Contact Lens Update
CLINICAL INSIGHTS BASED IN CURRENT RESEARCH

Anatomy and Physiology of the Anterior Eye

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Downie LE, Bandlitz S, Bergmanson JPG, et al. CLEAR – Anatomy and physiology of the anterior eye. Cont Lens Anterior Eye 2021;44:132-56.

An important aspect in caring for the contact lens-wearing patient involves a clinical examination of the anterior segment health. Knowing the structure and function of the anterior segment is crucial for understanding the interaction and impact of contact lens wear on ocular health. This report reviews the anatomy and physiology of the anterior segment that is relevant to contact lens wear.[1] The anatomical aspects covered in the report include the cornea, limbus, conjunctiva, sclera, eyelids and eyelashes, lacrimal system, and the tear film. In addition, there are two new recommendations for change in nomenclature; the terms anterior limiting lamina, and posterior limiting lamina have been proposed to replace Bowman's membrane, and Descemet's membrane, respectively. The change was proposed to standardize terminology used in clinical care by adopting recommendations from the Federative Committee on Anatomical Terminology (FCAT).

The cornea functions to maintain optical transparency and UV protection for the intraocular structures. It is also responsible for two-thirds of the total refractive power of the eye. It consists of five distinct layers: epithelium (~50 µm), anterior limiting lamina (formerly known as Bowman's membrane, ~8 µm), stroma (~470 µm), posterior limiting lamina (formerly known as Descemet's membrane, 3-20 µm), and endothelium (3-5 µm). Its hydration, which is dependent on the endothelial layer, is crucial to maintaining its transparency. Deprivation of oxygen, particularly with low transmissibility contact lens materials, results in corneal edema and loss of transparency. The limbus mediates physiological replacement of the corneal epithelial cells and wound healing.

The main function of the conjunctiva is to act as a barrier against pathogens and to facilitate mucin secretion. The conjunctival epithelium is continuous with the corneal epithelium at the limbus and with the skin at the mucocutaneous junction of the eyelid margins. The epithelium is non-keratinized and contains two main types of cells: epithelial cells and goblet cells. Goblet cells are specialized cells that are distributed across the conjunctival surface; they secrete MUC 5AC, an important mucin for maintenance of the tear film.

The sclera is opaque and is composed of elastic and collagen fibers. The function of the sclera is to protect the intraocular contents from traumatic injury and mechanical displacement, and to provide insertion points for extraocular muscles.

The eyelids function to protect the ocular surface from injury, to dam and distribute the tear film, and to control the amount of light entering the eye. The eyelid movements serve to distribute the tears and act as a tear pump mechanism, facilitating the drainage of the tears through the puncta and lacrimal sac. The eyelids contain the meibomian glands and accessory lacrimal glands, both of which function to sustain the tear film.

The lacrimal gland secretes proteins and electrolytes into the tear film to maintain immunity and health of the ocular surface. These components are often observed depositing onto contact lens materials, which could result in decreased visual performance. Hormones have been demonstrated to influence the activity of the gland. The tear film drains from the ocular surface through the lacrimal canaliculi, the lacrimal sac, then through the nasolacrimal duct.

The tear film consists of a superficial lipid layer, overlying the aqueous-mucin phase, which in turn overlies the glycocalyx. The lipid layer, which is approximately 40 nm thick arises from contributions from the meibomian glands. The aqueous-mucin phase, making up the majority of the tear film, receives contributions from the main lacrimal gland, accessory lacrimal glands, and ocular surface epithelial cells. The glycocalyx is composed of mucins (MUC 1, MUC 4, MUC 16) that are bound to the ocular surface epithelium.

The lipids in the tear film serve to inhibit aqueous evaporation and to reduce its surface tension to encourage spreading over the ocular surface. Mucins are proteins which have domains that are heavily glycosylated, and these domains allow mucins to retain large amounts of water to help the tears and ocular surface maintain hydration. Mucins also play a role in reducing friction during blinking and trap debris for removal. There are >2000 proteins in the tear film that are involved in functions related to microbial inhibition, neuromediation, and inflammation. The tear film also contains electrolytes that contribute to ocular surface health and epithelial integrity; the main electrolytes are sodium, potassium, chloride and bicarbonate.

The normal pH of the tear film ranges between 6.8 – 8.2 and the normal osmolarity of the tear film ranges between 270 – 315 mOsm/L. Basal tear production ranges between 0.19 to 1.2 µL/min and reflex tearing could increase tear production up to 100 µL/min. Tear production related to emotional tearing could be up to 400 µL/min. Some advanced clinical testing techniques for quantifying various aspects of the ocular surface include pachymetry (corneal thickness), esthesiometry (ocular surface sensitivity), and conjunctival impression cytology (goblet cell density).

REFERENCES:

1. Downie LE, Bandlitz S, Bergmanson JPG, *et al*. CLEAR – Anatomy and physiology of the anterior eye. Cont Lens Anterior Eye 2021;44:132-56.