International Journal of
Science, Architecture, Technology and Environment

A Comprehensive Review of Occular Drug Delivery System

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DOI: https://doi.org/10.63680/ijsate112630.27

Abstract

The eye is one of the most anatomically protected yet pharmaceutically challenging organs for drug delivery. Precorneal, corneal, and dynamic ocular barriers restrict the entry of therapeutic agents into ocular tissues, so that less than five percent of a topically instilled dose typically reaches the intraocular compartment. Conventional ocular dosage forms such as eye drops, although widely prescribed because of their simplicity and patient acceptability, suffer from rapid precorneal drug loss, poor bioavailability, and the need for frequent instillation, which in turn compromises patient compliance and therapeutic outcomes.

The various barriers that limit ocular drug absorption, along with drug related and patient related factors influencing bioavailability, are discussed in detail. A dedicated chapter addresses the pharmacopoeial and in house evaluation parameters used to assess the quality, safety, and performance of ocular formulations, describing the underlying principle, procedure, significance, and acceptance criteria for each test.

Keywords: Ocular Drug Delivery; Ocular Barriers; Bioavailability; Evaluation of Ocular Formulations

Introduction

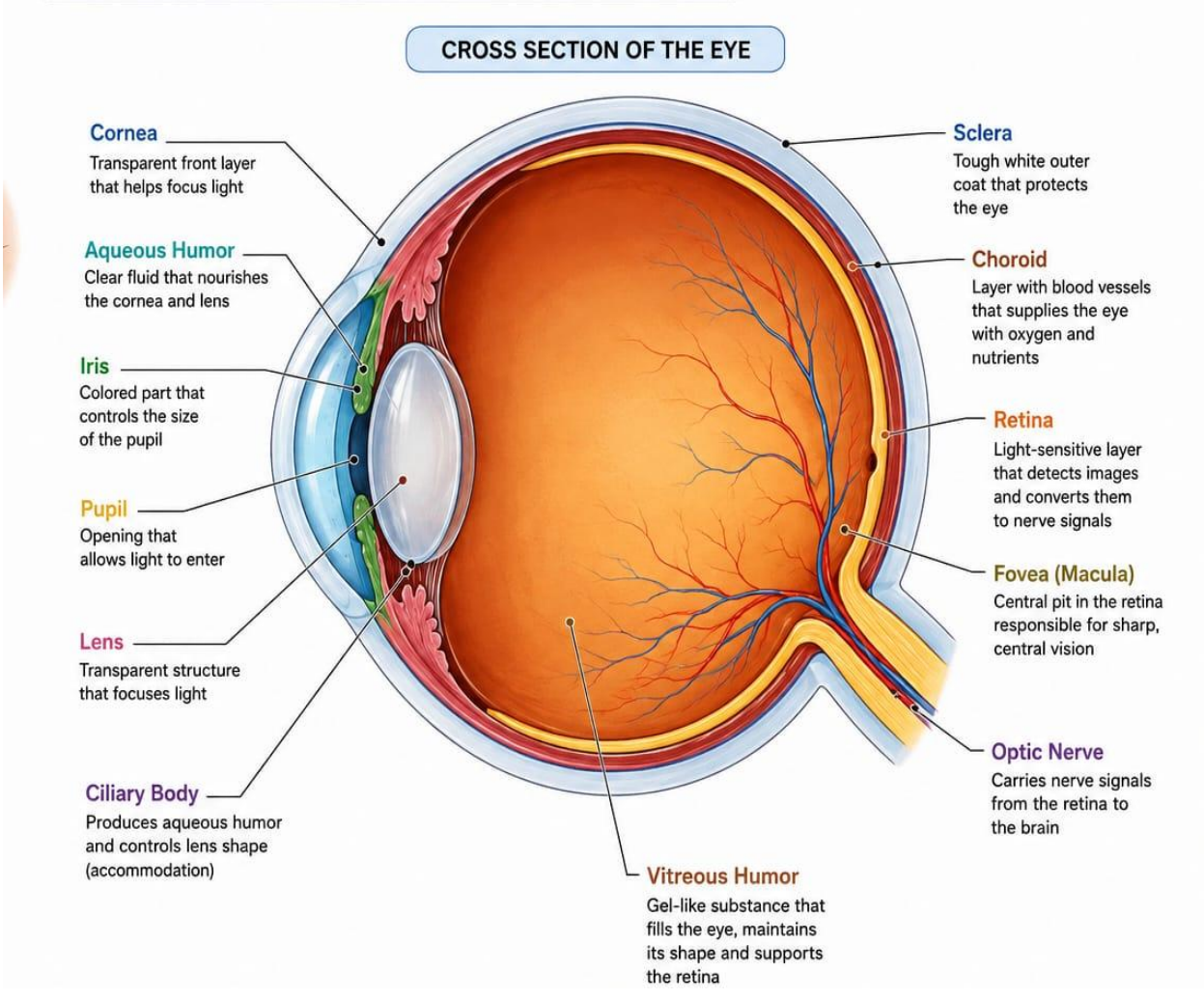
The drug delivery specialized methods used to deliver medicine to different parts of the eye for the treating of various eye diseases and disorders. These systems play an important role in managing situations like glaucoma, conjunctivitis, dry eye, eye infections, and other ocular problems. The main motive of drug delivery to eye is to provide the required amount of medicine to the affected area safely and effectively while reducing unwanted side effects.

Conventional eye drops are widely used because they are easy to apply and convenient for patients; however, a considerable portion of medicine may be lost through tear drainage, blinking, and natural protective mechanism of eye. Overcome these limitations and researchers have developed advanced drug delivery approaches such as ophthalmic gels, ointments, nanoparticles, liposomes, ocular inserts. These systems can improve drug absorption, increase the time of medicine remains in contact with the eye, and provide a long-lasting therapeutic effect. The selection of suitable drug delivery depends on the type of eye disease, the drug

properties, patient comfort. Overall, modern drug delivery motive is to improve treatment effectiveness, improve patient comfort, and support better eye health.

ANATOMY AND PHYSIOLOGY

Structure of the eye plays a key role in developing an effective way of delivering of medication to the eye because specific structure of the eye enables the entry of medication to the eye, causing some difficulties in this process. Eye has two parts, namely the anterior part, which includes cornea, conjunctiva, sclera, aqueous humour, iris, ciliary body, and lenses, which are in the front and posterior part. Which include vitreous humour, retina, choroid, and optic nerve.



human eye is an important sensory organ that helps us see and understand the world around us. Each part plays an important role in the process of vision. The cornea is the transparent front layer of the eye that allows light to enter and helps focus it. Behind the cornea, the aqueous humor is a clear fluid that provides nutrients to the cornea and lens. The iris is the coloured part of the eye that controls the size of the pupil, which is the opening through which light enters.

s.no	parts	Function
1	Cornea	Transparent front layer; allows and bends light into the eye.
2	Sclera	White outer layer protects and maintains the shape of the eye.
3	Conjunctiva	Thin membrane covering the front of the eye and inner eyelids.
4	Iris	Coloured parts of the eye control the amount of light entering.
5	Pupil	Light enters through the opening of the centre of iris.
6	Lens	Focuses the light into the retina.
7	Ciliary body	Controls lens shape for the focusing and produces aqueous humor.
8	Aqueous humor	Fluid in the front part of the eye which nourishes the cornea and iris.
9	Vitreous humor	Gel-like substance that fills the main cavity and maintains eye.
10	Retina	Light-sensitive layer where images are detected.
11	Choroid	Vascular layer that supplies nutrients to the eye.
12	Macula	This area is responsible for the sharp central vision.
13	Optic nerve	Carries visual signals from the retina to the brain.
14	Extraocular muscles	It will move the eyeball in the different possible directions.

ADVANTAGES

- The ocular drug delivery systems deliver medicines directly to the eye, helping to treat eye diseases effectively.
- These systems help deliver medicines to specific parts of the eye, depending on the formulation and administration method.
- Ocular drug delivery methods, such as eye drops and ointments, do not require surgery or injections.
- Direct application to eye can reduce unnecessary exposure of other body parts to the medicine.
- Most ocular formulations are easy to use, making it convenient for patients to follow their treatment schedule.
- Advanced system can release the medicine slowly, allowing its effects to last longer.
- Formulations help improve the absorption of medicine through the tissues of the eye.
- This system can provide quick relief from symptoms such as redness, irritation, itching, and inflammation.

DISADVANTAGES

- Only a small amount of the applied medicine may enter the eye because tears and natural eye barriers reduce drug absorption.
- Eye drops need to be applied several times a day because the medicine does not remain in the eye for long.
- patients, especially elderly people and children, may find it difficult to apply eye drops correctly.
- Advanced ocular drug delivery system may require special materials, equipment, and manufacturing techniques, increasing their overall cost.
- Ocular formulations may cause allergic reactions, irritations, or other unwanted effects depending on the medicine and the patient's sensitivity.

Applications

Ocular drug delivery system plays a key role in the treatment and management of various eye diseases. They help deliver medicine directly to the eye, making treatment more convenient and effective. These systems are used to treat conditions such as glaucoma, dry eye disease, eye infections, allergies, and inflammation. In glaucoma, they help control the pressure inside the eye and reduce the risk of vision loss. In dry eye disease, artificial tears and lubricating formulations help keep the eyes moist and relieve irritation. Antibiotic and antiviral eye preparations are used to manage certain eye infections, while anti-allergic medicine help reduce itching, redness, and watering. Corticosteroids and other anti-inflammatory medicine may be used to control eye inflammation under medical supervision. Advanced ocular drug delivery system, such as implants, gels, and nanoparticles, are being developed to improve drug absorption and provide prolong drug release.

Conclusion

Ocular drug delivery system play an important role in the effective treatment of various eye diseases. They help deliver medicine to the required parts of the eye and improve the therapeutic effect of drugs. Conventional eye drops are commonly used, but their effectiveness may be limited because of tear drainage, frequent blinking, and natural barrier of the eye, to overcome these challenges, advanced drug delivery approaches such as in-situ gels, ocular inserts, nanoparticles and controlled-release systems are being developed. These system may improve drug retention, increase treatment effectiveness, and reduce the need for frequent administration.

Declaration of Conflicting Interests

The authors declare no potential conflicts of interest with respect to the research, authorship and publication of this article.

Funding

The author received no financial support for the research, authorship and publication of this article.

References

1. Ahmed S, Amin MM, Sayed S. Ocular drug delivery: a comprehensive review. AAPS PharmSciTech. 2023;24(2):66. doi:10.1208/s12249-023-02516-9.
2. Yang Y, Lockwood A. Topical ocular drug delivery systems: Innovations for an unmet need. Experimental Eye Research. 2022; 218:109006. Doi: 10.1016/j.exer.2022.109006.
3. Ali M, Byrne ME. Challenges, and solutions in topical ocular drug-delivery systems. Expert Review of Clinical Pharmacology. 2008;1(1):145-161. doi:10.1586/17512433.1.1.145.
4. Jumelle C, Gholizadeh S, Annabi N, Dana R. Advances, and limitations of drug delivery systems formulated as eye drops. Journal of Controlled Release. 2020; 321:1-22. Doi: 10.1016/j.jconrel.2020.01.057.
5. Momin MM, Afreen SD. Nanoformulations and highlights of clinical studies for ocular drug delivery systems: An overview. Critical Reviews in Therapeutic Drug Carrier Systems. 2021;38(4):79-107. doi:10.1615/CritRevTherDrugCarrierSyst.2021035767.

6. Li S, Chen L, Fu Y. Nanotechnology-based ocular drug delivery systems: Recent advances and prospects. Journal of Nanobiotechnology. 2023; 21:232. doi:10.1186/s12951-023-01992-2.

7. Shafiq M, Rafique M, Cui Y, Pan L, Do CW, Ho EA. An insight on ophthalmic drug delivery systems: Focus on polymeric biomaterials-based carriers. Journal of Controlled Release. 2023; 362:446-467. Doi: 10.1016/j.jconrel.2023.08.041.

8. Han H, Li S, Xu M, et al. Polymer- and lipid-based nanocarriers for ocular drug delivery: Status and future perspectives. Advanced Drug Delivery Reviews. 2023; 196:114770. Doi: 10.1016/j.addr.2023.114770.

9. Jimenez J, Sakthivel M, Nischal KK, Fedorchak MV. Drug delivery systems and novel formulations to improve treatment of rare corneal disease. Drug Discovery Today. 2019;24(8):1564-1574. Doi: 10.1016/j.drudis.2019.03.005.

10. Al-Kinani AA, Zidan G, Elsaid N, Seyfoddin A, Alani AWG, Alany RG. Ophthalmic gels: Past, present, and future. Advanced Drug Delivery Reviews. 2018; 126:113-126. Doi: 10.1016/j.addr.2017.12.017.