



Novel drug delivery systems based on silver nanoparticles, hyaluronic acid, lipid nanoparticles and liposomes for cancer treatment

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Abstract

Drug delivery is a method to control the delivery of pharmaceutical compound to achieve therapeutic effect in humans or animals. Several active pharmaceutical ingredients (APIs) used in chemotherapy are cytotoxic to both cancer and normal cells. The combination of anticancer immunotherapy and conventional therapy is attractive as the new strategy to treat cancer whilst reducing cytotoxic side effects on the normal, healthy cells. Silver nanoparticles (AgNPs) have been developed as active drug delivery agents with anticancer, antibacterial, antiviral, antifungal, and antioxidant activities. The AgNPs exhibit enhanced physicochemical, optical, electrical, thermal and catalytic properties as compared to the bulk material. There are advantages as drug carriers including adjustable size and shape, high-density surface ligand attachment, enhanced stability for surface-bound nucleic acids, protection of the attached therapeutics from degradation, transmembrane delivery without harsh transfection agents, and high potential for improved timed/controlled intracellular drug delivery. However, AgNPs are toxic to normal cells and synergistic applications with natural products have been explored. Hyaluronic acid (HA) is a polysaccharide that has been widely explored for the development of anticancer therapies due to its ability to target CD44 receptors on cancer cells. HA can be used as a carrier and form conjugates with other drugs or for the delivery of multiple drugs to various pathological sites, for timing and targeted release. A novel HA-based strategy for the green synthesis of AgNP utilizes HA as reducing agent and stabilizer. Other most studied carrier systems to enhance drug delivery are lipid-based nanoparticles and liposomes. In pharmaceutical and cosmetic industries, liposome has been used to transport various molecules, and liposomal encapsulation of anti-cancer drugs is a stable platform for targeted delivery of anti-cancer drugs for cancer treatment. This review provides an overview of major development for novel delivery of drugs, highlighting the application of newly developed nano-carriers in combination therapies, immunomodulation, and theranostics, for encapsulating and targeting active molecules.

Keywords Drug delivery system · Silver nanoparticles · Hyaluronic acid · Liposomes · Co-application · Anticancer

Introduction

During chemotherapy, anti-cancer drugs such as doxorubicin (DOX), paclitaxel (PTX), tamoxifen (TMX), SN-38, or cisplatin (cis-diamminedichloroplatinum (II) or CDDP) enter the body to target the cancer cells or tissues by decreasing

the cell viability or accelerating specific immune response to remove the cancerous tissues. However, these can damage both the normal and cancerous cells, leading to various side-effects. Moreover, the drugs can be easily broken down by physiological or immune reactions in the body (Lee et al. 2020). It is therefore imperative to control the drugs to affect only the cancer tissues, without affecting normal, healthy cells and preserve stable condition in vivo microenvironments until the delivery of the drugs (Lee et al. 2020). Drug delivery system (DDS) controls the delivery of pharmaceutical compound to obtain therapeutic effect in humans or animals. These include the nasal and pulmonary path of drug delivery, as alternatives to parenteral route, especially for peptide and protein therapeutics, for the treatment of human diseases. Several DDSs have been developed which include

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