target specific action was analyzed by researchers Yeh et al.[35] using the ELISA and the flow cytometry method. The authors made use of doxorubicin and vinorelbine. The purpose of peptide conjugated nanoparticles is hence more efficient in treatment delivery and effects. Tumor targeting ability as tested with a xenograft model supports this assessment[36,37]. In addition to targeting tumors, and delivering drugs to the site of needed action, the peptides are useful for enhancing drug effects as well. The phages helped deliver drugs to the end target which is the tumor. These targeting effects were validated in a xenograft model, in which a high accumulation of targeting phage was observed.

Peptide-conjugated nanoparticles are active for the targeted therapy of various ways of cancer and different forms of treatment. Research on the use of peptide conjugated nanoparticles was conducted by Yu et al. where the authors made use of them in antiangiogenic cancer therapy. "Angiogenesis plays a critical role in the growth of cancer because solid tumors need a blood supply if they are to grow beyond a few millimeters in size. Tumors can cause this blood supply to form by giving off chemical signals that stimulate angiogenesis. Tumors can stimulate nearby normal cells to produce angiogenesis signaling molecules". Tumor cells could cause the formation of new blood vessels whose sole activity is to support the cancer cells, and this helps the cancer cells proliferate faster to form new cancer cell clusters (the process of metastases). Thus, in the context of cancer, anti-angiogenesis refers to the inhibition of the formation of those new vessels that make the cancer cells thrive. The researchers used a drug delivery system DDS where the nanoparticles conjugated with the peptides[6-13]. The size of the conjugated nanoparticles made it easier for those particles to be assimilated and internalized within the human umbilical vein and expected antiangiogenic activity occurred. This antiangiogenic activity targeted the tumor's neovasculature structure, cutting off its blood supply. This leads to the death of the tissues, such as the necrosis of the tissues. Thus, the use of nanoparticulate peptide-based DDS strategies could aid in targeted necrosis and apoptosis of cancer cells and tissues as compared to other forms of drug delivery.

Conclusion

The work sought to present the role of Peptide-conjugated Lipid Nanoparticles on Anti-Cancer Drug Delivery. Secondary research review was conducted, and the different ways that lipid nanoparticles and ligand structures are used for improving transportation of the drug to target sites are assessed.

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