Preparation and application of functionalized nano drug carriers

Rudong Gong\textsuperscript{a}, Gaimin Chen\textsuperscript{b,*}

\textsuperscript{a} Public Teaching Department, Nanyang Medical College, Nanyang, Henan 473061, China
\textsuperscript{b} Pharmacy Department, Nanyang Medical College, Nanyang, Henan 473061, China

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**Abstract**  
Objective: Targeting at category memory characteristics and preparation methods of functionalized nano drugs, preparation technology of functionalized nano drug carriers is studied, and then important role of functionalized nano drug carrier in preparation of medicine is studied.

Methods: Carry out the relevant literature search with computer, change limited language in the paper to Chinese and necessarily remove repetitive studies.

Results: After first review of 1260 retrieved literature, it can be found that nano drug is with accurate quantity, relatively good targeting, specificity and absorbency. Necessary research of nano drug carriers can prevent and treat disease to a certain extent.

Conclusion: Preparation of functionalized nanocarrier is simple and convenient, which can improve frequency of use of nano preparation technology and provide better development space for medical use. Therefore, nanocarriers should be combined with drugs with relatively strong specificity in clinics, in order to be able to conduct effective research on nanometer intelligent drug, effectively promote long-term development of nano biotechnology, and then provide favorable, reliable basis for clinical diagnosis and treatment.

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1. Introduction

Nano drug carrier is a novel drug carrier in clinics, which usually has a diameter between 10 nm and 1000 nm. The drug is usually made from natural polymer material. The main advantage is that it can effectively improve stability of clinical drug, improve patients’ drug absorption capacity, and thus effectively improve targeting of drugs and drugs nature, which can effectively extend action time of drug, then effectively improve clinical effect of the drug and minimize toxic and side effects of the drug. At this stage, nano drug delivery technology has been fully applied to treatment course of tumor, diabetes and vascular disease, and can provide some guidance for clinical treatment work. Therefore, very satisfactory results have been received, so that this technology can be fully applied to the field of clinical medicine. By studying multiple documents, preparation technology and application prospect of functionalized nano drug carriers are effectively explored. Therefore, functionalized nano drug carriers can be effectively applied to manufacture of nano drug carrier, and action time of nano drugs can be extended, which enables use of nanotechnology in clinics more significant and provides more adequate applications.
treatment basis for clinical treatment. The nanocarrier and application principles are shown in Fig 1.

2. Materials and methods

2.1. General information

The author used the computer for retrieval and analysis of information in HowNet, Wanfang Data and other well-known database resources, with “functionalized nanocarriers” as a keyword for search and search language limited to Chinese and English. The contents of all documents are related to nano drug carriers, and closely related to clinical application of nano products. Moreover, the papers have clear argument and reliable basis. In effective evaluation of relevant literature of preparation of functionalized nano drug carriers, the author and related authors of this paper have carried out detailed assessment of each literature.

2.2. Evaluation method

The author used literature retrieval method to search 1260 documents in the database, made preliminary screening of literature titles, abstracts and keywords, etc., ruled out literature closely related to this study, and chose 56 valuable articles as research object for review.

3. Results

3.1. Characteristics of functionalized nano drug carriers

Functionalized nano drug carriers have obvious quantitative accuracy and ease of absorption. In clinical use of drugs, the particles are relatively small and it is possible to carry out necessary therapeutic drug dilution, then effectively increase concentration of drug in the blood of patients, extend action time of drugs, effectively reduce degradation of the drug, improve stability of the drug, and then establish a new route of administration on this basis (Zhang et al., 2015). Usage of preparation technology of functionalized nano drug carrier is with high drug loading capacity, which can help patients carry adequate treatment drug and significantly improve drug concentration of the target, thus allowing drug filtration and penetration through patients’ capsule wall (Deng et al., 2015).

3.2. Preparation of functionalized nano drug carriers

In the preparation course of functionalized nano drug carriers, preparation of nanocapsules and nanospheres is crucial. Nanoparticles are mainly composed of nanocapsule and nanosphere. Nanoparticles typically have a diameter between 10 nm and 1000 nm, a common polymer colloid system. Nanosphere is with polymer base material skeleton, and the drug can be dispersed therein. Nanocapsules are mainly prepared by polymer material. In clinical medicine, traditional Chinese medicine is used to support nanocapsules, or existing important compound is used to transform powder injection that supports nanoscale, which thus improves stability of nano drug and improves treatment effect of the drug. At the same time, release preparations, tablets, nasal sprays and other pharmaceutical preparations are used, so that collective immune function can be effectively enhanced, and in vivo distribution of non-encapsulated drugs can be effectively improved (Zhou et al., 2015). Thus, even holding time of the drug is relatively long, concentration of the drug can be effectively reduced, and good therapeutic effects can be achieved. In addition, charge on drug nano surface can also enhance sustained release of the drug, which means significant positive significance in the treatment of patients. The nanocapsule organization chart is shown in Fig 2.

Main application methods for preparation of functionalized nano drug carriers include natural polymer polymerization, flowery polymerization and automatic emulsion

Figure 1  Nanocarrier and application principles.
methods. In preparation of nano-carrier with molecular self-assembly method, no emulsifier needs to be added, and surfactants can effectively reduce toxicity of nano drug carriers. The preparation method is relatively simple, with relatively low cost and very broad prospects for development. For different preparation processes of functionalized nano drug carriers, nanoparticles will be used in different clinical applications and can receive corresponding different treatment effects. For example, nanospheres and nanocapsules for oral administration are generally used in preparation of non-degradable material, e.g., preparation of acrylic resin and ethylcellulose in clinics (Li et al., 2015).

Nano-liposomes are a novel targeted drug, a nano drug carrier that has gradually attracted clinical attention. Liposomes are mainly an orderly combination of phospholipid relying on hydrophobic effect. This drug is mainly of multilamellar vesicle structure, and each layer of drug is primarily lipid bilayer membrane. Bilayer membrane is mainly of oil phase, and currently used liposomes are typically unilamellar liposomes. Liposomes are a primary drug carrier for treatment of liver parasites, with phospholipids as main auxiliary materials. Phospholipid elimination in the blood is relatively slow, as pharmaceutical package can be released slowly by buried liposomes, which thus effectively prolongs action time of drugs, achieves significant treatment effect and effectively treats locus site of patients. At the same time, linkage of monoclonal antibody with liposome can provide targeted input of liposomes by means of specific reaction between antigen and antibody, and therefore effectively reduce adverse drug reactions in patients on organs and tissues. In recent years, interacting gene of liposomes has been effectively transferred (Zhang et al., 2013). At this stage, interacting gene of liposomes has been widely played, and liposomes can have hydration action through thin film and complete preparation of nano-medicine. In preparation process of solid lipid nanoparticles, solid lipid nanoparticles have grain size of 50 nm to 1000 nm, which is currently one of the most valued drug delivery system of nanoparticles. There is a significant difference between such system and phospholipid-based liposome double molecular structure. The system can be used for intravenous injection or topical application, and can also be used as targeting positioning carrier and carrier with controlled release effect, so it can effectively avoid drug leakage and degradation (Shang and Shen, 2013). Compared with liposomes, solid lipid nanoparticles are with relatively low toxicity, high drug loading capacity and relatively strong biological stability. Solid lipid nanoparticles can simultaneously effectively load
hydrophilic drugs and hydrophobic drugs, suitable for large-scale drug production (Ding et al., 2012). Studies have shown that average radius of solid lipid nanoparticles is about 106 nm. With a strong stability, it can support freeze dryer and be used in drug encapsulation. It is used in mifepristone encapsulation in clinics, with significant effect (Bi et al., 2011). The sketch map of nanoliposomes is shown in Fig 3.

Preparation process of magnetic nanoparticles is a major focus of current research. Under the role of improving applied magnetic field of nanoparticles, the temperature rises to about 40–45°C, which can kill the tumor. Through experimental transplant of rat liver tumor, it is found that it has effective treatment effect for liver cancer treatment (Tang et al., 2011). The hepatoma cells are shown in Fig 4.

3.3. Major clinical application of functionalized nano drug carriers

Clinical application of functionalized nano drug carriers means great significance for effects of drugs. Efficacy of oral drugs is very significant. Many drugs lose efficacy due to patients’ metabolism. Therefore, drug of oral medication needs to be changed to intravenous injection. In the anti-tumor process, nano drug carriers can increase water solubility by targeting at difference between the tumors under the premise of no damage to normal cells. At the same time, targeting specificity of tumor tissues can be effectively enhanced, and thus drug effect can be effectively evaluated (Yang et al., 2013).

4. Discussion and conclusion

In this paper, preparation and application of functionalized nano drug carriers are studied. Application prospect of nanotechnology has also been further researched and discussed. Nanobiotechnology is a frontier question in biological field, with characteristics of application security and high reliability. In the clinical course of medication, how to grasp the target substance and use reasonable and effective therapeutic drug is critical. In clinics, preparation and application of functionalized nano drug carriers should be strengthened to improve therapeutic effect and clinical significance, so that clinical treatment work becomes more meaningful.

References

Bi, H., Yu, L.L., Song, M.M., 2011. Progress in applied research of inorganic nanocarriers in targeted drug delivery. J. Anhui Univ. (Nat. Sci.) 19, 1–8.
Deng, C., Meng, F.H., Cheng, R., Zhong, Z.Y., 2015. Multifunctional biodegradable polymer nano drug carriers: design, synthesis and application in targeted cancer therapy. Chin. Sci. Bull. 19, 1339–1351.
Ding, H., Zhang, S., Liu, X.L., 2012. Application of nano pharmaceutical carrier molecular targeting in cancer chemotherapy. Chemistry 33, 621–627.
Li, Y., Wu, Y.J., Liu, H.L., 2015. Research of carbon nanotubes as drug and gene delivery vector. Chin. Med. Abstracts (Otolaryngol.) 18, 150–154.
Shang, H.H., Shen, Y.Q., 2013. Preparation and application of serum albumin nano drug carriers. J. Funct. Polym. 10, 317–324.
Tang, Z.K., Xiong, X.Q., Cai, L., Xu, Y.H., 2011. Advances in research of reduction responsive drug carriers. Acta Pharmaceut. Sin. 32, 1032–1038.
Yang, D.L., Cao, L.L., Liu, J.J., 2013. Application of carboxymethyl chitosan and its composite nanoparticles as drug carriers. Cent. South Pharm. 21, 669–674.
Zhang, P., Chen, Y.Z., Zhou, Q.B., Bai, J.P., 2013. Application of nano drug delivery system in tumor targeting treatment. Chin. J. Tissue Eng. Res. 9, 3975–3982.
Zhang, Y., Xing, S.G., Wang, Z., Kang, Q.H., Ling, J., Yao, M.Y., He, Y.P., Jin, Y., Chu, X.G., 2015. Research progress of aptamers in targeted drug delivery. Prog. Biochem. Biophys. 16, 236–243.
Zhou, J., Li, Y.M., Wang, L.L., Cui, J., Yuan, E.H., Mo, Z.L., 2015. New progress in applied research of silica-based mesoporous nano drug carriers. Pharm. Biotechnol. 23, 351–356.