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Occular Drug Delivery System

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• ABSTRACT

Ocular drug delivery system is a dosage form medium or structure calculated for injecting or delivering drug to eye against any disease or disorder involving or affecting vision. The most commonly utilized conventional preparations. Ophthalmic dosage forms are the compound, Suspension and ointments which are relatively ineffective as therapeutic systems. It is deviates through a number of anatomical and physiological fence, which have been bottleneck for the ophthalmologist. Calculating an ideal drug delivery scheme should included magnify drug bioavailability and controlled release of the drug at the site of action, which can control various occular barriers. Contact lenses are emerging as an alternative ophthalmic drug delivery system to resolve the imperfection of the conventional topical application methods like eye drops and ointment. Such a drug delivery can be achieved by designing formation such as microspheres, nanoparticles, liposomes which can act as systematic ocular drug delivery system.

• Keywords

Novel drug delivery, contact lens, barriers, suspension, emulsion, ointment

• Introduction

Eye is the most important organ due to its drug deposition characteristics. For ocular delivery it provides many more advantages for e.g. .sterilization, minimum irritation. Eye is the most accessible site for for topical administration and it is most convenient and patient compliant route of drug administration. The ideal ophthalmic drug delivery must able to sustain the drug release and to remain in the the vicinity of front of the eye for a long period of time. The eye is the very unique and very valuable organ. Novel ocular drug-delivery systems include Nano micelles, nanoparticles, drug-eluting contact lenses, ocular inserts, and ocular devices. Therapeutic action of ocular drugs can be divided into two categories, the first one is based on use of sustainable drug delivery system which can provide control and continuous delivery of ophthalmic drugs and second one involves maximizing corneal drug absorption and minimizing precorneal drug loss. The purpose of topical ophthalmic drug delivery devices is to deliver an adequate amount of medication to the anterior segment of the eye.

• ***THE ANATOMY OF THE EYE***

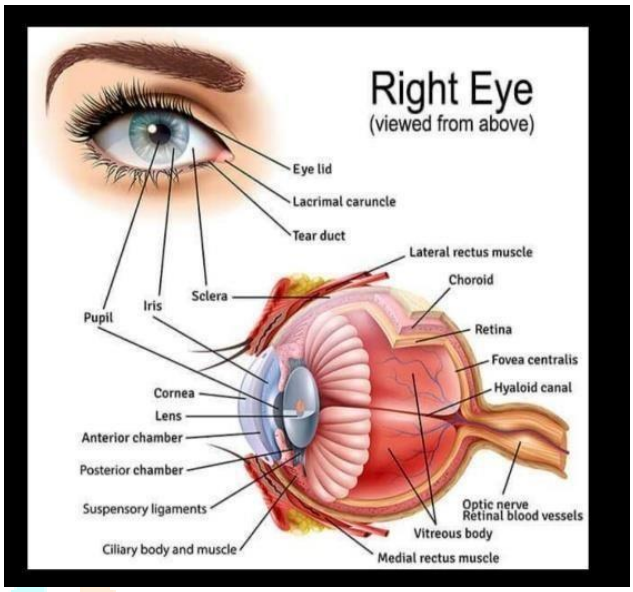

Fig. 1.1) Anatomy of the eye

1) SCLERA

It is the white layer of the eye that covers most of the outside of the eyeball. It is the dense connective tissue of the eyeball that forms the white of the eye. The junction between the white clearer and the clear cornea is called the limbus. The sclera ranges in thickness about 0.3 mm 1.0mm. It is relatively inactive metabolically and has only a limited blood supply. The tough ,fibrous nature of the sclera also protect the eye from serious damage.

2) CONJUNCTIVA

The conjunctiva is a clear thin membrane that it covers the the part of the front surface of the eye and inner surface of eyelids. It has many small blood vessels that provides nutrition to the eye and lids. Conjunctiva is a loose connective tissue. Conjunctivitis, also known as Pink eye is an inflammation of the conjunctiva.

3) CORNEA

The transparent part of the eye which can covers the iris and the pupil and allows light to enter the inside. Despite injury or disease, the cornea can still repair by itself quickly. Cornea helps to Shield the rest of eye and dust harmful matter.

4) AQUEOUS HUMOR

It is the fluid produced by the eye which is present between the cornea and front of the vitreous. It can helps in the nourishment of the lenses. The main function of the aqueous humor is to maintaining intraocular pressure. It is made up of 99.9%water and other 0.1%of sugar, vitamins and other nutrients. It is secreted from the ciliary body. It can play an important role in occular physiology.

5) PUPIL

It is the round opening in the center of the iris. The function of the pupil is to allow passing of the light into the eye. The size of the opening is operating by the muscles of the iris. The pupil opens and closes to control the amount of light that is allowed to enter the eye.

The pupil reacts to external light and changes its size according to the light intensity. A fully dilated pupil is about 4 to 8 millimeter in size, while a constricted pupil is in the 2 to 4 mm range.

6) IRIS

It is located in front of the lens and ciliary body and behind the cornea. The colored part of the eye is called iris. Irises are usually classified into six categories for eg .amber, blue, gray and green etc. The iris is mainly divided into two main regions i.e.; pupillary zone and ciliary zone. Iris is made up of the iris pigmented epithelium, dilator and sphincter muscles and stroma. It is helpful in controlling the size of the pupil to let more or less light.

7) CILIARY MUSCLE

It is an intrinsic muscle of the eye as a ring of smooth muscle in the eyes middle layer.

Ciliary muscles also changes the shape of the lens within the eye but not the size of pupil. This muscles occupies the largest portion of the ciliary body which is in between the anterior border of the choroid and iris.

8) LENS

It is curved structure in the eye that bends light and focuses it for the retina to help you see images properly. If is also works with the cornea to refract or bending of light. The lens is about 10mm across and about 4mm from front to back in adults. It consist of the lens capsules which is smooth and transparent and the lens fibers which are long, thin and transparent cells. The diseases of the lens mainly include cataracts, which can cause opacity or cloudiness in the lens.

9) VITREOUS HUMOR

It is a transparent colorless Jelly like substance located in the posterior Chamber of the eye. It also helps in maintaining the round shape of the eye. Vitreous humor is mainly composed of water, along with small percentage of collagen, glycosaminoglycan's, electrolytes and proteins. Vitreous humors can play important role in in protecting our eye.

10)RETINA

It is a thin layer of tissue that lines the back of the eye on the inside. Retina is mainly located near the optic nerve. The main function of the retina is to receive light that the lens has focused, convert the light into neural Signals and sending this signals on to the Brain for visual recognition. It is contains millions of light sensitive cells and other Nerve cells that receive and organized visual information.

10)MACULA

It is an oval shaped pigmented area in the center of the retina of the human eye and in other animals. The diameter of the macular in human eye is of around 5.5 mm and it is subdivided into umbo, foveola, foveal avascular zone, fovea, Para fovea and peritonea areas. It is responsible for the central high-resolution colour vision that is possible to good light and this kind of region is impaired if the macular is damaged, for eg macular degeneration. The need of the macula is to clearly see details of objects in front of you like faces and written text.

11)CHOROID

It is the middle layer of tissue In The Wall of the eye its found between the sclera and the retina. It is the life so that keep the retina healthy and functioning. The layer of choroid begins in the peripheral edges of the eyeball and lines the entire back of it. There is mainly different layers of choroid for example, brunch's membrane, choriocapillaris, Sattler's layer and haler's layer. The main functions of the choroid include providing nutrients for the retina macular and optic nerve, also helps in regulating the temperature of the retina, helping control pressure within the eye, also helps in absorbing light and limiting reflections within the eye that could harm vision.

12)OPTIC NERVE

It is a bundle of more than 1 million nerve fibres also known as second cranial nerve. It helps transmit sensor information for vision in the form of electrical impulses from the eye to the brain. Damages to an optic nerve can cause loss of vision. It is really an extension of the central nervous system. In the CNS the optic nerve is the only cranial nerve leave the cranial cavity.

• **Accessory organs of the eye**

Eye brows Eyelashes and eyelids Lacrimal apparatus

 Eye brows

It is an area of short hair above each eye that follows the shape of the lower margin of the bridges of some mammals. In humans the eyebrows plate two main functions ,first , communication through facial expression and second prevention of sweat with water and other debris from falling down into the eye socket. Eyebrows protect our eyes from moisture and light.

 Eyelashes and eyelids

Eyelid is a thin layer of skin that covers and protect the eye. Human eyelids contain a row of eyelashes that protect the eyes from the dust particles, foreign bodies and perspiration. The focus on eyelashes is often for their aesthetic beauty.

Lacrimal apparatus

It is consists of the lacrimal glands, which secret the tears and the lacrimal sac and ducts, which convert tears into the nasal cavity. The Secret function of the lacrimal gland declines with age, and many elderly individuals develop “dry eye” syndrome.

ROUTES OF OCCULAR DRUG DELIVERY

The three primary methods of delivery of ocular medications to the eye are topical local occular (i.e., subconjunctival , retrobulbar and intravitreal.)

• Topical route

The topical eye drop is the most convenient and patient compliant route of drug administration especially, for the treatment of anterior segment diseases. The ocular drug delivery is one of the most challenging and tough administration routes due to the eye's unique anatomy and Physiology.

• Subconjunctival route

The subconjunctival injections obviates the conjunctival epithelial barrier which is rate limiting for permeation of water soluble drugs. It is a type of periocular route of injection for ocular drug administration bi administration of a medication either under the conjunctiva or underneath the conjunctiva lining the eyelid.

• Intravitreal route

It is a route of administration of a drug, or other substance, in which the substance is delivered into the vitreous humor of the eye. The meaning of intravitreal means “inside the eye” .The advantage of an intravitreal route is an immediate and therapeutic effect in the intended retinal tissue.

• Physiological Barriers of Ocular Drug Delivery:

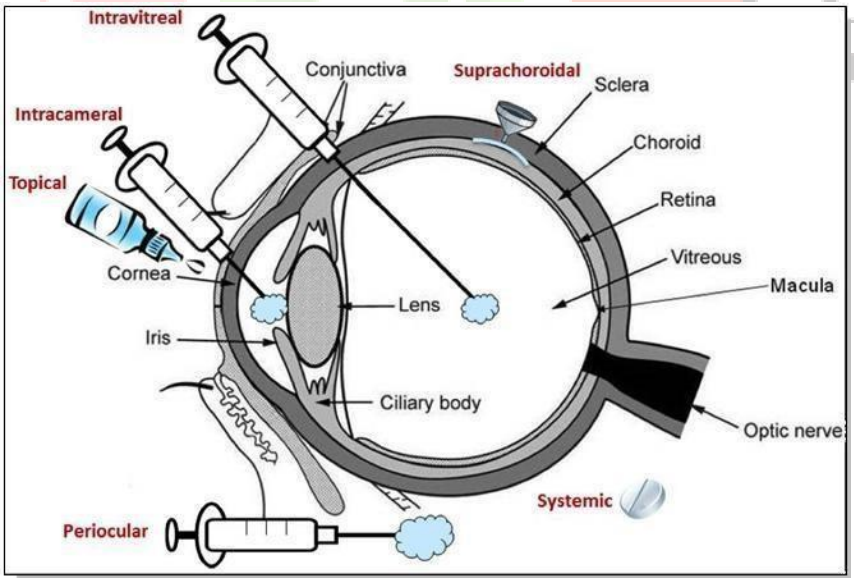

Fig 1.2) barriers for occular drug delivery

There square measure several challenges once it involves effective delivery of medication to the attention .The reason why it’s tough to attain relevant therapeutic doses at intervals the attention is primarily because of the presence of multiple barriers. Once a dose type is either administered locally or systemically, it faces multiple obstacles before it reaches its website of action . Static barriers (different layers of membrane, sclera, and membrane together with blood liquid and blood–retinal barriers), dynamic barriers (choroidal and mucosa blood flow, body fluid clearance, and tear dilution), and effluence pumps in conjunction cause a big challenge for delivery of a drug alone or in a very dose type, particularly to the posterior section.

1.Anatomical Barriers:

The sealed anatomical options of the attention and its physiological activity that quickly removes medicine square measure referred to as anatomical and physiological barriers, that square measure the reason for quite ninetieth of drug loss. This side remains a vital issue in eye surface medication . It acts as a serious barrier to hydrophilic drug transport through animate thing areas. On the opposite hand stroma, that consists of multiple layers of hexagonally organized albuminoidal fibers containing liquid pores or channels permit hydrophilic medicine to simply withstand however it acts as a major barrier for lipotropic medicine.

2.Drug loss from the ocular surface:

After exploitation the indefinite quantity type of the drug within the ocular system, flow of lacrimal fluid wipes out some of the drug from its surface and its turnout rate is just regarding one μ l/min, whereas, a serious portion of the drug is drained through the channel quickly at intervals minutes. alternative sources of drug removal embrace the general absorption of the drug, rather than being absorbed through the ocular route.

3.Blood-ocular barriers:

Blood-ocular barriers area unit gift within the blood, that defend the attention from enobiotics . It contains of 2 elements, specifically blood-aqueous barrier and blood-retina barrier. The anterior blood-eye barrier consists of epithelial tissue cells within the body structure, i.e., the center layer of the attention below sclerotic coat, iris, membrane and choroid coat .Choroid vasculature contains of intensive blood flow and leaky walls, thanks to that quick access of medication happens within the choroidal extravascular area, however their distribution within the tissue layer is restricted thanks to the presence of RPE and retinal epithelium.

4.Diffusion Barriers:

Vitamin E coatings form diffusion barriers within the lens, which forces the target drug to take long complex paths to diffuse from the lens and provide extended drug delivery.[61,62] Vitamin E loaded silicone contact lenses provided anesthetic release for about 1-7 days and released 0.5 mg of lidocaine and thus could be very useful for postoperative pain control after corneal surgery such as the photorefractive keratectomy.

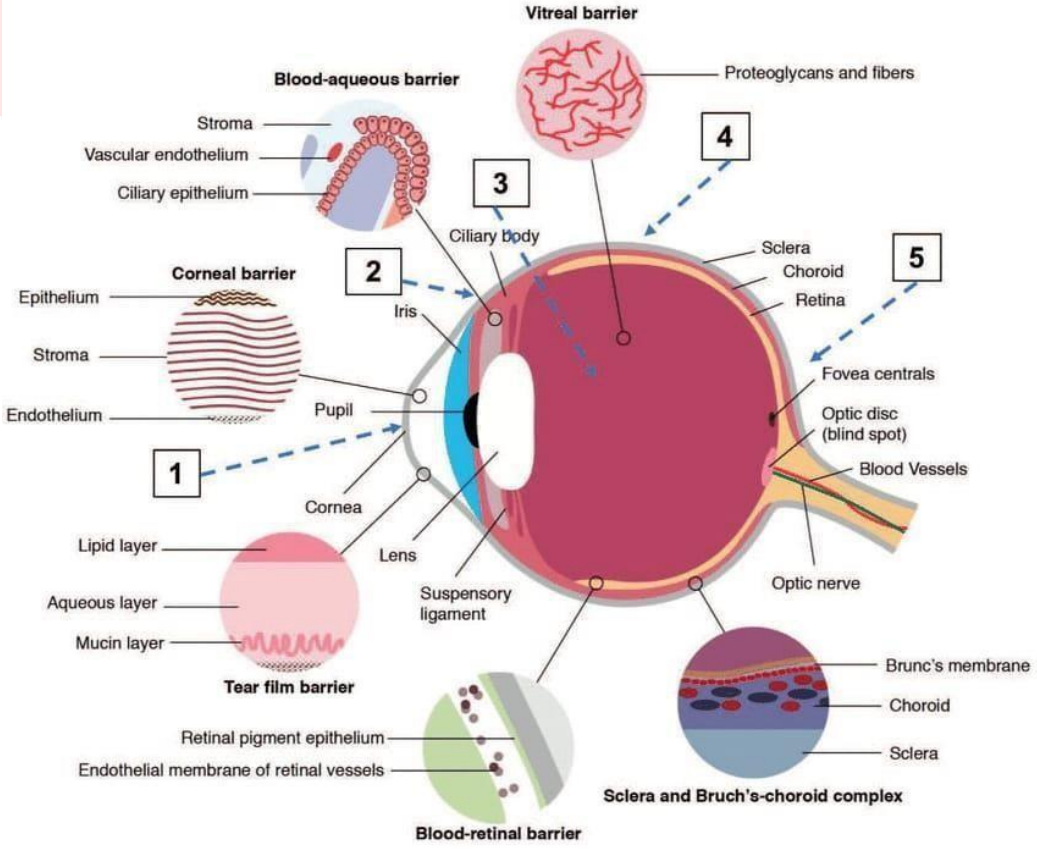

Fig. 1.3) barriers for occular drug delivery.

• **Eye infections**

1) Conjunctivitis

Conjunctivitis is also known as pink eye, is an infection to the conjunctiva. The most cases of pink eye are typically caused by adenovirus but can also be caused by herpes simplex virus, varicella-zoster virus, and various other viruses, including the virus that causes coronavirus. The infection last up to 7-14 days without any treatment.

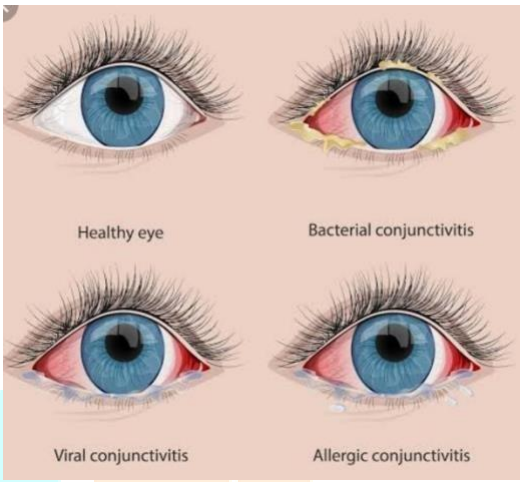

Fig. 1.4) conjunctivitis

2) Keratitis

It is an inflammation of the cornea — the clear, dome-shaped tissue on the front of your eye that covers the pupil and iris. Infectious keratitis can be caused by viruses, bacteria and fungi.

• **Symptoms**

- Eye Redness
- Eye pain
- Blurred vision
- Decreased vision

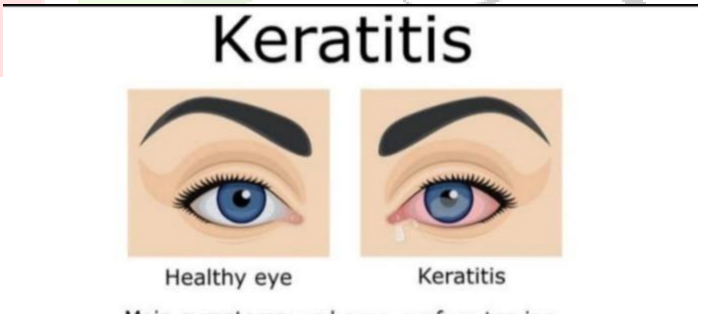

Fig1.5) keratitis

3) Endophthalmitis

It is an inflammatory condition of the intraocular cavities (i.e., the aqueous and/or vitreous humor), usually caused by infection.

Most common symptoms of endophthalmitis are:

- Eye pain
- Red eyes.
- White or yellow pus.

- Swollen or puffy eyelids.
- Decreased, blurred or lost vision.

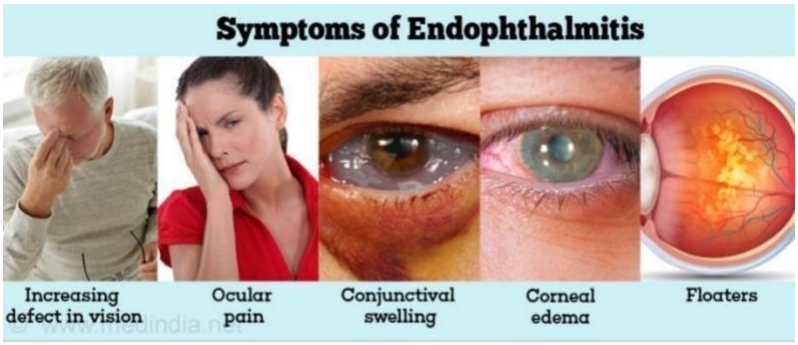

Fig 1.6) Endophthalmitis

• Conclusion

The new ophthalmic delivery system includes ocular inserts, collagen shields, disposable contact lens and other Novel drug delivery systems like liposomes 20 and nanoparticles. The administration of drug solutions as topical drop with conventional formulations was associated with certain drawbacks which initiated the introduction of different carrier systems for ocular delivery.

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