JANUARY/FEBRUARY 2020

RCCL®

REVIEW OF CORNEA & CONTACT LENSES

CONTACT LENS FITTING FOR COMPROMISED CORNEAS

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sphere power	cylinder	axes
plano to -6.00D (0.25D steps)	-0.75, -1.25, -1.75	10°, 20°, **30°, 40°, 50°**, 60°, 70°, 80°, 90°, 100°, 110°, 120°, **130°, 140°, 150°**, 160°, 170°, 180°
	-2.25	10°, 20°, **70°, 80°**, 90°, **100°, 110°**, 160°, 170°, 180°
-6.50D to -9.00D (0.50D steps)	-0.75, -1.25, -1.75	10°, 20°, 60°, 70°, 80°, 90°, 100°, 110°, 120°, 160°, 170°, 180°
	-2.25	10°, 20°, 90°, 160°, 170°, 180°
+0.25D to +4.00D (0.25D steps)	-0.75, -1.25, -1.75	**10°**, 20°, 70°, **80°**, 90°, **100°**, 110°, 160°, **170°**, 180°

axes in purple indicate prescriptions now available. **axes in teal indicate prescriptions available in Spring 2020.**

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1. *2019 CooperVision study; data on file. Based on the number of published prescription options available across all soft lenses from Alcon, Johnson & Johnson, and Bausch & Lomb; UK and US; April 2019. Prescription includes sphere, cylinder, axis & ADD combinations.*
2. *Around-the-clock axes in 10° from plano to -6.00DS in -0.75DC, 1.25DC, and -1.75DC.*

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JANUARY/FEBRUARY 2020

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CONTACT LENS FITTING FOR COMPROMISED CORNEAS

Managing Irregular Corneas with Soft Lenses

Clinical observations will aid in choosing a lens design that offers the appropriate features for patients. *Page 12*

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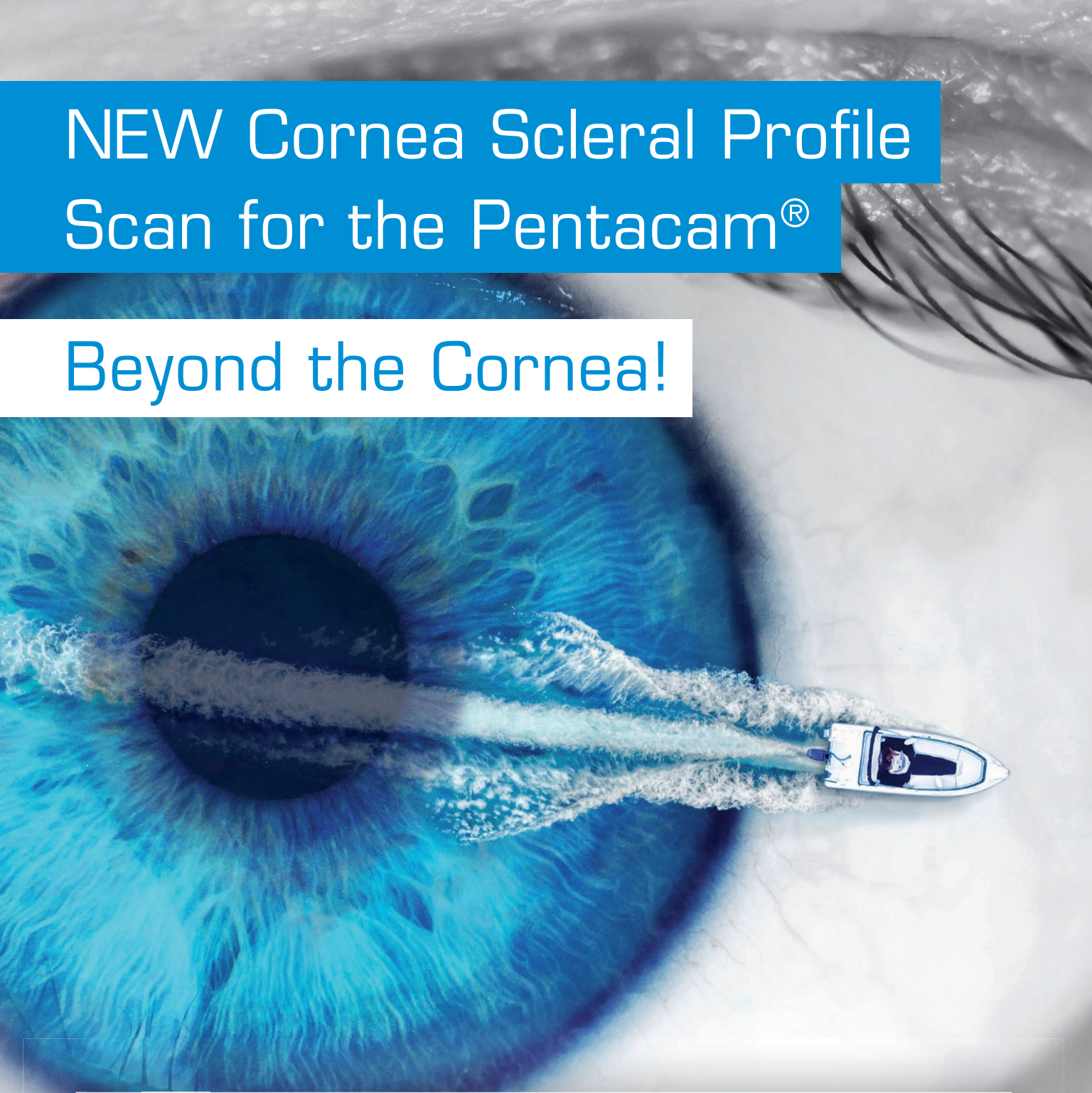

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IN BRIEF

■ Researchers recently observed dysbiosis in the lid microbiome of symptomatic contact lens wearers, and they found **lid margin exfoliation reduced the number, frequency of isolation and ratio of gram-positive rods and cocci**. They added that the number of bacteria, the ratio of rods to cocci and lipase activity correlated with lash contamination and anterior blepharitis, while bacterial lipase correlated with meibomian gland secretions and tear evaporation rates. Lid treatment converted 10 symptomatic contact lens wearers to asymptomatic lens wearers.

Siddireddy JS, Vijay AK, Tan J, et al. Effect of eyelid treatments on bacterial load and lipase activity in relation to contact lens discomfort. Eye Cont Lens. November 29, 2019. [Epub ahead of print].

■ In a new study published in *Contact Lens & Anterior Eye*, researchers showed that **multifocal contact lenses can increase light distortion effects under low-light conditions**. The investigators looked at 14 eyes of seven contact lens patients and used a light disturbance analyzer device to characterize the light. In addition, the study found **the size and shape of the pupil correlates with the size and shape of the distortion**. The elliptical pupil produced the largest discrepancy in the distortion size between the vertical and horizontal directions. The team didn't note any difference between the center-distance and center-near designs.

Monsalvez-Romin D, Gonzazlez-Meijome J, Esteve-Taboada J, et al. Light distortion of soft multifocal contact lenses with different pupil size and shape. Cont Lens Anterior Eye. December 4, 2019. [Epub ahead of print].

■ Cornea experts from Spain created a simple network classifier system they say can detect keratoconus with significant accuracy, and it can be easily used with any placido-based topographic system. Their study detailed a new Bayes classification **model for keratoconus detection** that used primary placido-based corneal indices noted in the literature and computed directly from the image of the discs reflected on the cornea. Researchers said the Bayes classifier showed perfect discrimination ability among normal and keratoconic corneas, with **100% of sensitivity and specificity, even in the presence of significant noise or incomplete data**.

Tanaka TS, Hood CT, Kriegel MF, et al. Long-term outcomes of penetrating keratoplasty for corneal complications of herpes zoster ophthalmicus. Br J Ophthalmol. February 7, 2019. [Epub ahead of print].

Vitamin D's Role Examined

Deficiencies in vitamin D have been tied to many conditions, including autoimmune diseases, lymphoma and various forms of neuropathy. Two studies assessed how low levels of the vitamin increased the risk of certain conditions. The first analyzed the link between low levels and dry eye severity in those with Sjögren's syndrome.[1] The second looked at neonatal levels possibly signaling myopia as adults.[2]

DRY EYE SEVERITY

While the relationship between low levels of serum vitamin D and Sjögren's syndrome have shown contrasting results in previous investigations, Korean researchers reported that vitamin D levels may be associated with dry eye severity in Sjögren's syndrome.

The study enrolled 74 eyes of 74 patients diagnosed with primary Sjögren's syndrome. The more severe eye was used for analysis. Only women were included, and the average age was 53. The study divided the patients into three groups: vitamin D deficiency (48 patients), vitamin D insufficiency (14 subjects) and a healthy, control group (12 patients).

The average vitamin D level was 20.4±8.0ng/mL. The study noted a strong negative correlation between serum vitamin D levels and corneal and conjunctival staining scores. Additionally, the Schirmer I value and tear break-up time showed a significant positive link with vitamin D levels.

The researchers found vitamin D levels didn't seem to have an impact on OSDI scores.

Additional studies may also be warranted that expand dry eye parameters and look at associations with other ocular inflammatory diseases, such as graft-vs.-host disease-induced dry eye.[1]

SHADE FROM UV DAMAGE

With myopia on the rise worldwide, researchers continue to search for modifiable risk factors. A recent study shows neonatal vitamin D levels aren't one of them, as they don't appear to play a role in the later development of the condition.

The case-controlled investigation compared dried blood taken shortly after birth from both myopic and healthy male newborns.

Since the time of year a person is born has been associated with later myopia risk—and neonatal vitamin D status is highly dependent on season of birth due to maternal sun exposure late in gestation—a team of researchers looked into whether prenatal exposure to low levels of vitamin D could factor into visual development and adult visual dysfunction.

The investigators analyzed neonatal vitamin D3 levels of 457 myopic and 1,280 healthy males from the Danish Conscript Registry. After adjusting for maternal age, maternal ethnicity, maternal and paternal education and season of birth, the researchers found seasonal variation of birth didn't affect myopia risk, and low neonatal vitamin D3 levels also didn't appear to increase the chance of developing the condition.[2]

1. Lee JH, Kim SJ, Byun YS, et al. The association of serum vitamin D level with the severity of dry eye parameters in primary Sjögren syndrome. Cornea. December 20, 2019. [Epub ahead of print].

2. Specht IO, Jacobsen N, Frederiksen P, Heitmann BL. Neonatal vitamin D status and myopia in young adult men. Acta Ophthalmologica. January 13, 2020. [Epub ahead of print].

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OCT-A Measures Corneal NV Depth

Clinicians have several tools available to diagnose corneal neovascularization (CNV), but they all have their shortcomings. Traditional methods such as slit lamp biomicroscopy, color photography and videography, can result in imprecise imaging that lacks quantification, and even more precise tools such as fluorescein and indocyanine green angiography are invasive and can be time sensitive. A research team from the United States and Germany suggests another option: optical coherence tomography angiography (OCT-A) as an effective and noninvasive approach in detecting CNV.

Their study included 12 eyes of 12 patients with corneal NV who were tested with both an 840nm spectral domain OCT-A and a 1,050nm swept-source OCT-A. Of the 12 cases, five patients had interstitial keratitis, two had limbal stem cell deficiency, three had corneal transplant rejection and one patient had pterygium or neurotrophic ulcers.

The researchers then compared the OCT-A results with clinical slit-lamp estimations of CNV depth.The researchers found OCT-A was able to map CNV in 3D and measure vessel depth and density. The investigators also noted the depth of corneal NV varied between different pathologies in a manner consistent with previous studies.

When looking at severity levels, the researchers found four patients had superficial CNV, four had midstromal NV and four others had deep NV. The superficial, midstromal and deep NV cases had average vessel depths of 23%, 39% and 66% on 1,050nm OCT-A, respectively.

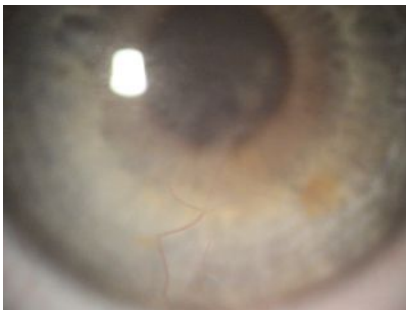

Photo: Mitch Ibach, OD

Volumetric OCT-A can evaluate corneal neovascularization in 3D.

Additionally, eight cases showed excellent agreement in the mean vessel depth between the two systems. However, the average vessel density measured by the 840nm OCT-A was about 1.6 times higher than that of the 1050nm OCT-A.

The investigators also noted the measured vessel density appeared to be affected by the interscan time, which impacted blood flow velocity sensitivity and wavelength and, thus, the ability to penetrate through opacity.

"This study represents the first application of corneal OCT-A to quantify the depth of CNV. The results demonstrate that OCT-A is capable of differentiating vessel depth in CNV and can provide an estimated average vessel depth, which corresponded well with the clinical examination," the researchers wrote in their paper. RCCL

Nanji A, Redd T, Chamberlain W, et al. Application of corneal optical coherence tomography angiography for assessment of vessel depth in corneal neovascularization. Cornea. December 20, 2019. [Epub ahead of print].

By Joseph P. Shovlin, OD

Our Ongoing Mission

Important concerns remain for contact lens–related corneal infections.

This past American Academy of Optometry meeting in Orlando held the inaugural "Think Tank" event. This year's topic, "Corneal Infections in Contact Lens Wear," was by all measures a tremendous success. The presenters posed provocative questions that need to be answered if we want to really understand sight-threatening infections in contact lens wearers.

As I listened to the presentations and discussions among the fabulous group of research scientists, clinicians and academics, I jotted down unanswered questions—*37 to be exact*. I'd like to share just two of those vexing concerns here:

(1) Why hasn't the overall rate of infections in lens wearers changed in the past two decades despite astonishing advances in both material and design technology and care products, along with campaigns to improve compliance and hygiene?

(2) Are daily disposable lenses really safer to wear than other lens types?

INFECTION RATE

Surprising, the overall rate of corneal infection in lens wear has not improved over the past several decades.[1,2] This is somewhat tragic, and even a bit embarrassing, since there has been a good amount of research on material property development, lens design and solution efficacy as well as how to minimize the chances of acquiring an infection.

What should the next steps be to favorably reduce the rate of corneal infection in lens wearers? It is vital that we engage all stakeholders: manufacturers, practitioners and patients. It may appear that we've reached the limit of what we can do from a material, design and modality standpoint. But, have we reached the pinnacle of safety in lens technology? What has happened in antimicrobial surface technology to reduce microbial burden? Can genetic testing help us garner valuable information to predict who is most vulnerable to infection?

Continued initiatives to educate patients help assure good practices in compliance and hygiene. The Centers for Disease Control and Prevention's recent initiatives have been laudable, but the impact of the campaign is hard to determine.

DAILIES' SAFETY

Researchers have generated meaningful data on the risks and overall safety of daily disposable lenses and their rate of infection.[1,2] Their findings would suggest that the infection rate of daily disposables is no safer (one to two per 10,000) than other daily wear lenses replaced at less frequent intervals (i.e., two-week or monthly replacements) even when appropriate practices are followed.[1]

However, serious infections were found to be less common in daily disposable wearers since there were fewer environmental organisms found with cultures of known infections related to daily disposable lens wear (0.5 per 10,000 wearers per year).[1] Considering the organisms found in corneal infections in daily disposable lens wearers, the infections may be related to lens handling.[1,3]

Additional research initiatives are needed to answer many of the questions posed regarding contact lens safety including safety with daily disposable lens wear. New lens designs and material updates have occurred since the completion of previous studies on lens safety. Some daily disposable brands have even been significantly modified. New data is sorely needed to verify any concerns. Will the results mirror those generated in the past?

In no fashion does this brief summary on disposable lens wear safety suggest that daily disposable lenses are not the preferred modality for nearly all lens wearers. Their low rate of corneal infection and favorable, convenient use compared with other options make them ideal.

Future Think Tanks, either as a branded Academy series or discussions conducted by other groups, will prove to be rewarding. Experts in their particular field can examine a topic and formulate pertinent questions that will fundamentally eliminate, or at least minimize or change, that problem. The Think Tank can then serve as a driver for future, valuable research and help move our understanding of a particular problem. Just *35* more to go!

We look forward to the Academy's summary of the Think Tank proceedings that should be out soon. RCCL

1. Stapleton F, Naduilath T, Keay LJ, et al. Risk factors and causative organisms for microbial keratitis in daily disposable contact lens wear. PLoS One. 2017;12(8):e0181343.

2. Stapleton F, Carnt N. Contact lens-related microbial keratitis: how have epidemiology and genetics helped us with pathogenesis and prophylaxis. Eye. 2012;26(2):185-93.

3. Cope JR, Collier SA, Rao MM, et al. Contact lens wearer demographics and risk behaviors for contact lens-related eye infections—United States, 2014. MMWR Morb Mortal Wkly Rep. 2015;64(32):865-70.

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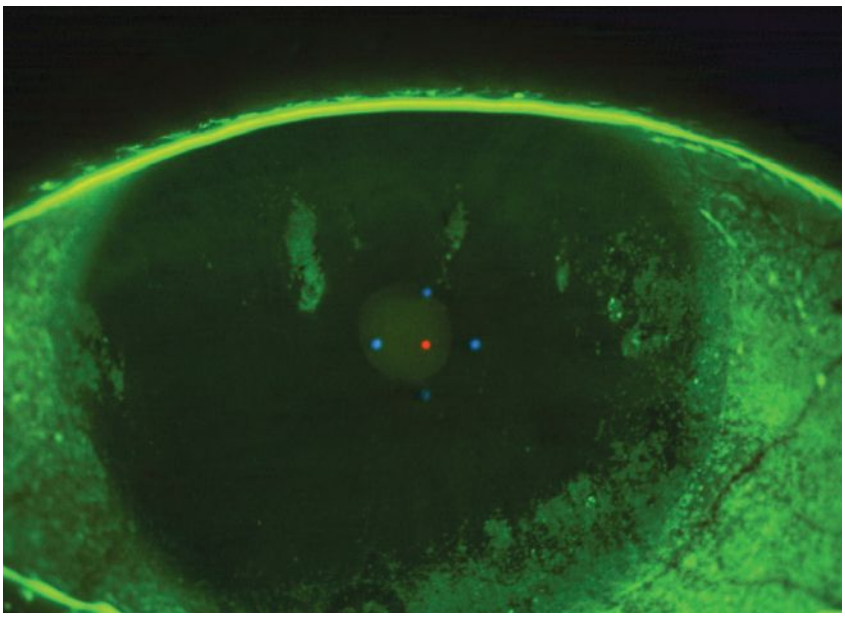
By Andrew Fischer, OD, Mile Brujic, OD, and David Kading, OD

Contact Lenses for the Compromised Cornea

This modality offers a solution for a handful of different ocular conditions.

In our profession, we have the opportunity to provide both an alternative to spectacle lens wear and a solution to compromised vision. As a result, we have seen the number of patients interested in contact lenses climb each year. Assuming a patient is a good candidate for contact lenses, we are able to provide a relatively straightforward fit thanks to the ever-expanding lens parameters available.

Although correcting ametropia is the main focus of most eye care providers and contact lens prescribers, it is important to think beyond vision correction for normal corneas and consider ways we can use contact lenses to improve vision and comfort for patients with corneal pathology.



Severe keratitis patients can benefit from daily disposables.

CONTACT LENSES BY CONDITION

Of course, there are numerous potential categories worthy of discussion, but we'll focus on a few of the most common.

Dry Eye. The treatment and management of dry eye disease has quickly become an important topic in eye care, not just for practitioners. Patients referred into our dry eye clinics are more informed now than ever about contact lens options for their dry eyes. While contact lenses do provide comfort for patients, they do not treat the disease process of dry eye.

In many severe cases, despite the best treatment protocol and patient compliance, it remains difficult to control corneal staining. Not only can this be incredibly uncomfortable for the patient, but it can also hamper their vision if the visual axis is involved. These patients' corneas need protection from the desiccating stress causing corneal staining. This is where soft, daily disposables (used as a bandage contact lens) and scleral contact lenses come into play. Sclerals have several advantages over bandage contact lenses and tend to be our preferred choice when considering contact lenses for dry eye.

Scleral contact lenses protect a larger surface area of the eye, as the diameter can cover up to 24mm, as opposed to a standard soft lens, which typically only covers a maximum of 15mm. Most scleral lenses are made with gas permeable materials that can be coated to minimize deposits and improve wettability—unavailable in soft contact lenses. Patients who have tried both often state that scleral lenses feel more comfortable and less dry throughout the day. Scleral lenses, however, cost more than soft lenses, since each lens is individually designed for optimal fit, and require more dexterity for insertion, as these lenses are larger and can't have bubbles upon insertion.

Though these lenses may help with patient symptoms, they generally do not treat the cause of the disease. For example, this modality does not allow the meibomian glands to regain function if compromised or actively decrease inflammatory dry eye. These problems should be addressed and treated prior to fitting contact lenses for dryness.

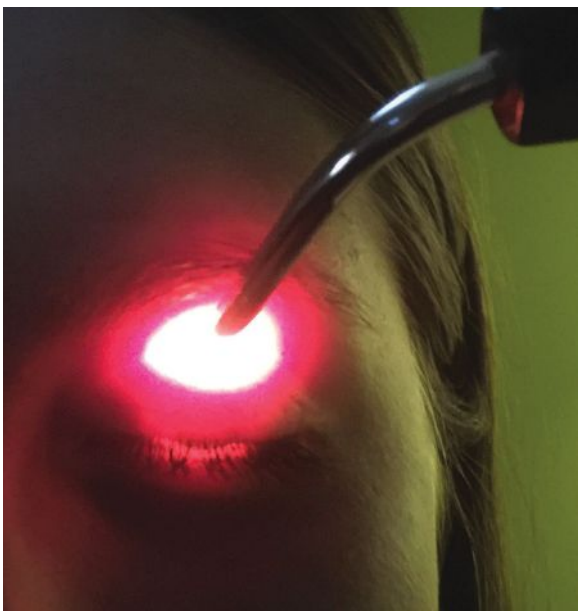
Exposure Keratopathy. We also find it useful to fit contact lenses

on patients with severe exposure keratopathy, such as that resulting from Bell's palsy, which involves the seventh cranial nerve. As the duration of Bell's palsy is generally short, with the patient typically fully recovering within three to six months, soft daily disposable lenses are usually the most reasonable choice.

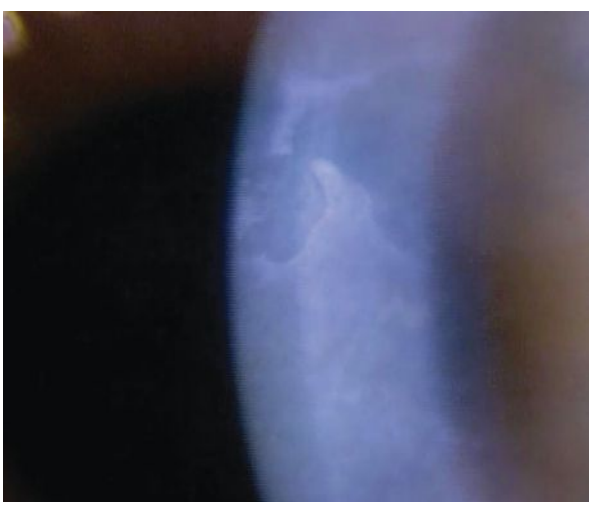
Anterior Basement Membrane Dystrophy (ABMD). When working with this corneal disease, it is common for the surface of the cornea to become irregular and fail to tightly adhere to the underlying stromal tissue. This can cause surface irregularity, which disrupts clear vision, necessitating contact lenses to maximize vision.

There are several contact lens options worth considering to alleviate visual complaints secondary to ABMD. For mild cases, soft lenses with a higher modulus, such as those made from silicone hydrogel materials, help normalize corneal surface irregularities. For moderate to severe ABMD, gas permeable lenses tend to provide better optics, as they negate most, if not all, of the subtle irregularities associated with the post-lens tear film.

Corneal Erosions. ABMD can cause these erosions, which may result in debilitating pain. Extended-wear contact lenses are best in these situations, as they accommodate continual wear for several weeks while the corneal erosion re-epithelizes and re-adheres to the underlying stroma. The main goal is to minimize discomfort. It is common for recurrent erosions to occur, and, in these cases, amniotic membranes can promote healing and hemidesmosome formation, which allows the regenerating corneal epithelium to anchor and stabilize.[1]



This patient is experiencing lagophthalmos.



There are several lens options for patients with ABMD.

When eye care providers think about contact lenses for compromised corneas, corneal ectasia, post-surgical cornea and corneal scar and opacity management are the first to come to mind. Our stories of patients who are finally able to see clearly after being fit with specialty contact lenses, and become emotional in our chairs, are what keep contact lens prescribers going. Our impact does not have to be life-changing; if we can improve a patient's ocular discomfort or visual clarity, then we have succeeded in providing optimal service and care. RCCL

Dr. Fischer completed his residency in cornea, specialty contact lenses and dry eye at Specialty Eye in Seattle in 2019. He practices at Professional Eyecare Associates in Huntingburg and Jasper, IN, and leads the Dry Eye and Specialty Contact Lens Clinic within the practice.

1. Resch MD, Schlötzer-Schrehardt U, Hofmann-Rummelt C, et al. Adhesion structures of amniotic membranes integrated into human corneas. Invest Ophthalmol Vis Sci. 2006;47(5):1853-61.

By Vivian P. Shibayama, OD, and Cory Collier, OD

Rosacea: A Double Whammy

Here's how scleral lens wear helped this patient.

Scleral lenses are a popular tool to manage the symptoms of patients with severe dry eye. This modality, however, only masks a patient's symptoms, so the root cause of dry eye must still be treated. In turn, optimizing the surface of the eye improves the likelihood of success with scleral lens wear. It's a win-win scenario.

THE CASE

A 78-year-old female with severe light sensitivity and blurred vision from ocular rosacea was referred for a scleral lens fitting. She wore glasses and was very hesitant to try contact lenses. Scleral lenses were a last-ditch effort to improve her severe symptoms.

The patient had been treated for ocular surface disease for many years. She had cataract surgery OU in 2015. Her ocular history was also positive for glaucoma, for which she was taking Combigan (brimonidine/timolol, Allergan) BID and latanoprost QD.

Her dry eye regimen for both eyes included lid cleansing with tea tree oil wash and hypochlorous acid spray twice daily, Retaine MGD preservative-free eye drops (Ocusoft) four to six times a day, warm compresses with a heat mask and omega-3 supplementation daily and Restasis (cyclosporine, Allergan) twice a day. She had just discontinued her course of doxycycline 50mg BID after six weeks because the drug upset her stomach and didn't improve her symptoms. She found symptom relief with Lotemax gel (loteprednol etabonate, Bausch + Lomb) but has not been using it because she responds to steroids and has glaucoma. She underwent LipiFlow (Johnson & Johnson Vision) a year ago, which provided minimal relief for a short period of time.

Visual acuities (VAs) were 20/40 OD and 20/30- OS, pinholed to 20/20 OU. Her pupils were round and reactive to light, with no relative afferent pupillary defects. Extraocular movements were full OU.

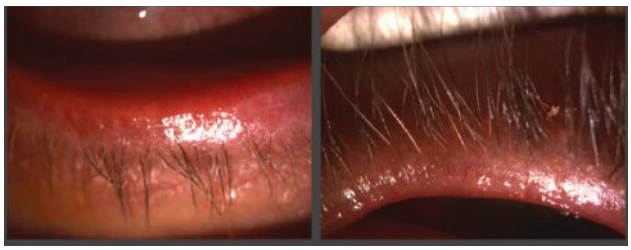


Fig. 1. The patient had significant telangiectasia and blepharitis.

The slit lamp exam revealed a thickened lid margin with telangiectasia OU, significant biofilm and debris on the lid margin along with cylindrical collarettes and 2+ diffuse punctate epithelial erosions OU as well as a deep and quiet anterior chamber OU (*Figure 1*). Posterior chamber intraocular lenses were noted in both eyes. Light pressure on the meibomian glands produced very little turbid expression. Non-contact tear break-up time was instant OD and three seconds OS. The patient's intraocular pressure was 11mm Hg OU. Her keratometry readings were 45.00/46.00@045 OD and 44.00/44.50@150 OS. Undilated posterior segment evaluation revealed thin neuroretinal rims of 0.7mm OD and 0.5mm OS with a clear macula.

DIAGNOSTIC FITTING

The patient found immediate relief from the burning sensation in her eyes with scleral lens wear. She was fit with SynergEyes VS scleral lenses OU with a base curve (BC)/vault of 8.4/3500 OU, a diameter of 16.0mm OU, powers of +1.75 OD and +3.25 OS and a haptic of 34/40 OU. Her VA was 20/20 OU with the diagnostic lens over-refraction. Hydra-PEG was added to the lenses to improve the lubricity of the front surface.

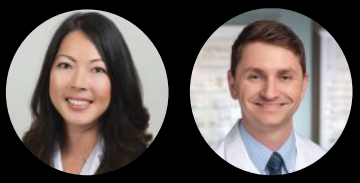
She was instructed to continue her regimen of tea tree oil wash, hypochlorous acid spray, warm compresses, omega-3 vitamins and Restasis. BlephEx treatment was performed in-office with tea tree oil on both eyes to address *Demodex*. The patient was referred for intense pulsed laser (IPL) treatment to manage surface inflammation and for dietary advice to formulate a low inflammatory plan while avoiding foods that could trigger her symptoms. She did not respond well to IPL, as the procedure was painful for her, her skin was sensitive for 24 hours and she started to bruise.

DISPENSING

The patient returned two weeks later. The fit was optimal, at 200µm of central clearance with limbal-to-limbal clearance. The haptic aligned with the conjunctiva with no blanching. Her VAs were 20/20 OD and 20/20 OS. She was trained to insert and remove her lenses and use Clear Care (hydrogen peroxide, Alcon) at night to minimize the preservatives to the ocular surface and non-preserved saline to fill.

FOLLOW-UP

The patient returned one week later. Her light sensitivity had improved, and the contact lenses provided immense relief. They became cloudy



after a few hours of wear, however, so she had to rinse them in the middle of the day to clear the debris. Other than that, she was able to wear her lenses for 14 to 16 hours per day with no issues.

Her VAs were 20/30+ OD and 20/25- OS. On slit lamp examination, both her lens chambers were filled with mucus and tear film debris. Fluorescein showed quick uptake at 12 o'clock and slightly inferior conjunctival chalasis under the lens, indicating excessive limbal clearance in both lenses. No over-refraction was noted after the lenses were rinsed and reinserted. Another set was ordered with a slightly tighter vertical meridian in both eyes.

The haptic lines indicating flat edge were at 3/9 o'clock in each eye. The 12/6 o'clock meridian was steepend. The BC of the lenses was also steepened to lower limbal clearance, and the power was adjusted as a result. She was refit with SynergEyes VS scleral lenses OU with a BC/vault of 8.0/3500 OU, a diameter of 16.0mm OU, powers of -0.25 OD and +1.25 OS and a haptic of 34/42 OU.

DISPENSING REDO

The patient returned five weeks later. She had an IPL session one week prior and responded much better to it, with less pain and residual side effects. Her tear film debris had improved, and her face was visibly less red. The lenses showed optimal haptic alignment and no superior seeping with fluorescein. The limbal clearance was 50µm to 75µm. Her VAs were unchanged at 20/20 OD and 20/20 OS.

SECOND FOLLOW-UP

The patient didn't return for another two months. This time, she had undergone four sessions of IPL and one session of LipiFlow in both eyes and had noticed a big difference in her overall ocular comfort even without contact lenses. Her lid margin was clearer and whiter (*Figure 2*). She preferred wearing the lenses but was able to go some weekends without them, which was not always the case. Her lenses were finalized.

Fig. 2. The patient eventually found success with IPL therapy.

DISCUSSION

Rosacea is a chronic inflammatory skin condition that primarily affects the face and periocular regions, with 58% to 72% of rosacea patients developing ophthalmic findings.[1] These patients typically have inflammatory dry eye with meibomian gland dysfunction (MGD) and *Demodex*-related blepharitis. MGD presents as abnormal turbid meibomian gland secretion, which causes blocking and/or atrophy of the glands and recurrent hordeolum. Typical slit-lamp examination of the eyelid margins shows telangiectasia and thickening of the lid margin in 50% to 94% of patients.[1]

The standard of care for these patients includes minimizing inflammation through medication use and treating the lid margin. Sometimes, this isn't enough. Left untreated, severe cases can lead to peripheral corneal ulceration, corneal scarring and neovascularization.[2]

Conservative treatment of mild ocular rosacea includes lid cleansing, warm compresses and artificial tears. Patients with ocular rosacea have enhanced sensitivity to common environmental stimuli, such as ultraviolet light, certain foods, extreme weather, stress, exercise, alcohol, caffeine and cosmetics and should avoid these triggers.[1] If symptoms are more severe, Restasis and/or oral doxycycline are recommended. LipiFlow has also been shown to improve meibomian gland inspissation. However, in my experience, reducing inflammation before gland expression has been more effective. IPL can limit lid inflammation by targeting blood vessels along the eyelid, inhibiting inflammatory mediators from accessing the meibomian glands. IPL also creates a mild local warming effect to allow better inspissated meibum expression and eliminate bacteria that cause meibomitis.[3]

Treat the root cause of a patient's dry eye and reduce inflammation rather than mask their symptoms with a scleral lens. These patients will, in turn, have a higher chance of success with contact lens tolerance. RCCL

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Managing IRREGULAR CORNEAS with Soft Lenses

Clinical observations will aid in choosing a lens design that offers the appropriate features.

By Tiffany Andrzejewski, OD

Irregular astigmatism occurs when the principle meridians are not 90 degrees apart and different parts of the same meridian have different degrees of curvature (*Figure 1*). Irregular astigmatism causes a reduction in the best-corrected spectacle acuity, a scissors reflex on retinoscopy and, most notably to patients, monocular diplopia, blurred vision and glare/halos.

Traditional treatment for irregular astigmatism has been rigid gas permeable (GP) lenses, which can provide superior vision compared with spectacles.[1,2] While these lenses work well at masking corneal irregularities, they often require a significant adaptation period for patients. Sometimes, these lenses simply are not be the best option for some situations, such as outdoor activities or sports. The CLEK study showed that 27% of keratoconic GP wearers reported contact lens discomfort.[3]

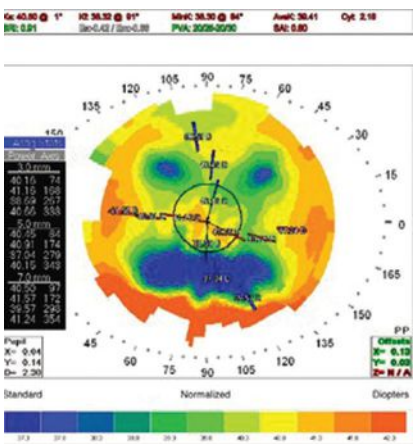

Fig. 1. Topography of irregular astigmatism secondary to radial keratometry. The blue areas indicate areas of flattening due to differing incision depths.

When irregular astigmatism patients are unable to obtain adequate vision in glasses and are GP lens intolerant, alternative contact lens options are available, such as piggyback systems, hybrid and scleral lenses. While these options may be helpful by providing good vision and improved comfort, some patients find them inconvenient, their size intimidating or application and removal challenging. Soft contact lens designs can serve a place for these patients, allowing them to remain in contact lenses.

STANDARD SOFT LENSES

Standard soft toric lenses have limited effectiveness for the irregular cornea patient. Their best application is in mild cases of irregularity where the topography is symmetrical centrally, there's minimal optical distortion and adequate vision is achievable in glasses (*Figure 2*). Benefits of standard soft lenses outside of patient comfort and cost is that they're readily available in most eye care practices. There are many replacement options, and most practitioners have expertise in fitting them. The downside to commercial soft lenses is that they don't correct irregular astigmatism and may exhibit rotational instability with greater amounts of cornea irregularity. These lenses are a good option for patients who do not have critical vision needs and desire spectacle independence, despite seeing well with them.

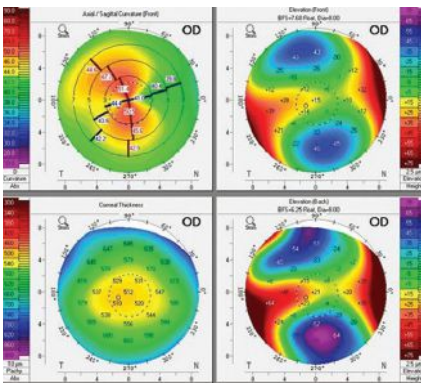

Fig. 2. Pentacam of mild keratoconus with symetrical astigmatism.

ABOUT THE AUTHOR

Dr. Andrzejewski works at Chicago Cornea Consultants with special areas of interest in the management of dry eye, keratoconus, and other cornea and contact lens-related issues, as well as scleral contact lenses. She also is an adjunct clinical faculty member of the Illinois College of Optometry.

Table 1. Custom Soft Lens Designs for Keratoconus and Irregular Astigmatism	
ABB Optical Group	Concise K, Kerasoft IC/Thin
Art Optical	Kerasoft IC Thin
AVT	Soft K, SH Soft K II, Naturasoft
Bausch + Lomb Specialty Vision Products	NovaKone
Continental Soft Lens	Continental Cone
Gelflex Labratories	Gelflex Reverse Geometry Post Surgical
GP Specialists	YamaKone IC
Metro Optics	RevitalEyes Post-Surgical, Kerasoft IC Thin
United Contact Lens	UCL-55 Keratoconus
Visionary Optics	HydroKone, RevEyes
X-Cel	Flexlens ARC, Flexlens TriCurve, Flexlens Piggyback, Flexlens PRS

CUSTOM SOFT LENSES

An increasing number of lathe-cut custom soft lenses are available for those with irregular astigmatism. This modality now encompasses more than 18 designs, some available in both hydrogel and silicone hydrogel materials. Custom soft lenses offer better initial comfort, centration and vision when standard lenses fail. They can be manufactured in virtually any parameter, including steep base curves and almost any conceivable sphere power, with cylinder and axis down to a single degree.

The downside for custom lenses is that some designs have multiple parameters to consider. Diagnostic, instead of empirical, fitting is necessary, and they're made-to-order, which can take time for manufacturing. The lenses also are associated with higher cost, less frequent replacement, reduced oxygen transmissibility and comfort can be reduced compared with mass-produced standard soft lenses due to increased thickness. The ideal patients for custom lenses are those who have a decrease in best-corrected visual acuity with spectacles and traditional soft toric contact lens options with mild to moderate irregular astigmatism.

CANDIDATES

Patients who could benefit from soft lenses for an irregular cornea include:

- Unilateral or asymmetric cones
- Initial keratoconus fits (straightforward on mild to moderate cones, easier insertion and removal than sclerals or hybrids)
- Post-penetrating keratoplasty surgery
- Pellucid marginal degeneration (PMD)
- Post-refractive surgery patients who cannot wear standard soft lenses
- Patients who have had intolerance to GP lenses (corneal or scleral)
- Patients who dislike or cannot be fit with piggyback lenses

Other candidates include irregular cornea patients whose anterior corneal higher-order aberrations (HOAs) are primarily offset by their internal or posterior corneal HOAs. Recent studies of HOAs in patients with keratoconus have revealed a problem where the residual irregular astigmatism derived from the posterior surface of the cornea causes deterioration of vision with GP lenses.[4]

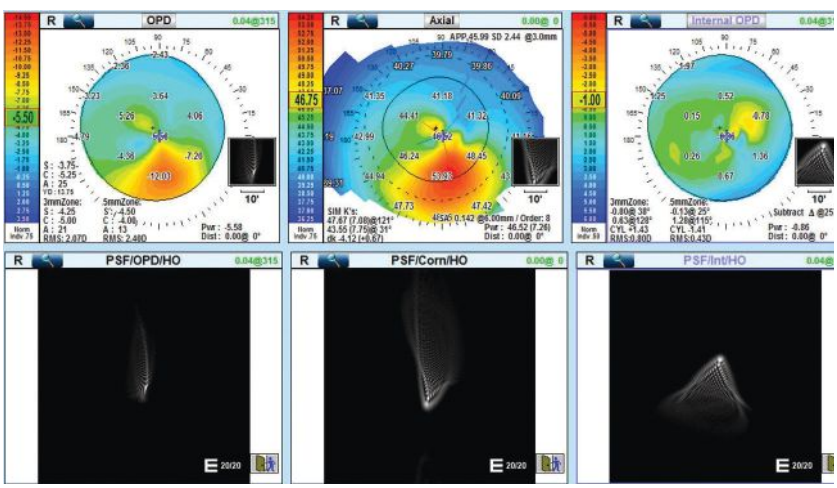

Photo: Barry Eiden, OD

Fig. 3. OPD3 wavefront aberrometry of a keratoconic patient.

Photo: John Gelles, OD

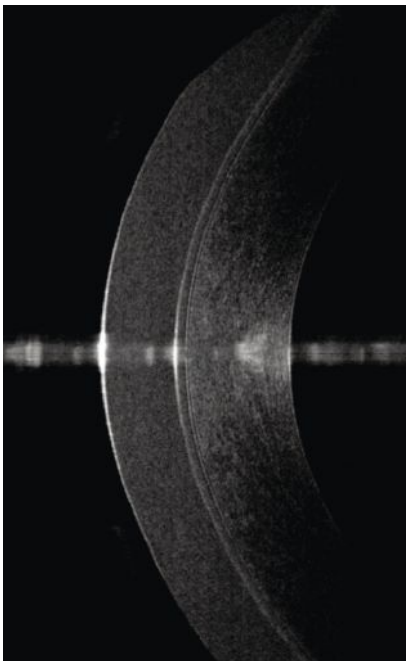

Fig. 4. Specialty soft lens designs have a CT typically three to six times that of traditional hydrogel lenses.

Standard GPs (hybrids and sclerals included) cannot correct internal HOAs or HOAs induced by the posterior cornea, only corneal aberrations. If the corneal HOAs are corrected with a GP lens, the patient will complain of worse vision with the GP lens—even if it's a scleral—compared with their spectacle correction because the higher internal HOAs will manifest themselves.

Figure 3 displays a wavefront aberrometry measurement of a keratoconic eye. Looking at the point-spread function, the total HOAs (left) is much less than that of the corneal HOAs (middle image) and the internal HOAs (right). This patient is a poor candidate for any lens that will help correct the corneal HOAs with an increased center thickness. Doing so will cause the residual internal HOAs to become apparent. Instead, this patient is a great candidate for a thin custom soft lens that will drape well and employ aspheric optics. Future research into employing wavefront-guided correction technologies may offer a better clinical solution for managing residual HOAs for patients.[5]

Custom soft irregular cornea designs are unique from standard soft lenses since they have an increased center thickness (CT) to mask irregular astigmatism (*Figure 4*) or use an aspheric design to limit aberrations.

Many of these designs have a thickness of greater than 0.35mm to 0.40mm, so even with a lathe-able silicone hydrogel material, the resulting Dk/t does not meet the Holden-Mertz criteria of 24 x 10^{-9} units to avert hypoxia in daily wear.[6]

Outside of the optical zone, these lenses are usually lenticularized to reduce lens profile thickness, improving the overall comfort of the lens and increasing oxygen transmissibility over the corneal limbus. Clinically, they must move more (~1mm) than what clinicians are accustomed to seeing compared with standard soft lenses on normal cornea patients. The observed absence of corneal hypoxic findings in these wearers suggests that a significant amount of tear exchange occurs during lens wear. The use of silicone hydrogel materials can also help reduce the risk of corneal neovascularization.[7] Still, there is a risk of neovascularization with this modality and these patients need to be monitored, especially if they have corneal incisions (post-RK and post-PK).

FITTING CHARACTERISTICS

Sagittal depth, or the height of the cornea, plays an important role in achieving a successful fit. Horizontal visual iris diameter (HVID), eccentricity, corneal curvature and scleral shape can impact it.[8] Most designs are fit using diagnostic lenses by matching the sagittal height of the anterior eye with the sagittal depth of the custom soft lens. The corneal feature that has the greatest impact on sagittal height is the overall corneal diameter. For the same corneal curvature, the larger the cornea, the deeper the cornea will be. Sodium fluorescein (in the case of hydrogel materials) can help clinicians assess flat or steep fits during the diagnostic fitting process.

The base curve (BC) directly impacts vision, while the skirt or periphery directly impacts

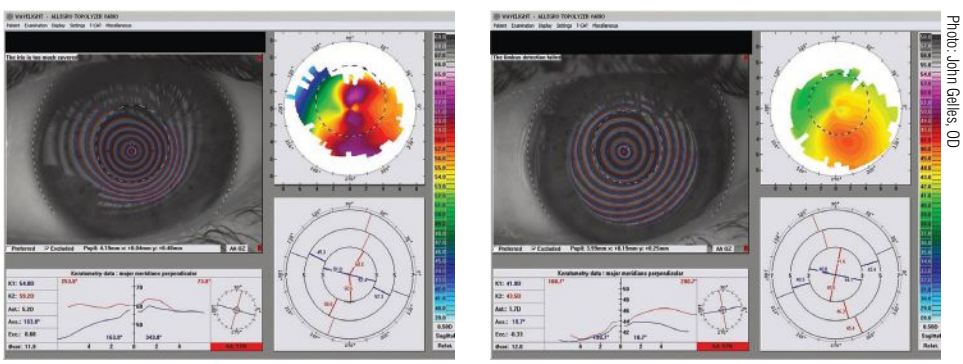

Photo: John Gelles, OD

Fig. 5. Topography of an irregular cornea can reveal the irregularity of the placido disc mires (left). Over-topography on the same irregular cornea with a custom soft contact lens with an increased center thickness of 0.65mm (right). Notice the mires are significantly more regular and the irregularity is "smoothed out."

the fit. If the BC is too steep, it will reduce vision. Conversely, a BC that is too flat causes vision to fluctuate appreciably. Based on clinical experience, the appropriate BC will often be flatter than anticipated. The periphery can be altered separately than the central BC, which helps in achieving a fit absent of air bubbles as well as the necessary lens movement to facilitate tear exchange. If the fit appears tight and devoid of movement, then flatten the periphery. The converse is true when there's excessive movement—steepen the skirt.

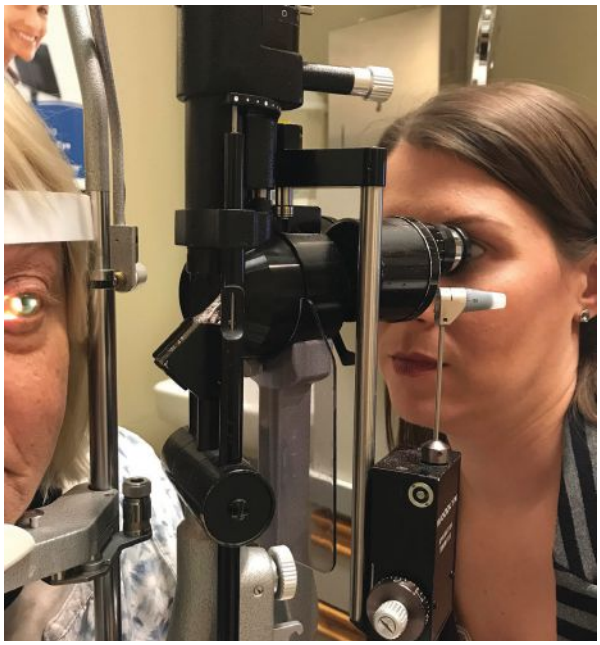

Fig. 6. Evaluate the corneal profile with a slit lamp.

For lenses with a reverse geometry design, the reverse curve should be steepened or increased if there are bubbles in the midperiphery. If edge fluting is observed, then steepen the periphery or, in some cases, sectoral changes are required.

Some products offer a variety of thicknesses. A thicker lens will often improve the quality of vision by providing a smoothing effect over the central area of irregularity or ectasia. Use of a placido disc topographer during the fitting process will help determine the amount of thickness to employ depending on the amount of irregularity present in the mires on topography over the lens (*Figure 5*). Increasing the central thickness can also reduce halos and sometimes allow another line of visual improvement.

WHERE TO START?

In fitting custom lenses, perform a manifest refraction as well as a topography or Scheimpflug tomography of the anterior segment. Doing so will determine potential areas of concern such as a protruding graft or areas of corneal elevation. Evaluate anterior segment health to rule out preexisting staining, neovascularization or corneal microcystic edema. After gathering this basic data, determine the severity of the irregularity and corneal shape before choosing a lens design or diagnostic trial. Custom soft lens designs for the irregular cornea typically are more successful when there's mild to moderate corneal irregularity allowing for a best corrected visual acuity equivalent to GP lenses, as opposed to more advanced irregularity and/or scarring.[9,10]

Lenses are fit with reference to the overall corneal shape rather than the steepest area on topography. To determine corneal shape, observe a side profile of the cornea. Have the patient look straight ahead in the slit lamp, rotating both the optics and the light source as close to 90° away as possible. Then use low magnification and a diffuser to evaluate the side profile of the cornea (*Figure 6*).

Looking at the corneal profile, ascertain whether the cornea is prolate or oblate (*Figure 7*). In an extremely prolate profile where there is a "ski-slope" like appearance to the cornea, a flatter skirt periphery may be required. In an oblate or "plateau-like" appearance, a reverse geometry design where the central BC is flatter compared with the secondary curve, may be necessary. If the corneal apex is within

Fig. 7. Observing the corneal profile can reveal whether it is prolate (left) or oblate (right).

the central 4mm of the cornea, a standard geometry lens may achieve a better result; however, if the corneal apex is outside of the central 4mm, a reverse geometry lens may work better.

In addition, the practitioner should note whether there is a significantly decentered ectasia, which may indicate the need for a peripheral skirt adjustment or a sector design.

FITTING TIPS AND TRICKS

If the cornea is highly irregular, consider a design with variable or a reinforced center thickness. Bulking up the center of the lens may be necessary to enhance vision.

Once an initial lens has been selected and applied, evaluate the lens fit within five minutes using a dynamic assessment of movement, rotation, centration, comfort and vision. Allow the lenses to settle for 20 minutes before performing an over-refraction and assessing vision. Ultimately, if the over-refraction is unstable, then the central fit may not be optimal and indicate that a BC adjustment is needed.

If the patient's visual acuity is clear immediately after a blink before slowly fading, the central fit is too steep—choose the next flatter BC in the fitting set. Conversely, if the patient's vision is blurred after the blink and improves if they stare for a while, the central fit is too flat, and the next steeper BC is needed. A steeper peripheral skirt is indicated when there's fluting and unstable rotation of the lens (*Figure 8*). Rotational stability is important, as high amounts of cylinder are often found upon over-refraction of these irregular corneas, and stability will allow for a good visual result.[11]

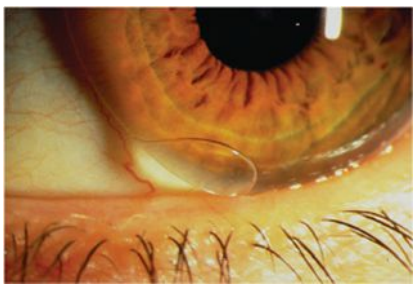

Fig. 8. Fluting will indicate if a steeper peripheral skirt is needed.

An automated over-refraction performed over the lens can help make sure enough cylinder is incorporated into the lens. The diameter of the lens should typically be 3mm bigger than the patient's HVID to allow for appropriate draping.

PUTTING IT ALL TOGETHER

Selecting a lens for managing irregular astigmatism includes many factors, and there are many options in the toolbox these days. Consider the severity of the irregularity, the location and size of the ectasia, the size of the cornea and eyelid fissures and the patient's ability to manage the lens care and handling. Most patients who have been previously diagnosed with irregular astigmatism are aware they are challenging to fit with contact lenses, however, newly diagnosed patients need to be educated on their condition, the various contact lens options available to them and how complex contact lens management may be.

Managing patient expectations is always difficult but can be even more challenging when their vision is affected and cannot be corrected to the degree that the patient anticipates. Although specialty soft lenses have the advantage of quick adaptation, good comfort and being familiar to patients, they do not always correct vision as sharply as GP optics. Address visual expectations with the patient up front. If a patient is switching from a GP modality, they might lose a line or two of acuity. For patients who have irregular astigmatism and cannot wear another type of lens comfortably, this may be an acceptable compromise.

Despite some drawbacks, specialty soft lenses can be a great option for many irregular cornea patients, especially in improving patients' quality of life.[12] With the right pre-fit testing, patient selection and a firm understanding of the fitting process and challenges, specialty soft lenses can go a long way to improve patients' vision and ocular comfort. RCCL

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COLORED CONTACTS:
More Than a Pretty Eye

These lenses have both therapeutic and prosthetic applications.

By Karen K. Yeung, OD, and Rachel Wong, BS

Colored contact lenses are used for more than what typically comes to mind—special movie effects and eye color enhancement. They can also be used therapeutically to alter vision or prosthetically to mask ocular disfigurements. Sometimes, a patient has a multitude of ocular issues requiring both therapeutic and prosthetic care. Myriad ocular conditions stand to benefit from colored contact lenses. This article helps eye care practitioners select and manage the proper contact lens for various clinical uses.

KNOW YOUR OPTIONS

First made commercially and widely available in the 1980s, colored contact lenses have evolved to satisfy the fashion-forward patient's desire for cosmetic change and improvement. Currently, these lenses are made in both HEMA and silicone hydrogel (SiHy) materials. Three main types of colored contact lenses can be used cosmetically, therapeutically or prosthetically for different ocular conditions (*Table 1*):

Transparent-tinted contact lenses. These lenses are fit to alter a patient's perception, especially in the case of sports (e.g., green tints can make a tennis ball appear darker, yellow tints can enhance the incoming image of a baseball, blue or violet tints can minimize glare for snowboarders), photophobia and color blindness. They can decrease stray light affecting the cornea, iris, lens and retina, effectively limiting ocular glare.[1]

This option has a uniform iris color with varying pupil sizes. The transparent tint overlaps the natural iris background, causing the iris to change in color and offering a more natural look. The iris background can be seen through contact lenses with lighter tints. Darker tints, such as a dark brown, may mask some corneal or iris irregularities, though not as effectively as computer-generated opaque and hand-painted custom contact lenses.

Full iris occlusion is not easily obtainable and, for light-colored irides that require a prosthetic lens, it may be hard to match the color of the eye with the lens. It is also difficult to obtain complete pupil occlusion if the black pigment is not dense enough. Again, computer-generated or hand-painted contact lenses may be more effective.

Clear, translucent-tinted and black pupils are available in a variety of pupil sizes, but there is a low degree of customization; iris and corneal details—such as pupillary ruffs and corneal arcus—are not available.

These lenses are easily reproducible and, thus, comparatively inexpensive relative to custom lenses. They are made of HEMA material, as the low water content of SiHy lenses does not allow them to tint well.[2] Due to limited color and pupil options, less chair time is required compared with custom, hand-painted lenses. While diagnostic sets are available from certain manufacturers, others can tint lenses already prescribed to the patient or provide consulting assistance for empirical fits.

Computer-generated opaque contact lenses. While transparent-tinted lenses have a uniform iris color, these opaque contact lenses have a variety of computer-generated patterns, colors and pupil sizes layered onto the lens to increase the availability of options that range from a natural, subtle look to a bolder statement. Some manufacturers offer the option to add a black, white or clear iris backing. Black or white options offer full iris occlusion to mask most iris irregularities, while clear backings

ABOUT THE AUTHORS

Dr. Yeung is a Diplomate of the Cornea and Contact Lens Section of the American Academy of Optometry and a senior optometrist at the University of California, Los Angeles (UCLA) Arthur Ashe Student Health and Wellness Center.

Ms. Wong graduated from UCLA with a degree in psychobiology. She is an optometry patient care representative at the UCLA Arthur Ashe Student Health and Wellness Center.

Photos: Christine Sindt, OD

Blunt ocular injury left this eye aphakic with a ruptured iris, irregular pupil and scarred ocular surface. Placement of a prosthetic contact lens by Crystal Reflections restored the patient's cosmetic appearance and gave her the confidence to continue her social interactions.

allow some of the natural iris details to be seen through the lens. The color of the backing can influence the perceived iris detail and color on the front of the lens, which needs to be taken into consideration when color-matching. For some patients with darker irides, a black color can provide complete iris occlusion and be a suitable cosmetic match to their eye. Some manufacturers offer subtle enhancement options regarding iris details, pupillary frills and limbal rings.

Since the lenses are computer-generated, their limited templates and color options make them more reproducible, with good consistency. These lenses do not fade. They are also easier to fit and require less chair time at a lower cost compared with painted lenses. Some can be replaced frequently, which improves comfort and decreases complications common with annual replacement lenses.

They are primarily available in HEMA materials, though one disposable, high Dk SiHy lens, Air Optix Colors (Alcon), is available and can be especially important for oxygen-compromised corneas. Diagnostic lenses are available from certain manufacturers, and other companies can provide consulting assistance for empirical contact lens fittings.

Hand-painted custom contact lenses. These lenses have the highest level of customization and can be produced on HEMA soft lenses or painted on scleral lenses in any color with any iris diameter and pupil size. An ocularist can add details, such as iris nevi and blood vessels, to match the eye. These lenses can conceal severe ocular disfigurements. For example, the position of the iris can be painted offset from the underlying iris in strabismic eyes to make a patient's eyes appear aligned.

The iris is painted on a clear, white or black backing. Depending on the look the patient is going for, black can make the surface color look darker and reduce glare and photophobia. Patients with light iris colors get the best of both worlds with these lenses, as they're dense enough to provide contrast and not too dark for a good cosmetic match.

To order these lenses, a photograph of the fellow eye is sent to a contact lens lab. Once the patient approves the lab's attempt at color-matching, the custom lens is made. Expect to wait several weeks to months to get the final lens. It may be worth consulting with your contact lens manufacturer, especially as these are the most expensive option, because generally there are limited warranties, and often once the lens is ordered, it cannot be changed or returned. Follow the manufacturer's cleaning recommendations to minimize fading, especially as the low Dk lenses are replaced annually.

MANAGE OCULAR CONDITIONS

Colored contact lenses can benefit a handful of different ocular conditions (*Table 2*). These lenses can be more cosmetically appealing than other options, such as wearing a patch, and increase patient compliance.

Corneal conditions. Any patient with corneal opacification can benefit from a prosthetic contact lens. The size and location of the corneal scar and the color of the iris will dictate the type of lens needed. For patients who can still see, choose a clear pupil. Consider a SiHy material if the cornea is compromised, as it can benefit from the higher Dk. SiHy lenses with a high Dk can also be beneficial when piggybacked below a gas permeable contact lens on a keratoconus patient who is experiencing excessive glare. Note that paint-on, custom painted lenses may also decrease oxygen permeability through low Dk HEMA lenses.

Iris conditions. When working with iris abnormalities, such as heter-

Photo: Bruce Baldwin, OD

This 39-year-old female with multiple sclerosis and optic neuritis has severe photophobia and must use sunglasses, even while indoors, to deal with the pain. She is now wearing Alden HP 49 lenses with full tint walnut brown #3 and, as she puts it, "I've got my life back." She only wears sunglasses outdoors now and likes her new brown eyes.

Table 1. Colored Contact Lenses for Cosmetic, Therapeutic or Prosthetic Use

Name	Type	Material	H_2O (%)	Sphere (D)	Cylinder (D)	Dk	Colors
ABB Optical — *www.abboptical.com*							
Concise Colors	computer-generated print	polymacon, methafilcon A, Definitive	38, 55, 74	-20.00 to +20.00	up to -4.50	—	Aqua, blue, green, baby blue, blue gray, Caribbean, turquoise, lavender, evergreen, pistachio, stormy gray, granite, honey, chestnut, pecan, dark cocoa; four underprint shades, one occluded pupil. Single- or double-color application, dark or light underprinting.
Adventures in Color — *www.techcolors.com/productsandservices*							
Hand-painted Iris	hand-painted	—	—	—	—	—	Any iris coloring; applied to previously prescribed lenses.
Enhancement Tint	transparent-tinted	—	45 to 60	—	—	—	Royal blue, sapphire blue, ciba blue, regular blue, ivy green, sea green, leaf green, evergreen, lavender, aqua, aqua marine, violet, warm brown, cool brown, yellow, amber, grey, achromatopsia. Tints previously prescribed lenses; all colors available in solid or clear center in varying color densities.
Sports Tint	transparent-tinted	—	45 to 60	—	—	—	Brown, copper, amber, orange, yellow, red, dark grey, blue, aqua. Tints previously prescribed lenses; 11.5mm standard tint or edge to edge.
Alcon — *colors.myalcon.com*							
Air Optix Colors	computer-generated print	lotrafilcon B	33	-6.50 to +8.00	—	110	Pure hazel, blue, green, gray, brown, honey, brilliant blue, gemstone green, sterling gray.
Dailies Colors	computer-generated print	nelfilcon A	69	-8.00 to plano	—	26	Mystic blue, mystic gray, mystic hazel, mystic green.
Freshlook (Colors, Colorblends, Dimensions)	computer-generated print	phemfilcon	55	-8.00 to +6.00	—	20	Pure hazel, blue, green, gray, brown, honey, brilliant blue, gemstone green, sterling gray, turquoise, amythest, true sapphire, violet, Caribbean aqua, pacific blue, sea green.
Alden (Bausch + Lomb) — *www.aldenoptical.com/products*							
Alden HP Prosthetic	computer-generated print	polymacon, hioxifilcon B	38, 49	-30.00 to +30.00	-0.50 to -10.00	15	Walnut (five shades) with black pupil opaque (dia. 2mm to 13mm), annular black (dia. 5mm to 13mm) with clear pupil (dia. 2-8mm). Enhancement tints can be added.
Alden Classic Enhancement Tints	transparent-tinted	polymacon	38	-30.00 to +30.00	-0.50 to -10.00	9	Aqua, azure, blue, brown, gray, green, jade, yellow, walnut. All colors are available in three saturations: light, medium, dark.
Alden HP Enhancement Tints	transparent-tinted	hioxifilcon B	49	-30.00 to +30.00	-0.50 to -10.00	15	
Advanced Vision Technologies — *www.cantor-nissel.co.uk/cantor-prosthetic*							
Cantor Prosthetic	computer-generated print	contaflex filcon I	38	-30.00 to +30.00	-6.00 to -0.75	7.9	Ten colors available; clear-backed options to allow iris to show through or occlusive back to mask iris; available in occlusive pupil, pinhole pupil.
Nissel Custom Prosthetic	hand-painted	contaflex filcon II	77	-30.00 to +30.00	-6.00 to -0.75	45	Iris enhanced to match digital images, with clear or black pupils and opaque backing, offset pupil/iris available.
Crystal Reflections — *www.handpaintediris.com*							
Prosthetics	hand-painted	—	—	—	—	—	Blue, green, grey, brown or custom, with or without limbal ring.
Cosmetics	hand-painted	—	—	—	—	—	Sky blue, khaki green, blue grey, honey, blue, taylor, hazel, olive green, light brown, light grey, light green, honey green, ice, ice blue, steel grey, dark grey, light gray green, light blue grey.
Tints	hand-painted	—	—	—	—	—	Mint green, emerald green, aqua, sky blue, lavender, violet, brown, amber gold, plus therapeutic and sports tints.
Custom Color Contacts — *www.customcontacts.com/prosthetic-contact-lenses*							
Custom Prosthetics	hand-painted	polymacon	38	custom	—	9	Any iris coloring, including opaque pupils or novelty designs. Color-bonded lens process to avoid fading.
Gelflex — *www.gelflex.com*							
Sofclear Enhance	computer-generated print	methafilcon A	55	-10.00 to +6.00	—	—	Aqua, royal blue, evergreen, neon green.
Sofclear Colors	computer-generated print	methafilcon A	55	-10.00 to +6.00	—	—	Blue, sapphire blue, gray, green, pure hazel, honey.
Johnson & Johnson Vision Care — *www.acuvue.com/contact-lenses/acuvue-define-1-day*							
1-Day Acuvue Define	transparent-tinted	etafilcon A	58	-9.00 to +1.00	—	—	Natural shimmer, natural shine, natural sparkle, accent, vivid.
Metro Optics — *metro-optics.com/project/metrotint*							
MetroTint	computer-generated print	polymacon	38	-12.00 to +12.00	—	8.4	Aqua, blue, green.
Orion Vision Group — *orionvisiongroup.com*							
BioSport	transparent-tinted	hioxifilcon B	49	-20.00 to +20.00	-0.50 to -6.00	15	Amber, green, blue, sun tac (dark brown), gray green, yellow. Available in full iris tint or pupil-only tint.
BioColors	computer-generated print	polymacon, methafilcon A	38, 55	-20.00 to +20.00	-0.50 to -6.00	8.4 or 18.8	Aqua, blue, green, baby blue, blue gray, Caribbean, turquoise, lavender, evergreen, pistachio, stormy gray, granite, honey, chestnut, pecan, dark cocoa.
BioMed	transparent-tinted	hioxifilcon	49	-20.00 to +20.00	-0.50 to -6.00	—	Lavender, migraine, blue blocker, cobalt, teal, red.
BioColors Prosthetic Soft	computer-generated print	polymacon, methafilcon A	38, 55	-20.00 to +20.00	up to -6.00	—	Aqua, blue, green, baby blue, blue gray, Caribbean, turquoise, lavender, evergreen, pistachio, stormy gray, granite, honey, chestnut, pecan, dark cocoa; four underprint shades (black, pecan, stormy, granite), occluded pupils. Single- or double-color application, dark or light underprinting.
PolyDev/X-Cel Specialty Contacts — *toricolors.com/eye-care-professionals*							
Toricolors Sphere	computer-generated print	hioxifilcon D	54	-4.00 to plano	-0.65, -1.25	21	Seabreeze blue, emerald green, golden amber, horizon gray.
United Contact Lens — *www.unitedcontactlens.com*							
UCL 55%	computer-generated print	ocufilcon C	55	-20.00 to +20.00	—	—	Green, blue, aqua, amber, brown, red, yellow.
UCL Tresoft	computer-generated print	ocufilcon A	46	-20.00 to +20.00	—	—	Green, blue, aqua, amber, brown, red, yellow.

ochromia, tinted or opaque contact lenses can cosmetically alter the differing iris colors of two eyes to make them look more similar. Enhancing tints blend with the underlying iris for a more natural look.

Iris defects often cause symptoms of glare and photophobia. In conditions such as aniridia, polycoria, colobomas and iridectomies, a colored lens with a clear pupil will reduce glare, provide normal light perception and cosmetically improve the appearance of iris defects, especially in the case of iris colobomas. Recommend a clear pupil and matching opaque iris for patients who have fixed mydriatic pupils from trauma or disease to reduce the glare. Colored contact lenses should be a viable option when attempting to reduce glare, as solutions such as corneal tattooing are more invasive and permanent.[3]

Seven percent of patients with iridectomies have visual symptoms of shadows, ghost images, crescents or lines, which are more prominent in cases of exposed iridectomies.[4] The colored annular iris of prosthetic contact lenses benefits these patients.

For albino patients whose lack of pigmentation causes extreme photosensitivity, darker colored contact lenses can act as filters. Compared with sunglasses, contact lenses provide complete pupillary coverage, limit peripheral glare and eliminate rear surface reflection. The diameter of the colored iris should be 2mm to 3mm larger than the patient's pupil in dim illumination. Because visual acuities may be significantly reduced in low light illumination, a moderately tinted contact lens should be prescribed. Sunglasses and hats should still be worn.

Retinal and lens conditions. The pupil may appear white due to certain lens conditions, such as leukocoria, or retinal issues, such as retinopathy of prematurity, retinoblastoma, persistent hyperplastic primary vitreous, Coats' disease or trauma. For non-seeing eyes, a black pupil with a matching opaque iris can improve a patient's self-esteem.

Uniform, dark brown contact lenses can be fit on patients with Bothnia dystrophy, a variant of retinitis pigmentosa with a prolonged dark adaptation. These lenses, worn only during the day, maximize visual potential by decreasing glare and extreme light sensitivity to improve orientation and mobility. The darkness of the tint is adjustable depending on the light intensity of different seasons.[5]

Cone dystrophies and achromatopsia can also cause severe photophobia. Similar to congenital color vision deficiency, these conditions reduce color vision and visual acuity but can also be accompanied by central scotomas and nystagmus.[6] Tinted contact lenses decrease photosensitivity, improve visual acuity, decrease the size of central scotomas, enlarge the peripheral visual field and enhance the visibility of long-wavelength stimuli in bright illumination.[7] Red lenses, especially in patients with achromatopsia, decrease the amount of short-wavelength light, reducing rod photoreceptor activity.[8,9]

The density and the tint color prescribed depends on the severity of the disease and the type of cone dysfunction. Red-brown tints may be more suitable for patients with residual cone function, and magenta may be favorable in cases of blue cone monochromatism.[7,10] Some recommend amber, gray or a combination of colors with a transmittance value of 14% to 30%.[8,10-12] To minimize debilitating photophobia, one study fit patients with cone disorders with red-tinted contact lenses, which immediately decreased their photophobia and improved their residual vision, allowing eight of the 23 participants to become eligible to drive.[8]

Globe conditions. For patients with smaller ocular globes, such as in cases of phthisis bulbi or microphthalmia, painted scleral shells can fill in for the lost orbital volume ö and realign the lid to a more normal position. The smaller eye can also appear bigger with a limbal ring and a clear contact lens fit on the normal eye. For extreme disfigurements, a prosthetic scleral shell may be an alternative to enucleation or evisceration.[13]

Photo: Alcon

Alcon Dailies Colors bring eye-changing capability to the daily disposable modality. Pictured is Mystic Green, one of four options in the new product line.

Photo: Mile Brujic, OD

Natural Sparkle 1-Day Acuvue Define lenses are designed to brighten light eyes.

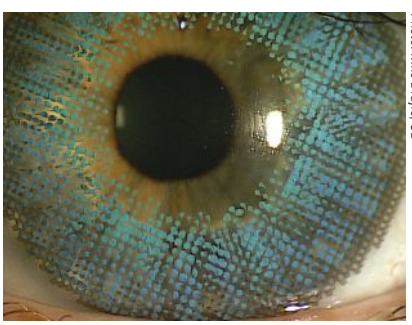

Photo: Mile Brujic, OD

Brilliant Blue Air Optix Colors are designed to blend with and enhance natural eye color.

Table 2. Ocular Conditions that Benefit from Colored Contact Lenses

Corneal Conditions
- Advanced corneal arcus
- Band keratopathy
- Bullous keratopathy
- Congenital defects
- Dermoids
- Leukoma
- Scarring
- Sjögren's syndrome
- Trauma
- Vitamin A deficiency

Iris Conditions
- Albinism
- Aniridia
- Colobomas
- Fixed mydriatic pupil
- Heterochromia
- Iridectomies
- Polycoria

Retinal and Lens Conditions
- Achromatopsia
- Coat's disease
- Cone dystrophy
- Leukocoria
- Persistent hyperplastic primary vitreous
- Retinitis pigmentosa
- Retinoblastoma
- Retinopathy of prematurity
- Trauma

Globe Conditions
- Microphthalmia
- Phthsis bulbi

Other Conditions
- Amblyopia
- Color deficiency
- Diplopia
- Glare
- Photophobia
- Strabismus

Other conditions. Tinted lenses cannot cure congenital color deficiencies, but they may help improve color discrimination by modifying the light spectrum and altering brightness and hue saturation.[14] For red-green color deficiencies, a red-tinted lens fit on the non-dominant eye can aid in color contrast.

An all-black contact lens (black pupil and iris) can remove all extraneous visual stimulation to eliminate diplopia. An appropriate front iris color can be printed on top to match the other eye.

Changing the size of the black pupil and the pattern of the iris print on colored lenses allows customization of visual penalization and leaves the peripheral fusion intact during amblyopia treatment.[15,16] The larger the opaque pupil, the greater the visual penalization. A color-matching lens with a clear pupil can be fit on the other eye to improve cosmesis.

A hand-painted scleral lens can be fit on a strabismic, non-seeing eye with the iris painted off-center to match the visual alignment of the other eye. The lens should be fit large and truncated for good stability and opaque to mask the underlying, off-centered iris. In the case of a prosthetic soft lens, use prism ballast to prevent rotation. The good eye should help you determine where the new pupil should be. For severe ocular disfigurements, gather information from the good eye, including corneal topography, pupil size (in low, normal and bright conditions), iris diameter and matching iris color.

SET EXPECTATIONS

As eye care professionals, we emphasize the treatment of underlying ocular pathology and the management of ocular health, but we must not neglect the emotional aspect that comes with patients who receive these services.

While colored contact lenses should be fit to maximize vision, prepare patients that these lenses can decrease and/or change their visual perception. Determine the functional needs and priorities of those who opt for therapeutic or prosthetic lenses. While this modality aims to marry cosmesis and vision, have patients choose which is more important to them. For non-seeing eyes, the priority is cosmesis, but for sighted eyes the patient may have to compromise, and their decision will dictate their options and outcomes.

For patients whose primary goal is cosmesis, be mindful to set realistic expectations. With current technology, colored contact lenses can look similar enough to the unaffected eye from a distance but will not be an exact match up close. While the iris and pupil are about 3mm to 4mm behind the cornea in a normal eye, the artificial iris and pupil are at the surface of the colored contact lens. Additionally, dot matrix color designs of computer-generated, printed contact lenses may appear artificial.

The fitting process, especially with custom, painted contact lenses, is expensive, time-consuming and complex, often requiring multiple visits. Because these lenses are generally low Dk and replaced annually, more frequent follow-up visits are necessary. The difficulty in fitting cosmetic lenses does not usually lie with the lens itself but with managing patient expectations.

BE AWARE OF COMPLICATIONS

Maintaining ocular health is always the most important aspect of fitting contact lenses. The eye must be able to support a lens with good fit and comfort. Unfortunately, sometimes contraindications occur, including blebs, sutures, dry eye and ocular allergies. Consider a SiHy contact lens to decrease conjunctival hyperemia and reduce the risk of corneal neovascularization, especially if there is an associated risk of corneal allograft rejection, corneal edema or bullae, all of which may lead to corneal decompensation.[17,18]

Trial a clear contact lens to ensure the eye can sustain contact lenses before ordering a colored one. A larger diameter will provide better centration and less lens movement for better cosmesis, though the lens cannot be too tight to limit tear exchange.

For those who use glaucoma medications, removing contact lenses to instill drops during the day may not be the most convenient option. Prescribing less frequent drug dosing will not only improve patient compliance but also make it easier for

those who wear contact lenses.

For amblyopia or monocular patients, prescribe polycarbonate spectacle lenses over contact lenses to protect the good eye. If the prosthetic eye is smaller in appearance, consider magnification with a plus lens in the spectacles to enlarge the eye or lid aperture. An antireflective coating or a light tint may also help camouflage the discrepancies between the eyes behind the glasses.

Before working with prosthetic lenses, it's important to understand that the rate of lens-related complications is higher. A pair of studies found the rate to be 40% compared with 20% in conventional soft lenses.[19,20] Solid pupil-colored contact lenses had a significantly higher complication rate than lenses with clear pupils, with higher incidences of giant papillary conjunctivitis, superficial punctate keratitis and corneal erosion.[19] Prosthetic contact lenses can also worsen meibomian gland dysfunction, induce allergic reactions or toxic keratopathy and cause trauma to the corneal and conjunctival epithelium.[21,22]

The risk of infection is always higher for those who wear contact lenses. Take extra caution when considering the risk-benefit ratio of colored lenses for patients who can see and prioritize cosmesis. A custom prosthetic lens may be cosmetically appealing, while a more disposable, computer-generated, printed SiHy contact lens may be healthier.

The colored annular iris of colored contact lenses can affect vision in seeing eyes. Tinted lenses reduce the optical quality in higher-order aberrations, which may decrease contrast sensitivity and night vision.[23-25] One study found that hand-painted, opaque, annular soft contact lenses decreased sensitivity over the central 120 degrees in subjects with normal vision.[26] Opaque- or semi-opaque-tinted contact lenses reduce the amount of light reaching the retina, resulting in decreased vision in mesopic or scotopic conditions.

Annular colored lenses can also cause visual field constriction, with one study finding that such a lens with a 5mm pupillary zone decreased visual fields by 21% to 47%.[27] Another observed a 10-degree scotoma nasally and temporally beyond the central 30 to 50 degrees from fixation, which corresponded with the opaque iris surrounding the central 5mm clear optical zone.[28] As the diameter of the annular pupil decreases, photophobia and glare improve at the expense of the visual field. It's important to strike a balance between visual comfort and field-of-view. For patients who are primarily indoors, match the final pupil diameter to the normal pupil in dim illumination. For those who spend more time outdoors, match the final pupil diameter to the normal pupil in light illumination.

Colored contact lenses are underused but versatile options for a population of patients who stands to benefit from them. Therapeutic colored contact lenses can help those who have working vision see the world more comfortably. For those who require extra aid, prosthetic colored contact lenses can improve their physical appearances and self-confidence. Colored lenses not only broaden the optometrist's scope of practice but also improve the quality of many lives. RCCL

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OVERCOMING POST-OP CONTACT LENS CHALLENGES

Follow this step-by-step approach when fitting specialty lenses.

By Langis Michaud, OD

Nowadays, practitioners are playing a more active role in comanaging patients after ocular surgery. This involves optimizing refractive results and, less frequently, restoring visual acuity to irregular ocular surfaces that may have been altered by infection or trauma (including the surgery itself). Specialty contact lenses are one solution, offering numerous possibilities that make it easier than ever to achieve efficient, accurate results. This article summarizes the steps required to determine the right lens for each post-op patient. In most circumstances, customization is key.

Step 1: Know What You Are Working With

First and foremost, we must understand what kind of ocular surface we are dealing with. This starts with good communication with the surgeon about the surgery, expected visual outcomes, post-op medications, possible complications and long-term issues. Learning the endothelial cell count after a corneal graft will dictate what lenses we can consider. If the patient had epithelial healing issues post-op, the contact lens fit will likely necessitate piggybacking or scleral lenses to vault over the fragile surface (*Figure 1*).

If this information is not readily available, obtain a thorough case history from the patient during their first follow-up. Use this time to take the patient's expectations and feelings toward contact lens wear into consideration. For some patients, especially if they aren't interested or able to be fit in specialty contact lenses, glasses are the modality of choice and offer decent vision. Keeping these elements in mind, determine the best strategy and put together a personalized plan with which to move forward.

Step 2: Take a Refraction

Although this may seem obvious, refraction should be the next step in addressing the patient's ocular needs after surgery.

Electronic refraction may be misleading in some cases of corneal irregularity and severe eye dryness. This is why I prefer starting my refractions with the tried-and-true retinoscopy technique. Not only can objective refraction be evaluated quickly, but it also provides a lot of useful information. For example, the presence of ocular media opacities may potentially limit visual outcomes. The quality of the red reflex says a lot about higher-order aberrations and surface irregularities. What you see through retroillumination is perceived by the patient and may disturb their vision. If you can't see well through this medium, this

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will also hold true for the patient. In the past, topography was frequently dictated by retinoscopy findings, which later showed forme fruste keratoconus on the posterior corneal surface. This type of abnormality might not have been detected if not for a quick but efficient retinoscopy.

Retinoscopy is even more important when contact lenses are introduced, as it can easily highlight over-correction and residual astigmatism. The best example is the patient between 36 and 40 years old who complains about vision but sees 20/20 perfectly. Most of the time, retinoscopy will show masked astigmatism and hyperopia. Knowing that binocular vision imbalance may mimic dry eye signs and symptoms, adjust the power and try toric lenses to reduce discomfort by enhancing the effect of accommodation and convergence.[1]

Subjective refraction, on the other hand, determines the potential visual acuity and may dictate the limits of contact lens selection in cases of powers or axes outside the available parameters. Whenever 20/20 is not achieved during subjective refraction, you can obtain pinhole acuity to evaluate visual potential.

Step 3: Optimize the Ocular Surface

For post-surgery patients, it is easier to select specialty contact lenses if you can back your decision with a series of clinical tests that include aberrometry, corneal and conjunctival topography and OCT imaging. Before assessing the ocular surface, make sure to optimize it, as ocular dryness, low tear break-up time and an unstable tear film can negatively influence results. You will have false negatives or positives, incorrect values and misleading information if the surface of the eye is not uniform enough to allow light rays to travel without disturbance or accurately reflect the ocular surface. Even a refraction will not be as precise in the presence of moderate-to-severe eye dryness.

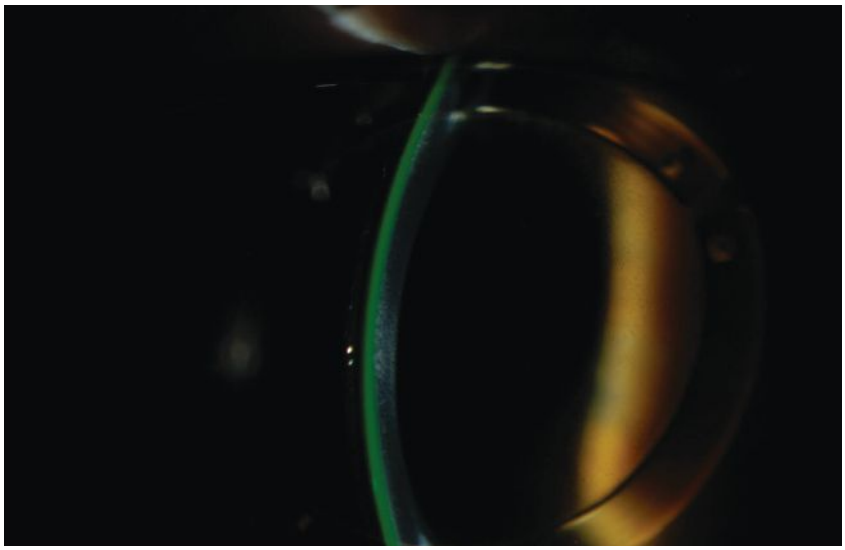

Fig. 1. Scleral lens over corneal rings.

According to the DEWS II report, a dry eye assessment should start with a few questions about patient symptoms and artificial tear necessity.[2] Using artificial tears more than two or three times a day indicates chronic eye dryness. Testing is then required to screen the face and lids for rosacea and to analyze tear break-up time, corneal staining and meibomian gland expression of the nasal quadrant of the inferior lid.

Significant findings should motivate practitioners to conduct a more comprehensive dry eye workup that will help assess and treat the condition to limit adverse events and optimize refractive outcomes. Even with normal findings, it is still considered adequate to instill one to two drops of artificial tears before assessing the ocular surface and performing ocular topography.

Step 4: Map the Cornea

The logical next step is to objectively log the patient's eye condition by mapping the cornea and the conjunctiva to get the most data possible.

Corneal topography captures and displays the irregularity of the surface after surgery. For post-op patients, an axial map is useful when viewing the cornea and establishing the presence of regular or irregular astigmatism. An elevation map is also essential because it highlights the highest point of the cornea you need to consider when fitting specialty lenses—and scleral lenses in particular—and pinpoints relative differences in quadrant elevation.

One study found that patients with 350µm or less of corneal elevation difference along the greatest meridian of change have an 88.2% chance of success with a corneal gas permeable lens vs. a scleral lens.[3] This map also provides practitioners with the best fit sphere, which represents the most valuable starting point when fitting gas permeable lenses, as the goal is to align the base curve of the lens with the best fit sphere value.

Mapping the conjunctival surface also aids in scleral lens fittings. In fact, this is the only objective method to determine how much toricity is required (peripheral haptics), and it helps predict lens rotation (along the steepest conjunctival meridian) in cases of front-toric lens designs. Remember that 65% of the sclera is highly irregular, asymmetric and non-rotational and has various amounts of toricity.[4]

When visual acuity is not as sharp as expected or patients complain about shadowing along images, aberrometry becomes an essential step toward understanding and improving the patient's condition. Conducting aberrometry when a patient is wearing their lenses is useful in diagnosing the presence of higher-order aberrations, especially coma, which is often mistaken for residual or induced astigmatism in scleral lens wear. In my experience, this is particularly true for patients with irregular corneas, whom I am able to refract to at least 20/30 in glasses. In such cases, hybrid lenses may be a better option.

Anterior segment OCT allows practitioners to evaluate the cornea, the conjunctiva, the corneo-scleral junction (the most important factor driving soft lens behavior) and the surface-to-lens relationship.[5] In cases of scleral lenses specifically, measurements include lens conjunctival compression, position, thickness and tear reservoir thickness. With proper and complete imaging of the anterior surface, it is possible to execute specialty contact lens fittings effectively.

Step 5: Select the Right Lens

Now it's time for the fitting process. A flowchart can help you determine the go-to lenses for each irregular cornea you encounter (*Figure 2*).

I gravitate toward scleral lenses under most circumstances. Marginal eye dryness can be better addressed with scleral lenses, particularly in an aging population. However, smaller gas permeable lenses may be justified in certain circumstances, such as: whenever corneal health is at risk (e.g., when a patient has a low endothelial cell count), the corneal surface elevation difference is less than 350µm, the scleral profile is highly irregular or scleral lens designs cannot be fully customized.

Hybrid lenses are still a valuable option, but they cannot be designed as front-toric lenses when residual astigmatism is in play. The fact that the gas permeable carrier junction lies on the cornea could also limit their use. The absence of a tear reservoir may represent another shortcoming in the presence of significant eye dryness.

Presbyopia must remain at the forefront of practitioners' minds, as many patients have declined or were not offered this type of multifocal implant. If astigmatism and presbyopia are present, gas permeable lenses, hybrids and sclerals are all choices that can compensate for these combined refractive errors.

Contact lenses don't have to be the only option for presbyopes struggling with fit, comfort or both. Wearing contacts for specific activities and glasses the rest of the time is a good way to overcome their concerns while still correcting their vision. Daily disposable lenses are the number one option for ocular health and convenience when part-time wear is involved.

I like to relate the diverse nature of vision, especially for active presbyopes, to shoes. When patients realize they have different shoes for different activities, it becomes easier for them to understand that vision operates in a similar way. There is no logical reason to shy away from offering presbyopic correction to post-op patients if the need to see clearly at near has not already been addressed with multifocal implants.

When sclerals, gas permeable lenses and hybrids are not well tolerated, you can consider soft custom lenses. However, these lenses are thicker and have low oxygen permeability. They should be fitted loosely to favor tear exchange, which is the only way to supply oxygen to the cornea when they are worn.

When dealing with post-op patients with normal prolate corneas, as is often the case after cataract surgery, silicone hydrogel lenses are a preferred option, especially if the patient has worn this type of modality in the past. Any residual refractive error can be easily corrected with disposable lenses.

Following each modality's fitting guide provided by the manufacturer is a must. Doing so could yield success rates as high as 90% with the first or second pair tried.[6] Satisfied patients are your biggest advocates outside of the office.

Step 6: Determine a Care Regimen

Chemical exposure secondary to preservatives and buffer agents may generate chronic reactions if the proper precautions aren't taken. The presence of these ingredients may also cause cross-reactions with other topical products (artificial tears, glaucoma medications, steroids, etc.).

Hydrogen peroxide systems are typically recommended because they do not contain preservative agents and are compatible with most of the lenses on the market.

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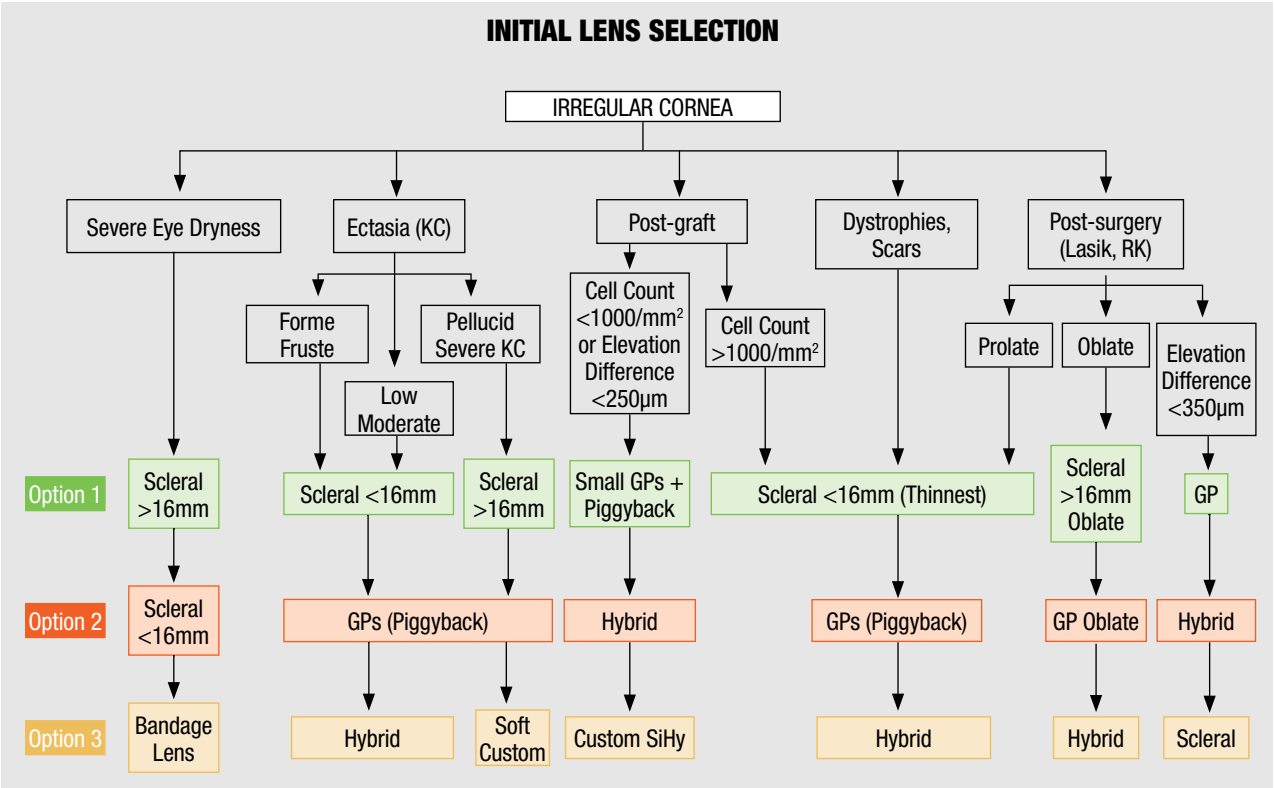

Fig. 2. This flowchart may come in handy when deciding on a lens for an irregular cornea.

For sensitive patients, keep things simple and alleviate formulation with wetting agents. The same holds true for comfort drops, artificial tears and topical medications, which should be prescribed non-preserved whenever possible.

Topical medications do not necessarily represent a contraindication for contact lens wear if the dosage is equal to or less than BID. Otherwise, it may be convenient for the patient to remove their lenses and apply the drug during the day.

Step 7: Schedule Regular Follow-ups

Post-surgery ocular health changes over time as a patient ages, and today's positive outcome could become tomorrow's terrible nightmare—think radial keratotomy patients who tend to be happy in the months following the procedure but then develop fluctuating vision and severe refractive shifts toward hyperopia over time. Regular follow-ups are needed to continue to optimize visual correction outcomes, especially when contact lenses are in use, and improve compliance. For new contact lens wearers, the initial three months post-fitting are the most important, as one study demonstrated that 25% of dropouts occur within the first 90 days of wear.[7] It goes without saying that the presence of comorbidities, such as diabetes and glaucoma, should dictate a specific and personalized follow-up schedule.

Post-surgery patients can be challenging in many ways. Luckily, numerous contact lens options exist to meet their visual and ocular health needs. Doing your best to customize a plan for each of your patients is all the more rewarding when you achieve successful outcomes. RCCL

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Blink Mechanics: Why it Matters

This incredibly important function has huge implications for dry eye and contact lens wear, especially when it goes awry. By Marc-Matthias Schulze, PhD, Dipl. Ing. (AO)

A blink is the rapid closing and opening motion of the eyelids, and may be either involuntary or voluntary.[1,2] But is blinking really this simple? What if it isn't performed properly or frequently enough? How does this affect your patients with dry eye disease (DED) or contact lens (CL) wearers complaining of discomfort and dryness?

This article reviews blink mechanics and how to assess them in the clinic and discusses how blinks can go wrong and what this means for your patients. It also reviews the options your patients have to improve their blink routine.

HOW DOES A BLINK WORK?

Involuntary blinks can be sub-divided into spontaneous and reflex blinks. Spontaneous blinks occur subconsciously, are triggered by the autonomic nervous system and account for the majority of the blinks performed during the day.[3] Spontaneous blinking helps to maintain an intact pre-corneal tear film to ensure optical quality as well as proper re-wetting of the ocular surface, and helps with removal of tear film debris.[1,4,5]

Reflex blinks are typically triggered by some kind of external stimulus, such as a sudden bright light, a loud noise or a foreign body touching the anterior surface of the eye.[1] Voluntary or consciously performed blinks are intentional lid movements for a specific purpose, for example to achieve re-wetting of the ocular surface after prolonged eye opening. Voluntary blinking is typically used during blinking exercises that aim at altering a patient's blink habits for the better.[5]

The blinking process involves movements of both upper and lower lid, with the upper lid doing the primary closing and opening motion, while the lower lid only exhibits a minimal upwards and nasal movement.[6] During a full eye closure, the upper eyelid touches the lower eyelid in the temporal location first, followed by a wave-like swiping motion nasally that also assists in tear exchange and drainage at the lacrimal puncta of the eyelids.[1,4,6]

Opening and closing of the eyelids is controlled by innervation of the 3rd and 7th cranial nerves, respectively, which innervate the levator palpebrae superioris and orbicularis oculi muscle, respectively.[2] Innervation of the levator palpebrae superioris muscle as well as Mueller's muscle contributes to raising the eyelid and holding it up, while the orbicularis oculi muscle closes the lids.[6,7] During a blink, the nervous system turns off the tonically active levator palpebrae superioris, allowing the orbicularis oculi muscle to rapidly lower the upper eyelid before the levator palpebrae superioris becomes active again and raises the lid.[6]

Complete eye closure is a crucial requirement for ocular surface health, as the contact of upper and lower lid during a complete blink promotes secretion of lipids from the meibomian glands, which protect the tear film from evaporation.[5] During a complete blink, mucins are secreted from the tarsal goblet cells over the entire ocular surface and tear film; for incomplete blinks, this only applies to the areas covered by the moving eyelids, thus impacting tear film integrity.[5]

The presence of incomplete spontaneous blinks is therefore of concern, particularly in patients with evaporative DED.[5,8,9] Researchers recently reported a two-fold increased risk for developing DED in patients with incomplete blinking patterns, suggesting it may be a predisposing factor towards the eventual development of evaporative DED.[8] Compared with participants with complete blinking patterns, participants who exhibited

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incomplete blinks were found to have significantly worse symptoms and signs of DED, including greater ocular surface disease index (OSDI) scores, greater meibomian gland drop-out and poorer meibum quality, as well as reduced lipid layer thickness and tear film stability.[8,10]

BLINK RATE SPECIFICS

A blink is typically subdivided into four parts: the downward motion, the turning point, the upward motion and the inter-blink period.[9,11] With completeness of a blink being the most important factor when it comes to blink mechanics, the inter-blink interval requires equally significant clinical attention as it relates to blink frequency. The inter-blink interval is inversely related to the blink rate—the longer the inter-blink intervals (i.e., the time between each consecutive blink), the fewer blinks a patient performs per minute.

Based on an extensive review, the average number of blinks per minute was reported to typically range from about eight to 22 blinks per minute in normal human subjects under different conditions, with large inter-subject differences reported in the literature even while performing the same tasks.[1,5,12] Various factors can impact blink rates, including gaze (lower in reading posture vs. conversational primary gaze), computer use (reduced) or certain medications such as birth control pills (32% more blinks/minute in women taking birth control pills).[12-19] Studies suggest patients with medical conditions such as anxiety or panic disorders have higher blink rates, while patients with Parkinson's disease blinked less frequently than normal controls.[20,21]

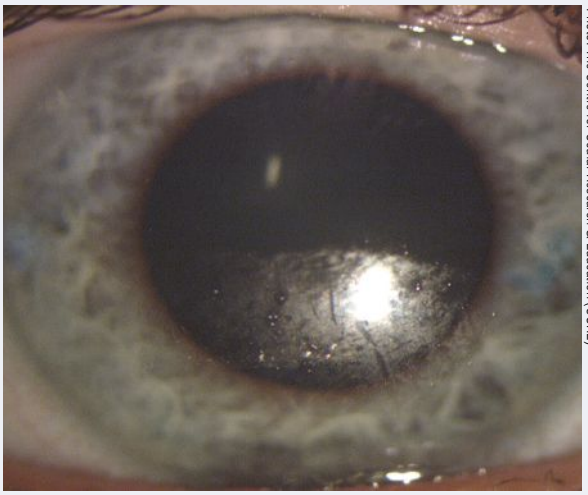

Photo: The Centre for Ocular Research & Education (CORE)

Fig. 1. This contact lens surface shows substantial drying across the inferior portion after a partial blink. Note the clear transition from dark (replenished) superior to speckled (dried) inferior portion of the lens, identifying where the downward movement of the blink ended.

Not surprisingly, dry eye patients were found to have significantly higher blink rates than asymptomatic controls.[14,16] This was particularly the case for patients with evaporative DED, who typically have rather short tear break-up time (TBUT) due to their compromised lipid layer and are strongly affected by prolonged inter-blink intervals. To avoid symptoms or any potential ocular surface damage, a dry eye patient's inter-blink interval needs to be shorter than their TBUT; in other words, they need to blink before their tear film breaks up.[1,5]

Blink rates vary depending on the required level of attention, with significantly more blinks during tasks that require less attention, such as watching a movie or during conversations, compared with more difficult tasks such as playing a video game.[14,15,22] The more cognitively demanding task of reading resulted in reduced blink rates compared with the simpler baseline task of observing a landscape picture, independent of the text being read on a computer screen at 100% or 330% display size, on a tablet, or when reading a hardcopy of the same

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- Assess a patient's blink clinically.
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text in silence or aloud.[23] Interestingly, the same study also shows that reading on an electronic screen results in a significantly higher percentage of incomplete blinks than when reading the paper hardcopy.[23]

Simply put, when a task requires a lot of attention, we tend to stare for longer periods of time, resulting in a thinning of the tear film and eventual tear film breakup. Many of the tasks surrounding digital device use, however—be it the computer at work or an addictive game on a smartphone—do require the attention levels that result in insufficient blink rates and dryness symptoms.

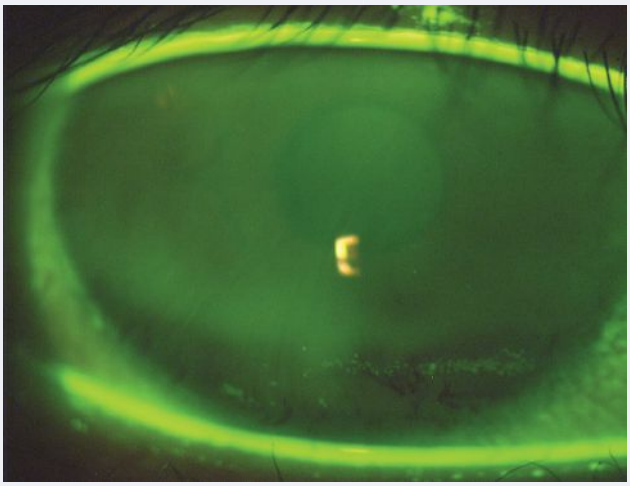

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Fig. 2. This image depicts inferior dehydration staining due to incomplete blinking. The darker horizontal band in the stained area corresponds to the turning point of the lid between the downward and upward motion of the blink.

Keeping in mind that blink rates in normal subjects typically range from eight to 22 blinks per minute, imagine a dry eye patient with a TBUT of about two seconds while using a computer, trying to focus on a task on their screen. To avoid dry eye symptoms and to maintain a completely and continuously replenished ocular surface in this scenario, the patient would theoretically need to perform more than 30 complete blinks per minute, much exceeding the typical blink rate of up to 22 blinks.

The impact of digital device use on ocular dryness is not only a concern in adult but also in pediatric patients. Studies show that the increased use of digital devices in school, coupled with the child's own smartphone or tablet use, is associated with increased symptoms and signs of dry eye that are reduced when smartphone use is stopped for four weeks.[24,25] In a group of 99 children between the ages of four and 17, 42% were found to have some level of meibomian gland atrophy, highlighting the importance of evaluating DED in pediatric patients.[26]

BLINKING AND CL WEAR

Contact lens wear and blinking are closely linked, with both blink mechanism and frequency impacting contact lens wear. Conversely, CL wear directly affects blink mechanics and frequency.[1]

Studies show that blink rate increased significantly after study participants were fitted with CLs compared with when no lenses were worn.[27,28] However, changes in blink rate from lens wear are thought to be temporary only, and to return to normal rates after CL wear.[1] In a study during which contact lens wearers were asked to perform four different digital device tasks (watching a Ted Talk, playing a word search game, playing a Tetris-like game and reading Wikipedia articles), blink rates during CL wear were between 1.7 to 2.5 times higher than when the same tasks were performed while wearing spectacles.[22]

Contact lens wear is known to disrupt tear film integrity, with a measurable worsening of tear film quality during the inter-blink interval when contact lenses are in place.[29] During CL wear, there are smaller amounts of pre-lens tear film compared with the pre-ocular tear film, which is also thinner than when no lenses are worn; CL wear also frequently results in a compromised lipid layer.[1,5,8] As a consequence, TBUT or the development of dry spots on the CL surface occur significantly earlier compared with no lens wear, especially in patients reporting symptoms of discomfort compared with asymptomatic lens wearers (*Figure 1*).[1,30]

Vice versa, poor blinking habits can negatively impact CL wear.[1] Insufficient blinking, often during digital device use, can lead to the drying of the contact lens surface, affecting optical quality as well as causing discomfort.[1,5] Incomplete or twitch blinks (minimal movements of the upper lid) result in areas of de-wetting in the inferior portion of the contact lens, affecting comfort and potentially reducing optical quality if an incomplete blink fails to replenish the tear film in front of the pupil.[1,5] Incomplete blinking can make lenses more prone to deposits, as evident from lens surface deposits in the inferior region of non-rotating, prism-ballast toric contact lenses that showed no deposits in the superior lens regions that were re-wetted by the partial blink.[1,5]

To effectively counteract these CL wear complications, patients with symptoms of dry eye and discomfort must ensure that their inter-blink interval is constantly shorter than the pre-lens TBUT.

BLINK ASSESMENT

The clinical assessment of each patient's blink mechanism should be a routine component when evaluating patients with DED or those complaining of discomfort or dryness during CL wear. Depending on available chair time and severity of symptoms, those assessments may include basic metrics such as counting the number of blinks per minute (blink rate) or metrics potentially associated with or caused by a patient's blinking action such as tear film quality or TBUT.

Questionnaires and patient lifestyle. With the ever-increasing prevalence of digital devices in everyone's lives, collecting information about hours of digital device use as well as lifestyle habits, both for the work place and at home, should be a routine component of every eye exam. Additional tools such as symptom questionnaires—such as the OSDI, standard patient evaluation of dye dryness (SPEED), 5-item dry eye questionnaire (DEQ-5) and 8-item contact lens and dry eye questionnaire (CLDEQ-8)—may also provide valuable insight into potential causes and triggers of the dry eye symptoms.[10,31-33] The CLDEQ-8 specifically addresses questions for CL wearers, including the patient's need to close their eyes during lens wear.[33]

Blink mechanism. Blink rate is perhaps the most obvious assessment of a patient's blink mechanism and is typically assessed by counting how often a patient blinks per minute. However, as simple as this appears, it may still involve potential pitfalls for the clinician. With blink rates being highly dependent on task difficulty, only a few scenarios can be assessed in the exam room. It is also crucial that patients are not aware that the blink is being assessed, as this can induce voluntary or forceful blinking.[8,15,34] Thus, the brief, casual conversation you have with your patient at the beginning of an eye exam may be used for a mental count of blinks to get a general idea about your patient's blink habits.

Incomplete blinking is perhaps best assessed at the slit lamp biomicroscope, after instillation of sodium fluorescein. While assessing the ocular surface, observe whether any dark horizontal bands parallel to and above the lower lid margin appear after the patient blinks. The presence of these dark lines indicates that there is incomplete eye closure and that the turning point between downward and upward motion of the blink is above the lower lid, leaving the inferior portion of the eye exposed without tear film replenishment (*Figure 2*). Similarly, superficial epithelial staining in the same area (also referred to as exposure staining) is a sign of continuous incomplete blinking habits.

The availability of imaging instruments such as the LipiView II (Johnson & Johnson Vision) also allows for a non-obvious assessment of blink rate and completeness. As a side-product of its lipid layer examination feature, this tool provides an automated analysis of the number of blinks performed

Blink Exercises for the Busy Patient

Performing blink exercises at regular intervals on a continued basis is crucial to achieve improvements, but many times, patients forget about their blinking exercises due to busy schedules. To help patients remember, clinicians can recommend a number of free tools, ranging from general break reminders combined with blink exercises to more specific blink exercise tools. Here are a few options:

- ***http://eyeleo.com (Windows only).*** While not necessarily blink exercise-specific, this small piece of software provides PC users with regular pop-up reminders to perform short (eight seconds; modifiable) eye exercises to prevent eye strain and improve ocular comfort by closing the eyes, blinking or looking from side to side. Preferences regarding frequency can be set up easily and include other break options such as "locking" the screen for a few minutes for an actual break away from the desk.
- ***www.regularbreaks.com (Browser based).*** This simple and free tool runs in any web browser in the background and provides pop-up reminders for regular breaks. Individualized break schedules can be set up, or the tool can be used for conscious blink exercises, as well as a reminder to drink (more) water or to get up for a stretch away from the desk.
- ***Donald Korb Blink Training (iOS app).*** This offers recorded verbal instructions on how to properly pace lid movements when performing the blink exercises and has a built-in reminder option; however, in its current version, there is a limit of three reminder notifications every 30 minutes or every hour before a new set of reminders has to be manually triggered.
- ***Blink Blink (Windows only).***[38] This is a computer-based blink-animation software that operates in the background. It mimics the blink movement of upper and lower eyelid by introducing two partially transparent bars onto a user's computer screen that simultaneously move in from top and bottom and then apart again. In a clinical study, computer users were found to have increased blink frequency after using the application for one week. A copy of the software can be obtained free of charge from the study author.[38]

Beyond these free options, additional fee-based smartphone or computer apps are available in the applicable app stores.

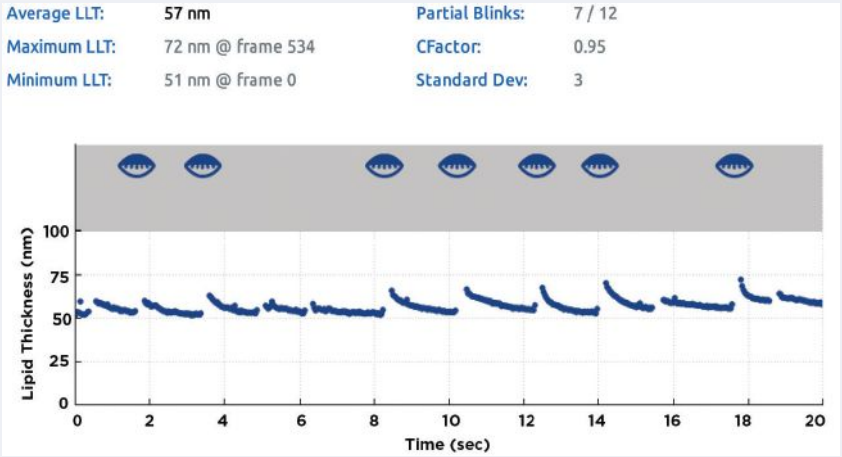

Fig. 3. Summary screen of a lipid layer thickness measurement obtained with the LipiView II. Partial blinks during the 20-second measurement and corresponding time-points are identified as partially closed lid icons in the grey area of the chart; the count for partial/total blinks (in this case, 7/12) is given in the summary table above the chart.

during the 20-second lipid layer thickness measurement, which are reported as partial (i.e., incomplete) and total blinks (*Figure 3*).

Tear film break-up time. According to the Tear Film and Ocular Surface Society's Dry Eye Workshop II (DEWS II) report, TBUTs of <10 seconds in at least one eye are indicative of evaporative DED.[35] Shorter TBUT has been associated with incomplete and too infrequent blinking that may be indicative of evaporative DED and is a simple but valuable assessment in clinical practice. TBUT is best assessed noninvasively, ideally with a device that projects placido disc-based ring patterns onto the tear film, such as the Keratograph 5M (Oculus) or the E300 corneal topographer (Medmont). Patients are asked to blink twice, and the time until a change or disruption of the reflected ring patterns is measured, either automatically or manually using a stopwatch.

Assessments of TBUT following sodium fluorescein instillation using blue light and a yellow filter are options if noninvasive testing is not available, although this typically resulting in shorter TBUT compared with noninvasive testing.[35] Both pre-corneal as well as pre-lens TBUT are valuable metrics for clinical settings to evaluate a patient's tear film over time.

Photo: The Centre for Ocular Research & Education (CORE)

Fig. 4. Blocked meibomian glands after manual expression. The cloudy appearance suggests poor meibum quality.

Meibomian gland assessment. For patients who do not blink fully, the expression of meibum from the meibomian glands is reduced, eventually causing gland blockage and atrophy.[5] Assessment of the meibomian gland structure using devices such as the Keratograph 5M or the LipiView II allow for quick visualization of the glands, in addition to monitoring changes over time. Meibography images are highly suitable for patient education, as patients can see the current status of their glands first-hand. Meiboscopy is a clinical technique during which the meibomian glands are assessed at the slit lamp using transillumination of the lids.[36] The assessment of meibum quality, using tools such as the meibomian gland evaluator, provides information whether additional treatments (e.g., applying heat) to improve meibum quality may benefit your patient (*Figure 4*).[37]

For those interested in further assessment options, the DEWS II Diagnostic Methodology report provides a thorough review of diagnostic measurement options for DED that go beyond the blink-related assessments presented here.[35]

TREATMENT OPTIONS

Dry eye patients, contact lens wearers and anyone spending significant amounts of of time in front of a computer screen can benefit from blink exercises that introduce a more frequent as well as consistent blink routine throughout the day.[34,38] Most blink exercises focus on conscious blinking to achieve complete eye closure, with frequent repetitions recommended so that full blinks become the habitual blinking mechanism.[39]

The most well-known exercise, particularly for those spending extended periods of time at their desk each day, is probably the

20-20-20 rule—every 20 minutes, take a 20-second break to look at a target at least 20 feet away.[40] Although conscious blinking is not mentioned in this rule, the simple action of looking away from the screen is typically accompanied by blinking and helps replenish the ocular surface.

A number of specific blinking exercise resources exist. During a common exercise patients are asked to complete two different blinking sequences, recommended to be repeated every 10 to 12 minutes, to improve their habitual blinking mechanisms.[39] In the first exercise, patients are asked to close their eyes normally, pause for two seconds, and open their eyes again. This is directly followed by the second exercise, during which patients also close their eyes normally and pause for two seconds, but additionally squeeze their lids forcefully for two more seconds prior to opening their eyes.

Squeezing the eyelids helps develop the muscles involved in eyelid closure and trains them to be use in the habitual blinking process.[39] To test whether the blink is performed properly, patients are asked to place their fingers at the corner of their eyes and blink. If they feel any movement, the defense muscles rather than blinking muscles are used.[39] The squeezing of the eyelids overemphasizes complete closure and muscle contraction.[39]

Reminding your patients of the importance of proper blinking habits should be a routine recommendation to all of your patients, but specifically for those where poor blink mechanics such as incomplete or infrequent blinking are suspected or observed. Patients who spend prolonged periods of time using digital devices are also more prone to poor blinking habits and potential ocular surface drying due to reduced blinking frequency.

Blink exercises are highly useful tools that any affected patients should introduce into their daily routines to achieve and then maintain regular and complete blinking patterns. These should assist in better ensuring continuous tear replenishment, result in a higher likelihood of meibum expression and improved ocular surface health. RCCL

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BLINK MECHANICS: WHY IT MATTERS

You can obtain continuing education credit through the Optometric Study Center. Complete the test form and return it with the $35 fee to: Jobson Healthcare Information, LLC, Attn.: CE Processing, 395 Hudson Street, 3rd Floor New York, New York 10014. To be eligible, please return the card within three years of publication. You can also access the test form and submit your answers and payment via credit card at Review Education Group online, www.revieweducationgroup.com. You must achieve a score of 70 or higher to receive credit. Allow four weeks for processing. For each Optometric Study Center course you pass, you earn 2 hours of credit from Pennsylvania College of Optometry.

Please check with your state licensing board to see if this approval counts toward your CE requirement for relicensure.

CE TEST ~ JANUARY/FEBRUARY 2020

1. Which of these statements is *true*?
a. The orbicularis oculi muscle is involved in the opening motion of the eye lid.
b. The levator palpebrae muscle contributes to the opening of the eye lid.
c. The levator palpebrae muscle actively closes the eye lid.
d. The orbicularis oculi and levator palpebrae muscle contribute to raising the eye lid and holding it up.

2. Which cranial nerves are involved in the closure of the eyelids?
a. 2nd and 3rd.
b. 4th and 5th.
c. 5th and 7th.
d. 3rd and 7th.

3. Which of these secretions, released and distributed during the blink cycle, is responsible for preventing evaporation of the tear film during the interblink cycle?
a. Meibum.
b. Mucins.
c. Aqueous.
d. Lactoferin.

4. All of these statements about incomplete blinking are true, *except*:
a. CLs may become more prone to deposits in the non-wetted areas.
b. Patients with incomplete blinking patterns are at a two-fold higher risk of developing DED than patients who perform complete blinks.
c. Incomplete blinking does not impact the severity of signs and symptoms of dry eye.
d. Lipid layer thickness and tear film stability are reduced.

5. Which of these statements is *false*?
a. For continuous rewetting of the ocular surface and contact lens, the inter-blink interval should be shorter than TBUT.
b. When the TBUT is shorter than the inter-blink interval, the patient is less likely to experience symptoms.
c. Longer inter-blink intervals are often found during digital device use.
d. Patients who blink eight times per minute blink more frequently than those with an inter-blink interval of nine seconds.

6. What is a reasonably normal range of blink rates, given normal blink rates vary widely?
a. 5/min to 12/min.
b. 8/min to 22/min.
c. 20/min to 32/min.
d. 30/min to 42/min.

7. Blink rate is likely the lowest while:
a. Reading a book.
b. Chatting with a friend.
c. Watching a movie.
d. Playing a video game.

8. All of these statements about TBUT are true, *except*:
a. Dry eye patients are more likely to have shorter TBUT than asymptomatic patients.
b. TBUT is longer during CL wear than during spectacle wear.
c. TBUT is shorter during CL wear than during spectacle wear.
d. Noninvasive TBUT are typically longer than TBUT assessments after instillation of fluorescein.

9. All of these statements regarding blink mechanisms during reading are true, *except*:
a. Blink rate when reading on a tablet is reduced compared with when performing an observational task.
b. The percentage of incomplete blinks when reading a hardcopy of a document is lower than when read on an electronic display.
c. Blink rate when reading on a computer screen is increased compared with when performing an observational task.
d. Blink rate during a downward gaze task (such as reading) is lower than during a primary gaze task such as a conversation.

10. Which of the following statements about digital device use and risk of dryness is *false*?
a. Only adults are at risk.
b. Both children and adults are at risk.
c. Digital device use is more strongly associated with dryness than reading hardcopy.
d. Cognitive demands of reading decrease blink rates compared with simpler tasks.

11. Based on the findings reviewed in this article, which of these statements is *true*?
a. Women taking birth control blink less frequently than those who don't.
b. Blink rate increases with computer use.
c. A person blinks less when looking down during reading.
d. Patients with anxiety blink less frequently than controls.

12. Which of these statements is *false* regarding contact lens wear and tear film integrity?
a. Pre-lens tear film thickness is thinner than the pre-ocular tear film thickness in non-wearers.
b. CLs disrupt tear film integrity.
c. Pre-lens TBUTs are faster than pre-ocular TBUTs.
d. Asymptomatic contact lens wearers have inter-blink intervals shorter than pre-lens TBUT.

13. Which of the following findings is not indicative of incomplete blinking?
a. Superficial epithelial staining in inferior cornea.
b. A dark horizontal band of staining above the lower lid margin.
c. Dry spots across the whole prism ballast toric CL surface.
d. CL surface deposits at the 6 o'clock marking of a prism ballast toric CL.

14. When doing blink exercises, the main purpose of squeezing the eyelids is to:
a. Develop the eyelid muscles involved in eye closure and train the eyelid muscles to become more routinely used in the habitual blinking routine.
b. Train the eyelid muscles involved in eye opening.
c. Develop the eyelid muscles involved in eye opening.
d. Remove debris from the ocular surface.

15. Which of the following questionnaires may be most useful for evaluating symptoms in your CL-wearing patients?
a. SPEED.
b. OSDI.
c. CLDEQ-8.
d. DEQ-5.

16. Which of the following statements is *true* when comparing fluorescein break-up time to noninvasive break-up times?
a. They are comparable.
b. Fluorescein break-up time is longer.
c. Noninvasive break-up time is longer.
d. Placido disc images are unaffected by tear film integrity.

17. Complete blinks benefit your patient in all of these ways, *except*:
a. They promote expression of meibum to stabilize the lipid layer.
b. They replenish the whole ocular surface exposed during the inter-blink period.
c. They help with removal of tear film debris.
d. They are beneficial for lid hygiene.

18. Which of the following may be a result of incomplete blinking?
a. Meibomian gland atrophy.
b. Extended TBUTs.
c. Evenly distributed mucin.
d. There are no adverse consequences.

19. Which of the following statements is *false*?
a. Meibomian secretion quality may be assessed.
b. Meibomian gland morphology may be assessed.
c. There is no way to assess meibomian glands over time.
d. Poor meibomian gland function decreases TBUT.

20. Which of the following is not a technique used to train blink rates?
a. The 20-20-20 rule.
b. Meibomian gland evaluator.
c. Specific smart device and computer apps.
d. Blink exercises.

Examination Answer Sheet

Blink Mechanics: Why it Matters

Valid for credit through February 15, 2023

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.

Directions: Select one answer for each question in the exam and completely darken the appropriate circle. A minimum score of 70% is required to earn credit.

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Payment: Remit $35 with this exam. Make check payable to Jobson Healthcare Information, LLC.

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Processing: There is a four-week processing time for this exam.

Answers to CE exam:

1. Ⓐ Ⓑ Ⓒ Ⓓ
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. Discuss how the blink works, and what happens when it doesn't work right. ① ② ③ ④ ⑤
22. Review how reduced blink rates brought on by digital device use impact ocular health. ① ② ③ ④ ⑤
23. Describe how the blink affects contact lens wear. ① ② ③ ④ ⑤
24. Assess a patient's blink clinically. ① ② ③ ④ ⑤
25. Identify what treatment options are available. ① ② ③ ④ ⑤

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

First Name
Last Name
E-Mail

The following is your: ☐ Home Address ☐ Business Address

Business Name
Address
City State
ZIP
Telephone # - -
Fax # - -

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_____

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

Lesson 119163

RO-RCCL-0220

By Lindsay Sicks, OD, and Tiffany Andrzejewski, OD

Old Mainstays Can Save the Day

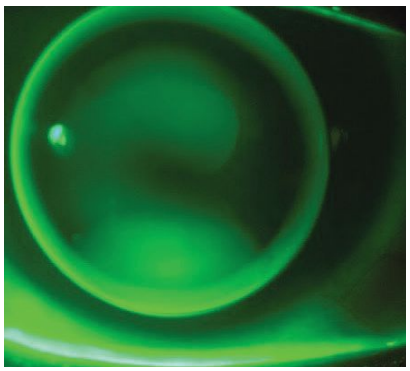
Understanding a patient's visual expectations can help you make the most out of simple solutions.

In the middle of the fitting process, you may find one lens choice is no longer working and switch gears to a different modality. Corneal changes over time may mean a lens that once looked perfect no longer gives the patient the desired vision, comfort or fit. Optimal corneal health is often a priority when choosing a design for the compromised eye; however, there are also considerations related to patient handling, wearing schedule and lens longevity. Sometimes, it is best to just start simple with a corneal gas permeable (GP) lens, which can offer excellent performance with streamlined fitting and ease of handling.

ADVANTAGES

In the irregular cornea, pursuing a small-diameter corneal GP lens allows for more movement on the eye while blinking, creating an active tear pump.[1] The tear turnover rate with a well-fitting GP lens exceeds the rate of other lens types (approximately five minutes for a GP lens vs. 30 minutes for a soft lens).[2,3] Tear turnover can facilitate the delivery of oxygenated tears to the compromised cornea but also reduces post-lens debris as metabolic byproducts stagnate between the lens and the cornea.[3] The high oxygen permeability attainable with GP materials can allow for optimal physiology and prevent hypoxic complications, especially in post-transplant eyes.

GP lens materials are durable, reducing the fear of developing defects, such as a rip or tear during the handling process. They also can provide superior optics to soft contact lenses due to material characteristics in conjunction with good stability and centration over the pupil.[4] GP lenses are relatively easy and inexpensive to manufacture. They can arrive in your office quickly after being ordered, and patients can obtain replacement lenses when needed. In fact, recommend all patients order a spare pair of lenses upon completion of their GP fit if their best-corrected acuity with spectacles is poor, if there is a possibility of high ametropia or anisometropia if a lens is lost, if they have high-level visual needs or if they operate a motor vehicle—so pretty much everyone!



Corneal lens displaying feather apical touch with divided support in a mild keratoconic eye.

Fitting a corneal GP lens also leaves the practitioner the option of using a piggyback system to improve centration or stability of the lens system when indicated. Use this option with an existing GP lens or during the course of a new fit.

DISADVANTAGES

Practioners can easily overcome some of the barriers that they find when fitting corneal GPs.[1,5] Concern over poor initial comfort and difficulty with adaptation can be mitigated with a confident GP lens recommendation, use of the proper language (i.e., "lens awareness" instead of "discomfort") and employing topical anesthetic during the initial fitting process.[1]

In the post-surgical cornea, sensitivity is often reduced in the first few years after surgery, meaning lens awareness is less of a concern.[6,7] There is the potential for instability, i.e., the lens could dislodge or shift off the irregular cornea, but this can hopefully be minimized with appropriate lens modifications during the fitting process in conjunction with patient education on lens handling. Making the switch to a reverse geometry lens design may also improve lens fit and centration in a corneal GP on an oblate eye. Any debris under the lens can be minimized by adding coatings, making changes in lens material, and paying attention to lid hygiene, lens care and handling processes.

CASE ONE

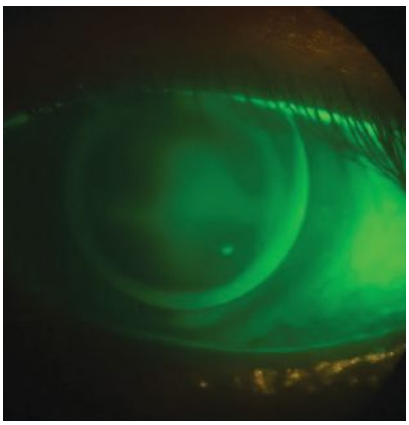
A 38-year-old male patient presented for a contact lens fitting, having been newly diagnosed with keratoconus. He had never worn contact lenses before. As an emergency room physician, he often works long hours and needs to sleep in his lenses on occasion. OD slit lamp evaluation showed mild apical corneal steepening but minimal thinning and no striae or scarring. OS slit lamp evaluation showed moderate apical steepening and thinning and central Vogt striae. Using a diagnostic fitting set in-of-


fice achieved a textbook keratoconic lens fit in each eye, and the patient was successful after dispense, training and follow-up visit.

In patients with keratoconus, GP lens materials tend to provide the best visual performance, so avoiding a soft contact lens is sensible in a patient whose vocation demands excellent vision.[4] Since this patient may also potentially sleep in his lenses while on shift, we shied away from fitting a large diameter scleral GP lens and made sure the corneal lens material was highly permeable to oxygen. In cases of mild keratoconus, fitting a corneal GP is fairly straightforward—aim for feather apical touch and adequate edge lift in combination with lens movement upon the blink. You can follow the fitting guide for a keratoconic GP lens design from your laboratory of choice or call the lab's consultation line for fitting assistance. Use of a wratten filter during the fitting process can also help highlight areas of lens touch or pooling.

CASE TWO

A 44-year-old male patient presents for a contact lens fitting due to regression after LASIK OU 15 years prior. He was undergoing treatment for ocular surface disease and experiencing end-of-day-dryness and frequent lens tears with his habitual monthly replacement soft toric lenses. A refit into a daily disposable soft toric resolved the lens handling issue, but he still experienced symptoms of dryness and only achieved 20/30 vision OD and 20/25 vision OS. The lenses were unstable on his oblate cornea,



GP lens fit on a patient with corneal scarring.

rotating unpredictably while he blinked throughout the day.

As a baseball coach, the patient longed for not only good vision but also the ability to wear sunglasses while out on the field. Having worn GP lenses in the past, he expressed a desire to return to their stability and durability. When fit with a 10.5mm diameter, reverse-geometry corneal GP lens, the patient was able to achieve 20/20 vision in each eye with good comfort. We discussed the possibility of incorporating multifocal optics into his lenses in the future when he has a greater need for presbyopic correction.

CASE THREE

A 60-year-old Caucasian male who had a penetrating injury OS at age 10 is now aphakic with a central corneal scar. He presents for contact lens fitting stating he "hasn't seen out of that eye in years." Manifest refraction of OS +11.25 -1.25 x 120 allowed for 20/40 vision, and a corneal GP lens centered well over the irregularity with some mild central pooling gave the same acuity improvement. We prescribed the patient full-time wear polycarbonate over-glasses for protection of the right eye and to incorporate the +2.50D add power necessary for best near vision.

No matter the disease state you encounter, there is a distinct possibility that a corneal GP lens is an option for your patient. When you consider these lenses, you can be confident they will deliver excellent visual acuity, corneal physiology, ease of handling and lens durability all while taking less chair time than some other modalities might require. The improvement in visual acuity achieved over soft lenses often negates any drawbacks you may encounter in the fitting process of a corneal GP lens design for patients with irregular corneal conditions, so don't hesitate to prescribe these lenses despite the allure of more complex designs. Sometimes the simplest option really is the best option. RCCL

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2. Holden, BA, Sweeney DF, La Hood D, Kenyon E. Corneal deswelling following overnight wear of rigid and gydrogel contact lenses. Curr Eye Res. 1988;7(1):49-53.

3. Muntz A, Subbaraman LN, Sorbara L, Jones L. Tear exchange and contact lenses: a review. J Optom. 2015;8(1):2-11.

4. Griffiths M, Zahner K, Collins M, Carney L. Masking of irregular corneal topography with contact lenses. CLAO. 1998;24(2):76-81.

5. Quinn TG. GP versus soft lenses: Is one safer? CL Spectrum. 2012;27(4):34-9,58.

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By Kerri Norris, OD

No Pain, No Gain

Learn how corneal anesthesia complicated this neurotrophic ulcer case.

When it comes to corneal disease, you'd think no pain would be a promising sign. In some cases, the opposite may be true. Practitioners must know when to be concerned about corneal anesthesia.

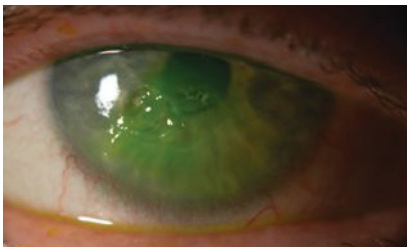
The cornea is one of the most innervated tissues in the body, involving much more than simple sensation. Corneal nerves are vital to maintaining the integrity of the ocular surface, inducing reflex tearing and blinking and are a source of neurotrophic growth factors. Consequently, damage to corneal nerves can break down the corneal epithelium, impair wound healing and cause opportunistic infections, scarring, irregular astigmatism, stromal thinning leading to perforation and vision loss.

Damage to the ophthalmic branch of the trigeminal nerve can occur anywhere along the nerve pathway. Injury is commonly caused by surgery and herpetic infection but could also result from trauma, chemical burns, diabetes, corneal dystrophies and chronic use of contact lenses or medications.[1-3] If there is no relevant history, think outside the box and order an MRI to rule out a compressive mass.[1]

SIZING UP NK

Gather a comprehensive patient history and perform a thorough examination followed by a neurotrophic cornea work-up, which is as low-tech as using vital dyes and testing corneal sensitivity with the tip of dental floss or a wisp of cotton. Things become complicated when a patient develops neurotrophic keratitis (NK).

NK carries a high burden, taking its toll on ocular health and patient quality of life. Thankfully, this orphan disease is rare, affecting only five in 10,000 people, and many patients respond to ocular lubrication, bandage contact lenses, amniotic membranes and autologous serum.[3] Once stable, NK patients can benefit from a scleral lens to constantly bathe the cornea.



The patient's neurotrophic corneal ulcer after fluorescein instillation.

However, supportive treatment may not always be enough. For a long time, the only other options included invasive surgery and Botox of the eyelid to induce ptosis. These options can limit vision, although a conjunctival flap is usually only considered in eyes that already have low potential, and significantly impact cosmesis.

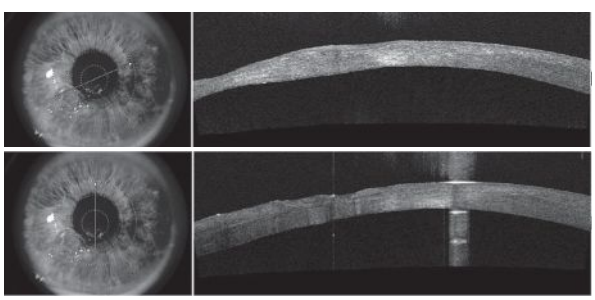
Approach NK conservatively and use the most successful, least intrusive treatment. Thankfully, we now have tools for more recalcitrant cases. A study explored treating refractory neurotrophic corneal ulcers with topical insulin drops and found that every patient re-epithelialized in one to four weeks.[4] Oxervate (cenegermin, Dompé) became the first FDA-approved treatment for NK in the summer of 2018 and is also the first to address the underlying cause of neurotropic disease by restoring corneal innervation. A pair of studies showed complete epithelial healing in 70% of patients after eight weeks of treatment and only 28% of controls.[5]

To acquire Oxervate, your office must fill out a form that your patient signs so that Accredo, the only pharmacy in the United States that fills the medication, can conduct an insurance benefits investigation. This form acts as both the prescription and the patient's insurance information. Once received, Oxervate has to be refrigerated until opened and kept below 77°F after.[5] Dosage is one drop six times a day instilled in two-hour intervals for an eight-week period. Your patient will need to be dexterous when opening the blister pack, adding the tip to the vial and using the pipette to draw and administer the medication.

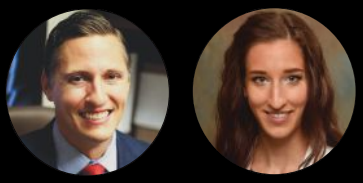
CASE STUDY

A 76-year-old female presented with classic NK complaints—a comfortable but red right eye with worsening blurry vision. She had received successful treatment for herpes zoster ophthalmicus (HZO) 12 years earlier. Her shingles had resolved without any trigeminal neuralgia. She experienced no pain and could not feel the entrenched neurotrophic ulcer on her cornea.

The patient's visual acuity was 20/200 OD with a large epithelial



Corneal OCT shows scarring, thinning and a highly irregular corneal surface due to the neurotrophic ulcer.



defect that showed mild thinning. She underwent epithelial debridement of dead tissue and started Vigamox (moxifloxacin, Novartis) QID, prophylactic famciclovir 250mg TID and preservative-free artificial tears Q1H. Her first Prokera (Bio-Tissue) was inserted at her next visit just days later.

Over the next year and a half, the patient was seen at least every three months, but often several times a month. Additional interventions included doxycycline when an ulcer began to thin, prednisolone in an attempt to limit scarring, topical ganciclovir when an active viral infection was suspected and a bland ointment for better lubrication at night. The latter was especially needed when she started developing filamentary keratitis. In an attempt to keep the cornea lubricated, a punctal plug was inserted. She was kept on an antiviral, antibiotic lubrication and an endless cycle of Prokeras. It was difficult to keep her epithelialized, even with amniotic membranes, so bandage contact lenses were not attempted.

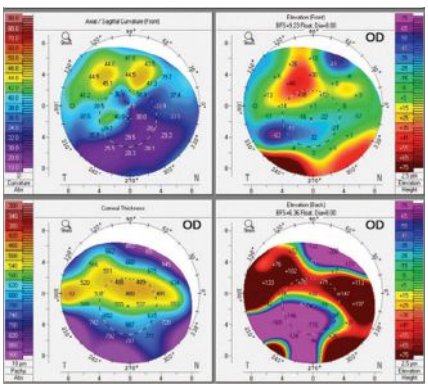
When the patient seemed stable enough to go a few months between appointments, she was asked to self-monitor for redness, vision changes and light sensitivity. Her cornea was scarred, and her vision was blurry, but the true danger lay in her inability to feel any recurrence.

A scarred but fully healed cornea following recurrent NK.

A colleague had cared for the patient before he retired and her case became my responsibility. The release of Oxervate, a recombinant nerve growth factor, just months prior could not have come at a better time. I introduced the idea of this orphan drug to the patient who, despite learning that it was new and tricky to acquire, was excited about a fresh option when she had already exhausted so many.

The patient's last Prokera was removed last March, and she started Oxervate in April. By June, she had finished the full course. Despite corneal neovascularization and scarring following her recurrent corneal disease, her epithelium was intact, and her cornea was the clearest it had been. For the first time, on a low prophylactic dose of famciclovir and with frequent lubrication, her cornea stabilized and suffered no erosions. At this point, we could finally start discussing options to improve her vision, such as a deep anterior lamellar keratoplasty (DALK) corneal transplant, cataract extraction or a combination procedure. The goal is always to perform surgery on a quiet eye to limit the risk of rejection or HZO reactivation.

The patient deferred a DALK, which has a high risk of failure in NK eyes due to poor healing, but was cleared for cataract extraction in September. She understood that her vision would still be significantly limited secondary to her irregular corneal astigmatism and scarring and that hers was a higher-risk surgery. She started taking famciclovir 250mg TID one week prior to the procedure, which she continued for one month before returning to her previous prophylactic dose of QD.



Irregular corneal astigmatism with inferior flattening secondary to corneal scarring.

The patient recently left the post-op period and is happy with her visual outcome of 20/200 OD without correction, pinholed to 20/50. She elected to pursue the nonsurgical route and wear scleral lenses. It has been about a year since the patient's last NK event.

Corneal nerves play a vital role in ocular health, so when diminished corneal sensitivity threatens vision, it is our duty to educate patients on all available treatment options. Where we once had no medical intervention for NK, we now have a drug that gets at the root of the disease. RCCL

Dr. Norris practices at the Pacific Cataract and Laser Institute and provides pre- and post-op care. She is an adjunct professor at the Pacific University College of Optometry.

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By Christine W. Sindt, OD

Last Line of Defense

A descemetocele leaves nothing but a thin membrane to protect the eye from perforation.

A 66-year-old white male sustained a job-related alkaline burn to his right eye 23 years prior to presentation at the clinic. The cornea referral note indicated advanced limbal stem cell dysfunction, with a completely opaque and vascularized cornea. He was experiencing increasing discomfort and was referred for a possible bandage or scleral contact lens fit to relieve pain.

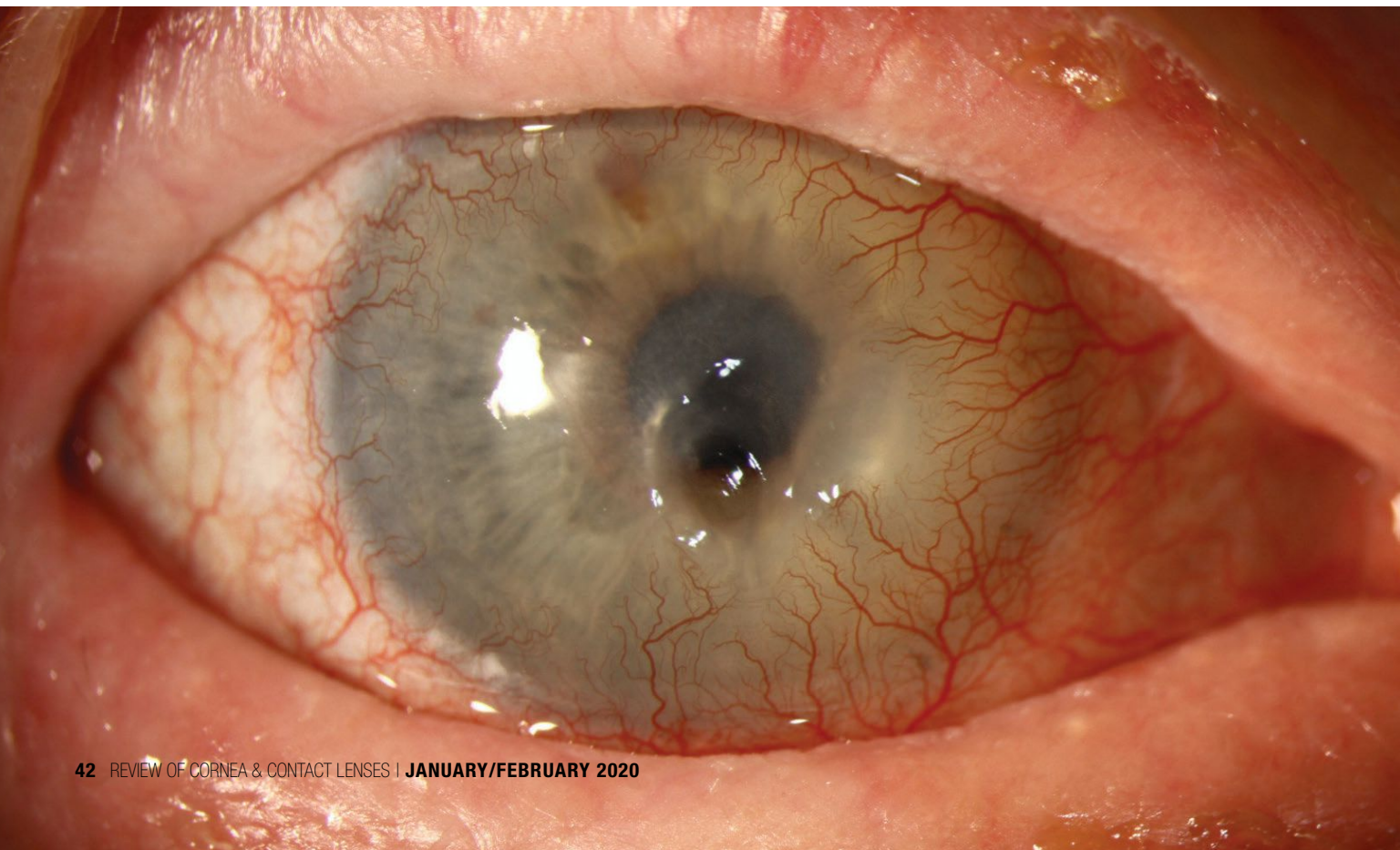
Upon examination, I noted a central clear area with a scant 30µm of corneal tissue in the 2x2mm clear zone. He was diagnosed with a descemetocele, immediately glued with tissue adhesive and administered a soft bandage lens. He was given topical and oral antibiotics as prophylaxis in case of perforation before he could return. An emergent mini-tectonic penetrating keratoplasty (PKP) surgery was performed at the soonest available time.

A descemetocele is a focal area of corneal thinning in which only Descemet's membrane remains. There will appear to be a clear, non-vascularized bulge of Descemet's through the overlying stroma and epithelium. Fluorescein will stain the area; it should be used to look for a positive Seidel sign, since this condition will lead to perforation.

Descemetoceles may form in an eye with a history of infection of any etiology but particularly herpes virus. Other common causes include corneal trauma, chemical injury, exposure keratitis, severe dry eye conditions (e.g., Stevens-Johnson syndrome, Sjögren's syndrome, vitamin A deficiency, graft-vs.-host disease), post ocular surgery, continuous wear contact lenses and underlying autoimmune diseases. A descemetocele may spontaneously form days, months, years or even decades after the original ocular insult.

Treatment includes lubrication, oral vitamin C to stimulate collagen production, antibiotics to prevent or treat infection, steroid drops if there is concomitant inflammation, oral tetracycline for its anti-collagenase properties, topical cyclosporine, an immunosuppressive, tissue adhesives (cyanoacrylate or autologous human fibrin glue), amniotic membrane transplantation and, ultimately, PKP or a conjunctival flap.

Prognosis for descemetocele is guarded, and the patient should be counseled on the likelihood of a poor visual outcome. RCCL



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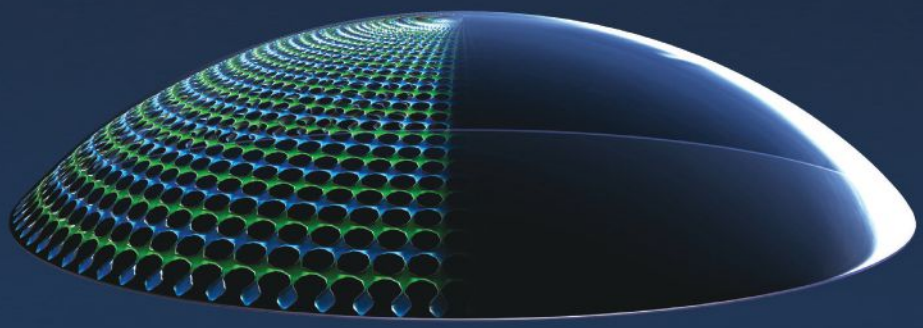

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