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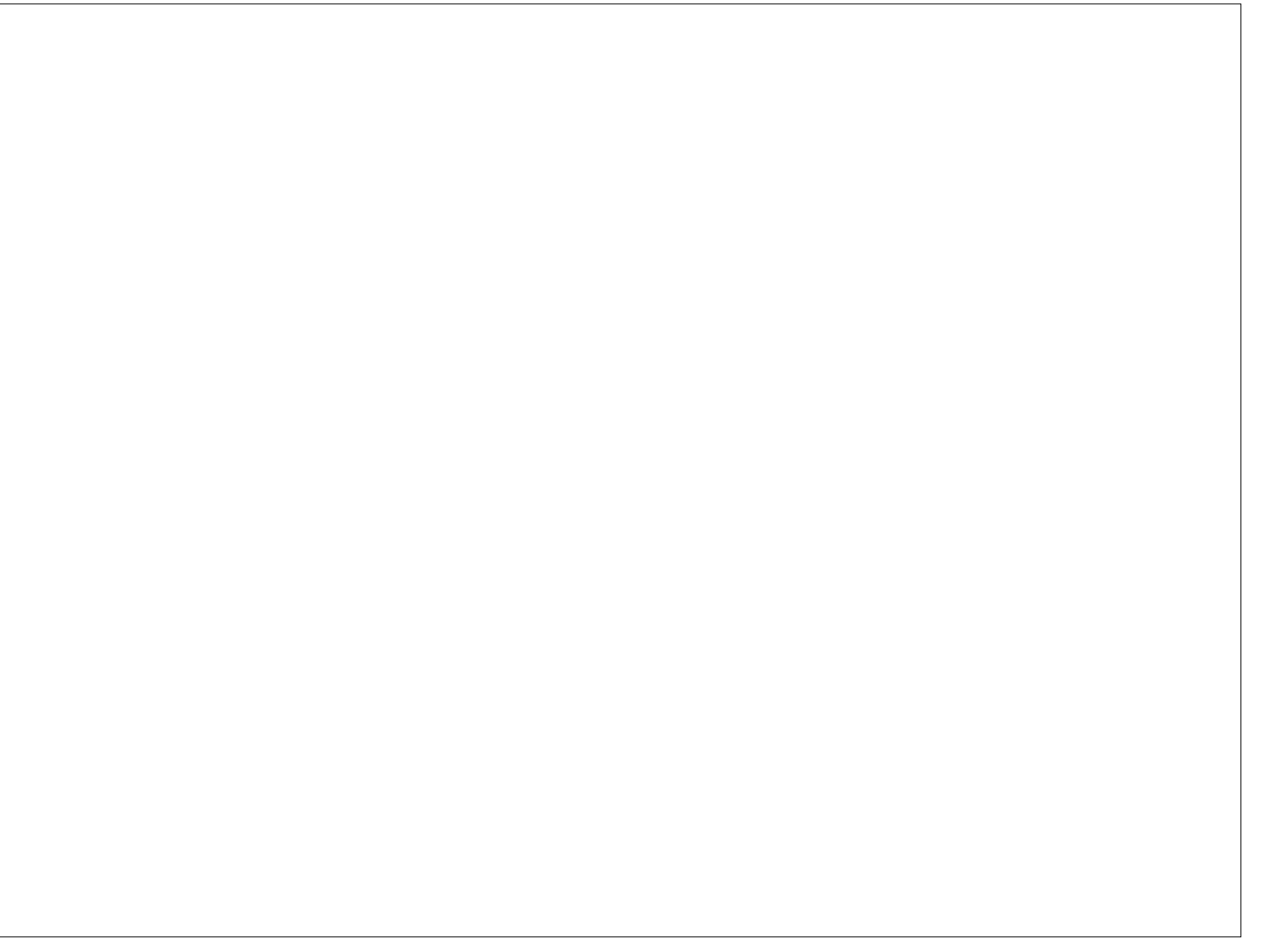
REVIEW OF CORNEA & CONTACT LENSES
NOVEMBER/DECEMBER 2021

FIND THE RIGHT FIT FOR KERATOCONUS

Sclerals, GPs and even some soft lenses are viable options. Here, we share



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FIND THE RIGHT FIT FOR KERATOCONUS

Sclerals, GPs and even some soft lenses are viable options. Here, we share guidance on how to choose the best one for each patient.

By Melissa Barnett, OD, Barry Eiden, OD, and Louise Sclafani, OD

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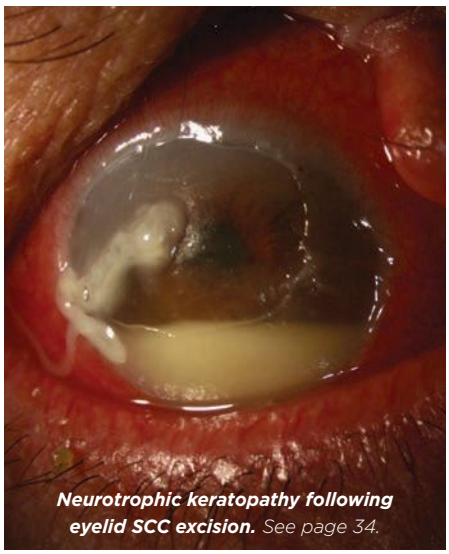

Neurotrophic keratopathy following eyelid SCC excision. *See page 34.*

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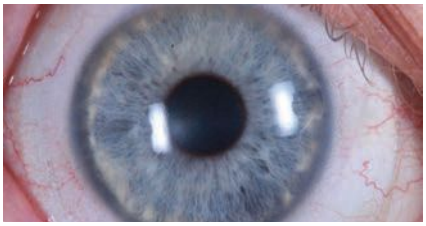

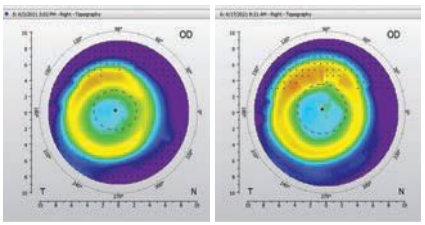

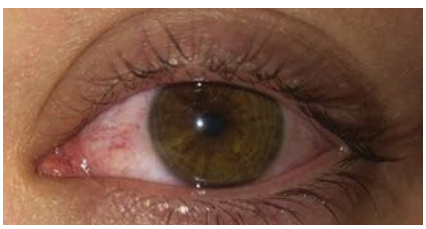

departments

IN BRIEF

■ Researchers performed a study that found several **indicators of keratoconus (KC) progression in children**, which could be used to help identify more affected patients at a younger age. The Shahroud Schoolchildren Eye Cohort Study included a total of 10,440 eyes of children aged six to 12, 18 who had KC (0.2%). After three years, every child with KC showed progression. **Changes in index of height decentration, zonal Kmax-3mm, refractive astigmatism, single point Kmax and index of vertical asymmetry** all scored as the top indicators for disease progression in children of the studied age group.

Hashemi H, Panahi P, Asgari S, et al. Best indicators for detecting keratoconus progression in children: a report from the Shahroud schoolchildren eye cohort study. Cornea. October 20, 2021. [Epub ahead of print].

■ A cross-sectional, school-based study found that **non-cycloplegic refractive error overestimated myopia in young students by approximately 1.00D, an overestimation that increases with more hyperopic refractive error and smaller axial length.** The researchers recommend steering away from non-cycloplegic refractive error and using cycloplegic refractive error instead in the evaluation of pediatric myopia to achieve more accurate measurements.

Gu F, Gao HM, Zheng X, et al. Effect of cycloplegia on refractive error measure in Chinese school students. Ophthalmic Epidemiol. November 12, 2021. [Epub ahead of print].

■ A study found **moderate-to-high hyperopic children had greater choroidal thickness than emmetropes, but smaller RNFL and ganglion cell layer (GCL) thicknesses.** They enrolled 53 children with moderate-to-high hyperopia and 53 emmetropic children. The **RNFL and GCL in the temporal and inferior quadrants in 1mm to 3mm of the macular fovea were thinner** in the moderate-to-high hyperopic group than in the emmetropic group. This group also had **a greater choroidal thickness in all regions**. Remain vigilant for these differences and mindful of their implications when caring for these patients.

Qian Y, Ma Y, Lin Q, et al. Retinal and choroidal changes in children with moderate-to-high hyperopia. J Ophthalmol. September 30, 2021. [Epub ahead of print].

0.05% Atropine Effective in Slowing Myopia Progression

Atropine is a well-established effective intervention to delay childhood myopia progression, but some concentrations may work better than others with less potential adverse effects, according to a new literature review from Korea.

In a comparison of 16 randomized controlled trials that collectively enrolled about 3,300 participants, investigators found the top three effective atropine concentrations to be 1%, 0.5% and 0.05% out of eight measured. Notably, they found 0.05% to be the most beneficial dosage for slowing myopia progression.

The authors selected studies involving atropine treatment of at least one year for myopia control in children. The investigation included a meta-analysis of placebo-controlled and head-to-head randomized controlled trials comparing eight atropine concentrations: 1%, 0.5%, 0.25%, 0.1%, 0.05%, 0.025%, 0.02% and 0.01%. The primary outcomes were mean annual changes in refraction (diopters/year) and axial length (millimeters/year). The researchers also considered the proportion of eyes showing myopia progression and safety outcomes such as photopic/mesopic pupil diameter, accommodation amplitude and distance/near best-corrected visual acuity.

As expected, there was significantly less myopia progression in the atropine treatment group than in controls.

Another key finding: higher-dose atropine was better at slowing refraction changes and axial elongation than lower concentrations. Among moderate doses (0.02% to 0.25%), 0.05% showed comparable efficacy to that of high-dose atropine and was ranked third in terms of slowing refraction changes and second in slowing axial elongation. As for myopia control, 0.05% was ranked the most beneficial.

Considering refraction change, axial elongation and relative risk for myopia progression, 0.05% was comparable to high-dose (1% and 0.5%) atropine.

The efficacy trends indicated that the various atropine concentrations might not always follow a dose-dependent order, the authors noted.

On the other hand, they found adverse effects from the various concentrations may be dose-related. For example, high-dose atropine showed lower-ranking probabilities for three safety outcomes (*i.e.*, photopic/mesopic pupil diameter, accommodation amplitude) compared with lower doses. In terms of atropine-related adverse effects, 0.05% showed better safety profiles than higher doses.

Photo: Getty Images

Children with myopia may respond best to an atropine concentration of 0.05%, study shows.

Of course, the optimal atropine concentration is the one with the best balance between efficacy and safety, the authors suggested.

Ha A, Kim SJ, Shim SR, et al. Efficacy and safety of eight atropine concentrations for myopia control in children: a network meta-analysis. Ophthalmol. October 21, 2021. [Epub ahead of print].

Tear Volume, Stability Related to LWE Grade

Many dry eye patients have lid wiper epitheliopathy (LWE) but the factors determining the severity of LWE are unknown. In this study, researchers investigated the relationship between LWE, tear abnormality and blinking in dry eye.

A total of 76 eyes of 76 female patients with dry eye took part in this study. Tear meniscus radius (TMR), spread grade (SG) of the tear film lipid layer, fluorescein breakup time (FBUT), fluorescein breakup pattern, corneal and bulbar conjunctival epithelial damage, upper eyelid LWE grade and Schirmer 1 test were evaluated.

LWE was significantly related to TMR and SG of the tear film lipid layer, which are correlated with tear volume. Additionally, the LWE grade was related to FBUT, which is correlated with tear film stability. These findings, similar to those in previous studies, indicate that tear volume and tear film stability are important factors in determining LWE grade.

No significant relationship was found between LWE grade and blink-related parameters. "However, multiple regression analysis demonstrated that the LWE grade was significantly related to SG of the tear film lipid layer, FBUT and upper eyelid closing phase maximum velocity," the authors explained. "To the best of our knowledge, this is the first report demonstrating that a dynamic blink factor (i.e., upper eyelid closing phase maximum velocity) is related to the LWE grade."

Compared with a previous study, it was found that the LWE grade is determined by similar parameters, and the SG of the tear film lipid layer, FBUT and upper eyelid closing phase maximum velocity were also nearly the same in this study.

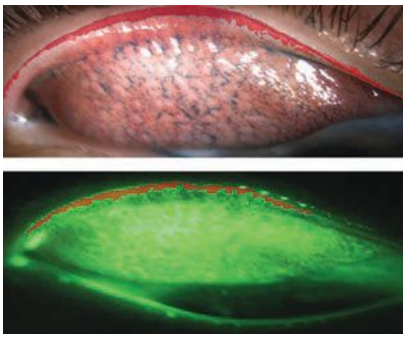

Photo: Chris Lievens, OD

The areas colored in red outline what is considered to be lid wiper epitheliopathy.

"This indicates that not only the determining factors for conjunctival epithelial damage (CjED) in dry eye, but also the contribution of each determining factor for CjED is similar to those for LWE in dry eye," the authors noted. "Thus, it is speculated that a common mechanism—increased friction, which is one of the essential mechanisms for dry eye—is associated with CjED and LWE."

It's worth noting that multiple regression analysis showed that the LWE grade was related to SG of the tear film lipid layer, FBUT and upper eyelid closing phase maximum velocity, making this the first report to demonstrate that a dynamic blink factor is related to the LWE grade.

"Based on these results, LWE can be treated by improving tear volume and tear film stability using eye drops or punctal occlusion in the clinical setting because the velocity of the upper eyelid during blinking cannot be changed," the authors concluded.

Kato H, Yokoi N, Watanbe A, et al. Clinical factors for determining the severity of lid wiper epitheliopathy in dry eye. Cornea. October 23, 2021. [Epub ahead of print].

RCCL REVIEW OF CORNEA & CONTACT LENSES

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By Joseph P. Shovlin, OD

Lifestyle Changes and the Ocular Surface

The upcoming TFOS report will continue to translate research into effective solutions.

Kudos to the Tear Film and Ocular Surface Society (TFOS) for forming another workgroup on lifestyle issues. For those who may not be familiar with this esteemed group's work, let me share who they are and highlight some of the many accomplishments they have achieved over the past 15+ years. TFOS, a nonprofit organization, was spearheaded in 2000 by a research group out of Boston led by David Sullivan, PhD, and is "dedicated to advancing research, literacy and educational aspects of the scientific field of the eye's surface."[1]

Starting with the original Dry Eye (DEWS) publication in 2007, TFOS DEWS significantly expanded the scope of dry eye disease. A decade later DEWS II, a 350+ page report, redefined our definition of dry eye and looked at many of the key components of the disease process revamping guidance for diagnostic methodologies and treatment modalities.[2] All of their reports are available in complete or at least partial translation in numerous languages, such as French, Italian, German, Spanish, Chinese, Korean, Portuguese, Vietnamese, Romanian and Turkish.[3]

DRY EYE REMINDER

TFOS DEWS II defines dry eye as the following: "Dry eye is a multifactorial disease of the ocular surface characterized by a loss of homeostasis of the tear film, and accompanied by ocular symptoms, in which tear film instability and hyperosmolarity, ocular surface inflammation and damage and neurosensory abnormalities play etiologic roles."[2] Significant additions to the first DEWS report included the recognition of loss of homeostasis and added neurosensory abnormalities as an etiologic component to dry eye disease.[2] TFOS DEWS II also highlighted the whole spectrum of the disease process rather than locking into two distinct, separate classifications (aqueous deficient vs. evaporative).[4]

The DEWS II report emphasizes the importance of an accurate differential diagnosis to assure appropriate treatments. Added significance is given to the fact that signs and symptoms in dry eye disease don't often correlate well.

Diagnostic procedures or tools are recommended using valid patient questionnaires and homeostasis markers, such as tear film break-up time, hyperosmolarity and staining of the conjunctiva and cornea.

The description of the tear film layers are typically described as a three-layer system. The report clarifies this by depicting a two-layered ecosystem composed of a muco-aqueous and an outer lipid layer.[2,4] Additionally, the report offers a very comprehensive and effective step-wise approach for management (see complete report).[4]

BEYOND DEWS II

This sets the stage and brings us to the next TFOS project, "A Lifestyle Epidemic: Ocular Surface Disease," which will address the challenges of the vision compromising problems associated with dry eye and other ocular surface diseases. TFOS groups have always been interested in identifying the gaps in research and then addressing the deficiencies in what we know or don't know to ask.

TFOS has assembled a task force of international experts with several workgroups and subcommittees that will focus on timely topics such as digital eyestrain, cosmetics, nutrition, self-iatrogenesis, environment, lifestyle challenges, contact lenses, societal challenges and public awareness.

One of the subcommittees, the Contact Lens workgroup, will be chaired by Lyndon Jones, FCOptom, PhD, professor of optometry at University of Waterloo in Canada. Some of the anticipated topic areas will be:

- lifestyle choices that directly or indirectly impact the ocular surface
- lifestyle choices that affect the overall performance of contact lens wear
- the impact of coexisting disease (along with dry eye disease) on contact lens performance

I'm sure you will join me in welcoming this new initiative and look forward to another extremely valuable end-product from highly skilled and exceedingly capable international experts working in each subcommittee. RCCL

1. TFOS – Tear Film & Ocular Surface Society. www.tearfilm.org. Accessed October 1, 2021.

2. Winebrake JP, Drinkwater OJ, Brissette AR, Starr CE. The TFOS dry eye workshop ii: key updates. Eyenet. www.aao.org/eyenet/article/the-tfos-dry-eye-workshop-II. November 2017. Accessed October 1, 2021.

3. TFOS. TFOS DEWS II report. www.tearfilm.org/dettreports-tfos_dews_ii_report/7259_7248/eng. Accessed October 1, 2021.

4. Craig JP, Nichols KK, Akpek EK, et al. TFOS DEWS II definition and classification report. Ocul Surf. 2017;15(3):276-83.

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By Marcus R. Noyes, OD, and John D. Gelles, OD

Counteract Corneal Complications

Here's how to optimize the lens reservoir to maintain ocular health in scleral lens wearers.

Corneal vault is a unique property of scleral lenses that can provide distinctive benefits to our patients, particularly those with corneal pathology. This column focuses on troubleshooting corneal health complications induced by the reservoir of scleral lenses and how to approach corneas with difficult pathology.

CAUSES OF COMPLICATIONS

The main corneal health issues induced by the lens reservoir are:

Insufficient vault. This can lead to corneal epithelial disruption, which may cause corneal scarring. Certain conditions, such as Salzmann's nodules, can be affected in a similar fashion. Insufficient limbal clearance can also result in epithelial disruption, as well as neovascularization and limbal stem cell deficiency (*Figure 1*).

Lens solutions. Incorrect solution use can lead to toxic reactions with pan-corneal disruptions. Preservatives in the reservoir can cause toxic reactions that mimic punctate erosions or superficial punctate keratitis (*Figure 2*). Also, problems with lens handling and insertion may lead to reservoir saline spillage and air bubble entrapment, causing localized epithelial desiccation if the bubble is stationary.

Excessive vault. This can be problematic in susceptible corneas, such as those with reduced endothelial function due to conditions like Fuchs' endothelial dystrophy or corneal transplants like penetrating keratoplasty or Descemet's stripping automated endothelial keratoplasty. Epithelial bullae, microcystic edema and corneal edema are possible when the cornea cannot manage the physiologic stress induced by a lens.[1] Also, excessive vault over the limbal area can lead to conjunctival prolapse, which may adhere to the cornea, leading to vascularized and localized limbal stem cell deficiency.[2-4]

ASSESSMENT AND IDENTIFICATION

A thorough history and vision questioning reveals many of the signs and symptoms of problems with the scleral lens reservoir, though many are non-specific and may arise with other complications. A commonly reported issue is vision clouding with increased wear time, which could indicate a variety of problems related to the reservoir. In corneas with a reduced ability to cope with the induced physiologic stress from the lens, patients may also describe a rainbow around light sources—a Sattler's veil—indicating corneal edema. Additionally, increasing burning or stinging with lens wear can be indicative of issues in the lens reservoir. Here's how to evaluate for these issues with the lens on and off:

Lens on. Corneal vault can be assessed in several ways: from slit lamp examination to anterior segment OCT (AS-OCT), or even a-scan ultrasonography. The most common way to distinguish corneal vault is by slit lamp examination. The vault can be assessed using a fine optic section with high-intensity white light illumination. Using known parameters, the corneal clearance can be estimated at the slit lamp. Vault is often easier to assess by instilling a drop of sodium fluorescein in the scleral lens reservoir; however, practitioners should become proficient at clearance evaluation without the use of dye, as patients who are following up do not have it instilled.

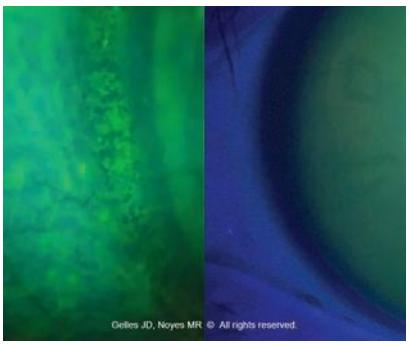


Fig. 1. Epithelial disruption and microcysts due to scleral lens bearing at the limbus.

Another wau to assess vault is to perform AS-OCT imaging of the lens; this allows for more exact calculation (down to a few microns) and can be particularly useful when corneal pathology must be vaulted. Remember, the ocular surface is a soft, compliant tissue, and initial corneal vault decreases by ~100µm after four hours of lens wear.

Lens off. Evaluate the cornea at the slit lamp with direct white light illumination, specular illumination, sclerotic scatter or retroillumination to reveal subtle pathology (*Figure 3*). These post-lens removal methods, along with sodium fluorescein and cobalt blue illumination to detect negative and positive staining, aid in finding corneal sequelae of scleral wear, such as corneal touch, toxic reactions, corneal bullae and microcystic edema. Also, tomography can be extremely helpful in monitoring changes to global corneal pachymetry to evaluate induced corneal edema. Ensure sodium fluorescein is not instilled prior to Scheimpflug camera-based tomography, as it may affect the scan accuracy.


PROBLEM-SOLVING

There are several ways to counteract issues arising from scleral lens wear:

Lens solutions. A major cause of corneal issues is the incorrect use of solutions. At every visit, confirm the patient's cleaning regimen. A commonly seen issue is confusion about filling solutions. *Prescribe*—don't recommend—lens solutions, and make it clear that they are not to be changed unless directed by you. Patients often confuse or replace solutions based on outside recommendations. Encourage them to communicate changes that have been suggested prior to making them. This prevents complications and builds trust in your expertise.

Another common issue is the use of preserved artificial tears and salines, and even multipurpose lens solutions, as an application fluid. Adopting a simple solution list for patients can be helpful, as an overwhelming amount of information is given during application and removal training.

Clearance. Manage insufficient or excessive lens clearance by changing the sagittal depth in the reservoir or adjusting the base curve to allow for changes in the optic zone or secondary curves in the case of a peripheral cornea and limbus. Some designs allow for independent changes to each region, while with others, a change in one zone affects another.[3]

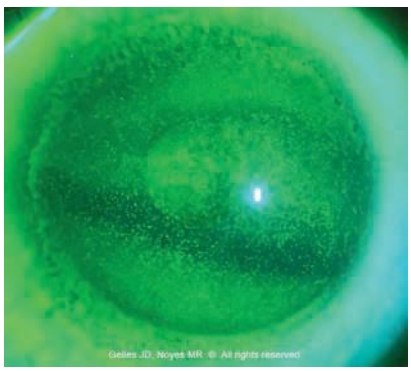


Fig. 2. Toxic keratopathy due to soft lens solution in the scleral reservoir.

For uneven clearance with insufficient corneal clearance in the superior cornea, achieve an even clearance by adding more custom landing zones, such as toric or quadrant-specific haptics, to center the lens.[3]

Estimates of the "optimum clearance" range from 100µm to 400µm+.[2,5,6] Recent studies have shown that in corneas without endothelial dysfunction, the value doesn't seem to matter, as long as corneal clearance is present to some degree.[5,6] Most studies agree that the average corneal swelling is just under 2% after eight hours of scleral lens wear, even in patients with a mean central vault of ~350µm, which is less than the 4% of natural corneal swelling that occurs while sleeping. Another study showed that vault has no impact on visual acuity or scleral lens success in patients with dry eye.[5,6]

On the flip side, a recent study found that endothelial blebs, or the "transient disappearing of corneal endothelial cells," occur after the first 15 to 25 minutes of scleral wear.[7] This phenomenon was evident with a corneal vault of 400µm but not 200µm. This implies that there may be increased strain on the endothelial surface with increased corneal vault in scleral lens wear. Same-day exams—where a lens is placed on the eye and the patient wears it for several hours before assessment of the corneal response to the physiologic stress induced by the lens—can be very helpful.

Fig. 3. Scleral lens-induced corneal edema in a case of compromised endothelial health.

TAKEAWAYS

The scleral lens reservoir is key in providing optimal optics and nourishing the ocular surface. These tips can help effectively troubleshoot common issues and sequelae related to the lens reservoir for a more successful fit. Baseline testing, documentation and evaluation after lens removal are paramount in maintaining or improving corneal health. It can be easy to chase the "perfect scleral lens fit," but don't lose sight of the eye underneath. RCCL

1. Schear MJ, Ibrahim K, Winokur J, et al. Treatment limitations with PROSE (Prosthetic Replacement of the Ocular Surface Ecosystem): one center's experience. Eye Contact Lens. 2019;45(5):315-7.

2. Barnett M, Courey C, Fadel D, et al. CLEAR—Scleral lenses. Cont Lens Anterior Eye. 2021;44(2):270-88.

3. Fadel D. Scleral lens issues and complications related to a non-optimal fitting relationship between the lens and ocular surface. Eye Contact Lens. 2019;45(3):152-63.

4. Kumar M, Shetty R, Khamar P, Vincent SJ. Scleral lens-induced corneal edema after penetrating keratoplasty. Optom Vis Sci. 2020;97(9):697-702.

5. Rathi VM, Mandathara PS, Dumpati S, Sangwan VS. Change in vault during scleral lens trials assessed with anterior segment optical coherence tomography. Cont Lens Anterior Eye. 2017;40(3):157-61.

6. Sonsino J, Mathe DS. Central vault in dry eye patients successfully wearing scleral lens. Optom Vis Sci. 2013;90(9):e248-51.

7. Giasson CJ, Rancourt J, Robillard J, et al. Corneal endothelial blebs induced in scleral lens wearers. Optom Vis Sci. 2019;96(11):810-7.

Off on a Tanget

Between inconsistent chart records and production delays, I had to think outside the box to make this patient happy.

Earlier this year, I started working part-time at an ophthalmology practice, mainly seeing contact lens patients. The staff looked at me with wide eyes and handed me a chart of a patient who was in the office for a "contact lens check" (as an aside, I despise that phrase). As it turns out, his simultaneous vision multifocal GP lenses were last exchanged six months ago and he was returning because he was unhappy with them.

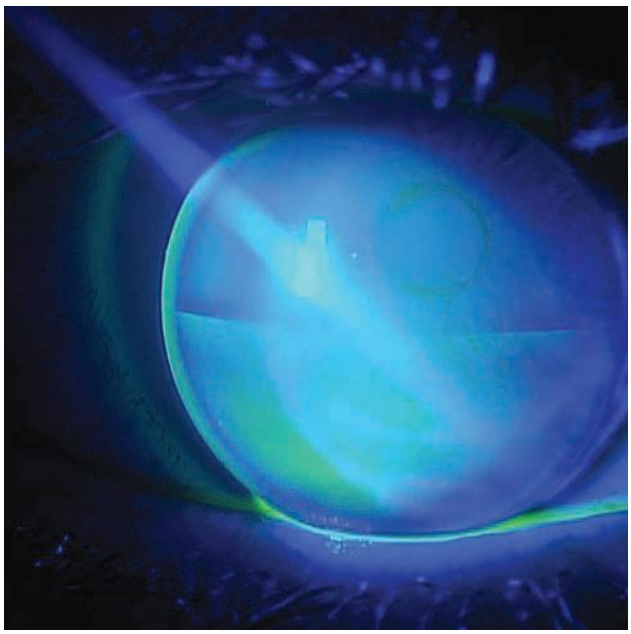
I tried to get the back story from the electronic medical record, but I was confused. I decided to talk directly to the patient—or rather, I should say, listen. My goal was to ask questions and be attentive (this is when being an optometrist is kind of like being a coach). The patient relayed to me that he is no longer wearing the simultaneous multifocal GP lenses he was dispensed six months ago (though he brought them for me to examine and they fit perfectly, if you're keeping score).

He proceeded to explain how he likes the "old" lens he has on his right eye. He has no lens on the OS because it's been lost for years. I looked at the lens and saw a scratched-up, flat-fitting, translating GP lens with a lined segment that is overall moving just a bit too much and decentering laterally. But I thought to myself, translating GP multifocal aren't that hard, so I told him we can order new translating lenses. He said he wants this exact lens and his records are in the chart. I thought to myself, "Great, I'll reorder the same thing!" and sent him on his way with a smile.

NOT SO EASY

It later occurred to me that if it were that easy, the previous practitioner who fit him probably would have also duplicated the lenses he liked. In addition, the only record I found is a decades-old single paragraph letter from his (now retired) doctor's office stating the parameters of one pair of Tangent Streak lenses. Who knows if this was the lens he had on his eye, which didn't fit very well. And did I mention the lined Tangent Streak lens is currently temporarily out of production?

I spoke with Dede Reyes, board member of the Contact Lens Society of America and director of professional education at ABB Optical Group, who explained that the lined Tangent Streak production delay is only temporary. There is difficulty with the British-manufactured lathe, and the engineers needed to do the repair are not available to travel from England due to COVID-19 restrictions. It takes a very customized lathe to manufacture the Tangent Streak design, and labs are in somewhat of a difficult spot getting this specific lens made right now. However, practitioners should note this only impacts the lined Tangent Streak design; the "no-line" version is currently available and in production.



Pictured here is a Tangent Streak GP lens.

Not willing to risk showing up with a lens that was "unlined" for a patient who is clearly expecting this, I re-designed a segmented translating GP with new parameters in an attempt to mimic the lined Tangent Streak as closely as possible. This patient was also aware of the presence of the truncation on his previous pairs, so I had to ensure that was appropriate.

I was able to look back and see the parameters of what could have been this patient's preferred lens in the old letter from his previous practitioner. I chose ABB Concise's Natural Vision TC translating GP lens design and did my best to adjust the fit to improve stability and centration. Since the habitual lens had excessive

movement and lateral decentration, I increased the overall diameter and prism. The new lens parameters were OD 7.58/9.6/-2.25DS and OS 7.58/9.6/-2.75DS. Both lenses were designed with a 2.50D add, 4.40mm segment height, 2.50D prism and a 0.40mm truncation. The material was Fluoroperm 30 to match his habitual lens material based on the provided note, and both lenses were blue in color.

A few things to note on the changes: typically, one would choose a 4.40mm segment height when visible sclera exists between the inferior limbus and lower eyelid. This patient did not appear to have that issue; however, I hesitated to change the seg height from his habitual lens, especially since I also made other parameter changes. The habitual lens was a 9.4mm OAD, but I decided to go slightly larger to attempt to improve the centration, although any GP expert would tell you that the 0.2mm increase I made was probably not clinically significant on its own.

Upon dispense, the patient saw my technician who placed the lenses on his eyes and relayed to me his immediate reaction—a huge smile. He could read 20/20 at distance and 20/25 at near and was elated with his vision improvement. In fact, he proudly announced that he didn't need to see me at all and was leaving with his lenses. Of course, the technicians insisted he stay so I was able to assess the lenses, which sat on the lower lid appropriately and moved between blinks, translating as expected. The fluorescein pattern was aligned and resting on the lower lid with good upward translation on near gaze. I was much happier with the centration, and the segment was positioned at 180°. There was no over-refraction.

Had the patient not been successful in these lenses (even despite any adjustments I deemed necessary on follow-up), my next step would have been to switch back to the Tangent Streak no-line aspheric multifocal. Thankfully, he was doing well at follow-up and had no complaints.

The patient left happily with his lenses and I was able to be the hero, or at least appear that way for a day. The real heroes are the people behind the scenes who not only make the lenses, but also repair the lathes. I'll never take those folks for granted again! RCCL

FIND THE RIGHT FIT FOR KERATOCONUS

Sclerals, GPs and even some soft lenses are viable options. Here, we share guidance on how to choose the best one for each patient.

By Melissa Barnett, OD, Barry Eiden, OD, and Louise Sclafani, OD

Practitioners who follow the oft-quoted estimate that keratoconus (KC) affects one out of every 2,000 individuals are apt to miss quite a lot of cases in clinical practice. This rule of thumb is based on a 1986 publication that used diagnostic criteria that today would be considered outmoded and insensitive. Thanks to more advanced diagnostic technologies, we now know the prevalence of keratoconus is five- to tenfold higher than previously thought.

Early diagnosis of keratoconus is key to halting its progression. To do so, one of three criteria must be met:

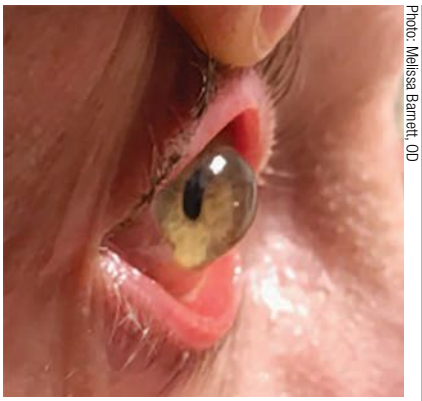


Photo: Melissa Barnett, OD

The often-extreme corneal shape change seen in keratoconus need not be intimidating to clinicians. The abundance of contact lens options all but assures we can improve vision.

abnormal posterior corneal ectasia, abnormal corneal thickness distribution (rate of change of corneal thickness across the corneal tissue) and/or clinically non-inflammatory corneal thinning.

Along with early diagnosis, appropriate medical management to preserve vision has become critically important in light of the introduction of corneal collagen crosslinking (CXL). However, it remains of utmost importance to provide visual rehabilitation for those who have already suffered vision loss from the disease. The mainstay of such an effort is the application of contact

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Dr. Sclafani is vice president of professional affairs at SynergEyes.

Table 1. Custom Soft Lens Parameters

(Numerous designs are available and are manufacturer dependent.)

Diameter	Base Curve	Sphere Power Range	Cylinder Power Range	Axis	Replacement Schedule
12.5mm to 16.0mm	6.9mm to 9.5mm	±25.00D (0.10D steps)	-0.25 to -8.00 (0.1D steps)	0° to 360° (1° steps)	practitioner discretion

lenses, and there are a plethora of options to help optimize vision that aren't just scleral or corneal gas permeable (GP) lenses. In this two-part article, we describe all the contact lenses available today and which ones can help your patients achieve the most effective results at each stage of keratoconus, including after undergoing a corneal procedure.

Part 1 (below) discusses contact lens use as a primary visual rehab modality for keratoconic patients. Part 2 (coming in the next issue) will address surgical interventions and post-procedure contact lens fitting. Taken together, these two articles should outline a comprehensive plan for success.

SOFT CONTACT LENSES

Those with early or mild KC may do well in commercially available soft contact lenses since toric and extended-range parameters are readily manufactured. If decreased acuity, reduced comfort or lens decentration is noted, numerous laboratories offer custom soft lenses with vast power ranges and parameter availability. These made-to-order lenses may provide improved vision, a better fit and greater comfort as they are tailored specifically for each patient (*Table 1*). In advanced KC, soft lenses have limited use since they tend to contour to and assume the shape of the irregular keratoconic cornea.

SPECIALTY SOFT LENSES

Masking front surface corneal irregularity requires a neutralizing tear lens under a smooth refractive plane, typically achieved with a GP lens.[1] Specialty KC-specific soft lenses exhibit characteristics similar to a GP and mask low amounts of corneal irregularity as they are lathed in higher-modulus materials or are designed with greater lens center thicknesses. Many are available in silicone hydrogel materials or use fenestrations to prevent corneal hypoxia. Diagnostic fitting and following each manufacturer's fit guide is recommended as numerous designs are available and vary greatly in fitting philosophy (*Table 2*).

CORNEAL LENSES

Previously known as corneal GPs, these lenses play a critical role in KC management and continue to be practitioners' initial lens of choice when fitting the irregular cornea.[2] Fitting goals for a corneal lens is to vault minimally over the corneal apex to prevent epithelial disruption, and provide mid-peripheral alignment and moderate peripheral clearance. In early KC, an ideal fit is easier to obtain. In moderate to advanced KC, due to corneal irregularities and increased frequency of decentration of the cone apex, it becomes more challenging to obtain a stable and optimal fit.

KC corneas with paracentral "nipple" cones often do well in smaller-diameter corneal lenses, while corneas with larger "oval" cones or decentered cones fare better in medium or large diameter corneal lenses. A known risk factor for corneal scarring is flat-fitting lenses with associated corneal staining.[3] Patients in flat-fitting lenses also experienced increased lens discomfort and a greater propensity for corneal transplantation.[4]

In general, KC corneal lenses are comprised of a small diameter, steep base curve radius and spherical or aspheric peripheral curves. A type of conventional lens design is the CLEK design. More recent designs include Rose K2, ComfortKone, TruKone, Dyna Z Cone, V Cone,

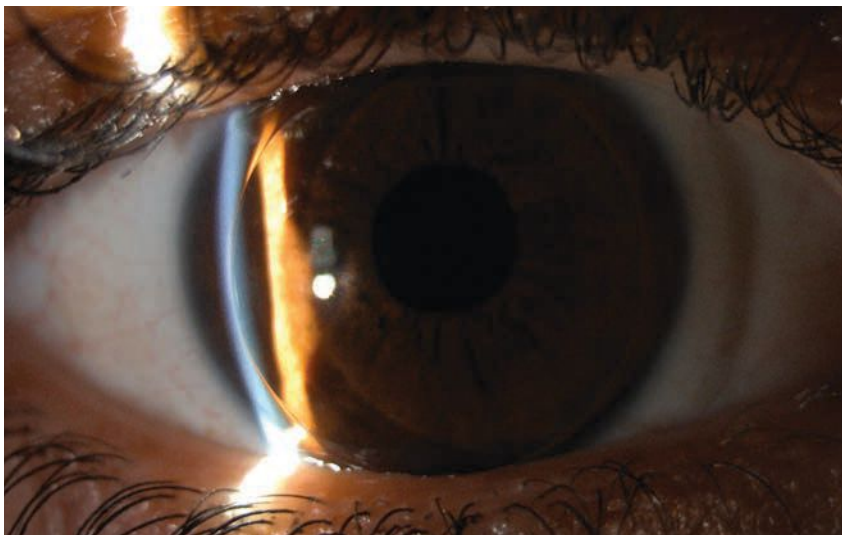


Photo: Suzanne Sherman, OD

A piggyback approach— as in this patient, wearing a corneal lens fit on top of a silicone hydrogel—combines the crisp optics of the rigid material with the comfort profile of a soft lens.

Table 2. Specialty Soft Contact Lenses for Keratoconus[5,6]

Adapted from Clinical Manual of Contact Lenses Fifth Edition (ref. 5) and Thompson TT (ref. 6)

Manufacturer	Contact Lens
ABB Optical Group	Concise K, KeraSoft IC & KeraSoft Thin
Acculens	Soft K
Advanced Vision Technologies	Soft K & Soft K Definitive, NaturaSoft IC & ICR
Alden Optical	NovaKone & NovaKone Toric
Art Optical	KeraSoft Thin
Continental	Continental Kone
GP Specialists	YamaKone IC
Gelflex USA	Keratoconus Lens
Marietta	Soflex
Metro Optics	Revitaleyes & Revitaleyes Definitive, KeraSoft Thin
Ocu-Ease, Optech	Ocu-Flex K
TruForm Optics	KeraSoft IC & KeraSoft Thin
United Contact Lens	UCL K-Lens
Visionary Optics	HydroKone & HydroKone Toric
X-Cel Contacts	Flexlens ARC & Flexlens Tri-Curve

C Cone and E Cone. Intra-limbal designs include Dyna Intra-Limbal, Rose K2 IC and the GBL.

It is imperative to avoid a harsh apical bearing relationship when fitting KC eyes, regardless of the corneal lens diameter. Two common fitting philosophies aim for either a very light apical bearing (three-point touch) or mild apical clearance (first definite apical clearance lens) fluorescein pattern.[5] Adequate peripheral edge lift and movement on blink is also necessary to facilitate tear exchange and debris removal. Lens design software in some corneal topographers may simplify the fitting process by relaying information directly to GP labs. Advanced lathing technologies can fabricate asymmetric peripheral curves, creating a more uniform edge during corneal lens wear.

PIGGYBACK LENSES

Poor corneal GP centration, lens discomfort and ejection with blink are often noted in advanced KC eyes. Although hybrid or scleral lenses are often a better match, refitting into these advanced designs can be cost-prohibitive. A piggyback system comprised of a soft lens under a corneal GP may be a viable solution that maintains ocular health while simultaneously improving both lens fit and vision. A plus-powered soft contact lens not only acts as a bandage but provides a centralized convex surface to aid GP centration.

Approximately 21% of the soft lens's power is contributed toward the total refractive error correction.[6] Minimize corneal lens power modifications by selecting a low powered, well-fitting silicone hydrogel lens of high Dk. Both the soft and GP lenses should exhibit good independent lens movement to allow adequate tear exchange. Selecting a lens with a lower modulus or steeper base curve may decrease edge fluting. The drawback to the piggyback system: it may be burdensome, as it requires proper care and handling of two different sets of contact lenses. Prescribing a daily disposable soft lens can simplify the process to minimize disinfection requirements, although costs may be increased.

Table 3. FDA-Approved Hybrid Contact Lenses for Irregular Corneas

Lens	Indication
SynergEyes KC	central prolate corneas, KC
SynergEyes PS	Oblate post-surgical corneas
SynergEyes ClearKone	Central and decentered ectasia and KC
SynergEyes UltraHealth	prolate corneas, KC

Keratoconus Interventions and Their Purpose

Contact lenses: vision improvement

Corneal crosslinking (CXL): halt progression

Corneal ring segments: reduction of disease severity, potentially improve UCVA and BSCVA, and improved contact lens response

Topography/tomography-guided PRK: reduction of disease severity, potentially improve UCVA and BSCVA, and improved contact lens response

Keratoplasty: primarily indicated for those patients who are contact lens intolerant. Goal is to provide a clear cornea, improved contact lens response and potentially improved BSCVA and BCLVA.

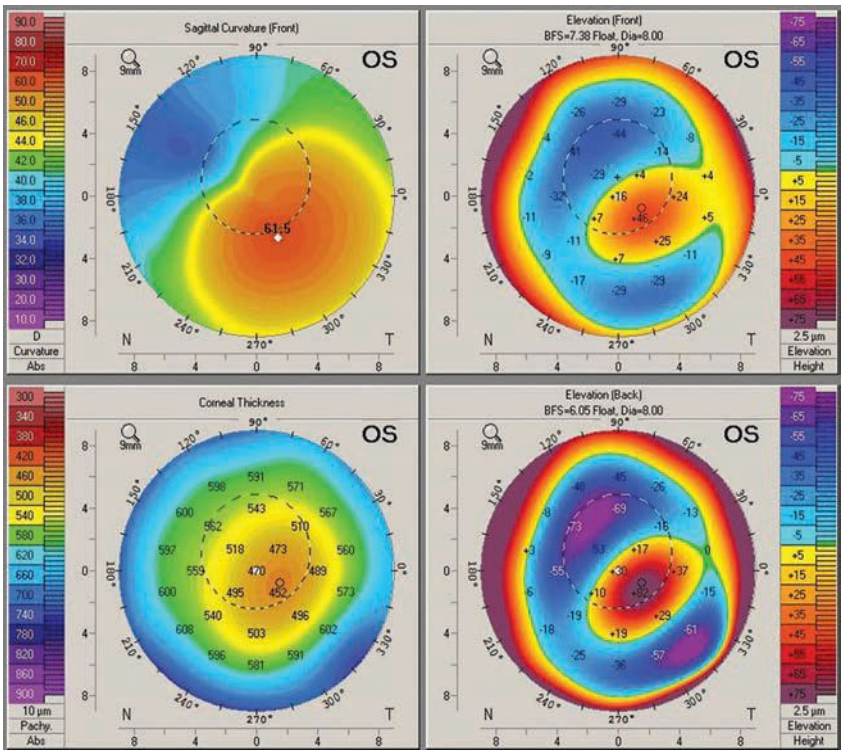
HYBRID LENSES

These are a natural progression from piggyback fitting. For those who have failed with corneal lenses due to poor centration, discomfort or dislodgment, hybrids resolve these issues and eliminate the cumbersome nature of tandem fitting since they are one unit. This design consists of a corneal GP bonded with a peripheral soft hydrogel or silicone skirt. The central GP lens provides crisp optics while the soft skirt enhances comfort, stability and centration.

A number of studies have detailed the benefits of fitting hybrid lenses for an irregular cornea, including increased comfort and tolerability over GPs and improvements in visual acuity, contrast sensitivity and subjective comfort vs. other contact lens options.[7]

SynergEyes, currently the only manufacturer of hybrid lenses in the United States, has a wide variety of designs available (*Table 3*), including a KC-specific lens with steep base-curve options and multiple skirts to lift the GP and allow total clearance of the ectasia. This first-generation lens is still widely used for very prolate, centrally located cones.

SynergEyes UltraHealth,the latest generation for hybrid lenses for irregular corneas,provides a reverse geometry system so that the GP center vaults over the cornea, yet with flatter base curves to eliminate high powers and aberrations. The GP core has a Dk of 130 and the skirt is made of silicone with a DK of 84 and a lower modulus to aid comfort. The weight of the lens is primarily on the soft landing portion, which also aids in centration. The SynergEyes UltraHealth FC is an extension of this lens design and is intended for more oblate corneas.



Having access to corneal topography and tomography is essential for achieving the best fit with custom-designed lenses for keratoconic eyes.

Hybrid lenses have certainly evolved over the years. Some early obstacles have been overcome with the use of higher oxygen permeable materials, stronger material junctions, vaulting with reverse geometry curves and the ability for these lenses to be designed empirically. While scleral lens designs are popular to best treat the advanced stage of the disease, hybrid lenses are a better approach for patients in the form fruste, mild and moderate stages.

Central clearance of approximately 75µm to 100µm over the apex and 1mm of movement is desired. Diagnostic fitting is still an option; however, with the ability to provide either the raw topographical data or specific values such as axial Ks

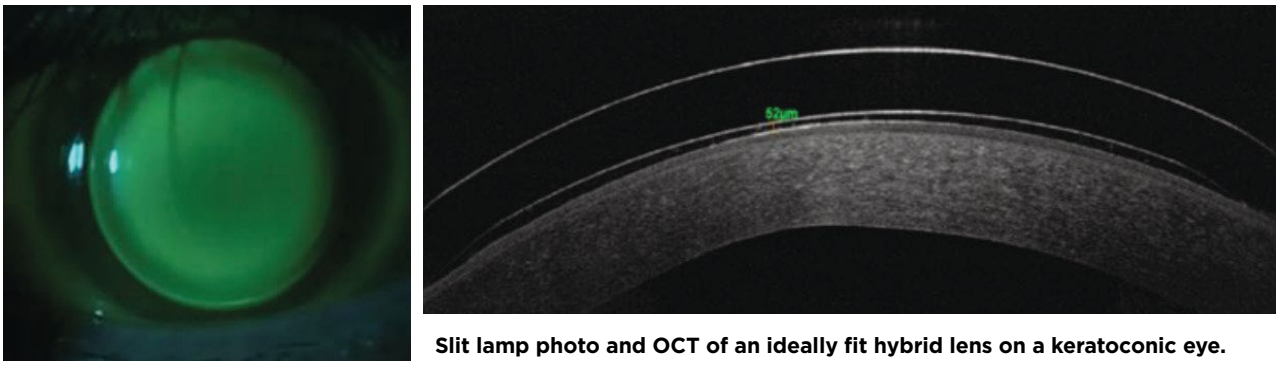
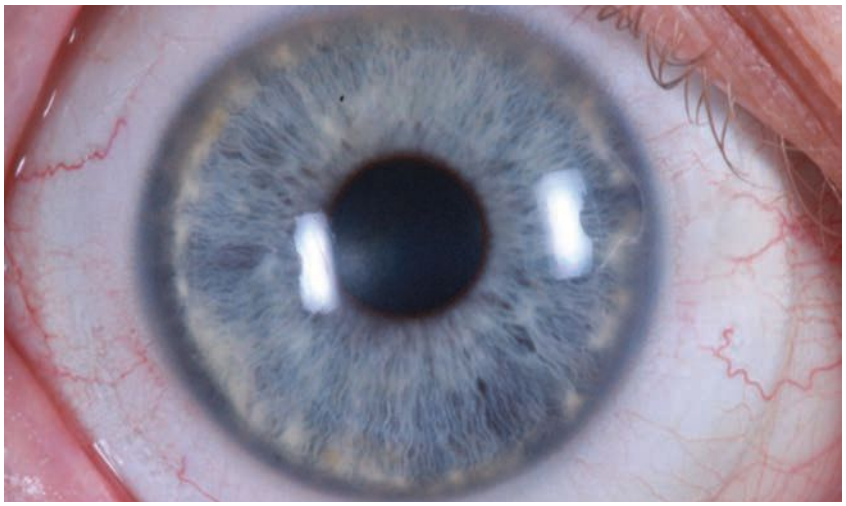


Photo: Tiffany Andrzejewski, OD

Slit lamp photo and OCT of an ideally fit hybrid lens on a keratoconic eye.

Photo: Tom Arnold, OD



Scleral lenses offer several advantages when fitting a KC patient, including improved centration, stability and comfort.

and eccentricity, these lenses can be designed empirically in hopes of getting a better first lens fit.

Patient selection is important. In the past, many doctors used this modality as a problem solver after other designs failed or as last resort on very challenging patients—thus, success rate was limited. Although hybrids do resolve many issues related to unstable optics of soft torics or discomfort from GPs, many reach for them successfully as first-line treatment.

SCLERAL LENSES

Keratoconus is the single most common indication for scleral lenses.[8-11] They neutralize irregularities of the corneal surface and offer have improved centration and stability compared to corneal lenses. Since the lens does not touch the cornea, there is improved comfort due to less lens awareness. A recent study compared the comfort and visual performance of rigid corneal lenses and sclerals in patients with corneal ectasia who successfully wore habitual corneal GP lenses. Significantly improved comfort was reported for sclerals.[12]

Sclerals are less likely than GPs to mechanically reshape the cornea and cause warpage. They may delay or even avoid surgical intervention, with a study showing the majority of participants who would have otherwise undergone corneal transplant surgery were successfully treated with long-term scleral lens

Keratoconus Care is a Team Sport

Successful management of keratoconus requires a comprehensive approach. The mainstays of management include early diagnosis, control of disease progression, vision rehabilitation and reduction of disease severity. Early diagnosis is essential in preserving visual function in light of our ability to control disease progression through CXL and other efforts.

It has become apparent that early diagnosis prior to vision loss requires the use of advanced genetic testing and diagnostic technologies that have the ability to measure posterior corneal shape, global corneal thickness and its distribution from center to periphery, corneal epithelial thickness and corneal biomechanical properties among others. Getting such technologies beyond keratoconus specialists and into the hands of primary eye care providers is required to have a significant impact on early diagnosis.

Medical management of disease progression via technologies such as CXL has already been shown to have a positive impact on the natural course of the disease. Rates of keratoplasty for keratoconus have been reported to have decreased since the introduction of CXL.[1] Reduction of disease severity is an area that continues to develop. Technologies such as corneal ring segments, topography- and tomography-guided PRK and others all aim to reduce disease severity via their impact on corneal shape and thus both uncorrected and best corrected visual acuity.

Still, to this day, the mainstay of visual rehabilitation and function for those who have suffered vision loss from keratoconus remains the application of contact lenses. As described in this feature, the armamentarium of contact lens technologies that are useful in keratoconus is extensive. Each case should be evaluated individually in order to come up with the most appropriate contact lens treatment.

Collaborative care is critical for successful management of keratoconus. Collaborations should take place between primary eye care providers and those who specialize in keratoconus management. This form of collaboration should take place both between and within optometry and ophthalmology. Early diagnosis must be placed in the hands of primary eye care providers in order to have a significant impact. Subsequent management often requires referral to those who specialize in keratoconus management and see large numbers of these patients. Their experience and expertise will allow the keratoconic patient to have access to the highest quality of care and greatest likelihood of successful management.

Comanagement between the primary eye care provider and the keratoconus specialist is a way to maximize outcomes as well as to improve the level of experience for the primary eye care provider.

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wear.[1] A similar study that evaluated the association of scleral use with the risk for keratoplasty in KC patients showed that contact lens wear significantly lowered the risk of undergoing keratoplasty.[13]

Factors to consider when selecting a scleral lens include corneal diameter, presence of ocular surface disease, palpebral aperture, ethnicity and disease severity. Corneal and scleral topography and/or tomography are also beneficial tools when determining the type of KC and areas of elevation.

With mild KC, a smaller-diameter scleral lens may be used. For those with advanced KC or keratoglobus, a larger diameter may be preferred. For progressive keratoconus, a scleral may be fit with additional sagittal depth to allow room for progression. In cases of extreme ectasia, a specialized design such as a quadrant-specific or impression-based lens may be preferred.

A recent publication described how a quadrant-specific scleral lens (BostonSight Scleral) resulted in visual improvement, a reduced need for mid-day removal and an average of two lenses needed to complete the fitting process.[14]

Another unique approach is an impression-based scleral lens design. In one study, patients fit with an EyePrintPro lens saw an improvement in the quality of vision, comfort of lenses, dry eyes, eye redness and pain symptoms.[15]

Scleral lenses are often used to minimize visual distortion after a CXL procedure for KC. They have also been used to improve vision and reduce higher-order aberrations after intracorneal ring segment implantation in keratoconic eyes. These applications of scleral lens fitting, and the various surgical procedures themselves, will be explored in detail in Part 2 of this article in the January/February issue. Stay tuned!

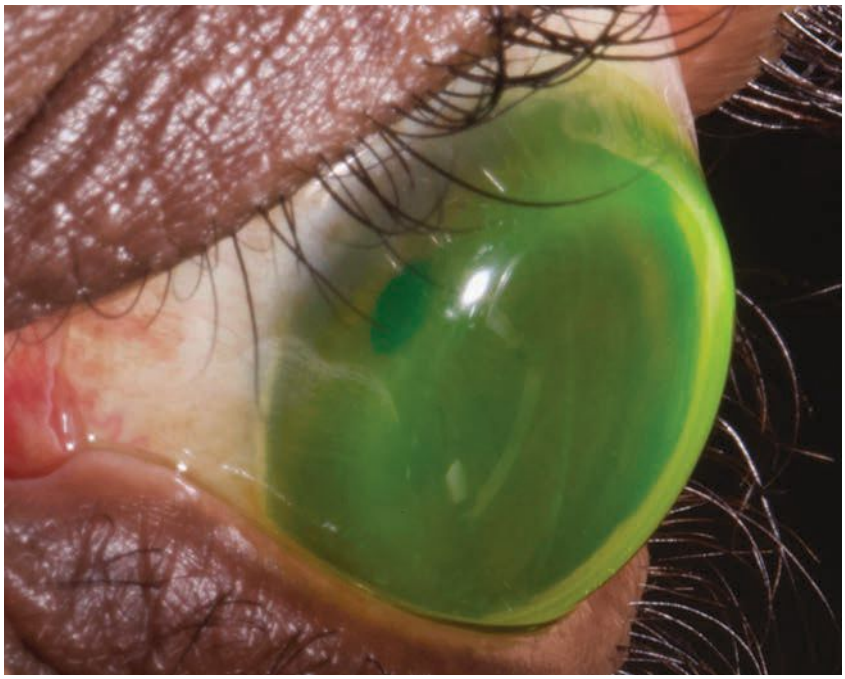

Photo: Tom Arnold, OD

A 19mm scleral lens with sodium fluorescein fit on an eye with a 25-year-old proud graft fit.

TAKEAWAYS

Keratoconus has significant implications on our patients' visual function and quality of life. Although its prevalence is fairly high, we have technologies that can halt progression and, as such, preserve visual function. Contact lenses remain the primary method of improved visual function in keratoconus.

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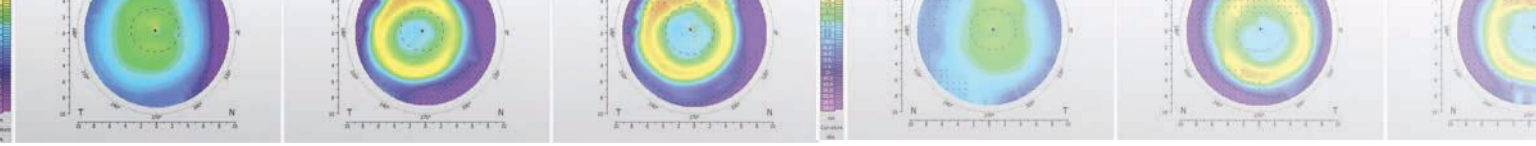

ORTHOKERATOLOGY:
PRINCIPLES, LESSONS, CASES

Learn how to best apply this modality for myopia control and more.

By Priscilla Chang, OD

Orthokeratology's (ortho-K) resurgence in popularity is a testament to extensive research efforts, lens design advancements and our growing understanding of the corneal shape and topography. As a specialty that was pioneered and refined by optometrists, clinicians should embrace the technology and continue to learn how current advances better serve our patients.

This article will discuss some dos and don'ts for those interested in using ortho-K in their practice before reviewing several case examples.

THE PRINCIPLES

Different brands may have different numbers of curves and the curves may have unique names, but the principle is the same. The ortho-K effect is achieved through central corneal epithelial thinning and mid-peripheral stromal and epithelial redistribution.[1]

Since the cornea determines 60% of the eye's focusing power, minor changes in the superficial epithelial cells thickness can change the refractive error. For example, 6µm of corneal flattening can result in 1.00D of reduced myopia correction.[2] The onset is observable after one night of wear, and the gradual stability is achieved after one to two weeks of wear time.[3]

The older the individual and the higher the refractive error, the longer the treatment takes to achieve stability. Advanced technology has led to ortho-K lenses that can correct hyperopia and presbyopia, but its most common application is for myopia. The lenses create myopic peripheral defocus that can reduce axial elongation.

1. Do: learn as much as you can. Each ortho-K lens system has its own design and fitting philosophy. There are three ways to approach fitting this modality: empirically, trial-based or custom lens design with topography and software). Each has its own advantages and disadvantages:

- *Empirical fitting* consists of supplying the lens manufacturer with either keratometry readings or topographic (i.e., eccentricity, HVID) and refractive data to order the lens. Then the OD receives, evaluates and dispenses the lenses if the fit is appropriate. This fitting works great for patients that fall under the parameters.
  - o Pros: less chair time initially, zero financial investment to start.
  - o Brands that do this: Contex OK Lens, Vipok, Paragon CRT, iSee, Euclid Emerald.
- *Trial fitting* involves taking K readings, topographic and refractive information and using a nomogram to choose an initial diagnostic lens to try. The fit of the lens is evaluated using fluorescein, and an over-refraction is performed. The trial lens can be changed based on the fit to reach the best fit prior to ordering a lens. If it's a new unopened diagnostic lens, you can even dispense it!
  - o Pros: a higher first fit success rate because the fit is validated in the exam room, sets patient expectation on comfort.

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Dr. Chang is a residency-trained optometrist in California. She is a Fellow of the American Academy of Optometry. She is a speaker for ZenLens and is a clinical sales consultant for Johnson & Johnson.

- Cons: chair time at first visit, the practitioner may be limited to available designs.
- Brands: Bausch and Lomb BE Retainer, Paragon CRT.

- *Custom topography-based design*s allow practitioners to import corneal topographies into a proprietary software, and then a customized lens is designed from the data. This can be a good learning opportunity for intermediate fitters to learn about the interdependence of all the modifiable curves.
  - Pros: works well with minimal modifications if data input is accurate, practitioners get more control on design, less chair time.
  - Cons: must have accurate topography data, may require a more advanced understanding of lens parameters and practitioner skill.
  - Brands: Wave NightLens, Eyespace Forge Ortho-K, OrthoTools, J&J Acuvue Abiliti.

Start off by choosing one or two lens designs to learn in detail and familiarize yourself with the types of modifications that can be made. It may be easier for a novice to start with empirical fittings and move to more advanced design(s) when more comfortable.

2. Do: use the right tools. This is essential to fitting and troubleshooting patients.

The gold standard is topography. The axial map can monitor how much power was changed. The tangential map is useful for patient selection, understanding the type of astigmatism and evaluating treatment centration. Topography is also used for documenting the treatment course and allows for gathering comparative data and troubleshooting on the treatment effect.

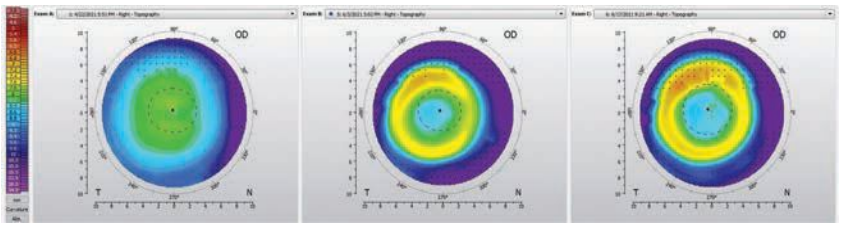


Fig. 1. Pre-ortho-K OD topography (left), post-ortho-K at one-day follow-up (middle) and post-ortho-K at two-week follow-up (right).

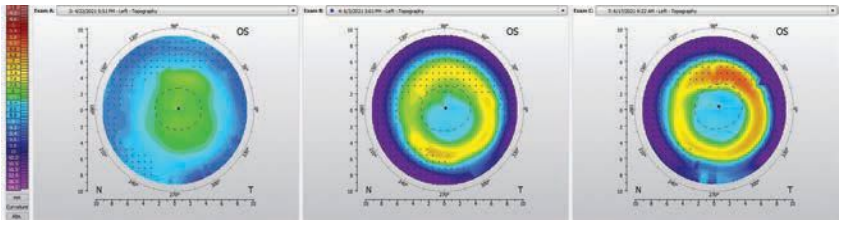


Fig. 2. Pre-ortho-K OS topography (left), post-ortho-K after one week of follow-up (right).

Having good-quality topographies is vital for first fit success. Don't hold back from capturing multiple topographies per eye pre-fit. Also note the consistency of topographic scans with the visual axis vs. the geometric axis.

Aim to capture as much corneal data as possible. If you can match your topography Ks to the autorefractor Ks, you get optimal accuracy.

Other tools worth mentioning include:

- Autorefractor.
- Slit lamp with cobalt blue light.
- Sodium fluorescein strips.
- Wratten filter.
- HVID ruler.
- Slit lamp camera/cell phone holder.
- Tools to measure and verify rigid gas permeable (GP) lenses (radiuscope, band magnifier or a V-gauge to measure lens diameter).

3. Do: prepare a protocol. Implementing a new service requires a good workflow to accommodate it. Prepare informed consent forms, instruction sheets on lens care, FAQs and figure out who in your clinic will be reachable if concerns arise. Keep the following in mind:

- Set an appropriate amount of time in your schedule for fittings and follow-ups if you are just getting started. For beginners, this can be 30-to-40-minute slots—long enough to gather relevant data and review expectations.
- Visits should include a thorough history, visual acuity (VA) with/without lenses, refraction with/without lenses, slit lamp evaluation with fluorescein, topography, check of lens condition and decision on whether modifications are needed.
- The suggested follow-up schedule includes dispense visit, one day, one week, one month, three months, six months and one year. Varying between morning and afternoon visits can reveal how well the treatment is maintained throughout the day. If the modified lenses need to be ordered, the schedule may be changed.

4. Do: offer ortho-K to all patients who are candidates. When patients have a history of having active lifestyles, find glasses inconvenient, exhibit myopia progression or are contact lens dropouts, check their ortho-K candidacy and offer it as an alternative if possible.

Many times, parents and patients have not heard of ortho-K lenses and are intrigued to learn more.[4] In general, good candidates have low-to-moderate myopia and mild-to-no with-the-rule astigmatism.

In adult patients, I discuss ortho-K with those experiencing mild dry eye and discomfort with conventional soft lenses, if there's an interest in refractive surgery but they are pre-presbyopic or if they work in occupations or play sports that require good unaided acuity. For instance, a long-distance truck driver once expressed a strong desire to be glasses- and contact lens-free for when he had to load and unload boxes in various weather conditions.

HARD LESSONS

Unfortunately, not all outcomes will turn out as expected. Certain situations can complicate the fitting process and drag you down.

1. Don't: make changes too early in the fitting process and chase perfection. As mentioned prior, these lenses can take longer to take effect in certain patient populations. The only time new lenses should be ordered at the one-day or one-week follow-up is if there is lens adherence, excessive decentration or corneal staining. Otherwise, give the eye up to two weeks to acclimate.

Patients with low myopia can be functional with their uncorrected myopia. In patients with moderate myopia, dispense daily disposable contact lenses in the first week while the myopia is reduced. Sometimes, the topography might not look perfect—as long as the treatment zone is complete and the patient is 20/happy, we're happy.

2. Don't: forget to set expectations and screen out bad candidates. Some patients may want crisp 20/20 uncorrected vision after treatment, and this may be unrealistic due to potential glare or poor treatment response. High residual lenticular astigmatism might influence the outcome. There are limitations with ortho-K, and a goal to set may be improving unaided vision, instead of correcting all refractive changes.

- Absolute contraindications include keratoconus, corneal dystrophies and active anterior segment pathology.
- Relatively bad candidates include patients who have irregular or limbus-to-limbus astigmatism, which will cause lenses to decenter superiorly or leave patients with more overall astigmatism. Toric ortho-K lenses exist for these more complex patients.

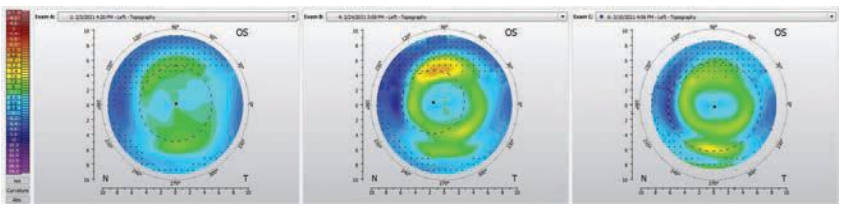


Fig. 3. Pre-ortho-K treatment corneal topography (left), one week after starting ortho-K (center), topography after modifying lens to have a toric landing zone (right).

3. Don't: use bad data. This is especially true if using software-based designs. In existing GP wearers, let corneas normalize before starting ortho-K. If not, the initial maps will be inaccurate, leading to excessive follow-ups and lens reorders. So, invest that time upfront to save time in the long run.

4. Don't: forget to test binocular vision in candidates. Although uncommon, patients with variable refractive endpoints warrant treatment and management prior to attempting ortho-K. Imagine how frustrating it would be to fit ortho-K in a patient with accommodative spasms!

Now that we've gone over the good and the bad, let's review some ortho-K cases that a clinician might come across.

PATIENT WITH LOW MYOPIA

A 13-year-old Caucasian male presented for a myopia management consultation after having a comprehensive eye exam with another doctor in my practice. The parents were worried that his prescription had progressed 1.00D OU in the last year. The dad being myopic and the mom being emmetropic, they wanted him to be glasses-free while playing sports and to have myopia management at the same time. Their son also frequently took naps during the day and enjoyed swimming.

The refraction was -2.00 DS (20/20) OD and -3.25+0.50x85 (20/20) OS. Binocular vision testing and ocular health examination were unremarkable. Corneal topographic data from the Oculus Keratograph 5M showed the presence of minimal central corneal astigmatism. K values were 41.3/42.2@82 OD and 41.5/42.1@92 OS. The axial

length as measured with the A-scan before ortho-K was 24.96mm OD, 25.23mm OS. HVID 11.89mm OD, 12.02mm OS.

Given that he enjoys swimming and taking frequent daytime naps, I advised against soft contact lenses and strongly recommended ortho-K. A set of lenses was empirically ordered from CooperVision Paragon CRT through the company's lens calculator.

The lenses ordered were:

- OD: CRT dual axis 8.7/11.0, return zone depth (RZD) 1: 525 and RZD 2: 525, Landing zone angle (LZA) 1: 32, LZA 2: 33, optic zone diameter (OZD): 5mm, power: +0.50, material: Menicon Z.
- OS: CRT dual axis 8.9/ 11.0, RZD 1: 525 and RZD 2: 575 LZA 1: 32 and LZA 2: 33, power: +0.50, material: Menicon Z, OZD: 5mm

At the one-day follow-up, the VA was 20/25 OD and OS. The sodium fluorescein pattern showed good centration, 4mm treatment zone, uniform landing in the landing zone and adequate 0.5mm edge lift. The cornea was clear. Subjective refraction was -0.25 OD and -0.25 OS. The refraction over the lenses was +0.75 OD and +0.50 OS. No new lens was ordered.

At the two-week follow-up, he was extremely happy with his vision and the quality. His uncorrected distance vision was 20/15 OD and 20/20 OS. The over-refraction over the lenses was +0.75DS OD and +0.50DS OS. The slit lamp examination with sodium fluorescein showed an ideal fit.

The corneal health without the lenses was good with no staining present. The topographies showed even treatment OU, with mild decentration temporally OD and slight decentration inferiorly OS (*Figures 1 and 2*).

Discussion: This was a slam-dunk, easy case for ortho-K. The patient had a low amount of corneal astigmatism and was motivated to be contacts- and glasses-free during the day. Soft contact lenses contraindicated in this patient, as he was a swimmer and took naps throughout the day.

Notice that the treatment ring appears to be decentered relative to the geometric center but is centered with the visual axis to offer the myopia control desired. The patient was 20/happy and additional lens modifications were not necessary.

MONOCULAR ORTHO-K IN PATIENT WITH ANISOMETROPIA

An 11-year-old Asian male presented for a contact lens fitting in the left eye due to history of anisometropia. The uncorrected VA was 20/20 OD and 20/100 OS. The subjective refraction was plano (20/20) OD and -1.50 (20/20) OS. Ks were 41.25/42.75@75 OD, 40/40.25@100 OS. HVIDs were 11.86mm OD and 11.84mm OS. The binocular vision status and ocular health were unremarkable.

The mother of the patient requested to pursue ortho-K fitting OS despite the possibility of myopia progression OD. The lens ordered empirically was: Paragon CRT: 8.7/10.5, RZD: 500, LZA 32, OZD: 5mm, power: +0.50, material: Paragon HDS. Moving forward, only the OS will be discussed.

At the next follow-up, the entering acuity without the lens was 20/20. The refraction over the lens was -0.50D. The sodium fluorescein pattern with slit lamp revealed a well-centered lens with adequate edge lift 360° but an uneven return zone.

A few modifications were made: the base curve was adjusted to account for the over-refraction. For every 0.10D change in base curve, there is a 0.50D change in power. The lens was reordered with a toric return zone: Paragon CRT 8.8/10.5, RZD 1: 500 and RZD 2: 550, LZA 32, power: +0.50, material: Paragon HDS.

At the follow-up with the new lens, the VA was 20/20. The topography showed a more even treatment zone (*Figure 3*). The refraction without the lens was plano and the refraction over the lens was +0.50 DS.

Discussion: This case highlighted the application of ortho-K in managing unilateral myopia to slow myopic progression and reduce anisometropic values. Since contact lens wear in anisometropia

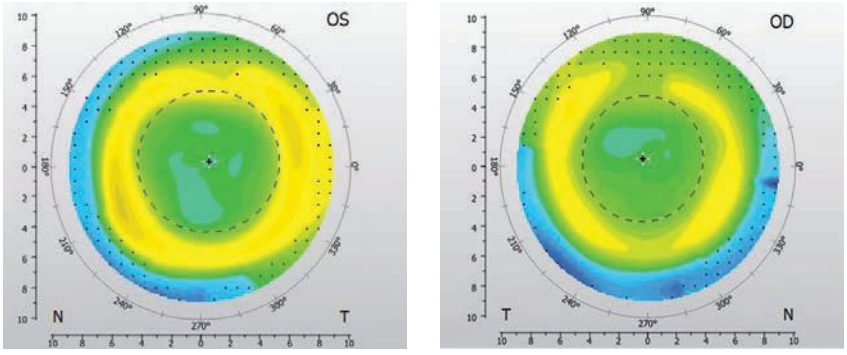


Fig. 4. Pre-ortho-K topographies OS (left) and OD (right) with visible post-LASIK pattern.

will reduce aniseikonia too, ortho-K was a great option. Interestingly, there is a subset of research on the topic of ortho-K in managing unilateral myopia with monocular vs. binocular ortho-K, but more prospective studies with longer follow-ups are needed.[5]

In this case, the ortho-K lens did not have a uniform return zone on the cornea. The Paragon dual axis lens design allows for modifications to be made to improve centration and treatment if there is toricity in the return zone, the landing zone or both.

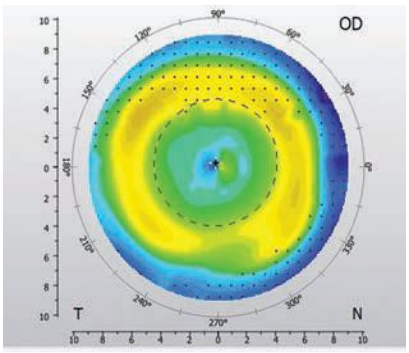
POST-LASIK MONOVISION IN PATIENT WITH EARLY PRESBYOPIA

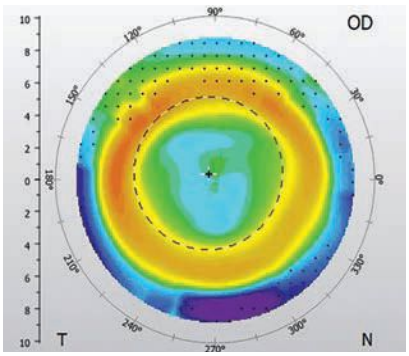
A 45-year-old Asian female presented with blurry vision at a distance in both eyes. Her ocular history was remarkable for myopic LASIK OU 10 years ago. She could not recall her pre-LASIK prescription ranges. She was currently wearing glasses for driving, especially at night. She was interested in more independence from wearing spectacles and contact lenses but was not interested in refractive surgery retreatment. After extensive discussion on options, she was mostly interested in monovision ortho-K.

Her uncorrected VA was 20/40 OD and OS. Ks were 40.75/41@75 OD DS, 40.75/41.00@140 OS. Subjective refraction was -1.00 OD and OS, with +1.00 add. She was OD dominant. HVIDs were 11.30mm OD and 11.37mm OS. Baseline topographies showed a large central zone of corneal flattening consistent with myopic LASIK correction surrounded by relative corneal steeping in the mid-periphery and no signs of ectasia or corneal irregularities (*Figure 4*).

Ocular health was unremarkable in each eye. Considering a relatively spherical central cornea OU and the need to correct low myopia, we discussed ortho-K as an option. However, since the patient had never tried monovision before, a trial with soft contact lenses was performed first. She was given Johnson and Johnson Acuvue 1-Day Moist -1.00DS for use OD only to trial monovision for two weeks. VA OD was 20/20. If well-tolerated, she could call back to the clinic to continue.

After two weeks, she called back and was ready to proceed with monovision. Since the case is more complicated than a classic case of ortho-K, the lens consultant was given more background information and a new lens was empirically ordered: Paragon CRT 8.7/10.5, RZA: 500, LZA: 32, power: +0.50D, material: Menicon Z.





Figs. 5 and 6. Post-ortho-k day-one (left) and two-week (right) follow-up and topography OD.

At the one-day ortho-K follow-up, the uncorrected VA OD and OS was 20/40. Subjective refraction was -1.00DS. Refraction over the lens was plano. Slit lamp examination showed ideal contact lens alignment and no corneal health concerns. No changes were made to the visit. Topography showed an early, incomplete treatment ring (*Figure 5*).

Since there were difficulties with scheduling a standard one-week follow-up, the patient returned for a two-week follow-up (*Figure 6*). At this visit, she reported that her vision improved. The uncorrected VA was 20/20 OD and 20/40 OS. Refraction was -0.50 OD and was -1.00DS OS. Refraction over the OD lens was plano. Slit lamp examination showed an ideal fit with the lens on and no corneal health concerns. No changes were made to the visit. Topographies showed a complete and well-centered treatment ring.

Discussion: Post-LASIK myopic regression is infrequently observed and has significant implications on a patient's quality of life.[6,7] Theoretically, LASIK surgery only affects the corneal stromal layer and not the epithelial layer. In ortho-K where the treatment effect occurs in the epithelial layer, the post-LASIK cornea theoretically should be able to respond to the intervention.

Since conventional ortho-K lenses are designed for normal prolate corneas, instead of oblate post-LASIK corneas, the clinician should set the expectation that more lens orders may be necessary to obtain good lens centration and fit.

Monovision ortho-K is one option of managing early presbyopes to keep them glasses- and contact lens-free for as long as possible.

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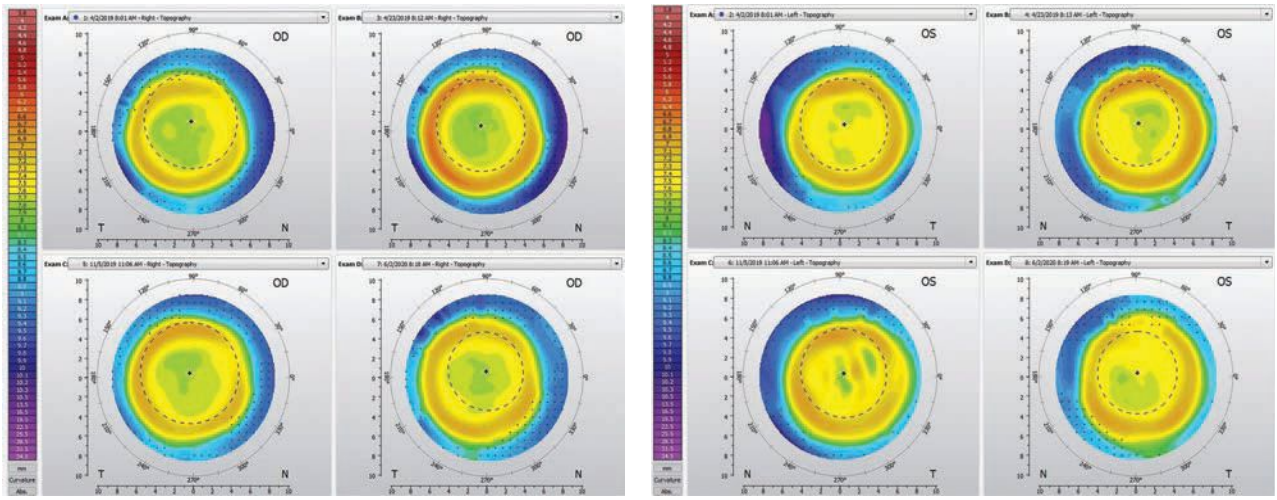

Figs. 7 and 8. Changes in corneal topography over the course of treatment OD (left) and OS (right), that includes one-week follow-up (top left corner of each figure), two-week follow-up (top right), six-month follow-up (bottom left) and one-year follow-up (bottom right).

YOUNG ADULT PATIENT

A 24-year-old Caucasian female presented to the clinic to inquire about ortho-K. She was motivated to pursue refractive surgery but is concerned about the cost and permanence. She did not any prior experience wearing contact lenses.

Her entering acuity was 20/100 OD and 20/100+ OS. Ks were 45/45.75@86 OD and 45.75 Sph OS. Subjective refraction was -2.00 OD and OS (20/20 in both eyes) and HVIDs were 11.46mm OD, 11.50mm OS.

The binocular vision status and ocular health were unremarkable. Based on her motivation, Ks and refraction, she was a candidate for ortho-K, and initial lenses were ordered empirically.

Parameters ordered were the same for both eyes: Paragon CRT 7.8/10.50, RZA: 550, LZA: 34, OZD: 6mm, power: +0.50D, material: Menicon Z.

At one-week follow-up, uncorrected VA was 20/30 OD/OS. The slit lamp corneal health check was unremarkable. The lens fit on the eye looked ideal. Subjective refraction was -0.50DS. The lenses were reordered with 7.9 base curve OU.

At the two-week follow-up, the uncorrected VA was 20/20+ OD and 20/20 OS. The patient was happy with the improvement in vision quality. Subjective refraction was +0.25 OD and +0.50 OS.

At the six-month and subsequent one-year follow-up, the VA uncorrected, subjective refraction and corneal health remained stable (*Figures 7 and 8*).

Discussion: Ortho-K is attractive to patients as an alternative to refractive surgery because the treatment is reversible and involves a relatively lower risk. This case highlights the difference in fitting adults vs. kids. In kids, the optic/treatment zone tends to be smaller (5.0mm to 5.5mm) to allow for more relative peripheral myopic defocus for myopia management; however, in adults, larger optic zones are better tolerated, as they reduce aberrations that can cause symptomatic halos/glares.[8]

Ortho-K is a complex fitting technique that requires time to develop an understanding. Thankfully, clinicians can start with the basics and build their understanding of different lens design approaches. Hard lessons learned ensure that there is quality data collection, patience, realistic expectations, and good patient selection.

Understanding the wide range of ortho-K candidates will open up the potential for more patients to benefit from this unique lens modality. RCCL

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Managing Contact Lens-associated Red Eye

Treatment of these patients requires a stepwise approach.

By Jennifer Harthan, OD

Many ODs have seen patients present with contact lens-associated red eye (CLARE), an inflammatory response to overnight lens wear that involves the cornea and conjunctiva.[1] While often easy to treat, it requires ongoing patient education to avoid recurrence.

Our job is to not only identify the signs and symptoms of CLARE but to also ask the right questions, including onset and severity of symptoms, history of extended wear with contact lenses, upper respiratory tract infection, noncompliance with contact lens wear and care and reduction in vision. This can help guide diagnosis and rule out differentials in the contact lens wearer, such as contact lens-induced peripheral ulcer, infiltrative keratitis and microbial keratitis. With the proper diagnosis, an appropriate treatment strategy can then be initiated.

Patients with CLARE often ask, "When can I wear my contact lenses again?" For most, treatment is relatively straightforward and begins with discontinuation of contact lens wear, artificial tears to help mitigate symptoms and lengthy patient education. Other patients may need topical antibiotics, topical corticosteroids or topical or oral NSAIDs. If the patient can resume lens wear, practitioners must feel comfortable proceeding with contact lens prescription recommendations that minimize the risk of recurrence and take into account lens fit, material, modality and/or replacement schedule.

This article discusses how to identify CLARE, relevant history to consider and differentials that must be ruled out. ODs must also understand the available therapeutics that can help alleviate symptoms while the cornea heals, including artificial tears, topical and oral NSAIDs and, if necessary, topical antibiotics. Once the patient is ready to resume lens wear, clinicians must know how to minimize risk of recurrence.

THE BASICS

To better understand CLARE's etiology, it is important to remember and review the anatomy and functions of the cornea and conjunctiva. The corneal epithelium acts as a protective barrier while the stroma provides strength and transparency, assists in immunity and is the main refracting portion. The endothelium removes fluid from the stroma to maintain clarity, and the basement membranes anchor the epithelium (Bowman's) and the endothelium (Descemet's).[2,3]

The avascular cornea does not have any blood vessels to supply nutrients or protect against infection. It is densely innervated by the ophthalmic division of the trigeminal nerve (CN V) via the ciliary nerves.[3] The limbus—the zone between the transparent cornea and opaque cornea—houses the stem cells and limbal blood supply to aid in the metabolic demands of epithelial cell renewal and aqueous drainage.[3]

The conjunctiva—a thin tissue of epithelial and goblet cells—assists with protection and lubrication. It is highly vascularized; the blood supply of the bulbar conjunctiva is primarily via the anterior ciliary arteries, and that of the palpebral conjunctiva is mostly from the branches of the ophthalmic artery.[3]

CORNEAL COMPLICATIONS

Look out for these concerns in CLARE patients:

Hypoxia. This occurs when there is a lack of oxygen. Epithelial cells respire anaerobically, lactic acid builds up and the cornea swells. Stromal tissue weakens from chronic edema and stimulates blood vessel growth, causing cells to migrate. Clinical signs include conjunctival redness, limbal redness, epithelial microcysts, endothelial blebs, corneal neovascularization, corneal edema and corneal infiltrates.[4]

Neovascularization. This is the formation of new blood vessels and

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extension of vascular capillaries within and into the avascular cornea. This growth is mediated by vascular endothelial growth factor. Initially, the limbal blood vessels dilate, so it's important to differentiate this occurrence from true neovascularization.

Endothelial cells proliferate and migrate toward the area of insult parallel to the stromal lamellae. Sprouts become tubes with lumen and can mature into small arterioles and venules. If the initiating cause of neovascularization is controlled, the blood vessels may regress and form ghost vessels if chronic.[5,6] In contact lens–induced cases, superficial neovascularization is commonly seen.[6]

Edema. This primarily occurs due to lactate buildup during hypoxia. Fluid builds up in the stroma and over time the endothelial pumps cannot maintain function. Clinically, to differentiate folds from striae, it is important to look at the appearance of "lines" in the posterior stroma. Endothelial folds may appear as long, straight, dark lines in the posterior stroma, whereas striae appear as fine, white, vertical lines in the posterior stroma that do not branch. This occurs with increased hydration in the posterior stroma, which results in collagen fibril separation.[7]

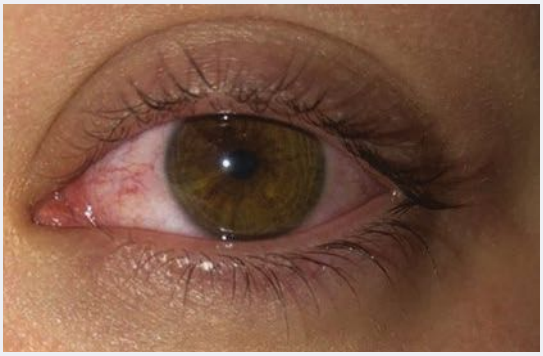
Infiltrates. These are gray or white aggregates of inflammatory cells. Epithelial cells identify the corneal insult and release cytokines to mount an immune response, and neutrophils and lymphocytes are released from the limbal vessels. The collection of inflammatory cells within the cornea forms an infiltrate and appears whitish-gray in color.[8]

WHAT IS CLARE?

CLARE is thought to occur in conditions under hypoxic stress and in the presence of gram-negative bacteria that colonize contact lens surfaces, stimulating an inflammatory event of the cornea and conjunctiva, secondary to the release of bacterial endotoxins.[8-11]

There are several risk factors for CLARE, including extended contact lens wear, tight-fitting lenses, high water lenses, replacement noncompliance, improper contact lens solution use, poor contact lens hygiene and a history of upper respiratory tract infection.[9,10,12]

Patients with CLARE have an acute onset and wake up with symptoms of irritation to moderate pain, epiphora and photophobia. They often have prominent circumlimbal redness and may present with multiple, small focal or diffuse infiltrates that rarely stain with sodium fluorescein. There may also be associated corneal edema and haze.[8-10]



This patient slept in their contact lenses and woke up with acute redness and pain. They were subsequently diagnosed with CLARE. Note the prominent redness OS.

PATIENT CASE HISTORY

As with other "red eye" conditions, a detailed case history is crucial when making an accurate and timely diagnosis. Asking focused questions can also eliminate many conditions from your list of differentials.

CLARE is associated with sleeping in contact lenses, so detailed questions about a patient's wear schedule and hygiene habits are important.[9,13] This condition has also been linked to extended wear, tight-fitting, low oxygen, high water hydrogel contact lenses, as well as extended wear, high oxygen, silicone hydrogel lenses.[8,10,12]

Sometimes, asking a patient if they sleep in their contact lenses will automatically elicit a "no" response. The patient may be embarrassed or fearful of not being able to wear lenses in the future. Additional questions such as, "Do you nap in your contact

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Educational Objectives: *After completing this activity, the participant should be better able to:*

- Identify the signs and symptoms of contact lens-associated red eye.
- Educate patients on contact lens-associated red eye.
- Understand the available therapeutics for this condition.
- Effectively treat contact lens-associated red eye.
- Minimize the risk of recurrence.

Target Audience: This activity is intended for optometrists engaged in managing patients with contact lens-associated red eye.

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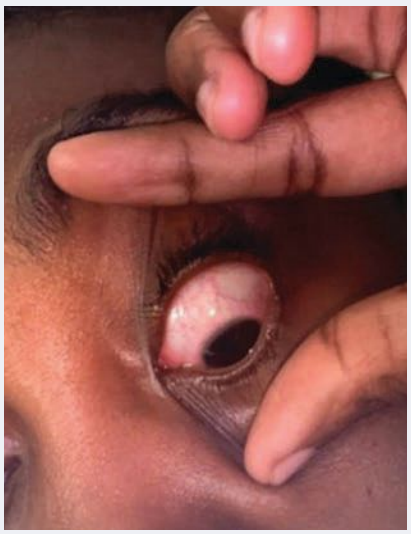


A patient who presented with an irritated, painful eye after sleeping in her contact lenses was diagnosed with unilateral CLARE.

lenses?" or "How many hours per day do you sleep in your lenses?" or "How many days per week do you sleep in your lenses?" may provide a more truthful response.

For new patients, knowing what type of lenses they wear may benefit future management options. Some patients don't know what lenses they are wearing, so asking about their replacement schedule, solution(s) used and any difficulty with lens removal can provide helpful information.

Additional questions to ask patients, particularly in the case of recurrent episodes, include previous treatment(s) they have received and whether they have a pair of spectacles. Knowing the answers to these questions may help address noncompliance. It is also important to ask patients presenting with symptoms of CLARE about any recent upper respiratory illness, as *Haemophilus influenza* has been associated with infiltrative events and CLARE.[9,12,14]

SIGNS AND SYMPTOMS

Patients with CLARE often present with a sudden onset of mild to moderate pain, photophobia, epiphora, contact lens intolerance and overall discomfort. They may have unilateral or bilateral involvement. Slit lamp exam will reveal mild to moderate conjunctival and limbal hyperemia, along with corneal epithelial and subepithelial infiltrates in the periphery to midperiphery.

Infiltrates with CLARE will have little to no sodium fluorescein staining, as there is minimal associated epithelial disruption.[9,13,15] Vision is typically not affected. However, the number of infiltrates varies, and in severe or recurrent cases of CLARE, vision may be affected due to subsequent corneal scarring.[9,12] In severe cases of CLARE, corneal edema and/or uveitis may also be present.[9,12]

DIFFERENTIALS

To initiate appropriate therapy and prevent complications, it's imperative to differentiate CLARE from conditions such as microbial keratitis, infiltrative keratitis and contact lens peripheral ulcers (CLPUs).

Microbial keratitis. This rare but potentially serious and sight-threatening complication of contact lens wear typically results from bacterial pathogens but can also be caused by amoeba and fungi.[9,16] Trauma and epithelial defects predispose the cornea to infection; depending on the pathogen, patients will present with increasing levels of pain, redness, inflammation and photophobia.[8,9,16,17]

Patients often have decreased vision, particularly if microbial keratitis is within the visual axis; however, the condition is not limited to a specific region. Unlike CLPUs, infiltrative keratitis and CLARE, patients with microbial keratitis will typically have a more significant epithelial defect that stains with sodium fluorescein and overlies a dense white stromal infiltrate. Corneal thinning, stromal edema, Descemet's folds, an intense anterior chamber reaction and mucopurulent discharge are also associated signs. If untreated, corneal perforation may occur, depending on the causative pathogen.

Infiltrative keratitis. This is an inflammatory reaction that occurs over a period of days vs. CLARE's acute onset. Symptoms include mild to moderate irritation, redness and occasional discharge. Anterior stromal infiltrates will be present in the midperipheral to peripheral cornea that may or may not stain with fluorescein. Infiltrative keratitis is associated with bioburden on the eyelids from *Staphylococcus aureus*, contact lenses, contact lens cases and extended contact lens wear.[8] Management of infiltrative keratitis includes discontinuation of contact lens wear, lid hygiene, artificial tears, topical steroids or a topical steroid/antibiotic combination. Once the condition has completely resolved, the patient may be refit into a different contact lens modality with decreased wear.[8]

CLPUs. This is also an inflammatory response and has been called a "sterile ulcer." Patients may be asymptomatic or have symptoms of moderate to severe irritation or pain. Slit lamp exam will show a small, circular, well-defined focal infiltrate usually <2mm in size in the peripheral cornea at the depth of the anterior stroma with Bowman's remains intact. With a CLPU, there will be fluorescein staining if an epithelial defect overlys the infiltrate. There may also be an anterior chamber reaction associated with the infiltrate.[17]

CLPUs are linked with gram-positive bacteria (*Staphylococcus*) and extended contact lens wear.[8] It is critical to differentiate a CLPU from an infectious etiology before initiating therapy. Treatment is targeted at eradicating the underlying pathogen, decreasing inflammation and healing the tissue.[16,17] During treatment, lens wear should be discontinued. Eye care practitioners may prescribe a topical prophylactic or fortified anti-

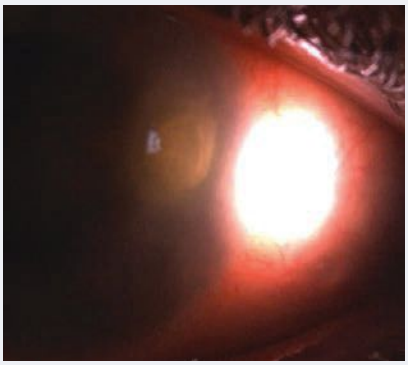
biotic, topical steroid or steroid/antibiotic combination. These patients require close observation and daily follow-up. Once the condition has resolved, the patient's contact lens modality should be changed, usually to one of less frequent wear and with increased oxygen transmissibility.[8]

STEPWISE MANAGEMENT

Once it has been determined that a patient has CLARE, a stepwise plan can—and should—be initiated.

Discontinue contact lens wear. Management begins with this step to remove the trigger for inflammation. Patients must be educated to not wear their lenses until their signs and symptoms have completely resolved. This may take several weeks depending on the number and severity of the infiltrates. Some may resist, particularly if they do not have a backup pair of spectacles or have high refractive error. Educating the patient on the etiology, possibility of recurrence and importance of treatment compliance and follow-up is important, especially if resuming contact lens wear is the goal.

Supportive care. Many patients may not need further management beyond discontinuation of contact lenses and supportive care with artificial tears, as the inflammatory condition is typically self-limited.[8,10]



This large epithelial defect overlies a dense stromal infiltrate in microbial keratitis. The patient presented with significant pain, mucopurulent discharge and reduced vision.

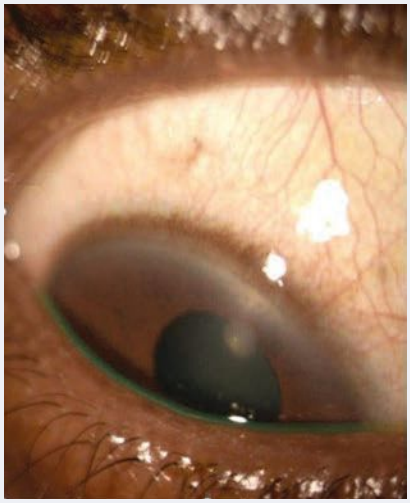
Therapeutics. The amount of corneal staining overlying the infiltrates and the level of patient discomfort can help determine if—and when—therapeutics are needed. Instillation of sodium fluorescein is beneficial to determine the size of the epithelial defect over each infiltrate. For patients who have increased corneal staining, a differential of microbial keratitis needs to be ruled out. If corneal staining is present, a broad-spectrum topical antibiotic should be deployed for 24 to 48 hours to minimize risk of infection. Some practitioners prefer a steroid/antibiotic combination to concurrently treat the inflammatory reaction.

Initially, patients are followed every 24 hours until corneal staining completely resolves, then a topical steroid or antibiotic/steroid combination can be prescribed to help decrease inflammation. These are often prescribed four times daily and tapered as the inflammatory reaction shows signs of improvement.[8,10]

More symptomatic patients can be prescribed a topical cycloplegic and/or a topical or oral NSAID to improve comfort. If an anterior chamber reaction is present along with the infiltrates, a topical steroid may be considered to decrease inflammation and improve comfort.

Return to contact lens wear. Once the inflammatory reaction has completely resolved, it may be determined that a patient can resume lens wear. It's critical to educate the patient that under no circumstance should they wear lenses on an extended wear basis, and if they do so, it will increase the risk of recurrence. There are several options to manage the contact lens patient as they return to wear, and it is important to remember that there is no "one-size-fits-all" approach that will work for every patient.

Refitting a patient from extended wear to daily wear is usually the first step and, if possible, a daily disposable should be the modality of choice. If this may not be possible, increasing the frequency of lens replacement, reducing wear time throughout the day, increasing oxygen transmissibility and changing the to a hydrogen peroxide-based system are all beneficial options.



This patient was diagnosed with a CLPU with minimal corneal staining overlying the infiltrate.

It is also important to evaluate the lens fit and make sure that there is acceptable movement, particularly if the previous fit was too tight or unacceptable. For many patients, changing the lens fit, modality, material and/or replacement schedule will help prevent recurrence of CLARE. For others, it may not, as some patients continue to sleep in their contact lenses and have recurrent episodes. For noncompliant patients, complete cessation of lens wear may need to take place.[8,17]

CLARE is not a difficult condition to manage, but it can take time to educate patients on the importance of compliance with lens wear cessation to minimize risk of recurrence. A detailed case history and careful examination to measure the size of the epithelial defect over the underlying infiltrate to rule out

infiltrative keratitis, CLPUs and microbial keratitis are important in determining the appropriate management. With a clear understanding of the condition and the potential differentials, optometrists can effectively manage these patients. RCCL

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1. Which of the following is NOT a differential for CLARE?
a. Blepharitis.
b. Infiltrative keratitis.
c. CLPU
d. Microbial keratitis.

2. Which is NOT a function of the cornea?
a. Protection.
b. Support.
c. Ocular immunity.
d. Refraction.

3. Which nerve innervates the cornea?
a. CN III.
b. CN IV.
c. CN V.
d. CN VI.

4. Which houses the stem cells and limbal blood supply to aid in the metabolic demands of epithelial cell renewal and aqueous drainage?
a. Corneal epithelium.
b. Corneal stroma.
c. Bulbar conjunctiva.
d. Limbus.

5. Which ocular structure consists of a thin tissue made of epithelial and goblet cells that assists with protection and lubrication?
a. Cornea.
b. Conjunctiva.
c. Sclera.
d. Lens.

6. Where does the bulbar conjunctiva receive its blood supply?
a. Anterior ciliary arteries.
b. Posterior ciliary arteries.
c. External carotid artery.
d. Central retinal artery.

7. Which is NOT a classic sign of corneal hypoxia?
a. Neovascularization.
b. Infiltrates.
c. Microcysts.
d. Punctate epithelial erosions.

8. Which is the most appropriate definition of CLARE?
a. Hypoxia coupled with gram-negative bacteria on contact lens surfaces that stimulate an inflammatory event of the cornea and conjunctiva secondary to the release of bacterial endotoxins.
b. Hypoxia coupled with gram-positive bacteria on contact lens surfaces that stimulate an inflammatory event of the cornea and conjunctiva secondary to the release of bacterial endotoxins.
c. Hypoxia coupled with gram-negative bacteria on contact lens surfaces that stimulate an infectious event of the cornea and conjunctiva secondary to the release of bacterial endotoxins.
d. Hypoxia coupled with gram-positive bacteria on contact lens surfaces that stimulate an infectious event of the cornea and conjunctiva secondary to the release of bacterial endotoxins.

9. Which is NOT a risk factor for the development of CLARE?
a. Extended contact lens wear.
b. Contact lens replacement noncompliance.
c. Loose-fitting contact lenses.
d. Improper contact lens solution use.

10. All are symptoms of CLARE except:
a. Acute pain.
b. Redness.
c. Photophobia.
d. Itching.

11. Which condition has been associated with CLARE?
a. Upper respiratory infection.
b. Diabetes.
c. Hypertension.
d. Thyroid disease.

12. Which condition has a large epithelial defect that stains with sodium fluorescein and overlies the infiltrate?
a. CLARE.
b. Infiltrative leratitis.
c. CLPU.
d. Microbial keratitis.

13. In which location of the cornea are infiltrates most commonly found in patients with CLARE?
a. Central.
b. Midperiphery.
c. Periphery.
d. Both b and c.

14. A patient presents with an acute red eye. You suspect that they may have a mild case of CLARE. Which additional clinical signs do you expect to see?
a. Little to no corneal staining overlying the infiltrates.
b. Significant corneal staining overlying the infiltrates.
c. Hypopyon.
d. Corneal thinning.

15. A patient presents with a small, circular, well-defined focal infiltrate less than 2.00mm in size in the peripheral cornea at the depth of the anterior stroma. The infiltrate shows mild sodium fluorescein staining. You suspect gram-positive bacteria as the underlying etiology. Which is your top differential?
a. CLARE.
b. Infiltrative keratitis.
c. CLPU.
d. Microbial keratitis.

16. This condition is rare but potentially sight-threatening. Patients typically have an epithelial defect that stains with sodium fluorescein and overlies a dense white stromal infiltrate. Corneal thinning, stromal edema, Descemet's folds, an intense anterior chamber reaction and mucopurulent discharge are also associated signs. Which is this condition?
a. CLARE.
b. Infiltrative keratitis.
c. CLPU.
d. Microbial keratitis.

17. Which is the first step in managing a patient with CLARE?
a. Discontinue contact lens wear.
b. Initiate a topical antibiotic.
c. Initiate a topical antibiotic/steroid combination.
d. Initiate an oral NSAID.

18. Patients who are more symptomatic with CLARE may need additional therapeutic support. Which may help reduce their symptoms?
a. Topical NSAID.
b. Oral NSAID.
c. Topical cycloplegic.
d. All of the above.

19. If corneal staining is observed over the corneal infiltrate in a patient with CLARE, when should their initial follow-up examination be scheduled?
a. One week.
b. Two weeks.
c. 24 to 48 hours.
d. One month.

20. Your patient's CLARE has completely resolved. Which may help reduce CLARE recurrence when resuming contact lens wear?
a. Refit from extended wear to daily wear contact lenses.
b. Reduce lens wear time.
c. Increase oxygen transmissibility.
d. All of the above.

Examination Answer Sheet

Managing Contact Lens-associated Red Eye

Valid for credit through December 15, 2024

Online: You can take this exam online at www.revieweducationgroup.com. Upon passing the exam, you can view the results immediately and download a real-time CE certificate. You can view your test history any time on the website.

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Answers to CE exam:

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2. Ⓐ Ⓑ Ⓒ Ⓓ
3. Ⓐ Ⓑ Ⓒ Ⓓ
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19. Ⓐ Ⓑ Ⓒ Ⓓ
20. Ⓐ Ⓑ Ⓒ Ⓓ

Post-activity evaluation questions:

Rate how well the activity supported your achievement of these learning objectives:
1=Poor, 2=Fair, 3=Neutral, 4=Good, 5=Excellent

21. Identify the signs and symptoms of contact lens-associated red eye. ① ② ③ ④ ⑤
22. Educate patients on contact lens-associated red eye. ① ② ③ ④ ⑤
23. Understand the available therapeutics for this condition. ① ② ③ ④ ⑤
24. Effectively treat contact lens-associated red eye. ① ② ③ ④ ⑤
25. Minimize the risk of recurrence. ① ② ③ ④ ⑤

26. Based upon your participation in this activity, do you intend to change your practice behavior? (choose only one)

Ⓐ I do plan to implement changes in my practice based on the information presented.

Ⓑ My current practice has been reinforced by the information presented.

Ⓒ I need more information before I will change my practice.

27. Thinking about how your participation in this activity will influence your patient care, how many of your patients are likely to benefit? (please use a number): ☐

28. If you plan to change your practice behavior, what type of changes do you plan to implement? (check all that apply)

ⓐ Apply latest guidelines ⓑ Change in pharmaceutical therapy ⓒ Choice of treatment/management approach
ⓓ Change in current practice for referral ⓔ Change in non-pharmaceutical therapy ⓕ Change in differential diagnosis
ⓖ Change in diagnostic testing ⓗ Other, please specify: _____

29. How confident are you that you will be able to make your intended changes?

ⓐ Very confident ⓑ Somewhat confident ⓒ Unsure ⓓ Not confident

30. Which of the following do you anticipate will be the primary barrier to implementing these changes?

ⓐ Formulary restrictions
ⓑ Time constraints
ⓒ System constraints
ⓓ Insurance/financial issues
ⓔ Lack of interprofessional team support
ⓕ Treatment related adverse events
ⓖ Patient adherence/compliance
ⓗ Other, please specify: _____

31. Additional comments on this course: _____

Please retain a copy for your records. Please print clearly.

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Rate the quality of the material provided:
1=Strongly disagree, 2=Somewhat disagree, 3=Neutral, 4=Somewhat agree, 5=Strongly agree

32. The content was evidence-based.
① ② ③ ④ ⑤

33. The content was balanced and free of bias.
① ② ③ ④ ⑤

34. The presentation was clear and effective.
① ② ③ ④ ⑤

By submitting this answer sheet, I certify that I have read the lesson in its entirety and completed the self-assessment exam personally based on the material presented. I have not obtained the answers to this exam by any fraudulent or improper means.

Signature _____ Date _____

Lesson 122191, RO-RCCL-1221

Finding Resolution

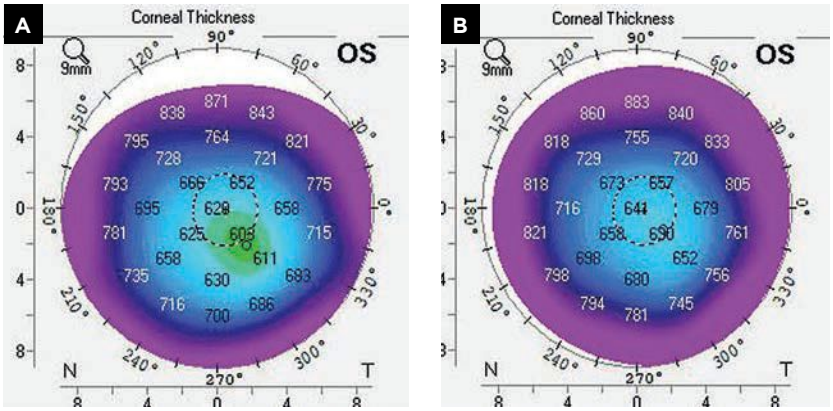
Know the risks, signs and methods you need to manage corneal allograft rejections.

A 65-year-old man presented for a scheduled six-month post-op follow-up of Descemet's stripping automated endothelial keratoplasty (DSAEK) OS. He was last seen three months prior, at which point the transplant was healthy and his vision was recovering nicely. Prednisolone acetate 1% had been tapered from QID to TID and he was asked to return in another three months. At that time, he reported good vision and comfort and had not noted any redness or irritation.

Vision was down from the 20/25 via autorefraction measured at his previous visit to 20/40 with no improvement on pinhole. IOP was 19mm Hg, and slit lamp OS showed normal lids and a white eye. His cornea had trace diffuse stromal edema and a well-centered DSAEK graft with 3+ diffuse keratic precipitates (KPs) scattered on the graft endothelium. The anterior chamber had trace cell, and deeper structures were unremarkable.

A diagnosis of corneal allograft rejection following DSAEK was made and we increased prednisolone to hourly. He was not followed up as closely as we prefer because he didn't live nearby—he traveled three hours to be seen—and instead was asked back in seven days. However, he was instructed to call sooner if he noticed deterioration of vision, worsening of comfort or increasing redness.

At follow-up, vision was 20/30, IOP was stable (18mm Hg) and the rejection episode was resolving, with reducing KP. He was asked to taper his steroid to Q2h for two weeks and return for evaluation. At this follow-up, the episode appeared to have resolved, with 20/20 vision on autorefraction and full resolution of KP and edema. The patient was asked to reduce his steroid to QID; however, he was instructed that we would not be reducing steroids further for up to a year.



(A) Pachymetric map at rejection. (B) Pachymetric map at resolution. Comparison of the two shows resolution of mild edema.

REASONS FOR REJECTION

Rejection of an allograft is possible in any donor-derived transplanted tissue containing cells; it indicates the host immune system has become sensitized to the donor tissue. This leads to a CD-4+ driven immune infiltration to the graft, where the donor nucleated cells are targeted. Though corneal transplants are at lower risk for rejection compared with most tissue or organ transplants owing to both passively and actively regulated immune privilege, rejection can occur.[1]

In intense episodes or those treated late in the process, rejection can precipitate failure of the graft. In most cases, rejection-induced failure results from direct attack and collapse of the donor endothelium, though resultant vascularization and scarring can also occasionally cause failure.

Of all types of corneal transplants, penetrating keratoplasties (PKs) are most likely to both reject (20% incidence) and fail as a result of rejection, as rejection is the leading cause of premature graft failure of a PK.[2] Though a deep anterior lamellar keratoplasty (DALK) transplant looks identical to a PK, the lack of donor endothelium makes rejection-based failure exceedingly rare.[3]

Finally, the risk of rejection and failure of the endothelial transplants DSAEK and Descemet's membrane endothelial keratoplasty (DMEK) falls somewhere between the two extremes of PK and DALK.[4,5] Despite the presence of donor endothelium in the DSAEK and DMEK, these grafts both have lower rates of rejection, as well as lower rates of rejection-induced failure compared with PK as they erode immune privilege of the cornea less than PK. Of the two, DSAEK is more likely to reject.[5] In cases of rejection of donor endothelium, the clinical appearances are KPs—generally in a diffuse pattern—but occasionally may take on a linear conformation and/or corneal edema overlying the zones of KP.

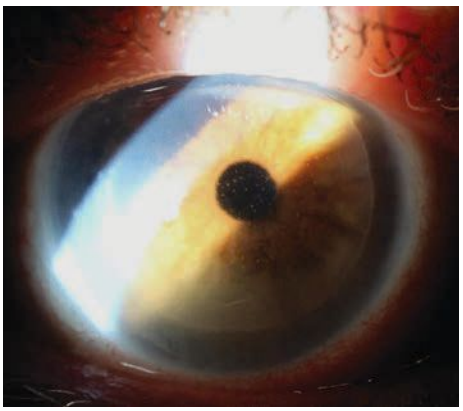

AN OUNCE OF PREVENTION

The primary treatment of corneal graft rejection is prevention. Following a corneal transplant, patients are placed on a corticosteroid in order to suppress the local immune presence. Studies have found that corneal allograft rejection is most likely to occur in the first several months following transplant, with reduced odds the further one moves beyond the early time period.

This trend of rejection over time has to do with an interesting process called immune tolerance, where the body's immune system is aware of the foreign tissue—but doesn't attack it. Immune tolerance of foreign antigen is possible across various locations of the body but is among the most naturally achievable with corneal grafts, which benefit from the pro-tolerance/immune-privileged status of the cornea.[6,7] Immune privilege status of the cornea can most easily be appreciated by recognizing that corneal transplants had been successfully performed many decades prior to the advent of immune modulation with topical glucocorticoids.

Immune privilege is derived from several different features of the tissue, but of particular interest is one called anterior chamber–associated immune deviation (ACAID). Though the full mechanism of ACAID is well beyond the scope of this column, it is a fascinating feedback cycle, whereby foreign antigens discovered through the anterior chamber and result in a population of T-cells that not only do not attack the antigen/graft, but also actively suppress immune response against it.[7,8] As previously stated, rejection of a corneal transplant is most likely to occur over the first few months postoperatively. This can be partially explained by a delay in the development of the ACAID, which takes time to establish.

Following uneventful surgery and early recovery with posterior lamellar transplants, topical steroid is tapered over a period of 12 to 24 months, depending on surgery center preference. In cases of graft rejection, where both immune tolerance and prevention dosing with steroid fail, increased immune suppression is needed. This is typically achieved with increased dosing of topical corticosteroids, though an oral corticosteroid or compounded topical cyclosporin A or tacrolimus may also be used.



Corneal rejection of DSAEK graft. KP is the diagnostic sign here.

Dosing should be initially high—every hour or more—with a gradual taper.[9,10] The final level of that taper will vary from case to case. I (Dr. Bronner) always use the benchmark of steroid dose at the time of rejection and plan on staying above that level for at least a year, depending on other variables, including the patient's response to steroids. Ocular surface disease, herpetic infection and lid margin health all play a role as well.

In this case, the patient's modest endothelial rejection of his DSAEK graft was able to be treated successfully with an increased corticosteroid. Following taper of the original rejection treatment, he was maintained on elevated dosing (relative to what he was on prior to rejection) for 12 months prior to reducing the medication further with three-month follow-up intervals over that time period. Today, two years after the rejection episode, the patient continues to be gradually weaned off the steroid and is maintaining at QD dosing. RCCL

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By Christine W. Sindt, OD

Uncomfortably Numb

Neurotrophic keratopathy complicates an already-difficult case, with stromal melt possible.

A 72-year-old male presented with a history of excision of squamous cell carcinoma of the right upper lid one month prior. His post--op course has been complicated by wound dehiscence and subsequent exposure keratopathy. On exam, he had >80% of the upper lid missing along with brow ptosis with trichiasis, dermatochalasis and a >60% lagophthalmos. The conjunctiva had 4+ injection with mucous discharge. The cornea had a large central/superior epithelial defect with rolled edges and stromal thinning. No infiltrate was present, but there was a 3.5mm hypopyon.

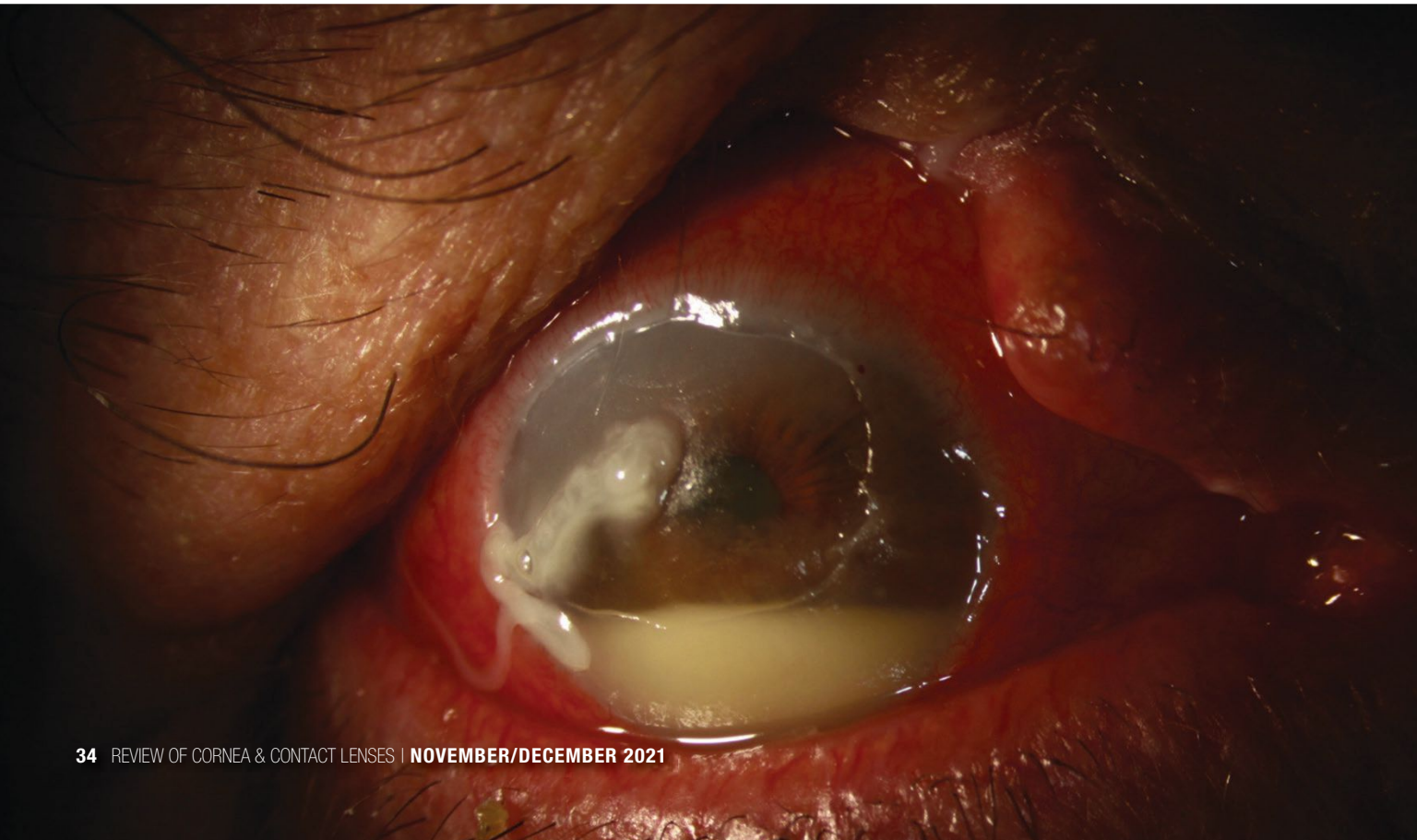
His history and exam are concerning for a sterile corneal melt in the setting of exposure keratopathy and possible HSV keratouveitis. An amniotic membrane was placed and fortified vancomycin and fortified tobramycin were started Q2h, along with artificial tear ointment. He was instructed to start doxycycline 100mg BID, vitamin C 1000mg BID and valacyclovir 1,000mg TID.

Exposure of the ocular surface has led to corneal anesthesia, known as neurotrophic keratopathy (NK). Loss of corneal sensation leads to progressive morphological and metabolic epithelial abnormalities and the development of epithelial defects and ulcers. When the underlying stroma is exposed, melting and progression to corneal perforation is possible.

NK is classified into three stages—(1) corneal epithelial changes, (2) persistent epithelial defects and (3) corneal ulceration with stromal involvement—and this staging guides treatment goals. *Stage 1:* prevent epithelial breakdown. *Stage 2:* prevent infection and mechanical epithelial disruption. *Stage 3:* intervene surgically to protect against perforation.

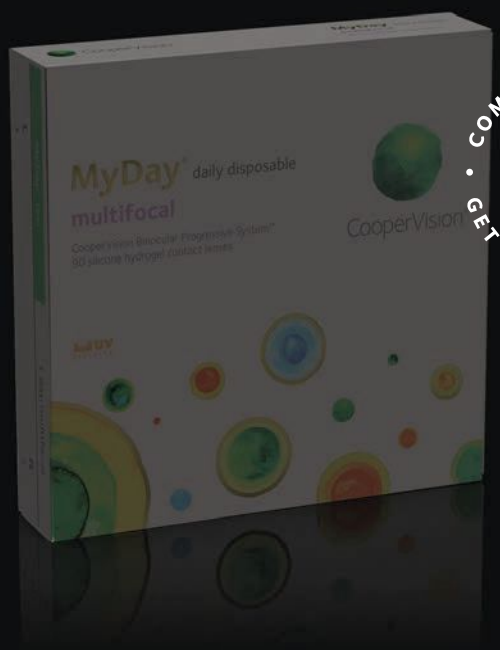
The hypopyon in this case is a collection of cells (leukocytes, erythrocytes and macrophages), fibrin and proteins and reflects the severe inflammatory status of this patient. The herpes virus should always be considered as a confounding factor in cases of NK and severe ocular inflammation. NK should always be considered in cases where signs outweigh patient symptoms.

This case is complicated by the patient's relative lack of compliance and heavy smoking habit. The very high risk of permanent vision loss or loss of the eye was emphasized to this patient. While lid reconstruction is the ultimate goal, ocular surface protection with a scleral lens is the first long-term treatment plan. RCCL



Presbyopia VS. You

Presbyopia is the ultimate opponent in the exam lane—and the newest multifocal contact lens is about to change the game.



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