



## The Emerging Role of Ocular Drug Delivery in Treatment of Corneal and Ocular Surface Diseases

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### DESCRIPTION

Topical eye drops are the most convenient and patient-friendly drug delivery method, especially in the treatment of anterior segment diseases. Drug delivery to target ocular tissues is limited by various precorneal dynamic and static ocular barriers. Structural changes in each layer of ocular tissue can be observed after drug administration by any route. Ocular drug delivery has always been a challenge for ophthalmologists and drug delivery scientists due to the presence of various anatomical and physiological barriers.

Medications used to treat eye conditions (glaucoma, conjunctivitis, trauma, etc.) can be mixed with inactive substances to form liquids, gels, or ointments applied to the eye. Liquid eye drops are relatively easy to use, but they can drain from the eye too quickly and be poorly absorbed. Gel and ointment formulations keep the drug in contact with the ocular surface for a long time, which can reduce vision. Solid inserts are also available that release drugs continuously and slowly, but can be difficult to insert and hold in place. Topical administration is the most common route of drug delivery to the eye. Despite it seems easy to access, and the eye is well protected from foreign substances and drugs that physically affect it, forming a biological barrier.

Drug delivery to the posterior segment is challenging, increasing the need to treat rapidly progressive posterior segment diseases such as diabetic retinopathy, age-related macular degeneration, and optic neuropathy. The cornea is composed of five distinct layers, three of which are the main barriers to absorption, epithelium, stroma, and endothelium. The lipophilic corneal epithelium contains 5 to 7 layers of cells, each connected by tight junctions and a rate-limiting barrier to corneal diffusion of most hydrophilic drugs. On the contrary, the stroma is composed primarily of hydrated collagen and exerts a diffusion barrier to highly lipophilic drugs. Ocular pathological conditions that affect the posterior segment of the eye commonly result in vision loss due to damage to the retina. The anterior and posterior ocular barriers slow the passive absorption of various therapeutic agents and reduce the ocular bioavailability of various drugs. Both static

barriers (corneal epithelium, corneal stroma, corneal endothelium, blood-water barrier) and dynamic barriers (tear dilution, conjunctival barrier, and retinal blood barrier) hinder the absorption of drugs in topical formulations and affect the biologics of drugs and reduce academic availability.

Over the past two decades, the field of ocular drug delivery technology has evolved dynamically, leading to new therapeutic interventions for chronic eye diseases. The primary goals of ocular drug delivery systems are to maintain therapeutic agent concentrations at target sites, reduce dosing frequency, and overcome various dynamic and static ocular barriers. Most importantly, the drug delivery system should not cause adverse ocular reactions and should aim to improve drug bioavailability. Drug delivery to the eye is altered by many anatomical and physiological barriers that are bottlenecks for ophthalmologists. Static and dynamic eye barriers reduce therapeutic agent absorption and xenobiotic entry. After the application of a drug dosage form in the ocular system, the tear stream wipes some drug from its surface, with an excretion rate of only about 1  $\mu\text{l}/\text{min}$ , although most of the drug is delivered within minutes through the nasolacrimal duct. Other causes of drug elimination include systemic absorption of the drug rather than absorption through the ocular route. Systemic absorption occurs primarily through the conjunctival sac into local capillaries or after the solution has flowed into the nasal cavity.

A variety of possible routes for drug delivery to the eye is the intravitreal route, where drugs are delivered by injection into the vitreous of the eye. This route of administration is used to cure many eye diseases. In the intracameral route, the anterior or posterior chamber of the eye is the site of action of the drug in this route of administration. It can usually be detected during surgery by injecting an anesthetic into the anterior chamber of the eye. In this route of administration, the drug is delivered around the eye. This can be explained by the dangerous eye steroid injections, in which steroids are placed around the eye to treat inflammation and swelling within the eye. Due to various anatomical and physiological barriers, approximately 1% or less of the injected drug reaches the intraocular tissue, reducing drug absorption.

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