Introduction

Although Part 4 is entitled *Anatomical Considerations*, it might just as easily be called *Potentially Adverse Effects of Contact Lens Wear.* In effect, this section will catalogue many of the potentially negative aspects of contact lens wear. However, with diligence on the part of the fitter and compliance on the part of the patient, many of these adverse effects can be greatly minimized if not virtually eliminated. Proper patient selection, well-fit lenses, and adequate follow-up will usually result in healthy corneas and satisfied patients. However, lack of concern, laziness, or simple negligence on the part of either the fitter or the patient can often cause the sort of problems we're about to study. Detecting many of these conditions will often require considerable clinical experience, and treating them should always be left to the prescribing practitioner.

The section begins with a review of certain anatomical structures which effect the contact lens fitter. These include the tear film, eyelids, conjunctiva, cornea, and limbus. It is followed by a presentation of some of the potentially adverse effects of contact lens wear which include corneal edema, corneal striae, conjunctival and episcleral injection, giant papillary conjunctivitis, and corneal vascularization.

Flourescein, in addition to its value in helping to evaluate the fit of a contact lens, is also used to facilitate the precise delineation of specific corneal epithelial defects. It acts either by pooling in the area of the defect or by staining the underlying exposed basement membrane or Bowman's layer. Corneal epithelial staining patterns could possibly be caused by direct trauma or by defective distribution of the tear film. This section will illustrate staining patterns which might be caused by a poorly edged or damaged lens, or by improper insertion, removal and recentering techniques. We will also discuss staining which might be the result of defective tear distribution such as "three and nine-o-clock" staining, or limbal peripheral staining.

This section will conclude with a discussion of the biomicroscope or slit-lamp and will emphasize the importance of this instrument in contact lens fitting. The various illuminations are discussed, illustrated, and the uses of each are described.

The practice test consists of twenty-nine questions. As a reminder, be sure to study the material as thoroughly as possible before completing the test.

4: Anatomical Considerations

Anatomy
Review

Anatomical & Physiological Considerations

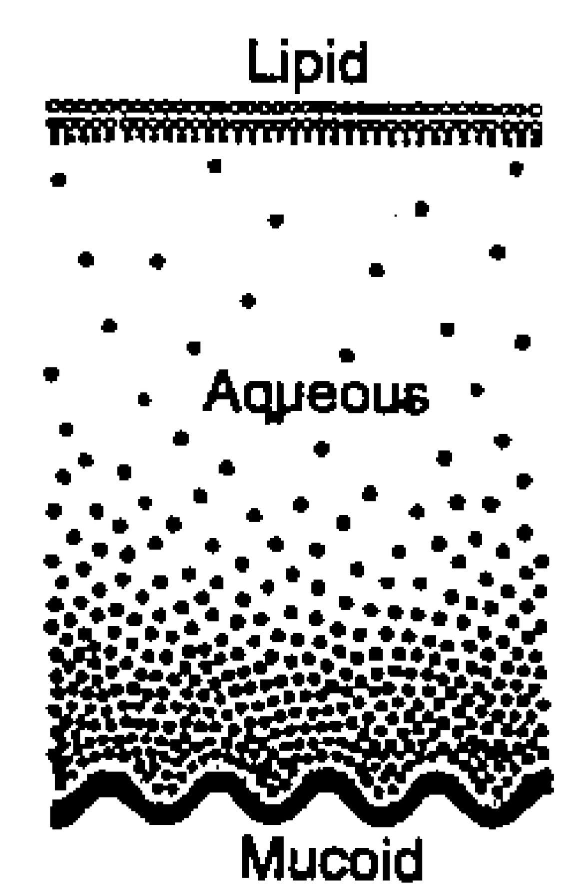
Successful adaptation to any contact lens, either rigid or soft, is largely dependent upon the adequate wetting of both the lens and the cornea, and sufficient oxygen flow to the corneal epithelium. In addition, a stable and adequate tear film is required as well as some means of removing metabolic by products from the cornea. When there is an adequate tear volume, these requirements can be met with the eyelids.

The health of the anterior surface of the eye is largely dependent upon the balanced interaction of several of its components. These include the eyelids, cornea, conjunctiva, sclera, and tear film. A contact lens on the eye can impose additional burdens to this system. If any one of the components are in some way altered, it can interfere with successful contact lens wear.

The taped discussion for Part 4 can be found on Tape 5, side 2. Simply follow along in the workbook as you listen to the tape for the first time. Then go over the material again to study it in more detail.

Tear Film–Three Layers

Lipid Layer: A fatty material produced by the meibomian glands which forms a very thin layer over the entire surface of the tear film. It functions primarily to prevent rapid evaporation which would result in dry areas on the cornea and subsequent discomfort and corneal damage.



The Mucoid Layer functions to convert the hydrophobic epithelial layer of the cornea to a hydrophyllic surface. It is the innermost layer of the tear film and located immediately against the corneal and conjunctival epithelial cells.
BUT or Break Up Time, indicates the amount of time it takes from a blink until the tear begins to break up or becomes discontinuous. BUT's shorter than 5-10 seconds are considered abnormal. Short BUTs may indicate a deficiency in the mucoid layer.

The Aqueous Layer is the middle layer of the tear film and consists of 98% water. However, it also contains ions, and other molecules such as sodium and potassium along with a concentration of protein.
A cornea is said to be *hypotonic* when more water flows in than out causing the cornea to swell. This occurs when normal evaporation is not allowed to occur. An isotonic cornea allows an equal amount of water to flow in as well as out allowing the cornea to maintain its normal thickness.

Anatomy Review

A normal cornea is in a continual state of partial dehydration which also known as *deturgence*. If more water flows out than flows in, the cornea becomes *hypertonic* resulting in corneal thinning. Hypertonicity can be caused by a higher salt concentration placed on the cornea. Another aspect of the tear layer which you may need to know is its pH, which refers to its relative acidity or alkalinity. The pH of the human tear is approximately equal to 7.4. pH will be menioned again in Part 6 when we cover contact lens solutions.

Eyelids:

The eyelids function primarily to help keep the eye moist and to help keep out foreign bodies. It is the opposing action of the eyelids which causes tears to spread evenly over the cornea thus keeping it moist. The lids play an important role in the fitting and wear of contact lenses for the following reasons:

They effect the wettability of the lens surface
They effect the positioning of the lens
They are sensitive and generally cause most of the discomfort when a lens is first placed on the eye

Conjunctiva:

The conjunctiva is the loose tissue covering the sclera and inside the lids. The *bulbar conjunctiva* covers the sclera while the *palpebral conjunctiva* is that portion which lines the inner surface of the upper and lower eyelids.

Cornea:

The cornea is the anterior refracting surface of the eye, it consists of transparent tissue and is devoid of blood vessels. The cornea is of utmost importance to the contact lens fitter since the lens sits directly on this tissue. The average corneal thickness is about 0.52 mm at its center and increases to about 0.65 mm at the limbal area and it is composed of five distinct layers.

Epithelium: That layer of the cornea which is exposed to the tears and comprises about 10 % of the total corneal thickness. The corneal epithelium is highly regenerative, demonstrating a remarkable ability to heal itself after being scratched. A corneal abrasion is often completely healed within 24 hours.

Bowman's Membrane: Is essentially a modification of the underlyhing stroma. Unlike the epithelium, if damaged by a scratch or cut, it can not regenerate itself so scarring will occur.

Stroma: The stroma comprises approximately 90% of the corneal thickness. It consists of 200 to 250 layers of cells called lamellae, which lie parallel to the corneal surface. If damaged by injury, scarring will occur which can result in opacities of the cornea.

Chronic infection or corneal edema can cause blood vessels to invade the stroma resulting in a condition known as *neovascularization*.. These blood vessels which enter to supply oxygen and nutrients can obscure vision.

Descemet's Membrane:: A strong structureless layer which is secreted by the endothelium. It is elastic, and resistant to trauma and pathology.

Endothelium: The innermost or most posterior layer of the cornea, consisting of a single layer of flattened cells. In contrast to Descemet's Membrane, these cells are very susceptible to trauma and pathology. And in marked contrast to the epithelium, endothelium cells are infrequently, if ever replaced as a normal process during adult life. If disrupted, however, they can be replaced by the spreading of healthy cells.

Limbus:

The limbus is a transition zone between the cornea and the sclera. It is approximately 1 mm wide and the cornea is dependent upon it for receiving part of its nutrients. The limbal region becomes significant when fitting contact lenses since it is so closely connected to the cornea and some contact lenses will bear directly on it.

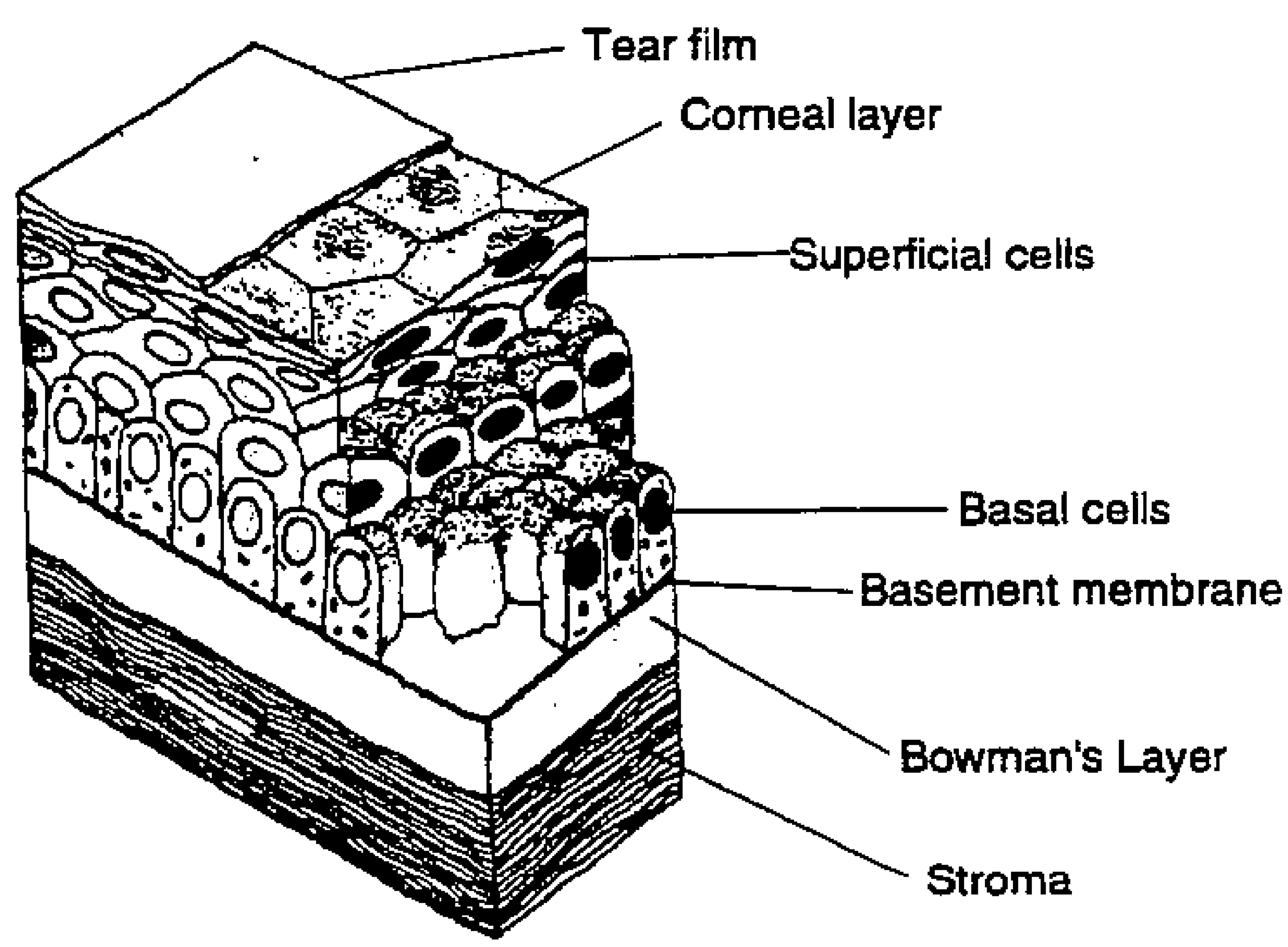


Diagram Of Corneal Epithelium

Adverse Effects

Corneal Edema:

When the combination of forces which normally serve to dehydrate the cornea are overcome by forces which drive water into the cornea, corneal edema may result.

This situation, which may be induced by contact lens wear when the corneal epithelium becomes deprived of its normal amount of oxygen, is known as *corneal hypoxia.* When PMMA lenses are worn, the amount of oxygen received by the cornea is dependent upon the adequate circulation of tears under the lens. An inadequate tear flow under the lens can result in corneal edema.

Corneal edema with PMMA lenses may be caused by the following factors:

Abnormalities in the tear film
A tight fitting lens
An excessively large lens
Poor blinking habits
Inconsistent or excessive wearing time

Corneal edema with rigid gas-permeable lenses:

In rigid gas permeable lenses corneal edema can be caused by all of the factors as in PMMA lenses but only if there is inadequate transmission of oxygen through the lens. This can occur if the surface of the lens is coated extensively with deposits.

Corneal edema with soft lenses:

Any factor which limits the transmission of oxygen through the lens can result in corneal edema with soft contact lenses. Some of these factors might include:

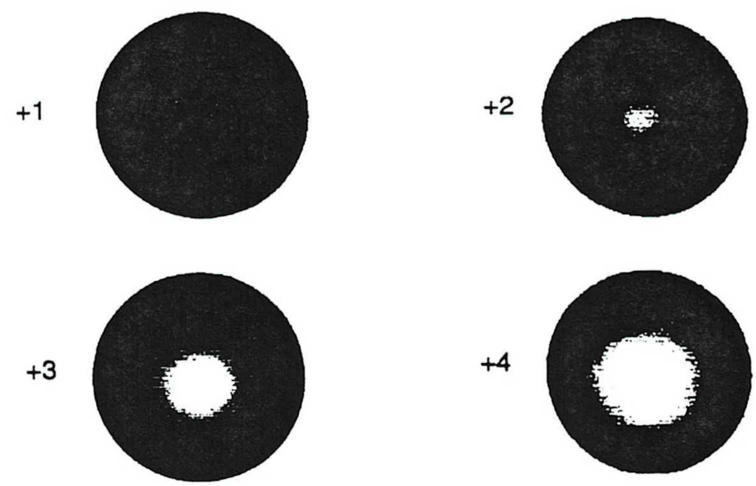
Inadequate lid closure
Excessive lens thickness
Relatively low lens water content

The interrelationship of these three factors becomes especially important when fitting extended-wear lenses.

Adverse Effects

Corneal Epithelial Edema

This condition appears as a grey corneal have and may be best observed with a slit lamp *utilizing sclerotic* scatter illumination and the unaided eye. The various slit lamp illuminations will be covered later in this section.

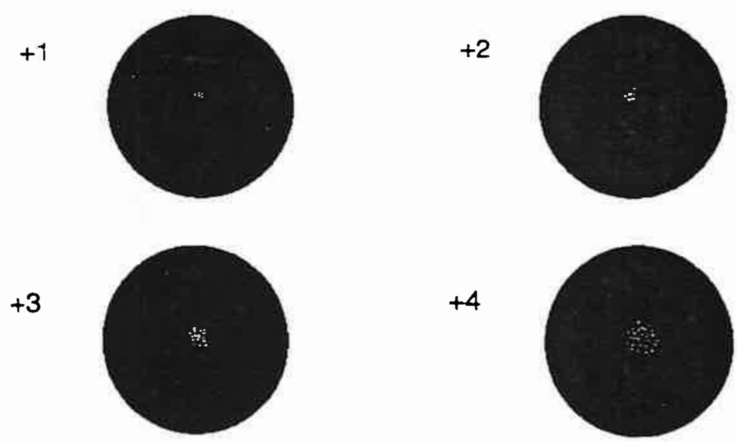


The severity of epithelial may be noted by grading it from +1, a barely perceptible haze to +4, which is a densely circumscribed area.

Adverse Effects

Microcystic Edema

Progressive corneal hypoxia can lead to the rupture of certain epithelial cell membranes which in turn can result in the formation of microcysts. Microcysts are the result of fluid which has accumulated in the spaces caused by the rupture of these cells. Microcystic edema is best seen utilizing a slit lamp with *retro-illumination.* Flourescein can also be used to outline intact microcysts and stain the punctate areas where microcysts have ruptured.



The illustration above depicts the gradation of contact-lens-induced corneal epithelial microcystic edema. Typically this edema is centrally located. The mycrocysts are frequently interspersed with punctate epithelial defects which result from microcyst rupture.

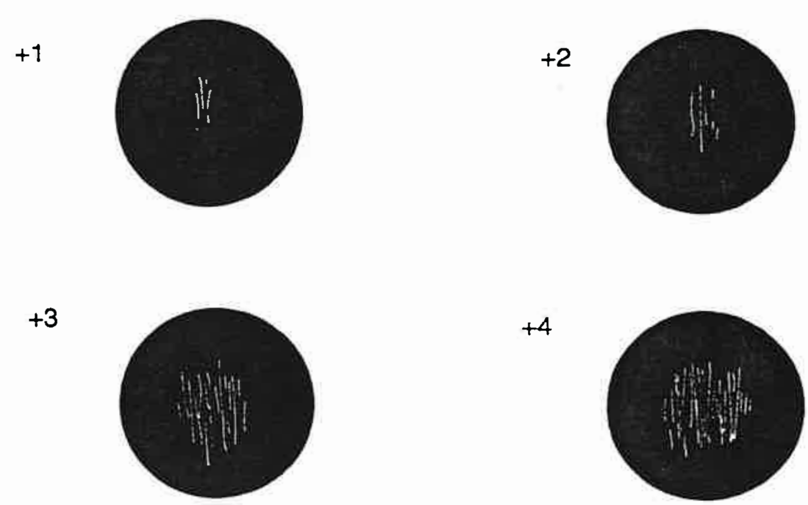
Adverse Effects

Corneal Striae

Corneal striae are linear opacities in the cornea. They may also be referred to as striae, folds, wrinkles, striate keratopathy, striate corneal lines. The terminology is ambiguous.

These are seen as vertically oriented, delicate, translucent lines located at or near the level of Descemet's membrane. Corneal straie are best seen either with retroillumination or with direct illumination.

They are found in up to 50% of soft lens wearers but are very rare in rigid contact lens patients. The reason for this is not completely understood.



Contact-lens-induced corneal striae are shown above graded from +1 to +4. They are quite subtle and can be easily overlooked. Typically they are slender, vertical, and occur in the pre-Descemet's region of the stroma.