“Contemporary Management of Ocular Surface Disease”

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Ocular surface disease is an umbrella term under which many disorders and deficiencies fall, but common to all is an abnormal pre-ocular tear film. The ocular surface is affected by a series of complex interactions between the eye lids, cornea, lacrimal and meibomian glands, as well as the multiple layers of the tear film. A deficiency in any one of these features can result in ocular surface disease. The American Optometric Association (AOA) classifies ocular surface disease predominately into two categories, tear film disorders and blepharitis. Approximately fifteen percent of the general population is affected by dry eye syndrome, although some estimates are much higher. The prevalence of dry eye syndrome is even higher in contact lens wearers, so clinicians should be prepared to manage this condition. Ocular surface disease is more common in older patients, and as the population over sixty-five continues to grow at an accelerated rate, this condition will become even more clinically relevant.

There are a multitude of dry etiologies, both pathological and physiological, and certainly the mechanism determines the most appropriate treatment. Not long ago, artificial tears were the mainstay of treatment and few practitioners varied from this standard treatment option. Today there is an abundance of treatment options including mild steroids, anti-inflammatory agents such as cyclosporine, and dietary supplementation with omega-3 fatty acids and many more promising treatments being developed currently.

Background

It is commonly known that the tear film consists of three major layers: lipid, aqueous, and mucin. Although originally these layers were proposed to be rather distinct entities with precise boundaries, it is much more likely that the three layers intermingle to form a gradual transition with the inner portion adjacent to the corneal surface being most mucin-like and the outer layer embodying hydrophobic qualities characteristic of the lipid layer. The lids are centrally involved with the production and dispersion of tears, thus concurrent lid disease such as blepharitis negatively impacts the quality of
the tear film and must be addressed for treatment of ocular surface disease to be truly effective. Tear secretion is regulated by a series of intricate relationships between neuronal signals, hormones, and other chemical messengers like cytokines. A disruption of this delicate balance results in decreased tear film stability which can ultimately lead to inflammation secondary to increased tear film osmolarity.²

**Etiology of tear film disorders**

A deficiency or abnormality in any of the three tear layers can be responsible for ocular surface disease. Meibomian gland dysfunction (MGD) decreases the secretion of the lipid layer of the tears, leaving the aqueous layer prone to increased evaporation without its protective outer lipid layer. Blinking promotes the secretion of the lipid layer, so patients exhibiting signs characteristic of MGD such as capped meibomian glands and poor tear film quality should be educated about the necessity of complete blinking.

Deficiencies in the aqueous layer have historically been divided into evaporative and secretion deficient by the National Eye Institute, but the distinction between these two is blurring, especially regarding contact lens-induced dry eye. Autoimmune disorders such as rheumatoid arthritis and Sjogren’s syndrome affect the lacrimal gland and cause a decrease in the aqueous layer which is crucial to maintaining the quality refracting surface necessary for good visual acuity. Aqueous deficiency can be treated by controlling the underlying systemic disorders and using a lubricant such as Refresh. Deficient lacrimation is most common in post-menopausal women due to altered hormone levels.³ Specifically, androgen levels decline with age and this reduction has been clinically correlated with dry eye symptoms.⁴

The mucin layer is secreted by the goblet cells of the conjunctiva and cornea and is important in promoting adherence of the aqueous layer to the hydrophobic corneal epithelium. Steven-Johnson’s syndrome and ocular pemphigoid are two conditions that result in damage to goblet cells. Contact lens wear is contraindicated in patients with these conditions due to the necessity of an intact mucin layer
for normal tear film function. Although rare in the United States, goblet cell damage can be caused by a Vitamin A deficiency which can result in a mucin layer abnormality.³

Many systemic medications can affect aqueous production, inducing an iatrogenic dry eye syndrome. Antihistamines, especially the first generation drugs, tend to decrease aqueous secretion. Anxiolytics, beta blockers, phenothiazines, anti-cholinergics, and oral contraceptives also can have a negative effect on lacrimation.⁴

The growing popularity of refractive surgery is definitely impacting the prevalence of ocular surface disease. Photorefractive keratectomy (PRK) and laser in situ keratomileusis (LASIK) are surgical procedures that can exacerbate symptoms of dryness. It is proposed that the corneal nerves become less responsive after refractive surgery, leading to diminished stimulation of the lacrimal gland.⁵ Fortunately the dry eye symptoms following refractive surgery generally resolve in about a year.⁶

Dry eye related to contact lens wear is a common condition. Up to 50% of contact lens wearers experience dry eye symptoms, making them twelve times more likely than emmetropes and five times more likely than spectacle wearers to be symptomatic.⁷ Dryness is second only to discomfort as the reason for discontinuation of contact lens wear. The very presence on the contact lens on the eye alters the normal physiology of the tear film. In order to have good comfort and vision, there must be an adequate pre-lens tear film and a post-lens tear film.⁸ Patients with lipid layer deficiencies or those wearing lens materials with poor wettability are especially susceptible to increased tear film evaporation.⁹ It has been suspected that meibomian gland dysfunction may play a significant role in contact lens-induced dry eye. This theory gained support recently when a group of researchers found that contact lens wear was correlated with a decrease in the number of operating meibomian glands.⁹

This article, published in the March 2009 issue of Ophthalmology, states that the meibomian gland function of a contact lens wearer is equivalent to a non-contact lens wearer in their seventh decade, a startling statistic.⁹ The mechanism of dryness is proposed to be that the presence of a contact lens
exacerbates the increased osmolarity caused by a decreased tear thinning time, although this interaction has not been fully elucidated. Lipid deficiency often exists in contact lens-induced dry eye, and Soothe XP is often beneficial in such cases because it replaces the lipid layer and is compatible with contact lenses although it is not approved by the Federal Drug Administration (FDA) for this use.

The mucin layer has also been implicated in the genesis of contact lens-induced dry eye. There have been conflicting studies regarding the changes in the mucin layer secondary to contact lens wear, but it is likely that mucins can actually increase deposits on the surface of the contact lens, generating an inflammatory response. Therapeutic agents containing 15-(S)-HETE, a mucin secretagogue, are currently being developed and have been shown to increase the mucin layer thickness in rabbit eyes.

Contact lens-induced dry eye is more common in certain populations including females, higher water contact lens wearers, patients using over-the-counter pain relievers, and those with limbal injection. Moss et al found that the odds of experiencing dry eye increase by thirty-five percent for every decade of age, so it is even more likely that presbyopic contact lens wearers will be affected by dry eye. Smoking and caffeine have also been linked to dry eye. It is, therefore, especially pertinent to ask patients who fall into the aforementioned categories about dry eye symptoms.

There are several mechanisms by which dry eye syndrome may be induced in contact lens wearers. It was assumed that lens dehydration was the most plausible mechanism of dry eye induction, but several studies have failed to show a causal relationship between lens dehydration and the severity of dry eye symptoms. This is an important finding because it stresses the effect of lens parameters other than lens material on comfort. Contact lenses materials which are classified as group two or group four by the FDA are two to three times more likely than group one materials to cause dry eye symptoms. Generally lenses with high water content, such as those in FDA group two or four, should be avoided in dry eye patients. Hypoxia is a likely cause of contact lens dryness, and it may be an even greater contributing factor than lens dehydration. Solution sensitivity may also be to blame for contact
lens-induced dry eye, although this is perhaps a lesser known etiology. Superficial punctuate staining is often a clue that a solution sensitivity may be present. In gas permeable lenses, punctate staining from solution sensitivity is visible under the lens apex, while in soft contact lenses the staining is more diffuse.¹⁵

Surfacing abnormalities can also promote the development of ocular surface disease. In order for the tear film to be properly spread over the ocular surface, the following three components must be present: a normal blink rate, normal corneal epithelium, and apposition of the eyelids to the ocular surface.¹⁶ Low blink rates can leave the corneal epithelium vulnerable to desiccation. If the tear film is not spread properly by the lids, it cannot provide a stable refracting surface or protect the cornea from environmental elements. Lagophthalmos and Bell’s palsy are two conditions which do not allow for proper lid closure and this causes poor tear film spreading. Congenital coloboma of the eyelids or lid trauma can cause exposure keratopathy because a portion of the ocular surface is not protected. Thyroid eye disease and other conditions which cause proptosis result in an abnormally large palpebral aperture which can result in exposure keratopathy.³

Corneal surface irregularities promote the formation of ocular surface disease because the tear film cannot adhere to the cornea as effectively, which increases the evaporation rate of the tear film. Normally tiny microvilli on the corneal epithelium allow attachment of the inner mucin layer, but if these microvilli are damaged, the bond between the cornea and the tear film is weakened. Corneal scars from Herpes simplex infections, chemical burns, or foreign bodies alter the normal physiology of the ocular surface, resulting in decreased stability of the tear film.³ Ulcers from contact lens overwear can permanently alter the corneal surface and may cause tear film abnormalities.
Etiology of blepharitis

Blepharitis is inflammation of the eyelids which is usually bilateral and symmetrical. Blepharitis is typically divided into two divisions, anterior and posterior. Posterior blepharitis is also known as meibomian gland dysfunction (MGD) and has been discussed in a previous section. Anterior blepharitis can have several etiologies and usually has a chronic course. *Staphylococcus aureus* is a ubiquitous organism which normally resides on the skin with no detrimental effects. In some patients, *S. aureus* can provoke a cell-mediated response which can cause injection and corneal infiltrates.16 Staphylococcal blepharitis can cause itching or a foreign body sensation and lid signs such as madarosis, collarettes, and conjunctival injection may be present. Seborrheic blepharitis is caused by glandular dysfunction and tends to occur in individuals who have seborrhea of other areas including the sternum, scalp, and nasolabial folds.16 Blepharitis of seborrheic etiology can produce symptoms such as burning and discomfort, and signs such as lid hyperemia and greasy scales on the lashes. Blepharitis that has both staphylococcal and seborrheic characteristics is mixed blepharitis. Mixed blepharitis will be accompanied by keratoconjunctivitis and the presence of papillae or follicles.

There are also several less common presentations of blepharitis. Angular blepharitis, which occurs in the lateral canthus, can be cause by staphylococcus or by moraxella. Angular blepharitis is usually unilateral and causes the skin at the lateral canthus to become red and macerated. Fissuring of the skin may also occur.16 Phthiriasis palpebrarum is caused by the crab louse which generally affects people living in poor sanitary conditions. Itching is the most common symptom with this infestation and the lice are visible on the eyelashes.

Diagnosis

The diagnosis of ocular surface disease consists of two basic components, the subjective patient history and the objective clinical tests such as the tear breakup time (TBUT) and tear meniscus evaluation. The patient history can be invaluable in the diagnosis of ocular surface disease. Symptoms
that the patient may report include burning, excess tearing, redness, transient blurring of vision, and
foreign body sensation.\textsuperscript{17} Dryness that worsens as the day progresses and increased symptoms with
increased wearing time are two easily elicited clues that can help confirm the diagnosis of dry eye
disease. The suspect dry eye patient should preferably schedule an afternoon appointment-the time of
day when both symptoms and clinical signs of dry eye are becoming more obvious.\textsuperscript{18}

The height and quality of the tear meniscus should be evaluated, and several measurements of
tear film integrity should be conducted, including the phenol red thread test, Schirmer’s test, and TBUT.
If the patient has a phenol red thread test result of less than nine millimeters of wetting or a Schirmer’s
test result of less than fifteen millimeters of wetting in five minutes, the patient will likely be
symptomatic.\textsuperscript{19} Sodium fluorescein will also stain epithelial and conjunctival defects which are often the
sequelae of dry eye. Lissamine green will stain devitalized cells which are not covered by the protective
mucin layer, indicating a deficiency.\textsuperscript{15} It is beneficial to perform these tests prior to fitting a patient in
contact lenses to circumvent potential problems with ocular surface disease. In patients with contact
lens-induced dry eye, corneal staining is more likely and the location of the staining depends on the type
of lens worn. “3 and 9 staining” is evident in about half of gas permeable (GP) lens wearers and is
caused by corneal desiccation.\textsuperscript{19,20} Hydrogel lens wearers typically exhibit staining on the lower third of
the cornea, deposits on the lens surface, poor lens wetting, and conjunctival hyperemia.\textsuperscript{19,20}

Management

Management of ocular surface disease must start with patient education in order for any
therapy to be effective. It does not matter how effective the drug or therapeutic technique is, if the
patient does not use it, it is useless. A thorough explanation of what ocular surface disease is a good
first step to successful patient education. The patient does not need to know every cytokine and
enzyme involved in dry eye, but the patient does need to understand that dry eye disease is a legitimate
condition which can be treated effectively. Dry eye is a chronic condition and the patient should
understand that there is no magic cure. Management of ocular surface disease should be multi-faceted and may include the following approaches: patient education, counseling about environmental triggers, dietary modifications, and pharmaceutical therapy.

A “step-up” approach to treatment of dry eye should always be utilized to maximize results and minimize risks. This treatment tactic involves using the mildest forms of treatment initially, and then gradually “stepping up” the aggressiveness of the treatment if the milder forms are not effective. Artificial tears have been the mainstay of dry eye treatment for years, and are usually the first treatment modality which is offered. Patients need to be educated about the importance of compliance with artificial tears and the chronic nature of dry eye syndrome should be emphasized so patients do not have unreasonable expectations. Although it may seem unnecessary, instillation of the drops should be demonstrated so the drop is properly delivered to the ocular surface. Older patients who have arthritis may have difficulty instilling the drops, and accommodations should be made such as holding the bottle in a nut-cracker or arranging for a family member to instill the drops.

The effect of environmental conditions on dry eye disease must also be emphasized during patient education. Many work environments have low humidity so the cornea is more susceptible to drying out. Office jobs which require excessive computer work can lead to a low blink rate so the quality of the tear film is compromised. If the patient is made aware of these precipitating factors, often they can take measures such as using a small humidifier to reduce symptoms. The computer monitor should also be placed below eye level to prevent dryness because the palpebral apertures are narrowed in this position. Patients wearing contact lenses are even more sensitive to these factors.

Many patients are unaware that their diet can affect their dry eye symptoms. Omega 3-fatty acids have been shown to provide anti-inflammatory effects which can help decrease dry eye symptoms. In addition to reducing general inflammation, omega-3 fatty acids may reduce the viscosity of meibomian gland secretions, improve function of goblet cells, and enhance the functionality of the
epithelial microvilli. Patients should be counseled about the benefits of incorporating foods containing omega 3-fatty acids, such as leafy green vegetables and fish, into their diets.\textsuperscript{22,23} Boerner found that flaxseed oil, a source of omega-3 fatty acids, improved eighty-five percent of patients’ dry eye symptoms after two months of supplementation.\textsuperscript{24} There are also supplements which contain omega-3 fatty acids that may be more convenient for the patient than dietary modifications. Melton and Thomas recommend TheraTears Nutrition and Tears Again Hydrate (OCuSOFT) as two such supplements in the 2008 Clinical Guide to Ophthalmic Drugs.\textsuperscript{25} Corneal expression of IL-1a and TNF-α is increased in dry eye syndrome as a result of epithelial cell damage.\textsuperscript{26} Topical use of omega-3 fatty acids has recently been shown to reduce corneal expression of IL-1a and TNF-α in coordination with epithelial healing.\textsuperscript{26} Therefore, topical use of omega-3 fatty acids is a promising future treatment.

Artificial tears usually serve as replacements for the aqueous layer, but no artificial tear can exactly replicate the complex composition of natural tears. Tear formulations which are contain cellulose derivatives such as Celluvisc (Allergan) and Tears Naturale (Alcon) are best utilized in patients with mild to moderate dry eye syndrome. Unfortunately, both these products tend to deposit on lashes and Tears Naturale contains a preservative which may cause unwanted reactions. These products should be recommended for the patient with mild dry eye symptoms as a first-line treatment, but the patient should be educated about the possibility of lash deposits.

Artificial tears such as Liquivisc (Allergan), Viscotears (Novartis), and Gel Tears (Chauvin) contain polyacrylic acid (carbomer) as the wetting agent. These drops are longer lasting than the cellulose derivatives, but some do contain preservatives which can cause toxicity. Polyvinyl alcohol is another wetting agent which is often used in artificial tears.

Acetylcysteine is useful in patients who have severe dry eye with filaments because acetylcysteine cleaves the mucus strands. Acetylcysteine also acts on the goblet cells to increase mucin
production. Stinging upon insertion is a common patient complaint and acetylcysteine is used sparingly because of this reaction.\textsuperscript{16}

Preservative-free artificial tears are the best choice for most patients. Patients can be allergic to the preservatives used in artificial tear formulations, leading to discomfort and redness. Benzalkonium chloride (BAK) is a widely used preservative, but it alters epithelium function and reduces stability of the tear film if used more than three times daily.\textsuperscript{27} Thimerosal was once a preservative found in a variety of ophthalmic solutions, but it has since lost its popularity because ten to twenty-five percent of patients will exhibit hypersensitivity.\textsuperscript{28} Chlorobutanol is another popular preservative, but it has the propensity to impair the functionality of the corneal epithelium. Ethylenediamine tetraacetate (EDTA) may cause contact allergy in patients, but it is still used in many solutions. Chlorhexidine is a preservative known for its efficacy, but it can build-up in the epithelium and affect corneal and conjunctival physiology.\textsuperscript{29} Due to the potential adverse effects of preservatives, pharmaceutical companies are developing an increasing array of preservative-free dry eye products.

Soothe XP has become increasingly popular for its lipid layer stabilization ability.\textsuperscript{25} The dosing schedule of Sooth XP is about half as frequent as most artificial tears which increases patient compliance.\textsuperscript{25} Contact lens wearers can also benefit from Soothe XP because this drop was initially formulated as a contact lens rewetting drop, although it is not officially FDA approved for this use.\textsuperscript{30} In the March 2009 issue of Optometry Times, Dr. Paul Karpecki recommends Refresh Plus (Allergan) because it has good retention and no preservatives.\textsuperscript{21} Another good choice for patients with milder dry eye syndrome is Optive (Allergan). Optive contains carboymethylcellulose, which is also found in Refresh, with glycerin in an easy to use eyedrop bottle.\textsuperscript{21} Oasis Tears (Oasis Medical) are preservative-free and also contain glycerin. Glycerin is a natural substance and is more desirable than other synthetic alternatives because it forms a protective coating on the idea without exposing the cornea to any potential toxins. Oasis Tears are also different from standard artificial tears because their molecular
structure contains hyaluronic acid that imparts an elastic quality to the tear film, increasing tear film spreadability.

Systane Ultra (Alcon Laboratories) is the second generation of Systane which offers more durability and better symptomatic relief. Systane and Systane Ultra both contain the active ingredients propylene glycol and polyethylene glycol. Both formulations also contain borate and HP (hydroxypropyl)-Guar which aid in adhering the active ingredients to the epithelium. The delivery system of Systane Ultra is superior to its predecessor because it is less viscous, allowing better spreadability. Systane Ultra also contains sorbitol which allows greater cross-linking of the borate and HP-guar on the ocular surface which increases stability of the drop on the ocular surface.\textsuperscript{31} The preservative in Systane Ultra is Polyquad, which has a good safety profile and also acts as a pH buffer. The higher pH of Systane Ultra is often more comfortable to patients because patients with dry eyes who tend to have a higher tear film pH. Clinically, Systane Ultra is a good option for patients who desire a long-lasting artificial tear without the blurring of vision that can occur with the more viscous tears.\textsuperscript{31}

If artificial tears do not sufficiently alleviate the patient’s symptoms despite frequent dosing, the next step is to target the inflammatory component of dry eye with topical corticosteroids. Topical steroids can cause elevated intraocular pressure and posterior subcapsular cataracts, so it is important to choose an ester-based steroid that minimizes side effects.\textsuperscript{6} Lotemax ophthalmic suspension (Bausch and Lomb) is the steroid of choice for ocular surface disease for its efficacy and safety. Loteprednol has superior safety because it is the first ophthalmic steroid which is an ester instead of an amide. Esters are quickly broken down by the multitude of esterases in the body, reducing the number of potential side effects.\textsuperscript{25} Lotemax can be used for a few months in conjunction with Soothe XP or another artificial tear to reduce the inflammation which may be present, making the artificial tear more effective. Steroids should always be tapered to avoid rebound inflammation and allow the body time to resume
production of natural corticosteroids. Lotemax is an ophthalmic suspension, so the patient should be instructed to shake the bottle before use to ensure the greatest efficacy.

Restasis (Allergan) also has an anti-inflammatory effective by inhibiting T-cell signaling to B-lymphocytes, which diminishes the immune response. By reducing inflammation, Restasis reverses conjunctival metaplasia and can increase the goblet cell density, leading to a more stable mucin layer. Restasis can be dosed twice daily and it can be used with artificial tears or with Lotemax in more severe cases. Restasis often requires several weeks of regular dosing before a patient notices any change in his/her symptoms, so patients should be counseled on this matter.

The majority of artificial tears are formulated as a solution or a gel, but there are commercially available artificial tear inserts such as the Lacrisert (Merck). The Lacrisert is a water-soluble pellet of hydroxypropylcellulose that is placed in the lower cul-de-sac. Upon insertion, the Lacrisert initially swells and then begins dissolving. The Lacrisert should be replaced by the patient every twenty-four hours. Although most patients tolerate the Lacrisert well, some do report a foreign body sensation or blurred vision. Clinical studies have not shown the Lacrisert to be superior to conventional artificial tears, but it might be a viable option for patients who desire a once daily dosing schedule.

Punctal occlusion is an underutilized method of tear preservation. By occluding the puncta, tear drainage is decreased and the tear reservoir increases in volume. Temporary occlusion with collagen plugs should occur before the more permanent silicone variety of plugs are inserted. Initially the lower puncta should be occluded and the patient should be re-evaluated in two to three weeks. Typically collagen plugs will dissolve in two weeks, and if the patient experiences relief during this period, the patient is a candidate for silicone punctal plugs. The patient should report an initial decrease in dry eye symptoms for about two weeks, followed by a return of symptoms as the collagen plugs dissolve. Patients with severe aqueous-deficiency dry eye syndrome can benefit from punctal occlusion. Punctal occlusion seems to be less effective in those with contact lens-induced dry eye because this variety of
Dry eye syndrome tends to be evaporative in nature. Complications of punctal plugs include extrusion or infection and the patient should be asked to sign an informed consent document before this procedure is performed. In a study conducted by Tai et al, the retention rate of punctal plugs was only fifty percent and the duration of effectiveness was approximately two years. Permanent occlusion of the puncta by cautery is an option if the patient has poor retention of punctal plugs and has severe ocular surface disease.

The application of platelet-rich plasma (PRP) to the ocular surface in patients with moderate to severe dry eye is a promising new treatment. PRP is generated from the patient’s own blood and contains no preservatives, so contamination and side effects are not likely. PRP has a high concentration of growth factors and platelets. Growth factors prompt cell proliferation and wound healing, and platelets actually release some of these growth factors including platelet-derived growth factor, platelet-derived angiogenesis factor, and platelet-derived epidermal growth factor. Platelets are also directly involved in wound healing. Platelets initiate wound healing by binding to the damaged area and releasing the appropriate factors. Ocular surface disease often causes epithelial damage such as punctate keratitis and PRP application may accelerate healing and decrease inflammation. Alio et al conducted a pilot study with PRP in which eighteen patients with moderate to severe dry eye applied PRP four to six times daily for two months. Eighty-nine percent of the patients reported improvement in their symptoms, and fluorescein staining decreased in seventy-two percent of the patients. More research about PRP is needed, but initially PRP seems to be an efficacious and safe treatment for moderate to severe dry eye.

When the ocular surface is compromised in advanced cases of ocular surface disease, a temporary bandage contact lens can provide protection to a vulnerable cornea. Three silicone hydrogel lenses are approved for therapeutic use including the Acuvue Oasys (Vistakon), PureVision (Bausch and Lomb), and Night and Day (Ciba Vision) lenses. Scleral contact lenses vault the cornea, allowing a
reservoir of tears to form, can be used when the ocular surface is severely compromised such as in Stevens-Johnson syndrome.\textsuperscript{15}

In rare cases, surgery may be the best option for patients with severe ocular surface disease. Tarsorrhaphy minimizes the exposed ocular surface area and decreases the rate of evaporation, but this option should only be considered in patients with severe, unresponsive disease. Salivary gland transplants of the submandibular gland to the temporal fossa are possible, but such an extreme measure is rarely needed, especially with the increased risk of complications that accompanies an invasive procedure. Limbal grafts are a potential mode of treatment, but have not yet been fully developed.\textsuperscript{3}

In an article published in the February 2009 issue of the American Journal of Ophthalmology, researchers compared the effects of topical vitamin A drops and cyclosporine A on dry eye syndrome. This study found that both treatments were effective in reducing blurred vision, improving tear break-up time, and increasing goblet cell density.\textsuperscript{37} Vitamin A actively regulates epithelial cell growth and potentially helps the epithelium recover from inflammation secondary to dry eye syndrome.\textsuperscript{37} In the future Vitamin A drops may be used in combination with traditional lubricants to treat ocular surface disease more effectively.

Management of contact lens-induced dry eye

One of the best strategies for treating contact lens-induced dry eye is to prevent the condition from ever developing by carefully screening patients who are interested in contact lens wear. Good candidates for contact lens wear include those with a TBUT of ten seconds or greater, high motivation, no lid disease or inflammation, and overall healthy corneas.\textsuperscript{15} These are not absolute rules and patients who are determined to be successful contact lens wearers often overcome such obstacles like a poor TBUT with a little extra effort. If the patient has a TBUT of less than ten seconds and is highly motivated, lenses can be worn on a daily wear schedule with reduced wearing time. Rewetting drops are also
useful in preventing lens dehydration. TBUT is negatively affected by contact lens wear so TBUT testing should not performed directly after lens removal.

The lens material is one parameter that has a big impact on lens comfort, and fortunately there are a wide variety of lens materials available, some which are specifically marketed to dry eye patients such as Proclear (CooperVision) and Extreme H2O (Hydrogel Vision Corp.) lenses. The Proclear material is FDA approved for dry eye patients and is an excellent choice for those with dry eye symptoms. The Proclear material exhibits improved lens hydration due to the presence of phosphorylcholine. Ionic materials are not optimal because they tend to promote deposit formation, which can intensify the inflammatory reaction present on the ocular surface.

Daily disposable lenses offer the dry eye patient increased comfort, reduced symptomatology, and increased convenience. Daily disposable lenses eliminate the need for solutions, so the potential for ocular inflammation is reduced because preservative hypersensitivity does not occur. Focus Dailies with AquaRelease (Ciba Vision) are daily disposable lenses that contain an additional wetting agent, polyvinyl alcohol, to increase wettability. Another daily lens developed for patients with dry eye syndrome is the 1-Day Acuvue Moist (Vistakon) which incorporates polyvinyl pyrrolidone to increase lubrication. The introduction of silicone hydrogel lenses has provided the contact lens practitioner with another option for contact lens wearers with dry eye symptoms. The high oxygen permeability and low water content of silicone hydrogels is optimal for dry eye patients. These lenses also tend to be more deposit resistant, reducing inflammation on the ocular surface.

There are several relatively simple yet effective strategies that can decrease symptoms from ocular surface disease. Recommending that the patient remove their lenses for a quick soak in multi-purpose solution midday can often alleviate the symptoms the patient might otherwise experience later in the day. Changing the patient’s solution to a preservative-free system, or adding an enzymatic cleaner can also increase the patient’s comfort. Rewetting drops such as Blink used with contact lens
insertion or during the day as the patient feels they are needed to maintain lens hydration and lubrication. Soothe XP (Bausch and Lomb) is another artificial tear which is beneficial for contact lens wearers, especially if it is instilled just prior to contact lens insertion.15

There is some evidence which suggests that oral omega-6 fatty acids may be beneficial to the contact lens wearer experiencing dry eye symptoms. Gamma linoleic acid (GLA) is found in primrose oil and evidence suggests that the GLA has anti-inflammatory properties. GLA acts by increasing synthesis of 1-series prostaglandins which are active in reducing immune responsiveness, thus diminishing inflammation.39 In a recent study of fifty-two female contact lens wearers, oral supplementation with evening primrose oil increased lens comfort and reduced dry eye symptoms by forty percent.40 This study is clinically significant because it emphasizes the effect that relatively small dietary modifications can have on contact lens wear. Contact lens wearers should be educated about the benefits of omega-6 fatty acids, especially those patients with borderline dry eye whose success in contact lens wear hinges upon adequate surface lubrication.

In summary, contact lens-induced dry eye can be avoided to a large extent by only fitting patients who have adequate tear volume and a healthy ocular surface into contact lenses. Choosing the proper lens material and suggesting simple strategies like mid-day soaks and rewetting drops to patients are often the only treatment needed for contact-lens induced dry eye. Preservative-free solutions should always be recommended to patients with dry eye symptoms to eliminate any additional inflammation from a preservative reaction. The contact lens wearer is especially susceptible to environmental conditions and should be counseled accordingly.

Management of anterior blepharitis

The management approach to blepharitis depends on its causative organism. Blepharitis is usually of a chronic nature and patients should be educated that while a cure for the condition is unlikely, the symptoms can be managed effectively with proper treatment. Lid hygiene is
the first step in treating blepharitis. A variety of lid hygiene products are available commercially including lid scrubs and foaming cleanser, but often simpler treatments are just as effective. Warm compresses are useful in both staphylococcal and seborrheic blepharitis to increase blood flow and soften any scales or collarettes which might be present on the lids. The patient should be advised to apply a clean, warm rag to the eyes several times daily. Lid margins may be cleaned by using baby shampoo and a cotton tipped applicator. The patient should be counseled to continue practicing good lid hygiene even if the symptoms subside. If these methods fail to eliminate the blepharitis, topical antibiotic ointment should be used to specifically target the causative organism. Topical antibiotics with a gram positive spectrum such as bacitracin or erythromycin ointment are often effective in treating blepharitis. Ointment should be used in conjunction with lid hygiene measures, and should be applied three times daily. Patients should be warned about the possible blurring of vision an ointment may cause. If the blepharitis is unresponsive to topical treatment, oral antibiotics may be utilized to help resolve the inflammation. Oral azithromycin dosed three times daily is a good choice for an oral agent. Topical azithromycin, AzaSite (Inspire) is another option for patients with chronic blepharitis, although the FDA has not approved it for this use. AzaSite combines the antibiotic properties of azithromycin with a vehicle (DuraSite) that increases conjunctival concentrations up to six fold compared to azithromycin alone in clinical trials. Another benefit of AzaSite that patients appreciate is that it can be applied to the lid margins, so it does not blur vision. AzaSite should be dosed one drop twice a day for two days, and then one drop once a day for the next five days.

Management of posterior blepharitis (MGD)

Patients with MGD should be advised to use hot compresses several times daily in conjunction with lid massage to allow the sebum to more easily flow from the glands. Antibiotics such as doxycycline dosed twice daily can be very useful in the more difficult cases of MGD which do not respond to massages and compresses. Doxycycline allows the bacterial lipases to be more active,
resulting in less viscous secretions and better tear film spreading. Recently, products such as the Nutridox Convenience Kit and the Alodox Convenience Kit combine several forms of treatment into a single box which maximizes convenience. The Nutridox Kit (Advance Vision Research) contains doxycycline monohydrate capsules which reduce bacterial colonization, an omega-3 supplement with vitamin E to reduce inflammation, and a self-heating compress system which increases compliance. The Alodox Kit (OCuSoft) has four components: doxycycline hyclate tablets, OCuSoft lid scrubs, OCuSoft lid scrub foam formula, and Tranquileyes goggles which create warm, moist chambers around the eyes.

Conclusion

The management of ocular surface disease is as varied and complex as the disease itself. The treatment of ocular surface disease should be specific to the etiology whether it is caused by staphylococcal blepharitis or a contact lens. Patient education should be emphasized in every treatment plan, regardless of the type of ocular surface disease. All the variations of ocular surface disease have factor, inflammation, in common. Every treatment should address this underlying cause whether by prescribing anti-inflammatory agents such as Lotemax or Restasis or merely educating the patient about the benefits of omega-3 fatty acid supplementation. There is much promising new research that will certainly continue to alter the treatment of ocular surface disease and every clinician should strive to keep pace with the new developments to offer the best care possible patient care.