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The Dreaded Dry Eye

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Dry eye is a common condition that is encountered in optometric practice. It is estimated that anywhere from 12 percent to 20 percent of the population has dry eye¹⁻⁴. As our population ages, these percentages are sure to increase as dry eye is more common in the elderly. To understand dry eye, we need to first review the anatomy of the tear film, including those

ocular structures that are involved in producing these components. We will then discuss the clinical consequences of what occurs when these structures are not functioning properly.

The Tear Film

The tear film is a complex structure composed of three different layers: the lipid layer, the aqueous layer and the mucin layer (figure 1). All three layers are key components to a healthy tear film. A deficiency in any of these layers will affect the integrity of the others. We will now discuss each of these layers in greater detail.

The Lipid Layer

The lipid layer is the outermost layer of the tear film. It covers the entire tear film and prevents evaporation of the underlying aqueous layer. This layer is produced by the meibomian glands located on the lid margins of the upper and lower eyelids⁵(figure 2). This layer has an oily consistency, and as such, will spread smoothly over the surface.

The lipid layer is integral for a healthy tear film. When the lipid layer is compromised, it affects the integrity of the underlying layers. The most common reason that the lipid layer will be compromised is if the meibomian glands produce altered oils that do not spread over the ocular surface optimally.

The health of the meibomian glands is key to a healthy lipid layer. The lipids that are produced by these glands are often altered by bacteria that reside on the eyelid margins. These bacteria produce secretions that can decrease the fluidity of the oils. Bacteria around the meibomian gland region often cause an inflammatory response. The inflammatory cascade reduces the quality of the oils that are produced by these glands. This will be seen clinically by a thickened red eyelid margin⁶. The lipid layer and the health of the meibomian glands are key to maintaining the integrity of this vital tear film layer.

The Aqueous Layer

This is the middle layer and also the thickest layer of the tear film. As its name implies, it is mainly composed of aqueous, a watery substance. However, it also contains critical proteins that contain antibacterial properties including lysozyme, betalysin and lactoferrin⁷. These substances act as a natural defense mechanism for the eye because they help protect it against infection.

A robust tear film is critical for a healthy ocular surface. The examiner can quickly get a sense of the health of the tear film by assessing the tear prism. The tear prism is where the tear film accumulates on the lower eyelid (figure 3). There are certain inflammatory conditions such as Sjogren's Syndrome or Rheumatoid Arthritis that can cause an insufficient production of tears in these patients. Certain medications patients may take such as anti-histamines, anti-depressants and diuretics can also compromise the aqueous layer. Additionally, a compromised lipid layer will also affect the aqueous layer by allowing it to evaporate more quickly than when a healthy normal lipid layer is intact.

Mucin Layer

The mucin layer lies directly beneath the aqueous layer and lines the ocular surface. The corneal epithelium, which is part of the ocular surface, is a hydrophobic (water repelling) structure. This structure is similar to a freshly waxed car that repels water by causing it to bead up on the surface. The mucin layer binds itself to the ocular surface, allowing the aqueous layer to evenly distribute over the corneal epithelium⁸. Without the mucin layer, the aqueous layer would not be able to form such an intact layer over the ocular surface.

The Tear Film as a Whole

As you can see, the lipid, aqueous and mucin layers are all critically important to the health of the tear film. Although they all have their unique properties that make them important to the ocular surface, they are not mutually exclusive. This means that when one layer is affected, it will likely have effects on the integrity of the other layers. Thus, our goal when treating patients with dry eye is to make the proper environmental recommendations and proper agents to promote a healthier tear film.

Treating Dry Eye

The ocular surface is a delicate structure that requires many components to re-establish a healthy surface. Here we will discuss the most common treatment options and the reasons why they provide the building blocks for a healthy tear film.

Environmental Modifications

The initial treatment for dry eye involves educating the patient on factors in their environment that may be causing their ocular dryness and giving them strategies to minimize the effects of these factors. One of the first things we will normally discuss

with patients is water intake to make sure that they are consuming the recommended 5 to 8 glasses of water per day. It is critical that patients stay hydrated.

Computer usage is another factor that may cause ocular dryness. Studies indicate that patients blink less while they are working at a computer. A reduced blink rate exposes the ocular surface longer, allowing the tear film to evaporate. For individuals who spend a significant number of hours on the computer, this can be a major issue. Often, the symptoms that they will complain about are eye strain, eye fatigue, eye soreness and discomfort. Often, lowering the height of their computer monitor will help these patients significantly. By lowering the monitor, the size of the interpalpebral fissure (space between the upper and lower eyelid) will be reduced, exposing less of the ocular surface to the environment. (NOTE: try this by having someone simply look up and then down to see the dramatic change in how wide open the eyes seem while the person is looking up compared to when they are looking down)

Additionally, heating and cooling vents that are positioned toward patients while at work, in their automobiles, or while sleeping can also have a dramatic effect on the tear film. Make sure to educate these patients that they should avoid this or redirect the vents if at all possible.

Artificial Tears

Artificial tears are usually the first line of therapy for most patients. However, keeping patients compliant with our prescribed artificial tear and dosage recommendation is often very difficult. Unfortunately, there are usually major differences between the name brand and generic (or store) brands. One of the major differences is the preservative that is contained in the artificial tears. Many of the newest artificial tears have very gentle preservatives that do not irritate the ocular surface. Unfortunately, generic versions of artificial tears are often preserved with benzalkonium chloride (BAC). This preservative is known to be harsh on the ocular surface and may counteract many of the benefits that the wetting agents in the artificial tears would otherwise deliver^{9,10}.

There are many brands of artificial tears. We will review some of those most recently introduced to the market:

Alcon produces Systane and Systane Ultra. This line of artificial tears contains HP-Guar and Borate, which creates an organized structure that mimicks the structure of the mucin layer¹¹. This structure will then bind the wetting agents and retain them on the ocular surface for long lasting relief¹².

Allergan produces the Refresh line of tears. This line of tears uses carboxymethylcellulose (CMC) as the wetting agent. The company has altered the concentration of CMC to produce artificial tears of varying viscosity. Recently, the company released Optive, which introduced a compound called glycerin to its original CMC formulation^{13, 14}.

Abbott Medical Optics has an artificial tear called Blink. This artificial tear solution contains propylene glycol and sodium hyaluronate¹⁵.

Many of the artificial tears will produce successful therapy if the patient is compliant with their therapy. Make sure to give the patient very specific instructions on when to utilize the drop. Many have treated it as a prescription product to maximize compliance efforts with the use of artificial tears.

Lacrimal Inserts

For those patients that benefit from regular artificial tear use but find it inconvenient to utilize tears as frequently as they would like, a more convenient option exists. Hydroxypropyl cellulose ophthalmic inserts (Lacriserts) are placed directly in the lower fornix. The lower fornix is the small pocket where the palpebral conjunctiva joins the bulbar conjunctiva. Over a 24 hour course, the insert slowly dissolves, releasing a constant flow of lubricants to the ocular surface. Many enjoy the convenience that this option offers¹⁶.

Eyelid Hygiene and Therapy

As discussed earlier, the health of the meibomian glands will dictate the health of the tear film's lipid layer. As such, those patients who seem to have eyelid disease concurrently with their dry eye should be treated to help the lids regain normalcy.

The eyelashes and lid margins should be examined very critically. Eyelashes should be examined closely for any debris that may be present. At times, deposits (collarets) can build up at the base of the eyelashes (figure 4). These deposits will often irritate the lid margin, and because the orifice of the meibomian glands is so close to the lid margin, it will invariably be affected. Examination of the lid margin for any thickening and redness is extremely important. Assessing the fluidity and color of the meibomian gland secretions is critical to ensure a proper lipid layer. The oils that are emitted from the meibomian glands should be clear and fluid, resembling that of vegetable oil. Oils appearing any different than that may indicate dysfunctional meibomian glands.

A proper course of treatment for these patients usually begins with eyelid hygiene. This will entail using a commercially prepared eyelid cleanser one to four times per day to mechanically remove the deposits from the lashes. Additionally patients can use a mixture containing four parts water and one part baby shampoo to mechanically rub along the lid margin with a cotton swab, removing some of the debris. We recommend our patients use the commercially available cleaners as they are specifically formulated for the deposits and bacteria found in the eyelid margins.

Sometimes patients will also need the help of an antibiotic to control the bacterial populations that are likely causing much of the debris seen in the lid margins. If one chooses to apply antibiotics to the lid margins, it is ideal to apply either a gel or an

ointment at bedtime as thicker agents will reside on the margins for longer periods of time than a drop would.

When meibomian glands are plugged, it is very important to use the proper treatment regimen. Often, this begins with the addition of heat and lid massage. The goal of this regimen is to thin the lipids so that they can flow out of the meibomian glands. Providing heat to the glands will make the gland flow better, much like providing heat to a stick of butter will liquefy it. The use of a massage during the application of heat helps to facilitate the expression of the lipid layer of the tear film.

Oral doxycycline, an antibiotic, is sometimes prescribed to help add fluidity to the meibomian gland secretions. It has anti-inflammatory effects, which seem to help the meibomian glands produce healthy secretions.

Omega-3 fatty acids are now also being advocated by eye care practitioners to help manage dry eye and lid margin disease. Two to four grams of Omega-3 fatty acids are recommended daily to help promote healthy meibomian gland secretions. When patients begin using these agents, it will often take 6 to 12 weeks to produce noticeable results.

Currently there is a topical antibiotic that will also help meibomian glands produce healthier secretions. Azithromycin 1% (Azasite, Inspire pharmaceuticals) applied to the eyes twice a day for the first two days and then once a day for two weeks to one month will often be sufficient to regain some of the functionality of meibomian glands by facilitating healthy lipid secretions from the glands.

Anti-inflammatory Agents

When a patient has chronic dry eyes, their tear film is insufficient to support the ocular surface. As a result, the ocular surface, including the cornea, becomes inflamed. Often, this will mean that we need to utilize agents that will specifically address the inflammatory component of dry eye disease.

Cyclosporine ophthalmic emulsion (Restasis) was initially approved as an agent that facilitated more tear production. We now know that it also has anti-inflammatory properties that help produce a healthier ocular surface. Because controlling inflammation is important to helping those with dry eyes, many have embraced loteprednol 0.5% (Lotemax) as a viable option to help reduce that component.

Punctal Plugs

Punctal plugs are medical devices that are utilized to retain tears on the ocular surface. As their name implies, these devices are used to plug the punctum. The punctum is located nasally on both the upper and lower eyelid. This punctum is the orifice for the lacrimal drainage system that allows the tears to drain into the back of the nose and throat. Thus, blocking the punctum will allow more tears to be retained on the ocular surface.

Conclusion

With the vast number of treatments for dry eye that are available, it is important for paraoptometric to be familiar with the benefits and differences between them. With the information presented in this article, you will be armed with the tools to understand the condition and be able to provide a valuable service in your practice by educating patients on the importance of complying with therapy.

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The Dreaded Dry Eye Quiz

You must be an AOA Associate member, and answer 14 of 20 questions successfully to receive one hour of continuing education credit. This quiz is comprised of multiple-choice questions designed to test your level of understanding of the material covered in the continuing education article, "The Dreaded Dry Eye".

To receive continuing education credit, complete the information below and mail with your \$10 processing fee, \$10 per hour of CE before **December 31st of this year** to the: **AOA Paraoptometric Resource Center, 243 N. Lindbergh Blvd, St. Louis, MO 63141-7881**

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Select the option that best answers the question.

1. Which of the following is not one of the primary three tear film layers?
 - a. Lipid layer
 - b. Meibomian layer
 - c. Aqueous layer
 - d. Mucin layer

2. Which of the following best describes the location of the meibomian glands?
 - a. Along the lower eyelid
 - b. Along the upper eyelid
 - c. Outside of the eyelashes
 - d. Both a and b

3. Bacteria along the eyelid margin affects the quality of the tear film by disrupting what tear film layer FIRST?
 - a. Lipid Layer
 - b. Meibomian Layer
 - c. Aqueous Layer
 - d. Mucin Layer

4. When the tear film is compromised due to evaporation, it is due to a deficiency or compromise of which layer?
 - a. Lipid layer
 - b. Meibomian layer
 - c. Aqueous layer
 - d. Mucin layer

5. What layer of the tear film allows the hydrophobic corneal surface to connect to the Hydrophilic (water loving) tear film?
 - a. Lipid layer
 - b. Meibomian layer
 - c. Aqueous layer
 - d. Mucin layer

6. The aqueous layer is the thickest layer of the tear film.
 - a. True
 - b. False

7. As discussed in this article, which of the following is the first thing that Dr. Kading and Dr. Brujic discuss with their dry eye patients?
 - a. Computer use
 - b. Slit Lamp findings
 - c. Water intake
 - d. Restasis

8. As discussed in this article, which of the following will affect the amount of evaporation that occurs from the tear film?
 - a. A decreased aqueous layer
 - b. A decreased lipid Layer
 - c. Computer use
 - d. Both B and C

9. Which of the following makes artificial tears a difficult treatment option?
 - a. Patient compliance
 - b. Preservatives
 - c. That there are too many brands to chose from
 - d. All of the above

10. Lacrimal Inserts DO NOT work for patients who:
- Need frequent artificial tears
 - Experience dryness throughout the day
 - Seek convenience in their treatment options
 - None of the above
11. An acceptable treatment option for patients with eyelid/eyelash problems includes:
- Artificial tears
 - Lacrimal Inserts
 - Heat
 - Restasis
12. As mentioned in this article, which of the following can contribute to the development of dry eye symptoms?
- Bacteria
 - Inflammation
 - Decreased tear volume
 - All of the above
13. When used in combination, _____ allows the eye to retain tears longer and _____ aids in the production of additional tears.
- Lacrimal Inserts, Artificial tears
 - Azasite, Doxycycline
 - Punctal Plugs, Lacrimal Inserts
 - Punctal Plugs, Restasis
14. Which of the following is NOT a treatment for eyelid related dry eye issues?
- Azasite
 - Heat
 - Lid massage
 - Punctal Plugs
15. Damage of this gland causes damage to the lipid layer of the tears.
- Glands of Zeiss
 - Glands of Moll
 - Meibomian glands
 - Lacrimal glands
16. What is the thickest layer of the tear film?
- Lipid layer
 - Meibomian layer
 - Aqueous layer
 - Mucin layer

17. When this layer of the tear film is deficient, there is not even distribution of tears across the cornea/ocular surface.
- Lipid layer
 - Meibomian layer
 - Aqueous layer
 - Mucin layer
18. Which of the following environmental changes will help to decrease dry eye symptoms?
- Raise the computer monitor
 - Decrease water intake
 - Move to higher altitude
 - Increase Omega 3 fish intake
19. Which of the following treatment options work for patients with dry eye?
- Punctal plugs and lacrimal inserts
 - Increased Omega-3 fatty acids and artificial tears
 - Both A and B
 - None of the Above
20. Oral Doxycycline is an antibiotic that possesses an anti-inflammatory effect.
- True
 - False