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Editorial

Brain-targeting Nanoparticle Drug Delivery Systems for Brain Tumors

Yi Zhao[1,†,*], Yamin Cui[2,†], Yuanyuan Sun[1,*]

[1]Department of Translational Medicine Center, The First Affiliated Hospital of Zhengzhou University, 450052 Zhengzhou, Henan, China
[2]Zhengzhou Immuno Bio-Tech Co., Ltd, 450061 Zhengzhou, Henan, China
*Correspondence: fcczhaoyi@zzu.edu.cn (Yi Zhao); sunyy@zzu.edu.cn (Yuanyuan Sun)
[†]These authors contributed equally.

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The treatment of brain diseases, especially brain tumors, remains a major challenge in modern medicine. The current therapeutic strategies for brain tumors mainly include surgery, radiation therapy and chemotherapy, which have made some progress. However the blood-brain barrier (BBB) poses a considerable obstacle to the effective delivery of drugs to the target site [1]. This editorial is expected to afford useful guidance and provide inspiration for the potential of brain-targeting nanoparticle drug delivery systems to overcome this barrier and improve the prognosis for patients with brain tumors.

The BBB is a highly selective barrier that restricts the passage of most substances from the blood into the brain. This barrier is composed of endothelial cells in brain capillaries, which are interconnected by tight junctions that prevent the diffusion of large molecules and certain small molecules. Although this barrier is crucial for maintaining brain homeostasis, it also blocks the delivery of essential therapeutic drugs to brain tissue, especially in the case of brain tumors.

Nanoparticle drug delivery systems have emerged as a promising approach to treating brain tumors by delivering therapeutic drugs to the brain tumor sites across the BBB. By changing the particle size, composition, and surface chemical properties of the nanomedicine, it can also be endowed with multi-functional capabilities so as to target drugs to the correct location in the brain, minimizing systemic toxicity.

The most representative material for brain targeting nanoparticle drugs is the liposome. A liposome is a spherical vesicle composed of a phospholipid bilayer that can enclose both hydrophilic and hydrophobic drugs. It is advantageous to use liposomes as a drug carrier. Liposomes can protect encapsulated drugs and control drug release effectively [2]. It has a cell-like structure, and its primary component, phospholipid, is non-toxic, non-immunogenic, safe, and reliable. By changing the size and charge of liposomes, the distribution of drugs in tissues and their clearance in the blood can be controlled. Changing some physical factors, such as the local pH and the temperature of the lesion sites, can significantly alter the permeability of the liposome membrane and make the liposome selectively release drugs [3,4]. By changing the surface properties of the liposomes, the researchers have enhanced the ability of the liposomes to cross the BBB and aggregate at the site of the brain tumor.

Although the BBB can effectively prevent foreign toxic substances from entering the central nervous system, it allows nutrients, vitamins, or hormones to be transported into the brain. The abundance of carrier mediated transport (such as glucose transporter 1 and vitamin C transporter 2, etc.) on the BBB provides an effective pathway for these substances to enter the central nervous system and also provides a potentially effective pathway for drugs to cross [3,4]. In addition, polyethylene glycol (PEG)-modified liposomes can extend circulation time and reduce clearance by the reticuloendothelial system, thereby increasing their chances of reaching the brain. The liposomes can increase drug load and avoid engulfment by the reticuloendothelial system. However, the steric hindrance between liposomes and cancer cells increases, which affects the absorption of liposomes by cancer cells [5]. Although the application of liposomes has certain advantages in the targeted drug delivery system in the brain, traditional liposomes still have shortcomings such as poor targeting distribution and poor stability. Therefore, enhancing the tumor targeting of drug carriers, promoting the uptake of drug delivery systems by tumor cells, and ensuring the effective concentration of drugs in tumor cells are still the focus of current research [6,7]. The unique structure of liposomes makes it easy to achieve targeted modification through various means, which is of vital significance for the study of targeted delivery drug delivery systems.

Another promising approach is adapting inorganic nanoparticles, such as metallic or polymeric nanoparticles, for brain tumor targeting [8,9]. These particles can be designed to exhibit distinctive optical, magnetic, or radioactive properties that enable real-time imaging and monitoring of drug delivery. Furthermore, inorganic nanoparticles can be loaded with therapeutic agents and equipped with targeting ligands to accomplish precise and manageable drug delivery to brain tumors [10].

In conclusion, brain-targeted nanoparticle drug delivery systems have made impressive advances in treating brain tumors. They can effectively cross the BBB, enabling precise and manageable drug delivery to the tumor site,

thereby improving therapeutic effectiveness and reducing systemic toxicity. With further research in this area, we expect that nanoparticle based drug delivery systems will have a prominent impact on the treatment of brain tumors and other central nervous system diseases.

Author Contributions

YZ and YC conceived the project and drafted the manuscript; YZ and YS supervised the project and critically reviewed the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Not applicable.

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Conflict of Interest

All authors declare no conflicts of interest. Although Yamin Cui is from Zhengzhou Immuno Bio-Tech Co., Ltd, the judgments in data interpretation and writing were not influenced by this relationship. Besides, given his role as the Editorial Board member, Yi Zhao had no involvement in the peer-review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to Graham Pawelec.

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