Biochemistry & Physiology: Open Access

Hu et al., Biochem Physiol 2015, 4:1
DOI: 10.4172/2168-9652.1000e133

Editorial Open Access

The Bright Future of Liposome Mediated Drug Delivery

Dandan Hu[1], Shukun Tang[1], Haisheng Peng[1,2]*and Qun Wang[2]*

[1]Department of Pharmaceutics, Daqing Campus, Harbin Medical University, 1 Xin Yang Road Daqing, 163319, China
[2]Department 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 pellicle 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 myocardiopathy.

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 chemotherapy 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 polyethylenimine (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 were a successful carrier for HCC targeting [15]. In conclusion, liposome is a promising carrier for targeted drug delivery in treating cancers.

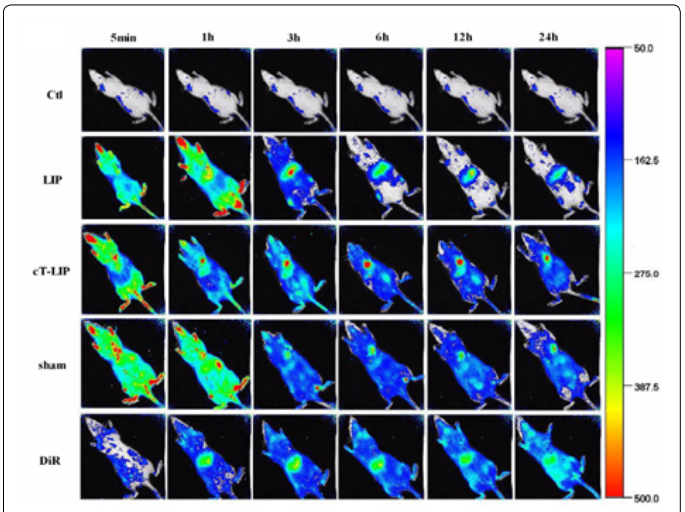

Figure 1: The fluorescence intensities of the whole body in experimental rats at 5 min, 1h, 3h, 6h, 12 h, and 24 h after administration of various preparations. The animals included the model rats intravenous injected with saline (Ctl), DiR-labeled liposomes (LIP), DiR-labeled anti-cTnI Ab modified liposomes (cT-LIP), or free dye (DiR), and the Sham-operated rats with cT-LIP. Reprinted with permission from ref. [3], Copyright © 2014, Elsevier.

***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

Received February 17, 2015; **Accepted** February 18, 2015; **Published** February 25, 2015

Citation: Hu D, Tang S, Peng H, Wang Q (2015) The Bright Future of Liposome Mediated Drug Delivery. Biochem Physiol 4: e133. doi: 10.4172/2168-9652.1000e133

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 glomerulosclerosis. 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 pellicle 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

1. Gregoriadis G (1991) Overview of liposomes. J Antimicrob Chemother 28 Suppl B: 39-48.
2. Liu M, Li M, Wang G, Liu X, Liu D, et al. (2014) Heart-targeted nanoscale drug delivery systems. J Biomed Nanotechnol 10: 2038-2062.
3. Liu M, Li M, Sun S, Li B, Du D, et al. (2014) The use of antibody modified liposomes loaded with AMO-1 to deliver oligonucleotides to ischemic myocardium for arrhythmia therapy. Biomaterials 35: 3697-3707.
4. Tang CS, Su JY, Li ZP, Zhang LZ, et al. (1993) Possibility of targeting treatment for ischemic heart disease with liposome (I). Sci China B 36: 590-598.
5. Hao ZF, Cui YX, Li MH, Du D, Liu MF, et al. (2013) Liposomes modified with P-aminophenyl-alpha-D-mannopyranoside: a carrier for targeting cerebral functional regions in mice. Eur J Pharm Biopharm 84: 505-516.
6. Du D, Chang N, Sun S, Li M, Yu H, et al. (2014) The role of glucose transporters in the distribution of p-aminophenyl-alpha-d-mannopyranoside modified liposomes within mice brain. J Control Release 182: 99-110.
7. Atri M (2006) New technologies and directed agents for applications of cancer imaging. J Clin Oncol 24: 3299-3308.
8. Jia F, Liu X, Li L, Mallapragada S, Narasimhan B, et al. (2013) Multifunctional nanoparticles for targeted delivery of immune activating and cancer therapeutic agents. J Control Release 172: 1020-1034.
9. Li M, Deng H, Peng H, Wang Q (2014) Functional nanoparticles in targeting glioma diagnosis and therapies. J Nanosci Nanotechnol 14: 415-432.
10. Yang Y, Wang S, Wang Y, Wang X, Wang Q, et al. (2014) Advances in self-assembled chitosan nanomaterials for drug delivery. Biotech Adv 32: 1301-1316.
11. Ding F, Deng H, Du Y, Shi X, Wang Q (2014) Emerging chitin and chitosan nanofibrous materials for biomedical applications. Nanoscale 6: 9477-9493.
12. Takeuchi Y, Ichikawa K, Yonezawa S, Kurohane K, Koishi T, et al. (2004) Intracellular target for photosensitization in cancer antiangiogenic photodynamic therapy mediated by polycation liposome. J Control Release 97: 231-240.
13. Brown S, Khan DR (2012) The treatment of breast cancer using liposome technology. J Drug Deliv 2012: 212965.
14. Li M, Yu H, Wang T, Chang N, Zhang J, et al. (2014) Tamoxifen embedded in lipid bilayer improves the oncotarget of liposomal daunorubicin in vivo. J Mater Chem B 2: 1619-1625.
15. Bansal D, Yadav K, Pandey V, Ganeshpurkar A, Agnihotri A, et al. (2014) Lactobionic acid coupled liposomes: an innovative strategy for targeting hepatocellular carcinoma. Drug Deliv.
16. Wagner EJ, Krugner-Higby L, Heath TD (2009) Liposome dependent delivery of S-adenosyl methionine to cells by liposomes: a potential treatment for liver disease. J Pharm Sci 98: 573-582.
17. Higuchi Y, Kawakami S, Yamashita F, Hashida M (2007) The potential role of fucosylated cationic liposome/NFkappaB decoy complexes in the treatment of cytokine-related liver disease. Biomaterials 28: 532-539.
18. Ito K, Chen J, Asano T, Vaughan ED, Jr, Poppas DP, et al. (2004) Liposome-mediated gene therapy in the kidney. Hum Cell 17: 17-28.
19. Lai LW, Moeckel GW, Lien YH (1997) Kidney-targeted liposome-mediated gene transfer in mice. Gene Ther 4: 426-431.
20. Bi R, Shao W, Wang Q, Zhang N (2008) Spray-freeze-dried dry powder inhalation of insulin-loaded liposomes for enhanced pulmonary delivery. J Drug Target 16: 639-648.
21. Ye J, Wang Q, Zhou X, Zhang N (2008) Injectable actarit-loaded solid lipid nanoparticles as passive targeting therapeutic agents for rheumatoid arthritis. Int J Pharm 352: 273-279.