The Bright Future of Liposome Mediated Drug Delivery

Dandan Hu1, Shukun Tang1, Haisheng Peng1,2,3* and Qun Wang1*

1Department of Pharmaceutics, Daqing Campus, Harbin Medical University, 1 Xin Yang Road Daqing, 163319, China
2Department of Chemical and Biological Engineering, Iowa State University, Ames, IA 50011, USA

There are many problems for conventional therapy which may be circumvented when using specific drug delivery systems to achieve the desired clinical results. Among the various delivery systems being investigated, liposomes hold great promise. The liposomes not only have a variety of structural characteristics, but can enlarge their scope of drugs to get their optimized pharmacological effects. In addition, it can be functionalized to target specific tissues [1].

Target strategy has been a good approach for oligonucleotides delivery to the pathological sites [2]. Today, more people have devoted themselves to design the targeted liposomes with receptor-mediated or antibody-mediated drug delivery systems. For example, the MicroRNA-1 (miR-1) has been detected in cardiac and skeletal tissues. Moreover, it is overexpressed in ischemic cardiac tissues. The downregulation of miR-1 could relieve arrhythmogenesis via the anti-miR-1 antisense oligonucleotides (AMO-1). As a result, researchers explored the applications of liposomes modified with anti-cardiac troponin I (cTn I) antibody. According to the in vivo image that evaluated the targeting abilities to foci, they found that it was effective for targeting ischemic myocardium tissues by loading AMO-1 into the modified liposomes (CT-A-LIP) and delivering the oligonucleotides to the affected heart (Figure 1). According to the paper, Liu and her colleagues not only confirmed that CT-A-LIP delivered AMO-1 to ischemic myocardium, but concluded that AMO-1 alleviated ischemic arrhythmia by silencing miR-1 in ischemic myocardium and restoring the depolarized resting pelvic potential (RMP) in MI rats [3]. Tang et al. [4] have also confirmed that liposomes drug delivery system improved the drug targeting on the ischemic heart tissue and myocardopathy.

As time went by, we will set into a period of aging. In order to keep healthy, we should pay attention to the central nervous system (CNS) diseases. It is a major challenge to find effective treatment moduli for central nervous diseases because of the presence of the blood brain barrier (BBB). Another major problem is how to achieve the special region delivery of therapeutics. According to these existing problems, many studies have found that liposomes modified with p-aminophenyl-a-D-mannopyranoside (MAN-LIP) could target the brain. Hao et al. have confirmed that glucose transporters (GLUT) can facilitate MAN-LIP to cross the BBB. They also found that MAN-LIP can target the cortex, cerebellum, brainstem, brainstem, hippocampus and pontine nuclei [5]. The experimental data demonstrated that MAN-LIP not only improved the brain delivery, but targeted intracerebral regions, particularly, in the cerebellum and cerebral cortex. Du et al. have indicated that both GLUT1 and GLUT3 have influenced on the brain delivery of MAN-LIP [6]. According to above results, we conclude that MAN-LIP is a promising brain drug delivery system which could improve brain delivery by targeting select brain functional regions.

With the development of nanotechnology, we have made tremendous progress in cancer research, especially in novel diagnostics and treatment [7-11]. However, there are big challenges to treat cancer. For example, the cancer chemotheraphy could form severe side effects, such as myelosuppression [12]. As we know, target therapy may be the most efficient way to deliver the cytotoxic agents to tumor tissue and minimize undesired side effects of these drugs. Liposome is widely used drug delivery systems. It can change the pharmacokinetics and bio-distribution of encapsulated drugs. As drug carriers, the unmodified and modified liposomes can be used to treat a wide variety of cancers [13]. For instance, Li’s research has revealed that liposomes modified with daunorubicin plus tamoxifen changed the plasma pharmacokinetics and bio-distribution of drugs in the breast cancer murine models [14]. Takeuchi et al. [12] showed that liposomes modified with cetylated polyethyleneimine (cetyl-PEI) were more effective than unmodified liposomes. Divya’s studies suggested that liposomes modified with lactobionic acid (LA-LIP) were effective to the hepatocellular carcinoma (HCC). The uptake and organ distribution of the LA-LIP revealed that loaded drug prominently accumulated in the tumor. The results showed that liposome was a successful carrier for HCC targeting [15]. In conclusion, liposome is a promising carrier for targeted drug delivery in treating cancers.

*Corresponding author: Haisheng Peng, Department of Pharmaceutics, Daqing Campus of Harbin Medical University, 1 Xinyang Rd Daqing, 163319, China, Tel: +86-459-8153 003, Fax: +86-459-8977 588; E-mail: fisher1688@163.com

Qun Wang, Department of Chemical and Biological Engineering, Iowa State University, 2114 Sweeney Hall, Ames, Iowa 50011, USA, Tel: (515) 294-4218; Fax: (515) 294-8216; E-mail: qunwang@iastate.edu

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The formation of hepatic failure has many reasons. One reason is the inflammatory cytokines produced by Kupffer cells which are related to endotoxin syndrome. It was reported that the acute or chronic conditions of hepatic failure is fatal to our lives [16]. We knew that liposomes could be utilized for effective targeting delivery by receptor-mediated endocytosis [15]. Higuchi et al. [17] showed that Kupffer cell-selective oligonucleotide could be carried through novel Fucose modified liposomes (Fuc-LIP) due to the recognition of fucose receptors on Kupffer cells. According to the cytokines production, liver injury was prevented by Fuc-LIP at the same time. In addition, Fuc-LIP played a significant role in treating fatal inflammatory liver disease which was associated with cytokine [17]. So, liposome is a promising approach for targeting liver diseases.

Inherited kidney diseases and common renal diseases can cause interstitial fibrosis, tubular atrophy, and glomerulocarcinomatous. However, it is difficult for gene delivery to the kidney due to the characteristics of renal cell biology. According to non-viral vectors, the liposome is a good candidate for kidney targeted gene therapy [18]. Lai et al. [19] have compared three different routes of liposome-mediated gene delivery to the kidney in mice: intra-renal-pelvic, intra-renal-arterial, and intra-renal-parenchymal injections. For mouse model, intra-renal-pelvic administration was more feasible than intra-renal-arterial injection. However, in humans, catheterization via renal arteries or renal pelvis directly could realize gene delivery. For liposome-mediated gene delivery, it is a possible route of intra-renal-pelvic or intra-renal-arterial which transfers gene sequence to renal tubular epithelial cells. Therefore, liposomes mediated gene therapy is a promising treatment for patients affected by hereditary kidney diseases [19].

It has been demonstrated that modified liposome is an effective way to target heart, liver, kidney, brain, lung and bone [20,21]. For cancers, there are plenty of papers to discuss the therapy of breast cancer and liver cancer using the modified liposome. People have admitted that liposome is a versatile drug carrier. Liposomes mediated drug delivery has wide range applications and functions, including using a specific cell ligand targeted on their surface because of the facile change of structure. Liposomes mediated drug delivery also has some disadvantages. The main problem is that it is impossible to cross most regular pelvic barriers due to their imposed size. Nonetheless, with the development of liposome technology, liposomes mediated drug delivery will play a more important role in clinical environment in the future [1].

References