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Review

Heart targeted nanoliposomal/nanoparticles drug delivery: An updated review

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ABSTRACT

Nanoliposomes are type of nano-sized vesicles made of bi-layered phospholipid membranes with an aqueous interior. They have been demonstrated to deliver several materials like low molecular weight drugs, imaging agents, peptides, proteins, and nucleic acids. Nanoliposomes have been demonstrated to slowly release an encapsulated drug, thereby leading to sustained exposure to target region and improved efficacy. This ability of nano-liposomes can be harnessed to deliver therapeutic agents precisely to the infarcted heart. Accordingly, this article will review recent developments in the application of nano liposomes and nanoparticles as drug delivery systems to treat cardiovascular related disorders such as atherosclerosis, restenosis and myocardial infarction.

Contents

1. Introduction

The use of nano-technology in providing treatment and therapy to cardiovascular diseases (CVDs) might be the answer to current challenges in CVDs. Kong, in his report says nano-technology helps to improve detection and therapy by advancing the ex-vivo and in-vivo detection and imaging of biomarkers, in addition will upgrade the delivery of drugs and tissue regeneration [1] (Fig. 1).

Nanoliposomes are type of nano sized nano-vesicles made of bilayered phospholipid membranes with an aqueous interior (Fig. 2) [2].

Nano-liposomes have been demonstrated to deliver several materials like low molecular weight drugs, imaging agents, peptides, proteins, and nucleic acids [3–7]. Nanoliposomes have been demonstrated to slowly release an encapsulated drug, thereby leading to sustained exposure to target region and improved efficacy. Most importantly nano-liposomes have been used effectively as both passive targeting and active targeting delivery routes [8]. As an active targeting route, it is loaded with

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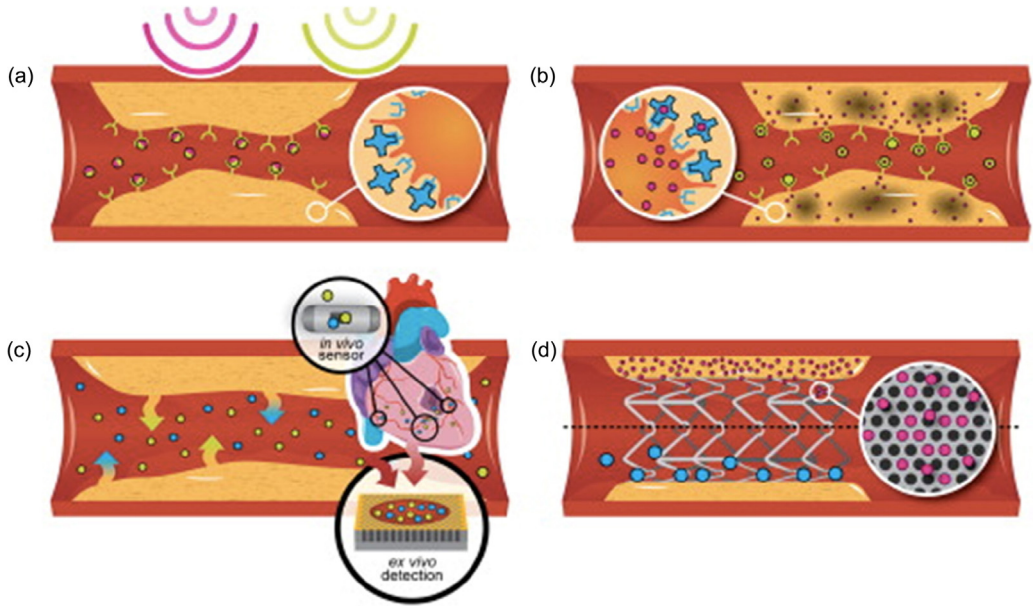

Fig. 1. Nanotechnology approaches for the advanced diagnosis and treatment of CVDs (schematic): Nanoparticles for (A) multimodal image contrast and (B) improved treatment of CVDs can be targeted to immune cells or specific ligands on the inflamed endothelium of the atherosclerotic plaque; (C) *in-vivo* sensors implanted in the pericardial region or on one of the main blood vessels and techniques for *ex-vivo*detection of biomarkers; (D) nanostructured drug/nanoparticle-eluting stents.

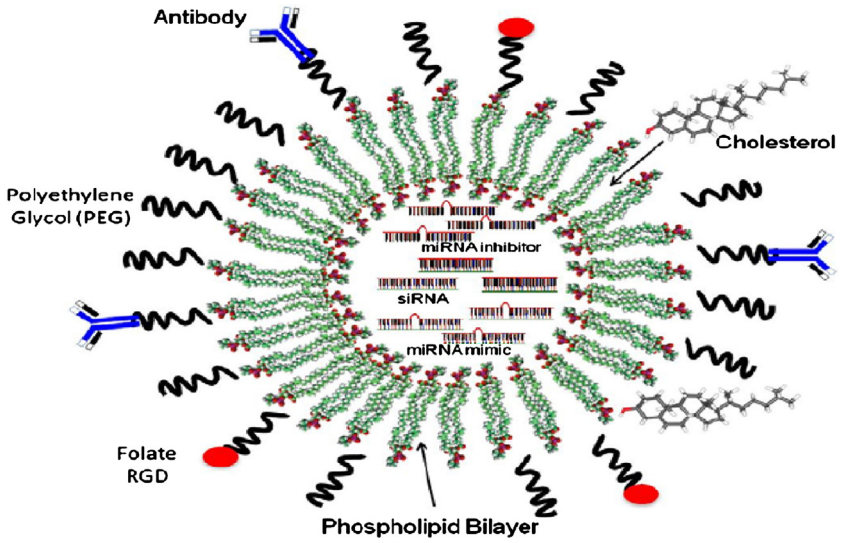

Fig. 2. Showing a diagrammatic representation of nano-liposome application in drug delivery.

bio-materials, antibody, ligands to be precisely delivered to the targeted organs or tissues, and release drug for a prolonged period of time, so that the healthy cells are not affected and only the unhealthy or infarcted cells are affected [9]. In this review, we will extensively give a summary of recent developments in nanotechnology for the detection and therapy of cardiovascular diseases (CVD) focusing on nanoparticles and nano-liposomes. Over the years liposomes have been used as a nano-carriers with different surface characteristics and have been investigated as therapeutic and theranostic agents for restenosis. Other examples of these classes are given in Table 1.

The treatment of infarcted heart through experimental studies has involved the delivering growth factors, cytokines and drugs to the infarcted cardiac cells [10] and they have been basically delivered via two ways namely direct injection, or by injecting biomolecule-loaded nano-particles/nanoliposomes or gels to the left ventricle (LV) [11,12]. However, the efficiency of these two basic methods may be decreased due to lack of retention of the factors or micro particles in the desired area. As such there is a need to develop an approach to deliver a biomaterial that will precisely deliver these bio-molecules into the infarcted area [13,14]. Fig. 3 shows a model of drug delivery by nanoliposomes.

1.1. Mode of action of liposomal-cell interactions

There are different ways by which a drug loaded on a liposome is delivered when a liposome interacts with a cell. Firstly, the cell membrane can be responsible for the inward absorption of the liposomes and lipases enzyme degrades the carriers' bilayer membrane. Secondly, the release of the liposome content as a result of its fusion with the plasma membrane of the target cells. Thirdly, it's a kind of receptor-mediated endocytosis. This process