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Understanding the Current Methods of Drug Delivery to the Inner Ear

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INTRODUCTION

Hearing and balance disorders are commonly treated by delivering drugs to the cochlea and inner ear vestibule. Although the structure of the inner ear is well understood, successful delivery of therapeutic agents to the inner ear tissue remains a challenge. This arises firstly from the existence of a blood labyrinth barrier between the inner ear and the systemic circulation and secondly from the fact that the inner ear arteries are very thin. Pharmacological challenges, on the other hand, include: Limiting RWM-mediated transport to the inner ear are the poor drug permeability, drug instability, and inability to effectively aggregate in the internal and external lymph when the drug enters into the body *via* the ear canal and non-targeted drug delivery. Procedures for delivery of therapeutic agents to the human inner ear are currently in clinical practice.

DESCRIPTION

Current methods of drug delivery to the inner ear include tympanic membrane injection, round window membrane injection, and semicircular canal injection. Systemic administration, commonly by oral, intravenous or infusion, or intramuscular route, has been used to effectively treat inner ear disorders such as AIED, Meniere's disease, and sudden deafness. AIED presents with bilateral asymmetry of progressive sensorineural hearing loss, may be associated with vestibular dysfunction, and is commonly treated with long-term oral corticosteroids. The current treatment regimen for AIED is oral high-dose prednisone for 4 weeks, followed by gradual taper to the lowest dose required to treat hearing symptoms while maintaining therapeutic efficacy.

Deficiencies in systemic drug delivery methods have prompted the development of new drug delivery methods. Intratympanic drug delivery is accomplished by introducing drugs into the tympanic cavity of the middle ear, passing through the RWM into the peritympanic lymphatic fluid of the inner ear, and diffusing throughout the inner ear. Intradrum delivery has been shown not only to increase drug concentration in the internal and external lymphatics compared to intravenous or oral delivery, but also to avoid the toxic side effects associated with systemic delivery.

For middle ear delivery into the tympanic cavity, drugs cross his RWM barrier, which is not only the necessary pathway for substances to move from the middle ear to the inner ear, but also the biofilm barrier that prevents substances from entering the inner ear is required. Intratympanic administration to the inner ear is more effective than intratympanic administration to the middle ear. Liposomal encapsulation enables sustained drug release and increased systemic circulation time, greatly enhancing drug efficacy. Due to the advantages of low toxicity, high biocompatibility and convenient handling by applying a magnetic field, magnetic NPs are promising for medical applications in recent years.

CONCLUSION

Compared to organic nanocarriers, inorganic nanocarriers have shown unique advantages such as high drug loading capacity, high yield and low production cost, making silica a material of choice for both inorganic nanomaterials and biomedical applications. It is often used as the blood labyrinth barrier makes it difficult for drugs to reach the inner ear *via* the bloodstream to achieve optimal therapeutic efficacy. In recent years, new nanodrug delivery systems have emerged as research hotspots for the treatment of inner ear diseases, with significantly improved therapeutic efficacy in various animal models, and rapid advances in research have resulted in hearing loss.

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