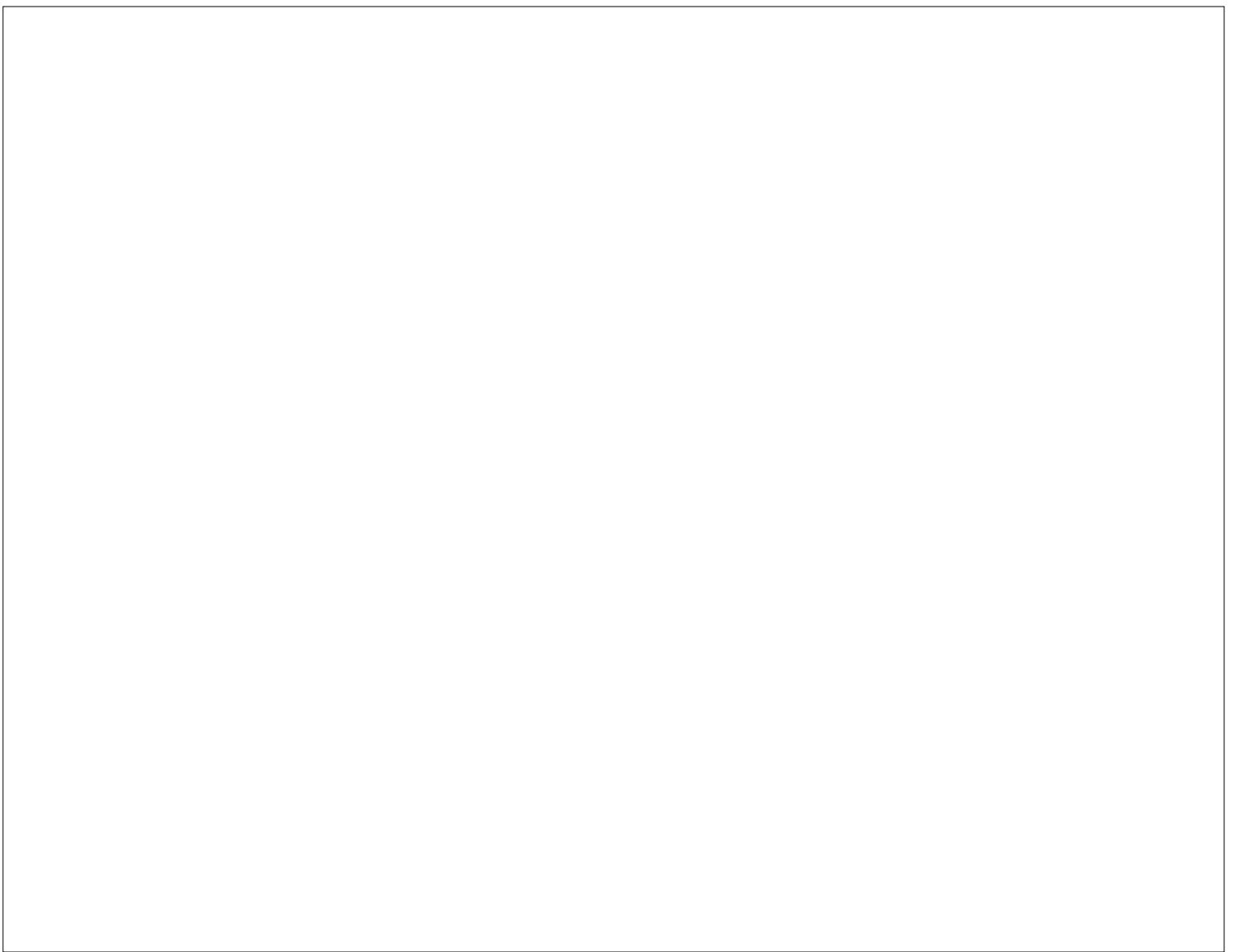
RCCL®
REVIEW OF CORNEA & CONTACT LENSES
SEPTEMBER/OCTOBER 2022



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***Indications for use:** MiSight® 1 day (omafilcon A) soft (hydrophilic) contact lenses for daily wear are indicated for the correction of myopic ametropia and for slowing the progression of myopia in children with non-diseased eyes, who at the initiation of treatment are 8–12 years of age and have a refraction of –0.75 to –4.00 diopters (spherical equivalent) with ≤ 0.75 diopters of astigmatism. The lens is to be discarded after each removal.

† Soft contact lens designed for myopia control in the U.S.

‡ Compared to a single vision 1 day lens over a 3 year period.

§ Fitted at 8–12 years of age at initiation of treatment.

References: 1. Chamberlain P, et al. A 3-year randomized clinical trial of MiSight® lenses for myopia control. *Optom Vis Sci.* 2019; 96(8): 556-67. **2.** Chamberlain P, Arumugam B, Jones D, et al. Myopia Progression in Children wearing Dual-Focus Contact Lenses: 6-year findings. *Optom Vis Sci.* 2020; 97(E-abstract): 200038.

IN BRIEF

■ To better pinpoint the relationship between contact lens wear and meibomian glands (MG), new research investigated the use of this modality in conjunction with **MG morphology.**

The study included 19 symptomatic (CLDEQ-8 score ≥12) contact lens wearers, 19 asymptomatic (CLDEQ-8 score <12) contact lens wearers and 22 non-contact lens wearers.

No differences were found between groups in the MG morphology of the upper or lower eyelids. **In all contact lens wearers, a correlation with CLDEQ-8 was found in the upper eyelid for the number of MG. In symptomatic wearers, correlations with CLDEQ-8 were found in the lower eyelid for the number and percentage of partial MG.**

"Alterations in MG morphology, without clinically apparent alteration in MG function, can be involved in causing contact lens discomfort and influence the degree of symptoms," the study authors wrote. "The differences in findings between eyelids indicate the need to monitor both eyelids, especially the lower one, in contact lens wearers."

Blanco-Vázquez M, Arroyo-Del-Arroyo C, Novo-Diez A, et al. Is contact lens discomfort related to meibomian gland morphology? Cont Lens Anterior Eye. August 24, 2022. [Epub ahead of print].

■ **Hemolacria, or bloody tears, is rarely seen, but its presence may signal malignancy.** A single-center review of 51 patients with hemolacria found that the **lacrimal sac was the most common origin of malignancy.**

The researchers noted that 96% of cases were unilateral, with blood originating from the nasolacrimal drainage system in 53%. **Lacrimal sac mucocele was the most common diagnosis (found in 16 patients). Overall, the rate of malignancy was 8% (four patients).**

The researchers concluded that although malignancy rates are low, early identification can boost life expectancy and increase patients' treatment options. **They recommended performing a thorough clinical assessment with lid eversion to exclude a conjunctival, eyelid, caruncle or canalicular cause. Lid eversion identified 27% of these causes.**

Kaushik M, Juniat V, Ezra DG, et al. Blood-stained tears—a red flag for malignancy? Eye Nature. September 10, 2022. [Epub ahead of print].

Trigeminal Neuralgia Causes Ocular Surface Changes

As anyone with chronic migraine or headache knows, they affect much more than just your head. A recent paper on trigeminal neuralgia evaluated the associated ocular surface effects and reported significant alterations.

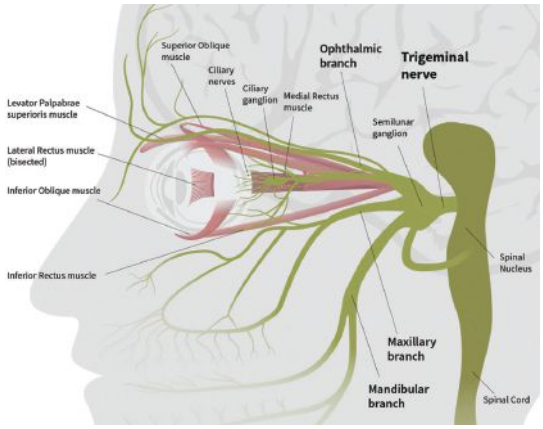

Photo: EyeBrain

Ocular surface changes occur in both eyes in trigeminal neuralgia.

Trigeminal neuralgia is a type of sensory disorder in the branch(es) of the trigeminal nerve that causes sudden onset and termination of electric shock-like pains triggered by harmless stimuli. The condition may be idiopathic, secondary to another disease or due to neurovascular compression. "Corneal nerves mainly originate from the trigeminal nerve," the researchers noted in their paper for the journal *Headache*. "Neurosensory abnormalities are important factors in ocular surface alterations and dry eye etiopathogenesis."

The study included 24 patients with idiopathic unilateral trigeminal neuralgia and 24 healthy controls. Group one consisted of eyes of the affected sides of trigeminal neuralgia patients, group two consisted of contralateral eyes and group three consisted of the right eyes of controls.

The researchers reported median Schirmer-1 test results in groups one, two and three as 5mm, 7mm and 10mm, respectively, with no significant differences among groups. Median tear break-up time (TBUT) scores were seven, eight and 12.5 seconds, respectively, which demonstrated reduced TBUT in groups one and two. Conjunctival impression cytology grades were higher in groups one and two vs. group three. Trigeminal neuralgia patients had a median Ocular Surface Disease Index score that was significantly higher than controls (30.2 vs. 8.3).

"The TBUT findings indicate a high incidence of tear film instability, and conjunctival impression cytology findings indicate cytological changes, including high grades of squamosal metaplasia and goblet cell loss, in patients with unilateral trigeminal neuralgia in not only the eye of the affected side but in the other eye as well," the researchers wrote. They noted that subjective dry eye symptoms were also more common among trigeminal neuralgia patients.

"This study suggests that a bilateral pathophysiological mechanism is active in trigeminal neuralgia, leading to bilateral ocular surface abnormalities regardless of the pain and operative procedures performed," they concluded.

Altas M, Oltulu P, Uca AU, et al. Impact of unilateral trigeminal neuralgia on bilateral ocular surface alterations. Headache. September 2, 2022. [Epub ahead of print].

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Large Magnitude of Ocular Residual Astigmatism in Myopes

Recent research assessing the correlation between ocular residual astigmatism and anterior corneal astigmatism among children with low and moderate myopia found that the magnitude of ocular residual astigmatism was relatively large in this patient population and mainly compensated for anterior corneal astigmatism.

Refractive and anterior corneal astigmatism was determined using subjective manifest refraction and the IOL Master, respectively. The study authors calculated ocular residual astigmatism and assessed the relationship between the amounts of ocular residual astigmatism and anterior corneal astigmatism through correlation analysis. A physical method was used to evaluate the relationship between the vectors of ocular residual astigmatism and anterior corneal astigmatism.

The right eyes of 241 children—ages eight to 18 years old—were analyzed. The researchers reported that the median magnitude of ocular residual astigmatism was 1.02D, with an interquartile range of 0.58D. They observed against-the-rule ocular residual astigmatism in 232 eyes (96.3%).

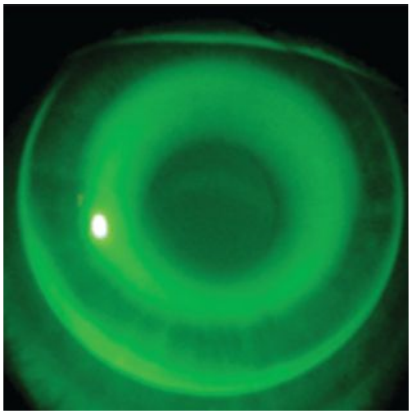

Photo: Kenneth Daniels, OD

These findings emphasize the importance of astigmatism assessment prior to fitting patients with orthokeratology lenses, the researchers concluded.

The data showed a significant and moderate correlation between ocular residual astigmatism and anterior corneal astigmatism. In 240 eyes (99.6%), ocular residual astigmatism compensated for anterior corneal astigmatism. The mean compensation value was 1.00±0.41D.

The findings also showed that the magnitude of the compensation values/anterior corneal astigmatism exceeded 1.00 among 6.7% (16/240) of eyes. After compensation effects, the data showed that 15.4% (37/240) had a different axial classification of anterior corneal astigmatism and refractive astigmatism.

"Evidence suggests that residual astigmatism might be more problematic than expected if orthokeratology was used. Measuring ocular residual astigmatism is equivalent to evaluating residual astigmatism that is not accounted for by the treatment," the study authors stated in their paper. "Therefore, the ocular residual astigmatism should be assessed first before the completion of a course of orthokeratology."

The researchers also emphasized the need for more attention to the specific impact of ocular residual astigmatism on the effectiveness of orthokeratology.

Lin J, An D, Lu YK, et al. Correlation between ocular residual astigmatism and anterior corneal astigmatism in children with low and moderate myopia. BMC Ophthalmol. September 19, 2022. [Epub ahead of print].

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*Prescription market data, Sept. 2021 – S01K without cyclosporine.
†To limit blurriness when using contact lenses, remove contacts, apply drops, then insert contacts.

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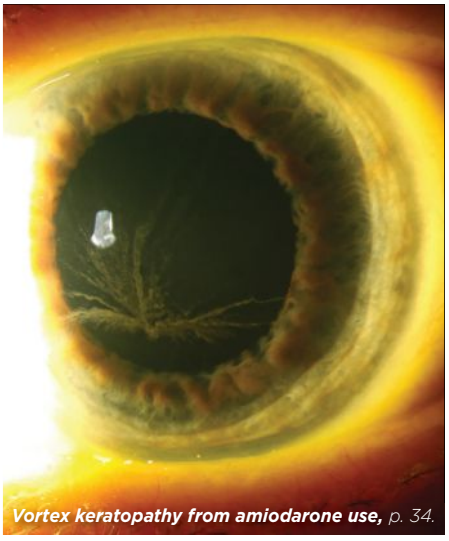

Vortex keratopathy from amiodarone use, *p. 34.*

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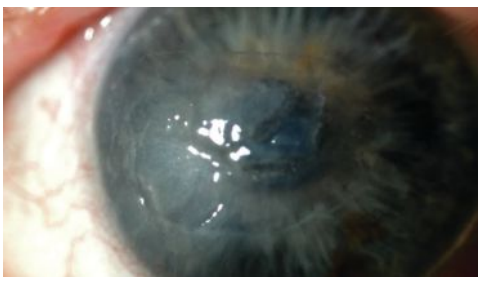

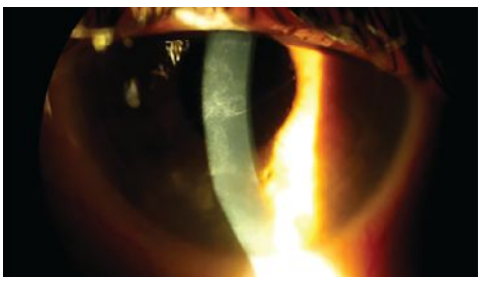

#01 OF SERIES

KERATOCONUS and CROSS-LINKING

Optometry's Role in the Patient Journey

Gloria Chiu, OD, FAAO, FSLS
Associate Professor
of Clinical Ophthalmology
USC Roski Eye Institute,
USC Keck School of Medicine
Los Angeles

KEY TAKEAWAYS

- Cross-linking with the only FDA-approved iLink® System can stop or slow progressive keratoconus.
- Early diagnosis and treatment are essential to preserve as much vision as possible.
- Optometrists are uniquely positioned to change lives and protect vision by identifying at-risk patients in the mild stages of the disease.

Keratoconus (KC) is a degenerative condition with onset in early adolescence. It is characterized by gradual thinning of the corneal stroma, causing a cone-shaped protrusion and worsening vision. As doctors of optometry, our top priority with these patients should be to manage their disease—and only secondarily to correct their vision.

A referral for corneal collagen cross-linking, which has been shown to halt progression in 92%-100% of cases[1], may be able to preserve vision. As with any surgical procedure, there is the potential for complications and cross-linking may not be right for everyone. After treatment, patients will still need regular optometric care. Follow-up care is similar to that required for PRK. However, there is no global period, so each follow-up visit is charged as a regular exam.

Without cross-linking treatment, progressive KC typically continues to worsen until around age 40 (and sometimes longer), with 10%-20% of cases requiring a penetrating keratoplasty (PKP).[2] When patients reach the advanced stages of keratoconus, it becomes a debilitating disease that affects every aspect of their lives. Worsening KC severity is associated with significant declines in reading, mobility, and emotional well-being quality of life (QoL) scores.[3] The impact on QoL can be even greater than that of retinal diseases and can be felt even when one eye still has good vision[4] so it is important that patients get help as early as possible.

In the U.S., when cross-linking is performed with the iLink® platform (Glaukos), the only FDA-approved cross-linking system, it is generally covered by insurance for 96% of those with commercial insurance. In a recent simulation model, treatment with iLink® was found to be highly cost effective, resulting in a 26% reduction in PKPs and patients spending 28 fewer years in the advanced stages of KC.[5] Young patients who can be treated early while their vision is still good have the most to gain.

That's where optometrists' role becomes so critical. Our awareness of early progressive KC signs and risk factors can be nothing short of life changing for that young myope in our chair. There is no need to wait until a patient has lost vision or has slit lamp signs (e.g., thinning or striae) to refer for a more in-depth KC evaluation. It is standard of care to intervene with cross-linking upon detection of progression.[6]

Advanced tomography/topography provides the most sensitive and accurate diagnostic information. However, there are a number of signs and symptoms that should heighten suspicion of KC and prompt further testing, either in the practice or by referral. These include myopic shift, rapidly changing astigmatism, vision that won't correct to 20/20 (with no other known reason), distorted mires on manual keratometry, and scissoring or an irregular retinoscopy reflex. Patients with a history of eye rubbing, connective tissue disease, Down syndrome, or a family history of KC are also at higher risk.

By promptly referring these patients for further testing and, if warranted, iLink® cross-linking treatment, optometrists are uniquely positioned to protect and preserve patients' vision over their entire lifetime. ▪

With Cross-Linking[5]

26% fewer PKPs | **28** fewer years in late-stage KC

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1. Koller T et al. J Cataract Refract Surg 2009;35:1358. **2.** Davidson AE et al. Eye (Lond) 2014;28:189. **3.** Tan JCK, et al. Cornea 2019;38:600. **4.** Kandel H, et al. Clin Exp Ophthalmol 2022;Epub ahead of print. **5.** Lindstrom RL et al. J Med Econ 2021;24:410. **6.** American Academy of Ophthalmology Preferred Practice Pattern, Corneal Ectasia, 2018

SCAN WITH PHONE
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Taking Monkeypox Seriously

Recognize the dermatologic and systemic signs and symptoms in a timely fashion.

By the time you read this, we'll likely know the significance of yet another virus, monkeypox (MPX). Human MPX presents with a smallpox-like disease, as both are orthopoxvirus infections. The virus is transmitted by broken skin in close or direct contact, respiratory droplets or bodily fluids and is believed to be amplified by sexual transmission networks.[1-3] Incubation after exposure is possible up to three weeks (generally seven to 14 days). So far, there have been reported outbreaks in over 50 different countries, including the United States.[2]

BACKGROUND

Recent reports of an MPX outbreak or its uptick in humans suggest changes in biologic aspects (mutations) of the virus and possible changes in human behavior.[1,4] Unfortunately, transmission, risk factors, clinical presentation and infection outcomes are not well defined.[2]

In one case series, monkeypox presented with a variety of dermatologic and systemic clinical findings.[2] The most common appears as initial skin lesion or lesions (macular, pustular, vesicular and crusted) primarily in the anogenital area, body or face, with the number of lesions increasing over time, either with or without systemic features.[2,3] Common systemic features during illness include fever, lethargy, myalgia and headache—symptoms that frequently precede a generalized rash.[2]

Identifying cases outside areas where monkeypox has traditionally been endemic highlights the need for quick identification to contain further spread.[3] Although unusual rashes do not cover the full range of possible manifestations, monkeypox should be on a list of differentials.[2]

Genital skin lesions and lesions involving the palms and soles may lead to misdiagnosis as syphilis or other sexually transmitted infections that could delay detection.[2,5] Throat or nasopharyngeal swab specimens taken from suspected skin or genital lesions are advised.[2]

ODs ON THE LOOKOUT

MPX virus is usually a self-limited disease with symptoms lasting two to five weeks, and supportive therapy is all that is necessary. Patients who experience more severe disease are or at risk for greater morbidity may be treated with oral antivirals such as tecovirimat cidofovir, brincidofovir and intravenous vaccinia immune globulin.[1,4,5] Data on effectiveness of any of these agents is limited. Containment is crucial and is accomplished by early identification. However, rapid identification is complicated by presentation of diverse signs and symptoms.[1-3,5]

Possible complications include periocular lesions, blepharitis, conjunctivitis and keratitis. Skin lesions around the eye may resemble varicella-zoster lesions.[4] Focal lesions on the conjunctiva and along the lid margin are generally seen with greater frequency among unvaccinated patients with confirmed MPX virus (nearly 25%).[4] Lymphadenopathy is a common finding similar to other viral diseases.[4]

MPX virus infection can result in severe corneal scarring that may require corneal trtansplantation.[1] Any ocular involvement is best managed with aggressive topical lubrication. Topical broad-spectrum antibiotics may be necessary for epithelial prophylaxis or bacterial superinfection.[1] Vaccinia is a similar viral infection, and reports suggest trifluridine may be helpful.[1]

Healthcare in-office transmission prevention is similar to suspected COVID infections. Patients should be isolated. Healthcare providers should wear personal protective equipment, and slit lamp shields may help with any spread. Office surfaces should be cleaned with hospital grade disinfectant.[6]

As healthcare providers, we need to recognize dermatologic and systemic signs and symptoms in a timely fashion and treat appropriately any ocular complications that might accompany the monkeypox infection. Both MPX virus and COVID have viral vectors and meaningful ocular complications. Let's hope this doesn't grab a hold in our communities and instead passes more like "dust in the wind." RCCL

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Thin but Strong

A corneal GP lens can be a good alternative in cases of soft lens overwear.

We've all had patients who wear their contact lenses for extended hours. In this case, my patient presented having worn his lenses for approximately 8,736 hours straight! Still, he noted good comfort and vision from these lenses, though some deposits were becoming noticeable and made him seek care. We ultimately chose to refit him into a GP lens design to optimize corneal health.

CASE PRESENTATION

A 43-year-old African American male presented to the clinic for a contact lens fitting OU. He had just seen our primary care service six days earlier and was prescribed spectacles which were on order. He stated he wore "hard contacts" that he was prescribed approximately one year prior at an outside practice. He reported that the lenses were causing itching symptoms. He admitted to wearing the lenses 24 hours a day, seven days a week—removing them just once per week to clean them. Cleaning consisted of lens removal and rubbing with an unknown lens solution followed by placing the lenses inside the case overnight. The lenses had never been replaced since they were obtained.

He had noticed deposits developing on the lenses over the last four to five months. He did not feel like his best-corrected vision was reduced but did complain of glare while driving at night. He did not currently have backup glasses. Entering VA was 20/50 OD and 20/50 OS with the patient's habitual lenses. Pupils, extraocular muscles and confrontation visual fields were all within normal limits. The patient was oriented to time, place and person and his mood/affect was normal.

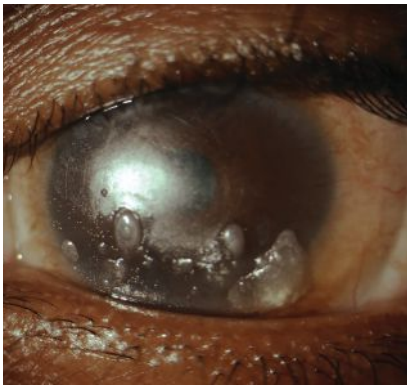

Fig. 1. Heavily deposited soft toric contact lens.

Contact lens assessment showed tight-fitting, well-centered, soft toric lenses with heavy central and inferior deposits and no movement OU (*Figure 1*). There was no over-refraction that improved vision in either eye. The lenses did not appear rotated. After lens removal, manifest refraction results were -10.25 -1.50 x 120 OD and -13.00 -3.00 x 095 OS with no improvement in best-corrected visual acuity (BCVA) from entering. Corneal topography revealed simulated keratometry values of 42.35/41.01@057 OD and 42.45/40.44@133 OS. Both maps showed steepening due to overwear of the steep-fitting lenses (*Figure 2*).

Upon further slit lamp examination, the lids and lashes were clear. Everting the upper and lower lids showed large palpebral conjunctival papillae and 3+ injection on both the lids in each eye. Corneal evaluation revealed peripheral corneal opacities OD>OS and central punctate sodium fluorescein staining OU. There was also extensive corneal neovascularization present at the limbus, 360° in each eye and greater inferiorly, presumably due to the patient's long history of soft toric lens wear and prior contact lens overwear (*Figure 3*).

The patient was diagnosed with giant papillary conjunctivitis OU, worse on the upper lid, from presumed contact lens overwear. He was started on prednisolone acetate 1.0% ophthalmic solution QID OU and advised to follow-up in two weeks for evaluation and intraocular pressure check. The corneal neovascularization was photodocumented for comparison at future visits.

New spherical corneal GP lenses were fit in a low mass ophthalmic design and a high Dk material. The patient was advised to discontinue wear of the habitual, heavily deposited soft toric lenses as soon as his

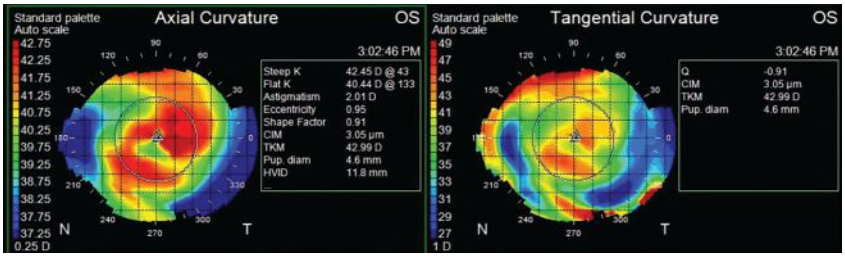

Fig. 2. Topography maps showing changes to tangential curvature consistent with a tight-fitting lens and associated corneal warpage. Note that the eccentricity value is abnormally high.

new spectacles arrive to allow for the corneal warpage to resolve. Of note, it takes approximately three weeks for warpage to resolve from soft contact lens wear.[1] In contrast, warpage from GP lens wear can take up to five months to resolve.[2]

LENS REFIT

New lenses were designed for the patient. Due to the degenerative myopia and low amount of corneal cylinder (<3.00D), we chose the Thinsite2 (Art Optical) spherical corneal lens design OU, as it has features particularly useful in patients with high ametropia.[3] The final parameters of the Thinsite2 lens designed was OD 7.9/9.5/-11.50DS and OS 7.9/9.5/-12.75DS in Boston XO fluorosilicone acrylate material. The lenses were ordered in green material OD and blue material OS, so the patient did not mix up the lenses. The lenses were ordered with a slightly larger 9.5mm diameter to further improve initial comfort.

The fit showed a well-centered lens with central alignment, mid-peripheral bearing and a minimally acceptable amount of edge lift with good centration and a lid attached fit (*Figure 4*). The lens was ordered, dispensed and followed-up over the new few months and the patient wore it successfully for the next year.

A GOOD OPTION

The Thinsite2 lens design was designed to fill the void left by the success of the low Dk Polycon II lens design—a low mass corneal lens that was able to retain rigidity and strength.[4,5] This specialized lens design features a posterior surface and an anterior surface with a spherical central optical correction zone, an aspheric intermediate zone and a peripheral zone.[4] The central optical zone of the anterior surface has a larger diameter than the central optical zone of the posterior surface. Also, the intermediate zone of the anterior surface has a larger diameter than the intermediate zone of the posterior surface.[4] These features are beneficial when applied to GP lenses made using high Dk materials.

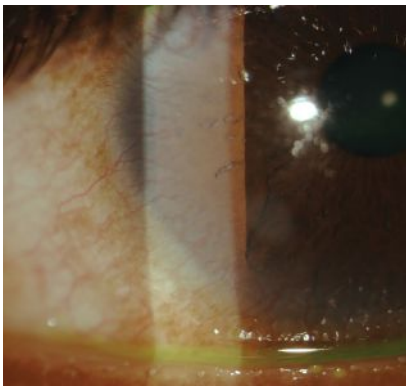

Fig. 3. Corneal neovascularization from overwear of a high-powered soft toric lens.

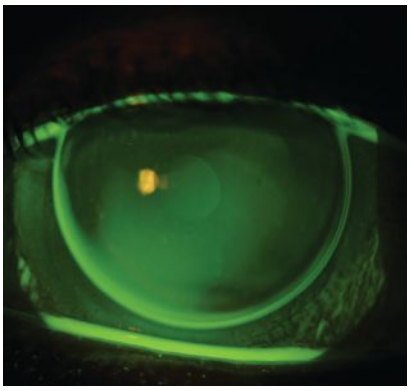

Fig. 4. Sodium fluorescein pattern of a high-minus gas permeable corneal lens fit.

Patients wearing corneal GP lenses often experience lens awareness, which is worsened by a lens with any significant amount of mass. Eyecare practitioners have sought to reduce the center thickness of these lenses to reduce their mass and increase their oxygen permeability; however, this can weaken the lens structure. These weaker lenses, while healthier for the patient, carry an increased risk of breakage, warpage and flexure.[4]

The Thinsite2 design's reduced lens mass allows for improved centration of the optical zone when compared with similar prescriptions in standard lens designs.[3] This ultra-thin design maximizes oxygen transmission for optimal corneal health—particularly important for patients with high ametropia. The lens is also manufactured with a junctionless aspheric front and back surface, which reduces lens-lid interaction as well as the patient's lens awareness. This eases patient adaptation, making this lens design a good option for any new GP lens fit or refit.[3] The added comfort was useful here as the patient was accustomed to the comfort of a soft toric lens. Despite a thin profile, the Thinsite2 lens's unique design is able to resist flexure and give an improved lens-to-cornea fitting relationship for higher prescriptions.[3] RCCL

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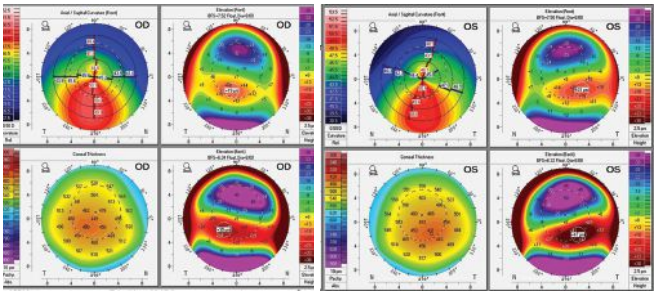
By Becky Su, OD, Marcus R. Noyes, OD, and John D. Gelles, OD

An Alternative Action Plan

When GPs fail, custom soft lenses may offer another option for keratoconus.

A 31-year-old male presented to the clinic with a history of keratoconus, treated with corneal crosslinking (CXL) several years ago. The patient also had a history of corneal gas permeable (GP) lens intolerance and was fit with scleral lenses, which were difficult for him to apply and remove, leading to discontinuation. The persistent irritation with rigid lenses and difficulty with handling raised interest in an easier, more comfortable alternative.

On initial presentation, best-corrected visual acuity (BCVA) with manifest refraction was 20/25- OD and 20/30 OS. Scheimpflug tomography showed a point of maximum keratometry of 50.1D OD and 50.4D OS and an IS ratio of 9.5D OD and 8.7D OS.



Corneal tomography of the patient's right and left eye.

CONSIDERATIONS

Here, we highlight how each of us would proceed in this case.

Dr. Su. Traditionally, corneal GP lenses have been the first-choice option in patients with irregular corneas, especially keratoconus. The varying severity of elevation and asymmetry can make GP fitting a challenge. These patients may experience poor comfort due to edge lift, apical bearing and poor stability, which can impact corneal health and result in complications with long-lasting effects such as corneal scarring. Additionally, lens decentration and small optic zones can lead to suboptimal vision. In these cases, scleral lenses can certainly help as they provide the visual benefits of a GP lens but with a larger optic zone and increased stability without touching the corneal surface, providing comfort and vision improvement.

That said, scleral lenses can be challenging for some patients due to the application and removal process. It is unsurprising that handling issues, such as in this patient, are among the main reasons for scleral lens dropout.

In this case, it is fair to start with a soft lens and assess the patient's visual potential. A custom soft lens is ideal for this patient as it has vast parameter customizations compared with the ready-made traditional soft contact lenses that typically fit the average "normal" corneal shape and depth. Changing the thickness of a custom soft contact lens also allows us to somewhat mask the elevations and asymmetry in an irregular cornea. Thus, a custom soft lens may provide adequate visual stability, comfort and centration. Other options to consider are a piggyback system using a soft lens to cushion the GP or hybrid lenses to maintain the optics of a GP lens while also increasing lens stability and comfort.

Dr. Gelles. In our clinic, we have found that keratoconus patients with low amounts of asymmetry, decently correctable with manifest refraction, are generally successful in custom soft lenses. Another option to consider is a hybrid lens; this could prove to be an excellent alternative for the patient before revisiting a corneal GP with a piggyback or scleral lens. I am always hesitant to repeat modalities the patient has tried in the past unless it is truly the best or only option.

Custom soft lenses for irregular corneas work by increasing the lens center thickness to reduce lens drape and mask mild irregular astigmatism. However, this modality is significantly compromised when it comes to Dk/t, with center thicknesses ranging from 0.2mm to 0.6mm and a lens made of a low Dk—typically 15 to 30—hydrogel material or a 60Dk silicone hydrogel material, creating a very low Dk/t. Following these patients on a six-month interval is prudent to monitor corneal health. Additional considerations for patients like this who have failed other contact lens options include surgical interventions.

A collaborative and comprehensive approach to keratoconus management has patients undergo CXL to prevent disease progression, specialty contact lens fitting to provide the best visual acuity and optional corneal contouring procedures to improve spectacle and uncorrected visual acuity. This combination of procedures and lenses differs for each patient based on their physiology and needs.

CXL has opened more surgical options, particularly excimer laser-based procedures that have

previously not been used due to the possibility of further biomechanically destabilizing the keratoconic cornea. Prior to CXL, the surgical options for a patient with contact lens intolerance were intracorneal ring segments or a corneal transplant, whether deep anterior lamellar or penetrating. Photorefractive keratectomy (PRK) procedures have become viable options when performed with CXL to increase biomechanical strength. These procedures can be performed sequentially or in combination.

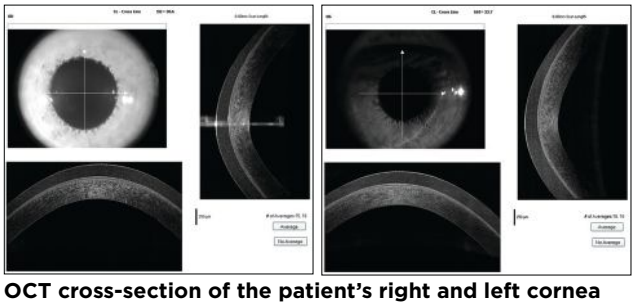
The goal of PRK procedures for keratoconus is not a full refractive correction but rather a targeted, tissue-sparing, topography-guided ablation to improve corneal symmetry and contour. Several studies have shown improvements in BCVA without disease progression, and in our clinic, we have seen this improved contour lead to improved outcomes with spectacles and less complex contact lens options. In this case, the patient has adequate corneal thickness and has had CXL. Should lens options be exhausted, the patient may be a good candidate for PRK. PRK in cases of keratoconus shouldn't be performed until ocular maturity is reached, and any patient undergoing this combination of procedures needs continued follow-up to monitor for progression.

Dr. Noyes. It can be easy to see patients like this and feel the urge to jump straight to GP or scleral lenses; however, we must remember that we are treating the patient's eye (as opposed to simply acting as "GP lens designers"), and we must do what is best for the eye/patient.

In milder cases of keratoconus, soft lenses are often an option, and custom soft lenses are able to provide many parameters to aid in fitting these eyes. In this case, custom soft lenses make a great starting point. When I come across this scenario in the clinic, I start with a soft lens and only make the jump to hybrid, GP or scleral if the patient does not have comfortable vision. Remember: if the patient's keratoconus progresses, you may still be fitting a specialty lens in the future.

DISCUSSION

Custom soft contact lenses are a good option for those with mild to moderate cases of keratoconus, especially with a history of GP or scleral lens intolerance. To address the irregular corneal shape, the central thickness of the soft custom lens is increased beyond the center thickness of a standard soft lens in an attempt to replicate the masking nature of a GP lens.



OCT cross-section of the patient's right and left cornea while wearing the custom soft lenses.

When the initial diagnostic custom soft contact lens is applied and allowed to settle, the physical fit is assessed, as is the visual potential through a spherocylindrical over-refraction.

Sometimes, patients may experience poor visual quality despite improved visual acuity and optimal lens fit due to lens drape and resultant higher-order aberrations. In these cases, lens center thickness can be increased to aid in a masking effect for these higher-order aberrations. Additionally, some visual symptoms can be addressed by changing the diameter of the optic zone of the lens.

As for the fitting relationship, these lenses can offer a variety of parameters for customization, the availability of which depends on the selected design. Some designs have multiple curves—a base curve to fit the cornea and a peripheral curve to control the movement and centration—and customizable diameters. For patients with mild to moderate keratoconus or a history of GP lens intolerance or scleral lenses dropout, custom soft contact lenses may allow for improved comfort, ease of handling and adequate visual correction.

RESULTS

The patient was fit with a 0.3mm central thickness custom soft lens for irregular corneas. He returned for application removal training, which was a success. The lenses were rotationally stable with adequate movement. He ultimately achieved 20/25+ vision OD and OS and was happy to have improved vision, comfort and ease of handling. RCCL

Dr. Su is the Cornea and Contact Lens Fellow at the Cornea and Laser Eye Institute (CLEI) Center for Keratoconus. She has no financial interests to disclose.

SCLERALS 101:

A PRIMER FOR LENS FITTING

Walk through how to best incorporate this modality into your practice.

By Maria K. Walker, OD, PhD, and Karen L. Lee, OD

Current scleral lenses present a remarkable modern option for refractive correction and ocular protection in a variety of distinct ocular indications. Firstly, they provide marked improvements in comfort and visual stability for individuals with irregular corneal astigmatism, the most common indication for scleral lenses (SLs) in the United States.[1-5] Additionally, SLs are increasingly being used to treat dry eye diseases as well as patients with "normal" corneas.[6-12] The decision to use a scleral lens begins with logical and basic decision-making to weigh benefits of using the device, and while specialists are certainly managing complex scleral lens fits, basic management can be practiced by any motivated eyecare practitioner. Here we will discuss the basic fitting considerations and techniques for entry-level management of patients with scleral lenses.

THE RIGHT OPTION

Scleral lenses are becoming readily available worldwide, and in the US alone there are over 20 manufacturers. Each of them has designed practitioner-friendly fitting sets and offer simple as well as sophisticated lens customizations to manage a variety of ocular shapes and conditions. This and the ease of obtaining high quality scleral lens education from free resources like the Scleral Lens Education Society (SLS) have made the accessibility of lens fitting expand to many practitioners over the past decade; the beginner need not be intimidated.

The first decision a practitioner must make is whether a patient can benefit from a scleral lens. This may seem obvious, but a common mistake is to think that all patients will have a perceived benefit from these devices. Critically weighing the benefits against the potential risks or downfalls of scleral wear before beginning the fitting process will save practitioners and patients time and energy. Scleral lens wearers typically come from one of three categories: the irregular cornea, ocular surface diseased and miscellaneous 'normal' category that encompasses high ametropia, presbyopia and other relatively normal conditions.

Irregular cornea. The most common SL indication in most practices is the irregular cornea, such as keratoconus and other ectasias.[4,5] Corneas that are highly irregular in shape (*i.e.*, have high differentials between the elevations and depressions on the anterior corneal surface) present a major challenge when fitting relatively small diameter corneal gas permeable (GP) lens, which have been the standard of care since the mid-20th century (*Figure 1*). Corneal GP lenses are supported by the shape of the cornea and often become unstable as disease severity increases.[13] Scleral lenses vault over the irregular cornea, landing on the conjunctiva overlying the sclera and largely avoiding the effects of an unstable lens.

Patients with lesser amounts of corneal irregularity often still prefer a scleral lens, which is surpassing the corneal GP lens as standard of

ABOUT THE AUTHORS

Dr. Walker and Dr. Lee are assistant professors at the University of Houston College of Optometry. Dr. Walker's PhD work centered on evaluating the inflammatory response of the eye to scleral lenses. The two are fellows of the American Academy of Optometery and the Scleral Lens Education Society.

care due to the improved visual stability and ocular comfort. Additional considerations when deciding if a scleral is the right choice for irregular corneas, as well as with other indications, are palpebral aperture size (larger is favorable, although not necessary, for lens wear), tolerability (*e.g.*, comfort), handling capacity (*e.g.*, ability to apply/remove), and overall motivation to manage these lenses that undoubtedly require more investment than other lens types.

In addition to corneal ectasias, individuals who have undergone corneal surgical procedures, such as radial keratotomy, LASIK or keratoplasties, who also often have irregular corneas, are likewise good potential candidates for scleral lens wear.

Ocular surface disease. Incorporating scleral lenses into an ocular surface disease (OSD) management strategy is usually more complicated than fitting irregular corneas. Although the fitting process is often straightforward when there is a normal ocular (*i.e.*, corneal) shape, managing OSD can be challenging. Scleral lenses are often not considered an initial therapy option for classic dry eye diseases, as many practitioners prefer more conservative approaches first, such as soft bandage lenses, topical lubricants or steroids, cyclosporine and punctal occlusion.[14] The DEWS II report agrees and recommends implementing scleral lenses after these approaches, likely due to the lack of evidence that these lenses are appropriate for the majority of patients in the mild to moderate classes of dry eye disease.[15]

For practitioners beginning with scleral lenses, we recommend approaching "dry eye" lens fits with caution due to their mixed efficacy. However, in severe disease, these lenses are essential and are often combined with the aforementioned therapies as well as autologous serum tears or amniotic membrane grafting in patients such as those with severe systemic pathologies including Sjögren's syndrome, ocular cicatricial pemphigoid, Stevens-Johnson syndrome or graft-vs.-host disease. These diseases often require comanagement with subspecialists including ophthalmology, rheumatology or oncology, and are out of the scope of this discussion of basic scleral lens management.

"Normal" cornea. Many practitioners are reporting fitting sclerals for "normal eye" indications, such as high ametropia, presbyopia and non-pathologic dry eye. While there are certainly patients who benefit from these lenses, there are no available studies on success rates of these lenses with normal patients, and scleral lenses are likely to be less comfortable than soft lenses in the normal population.[16] The normal patient who is interested in these lenses should be scrutinized to determine that the benefit (*i.e.*, vision, comfort) is greater than the risks, costs and inconveniences that sclerals can bring. For a beginning scleral lens fitter, we recommend that this group should be avoided until the practitioner feels comfortable with

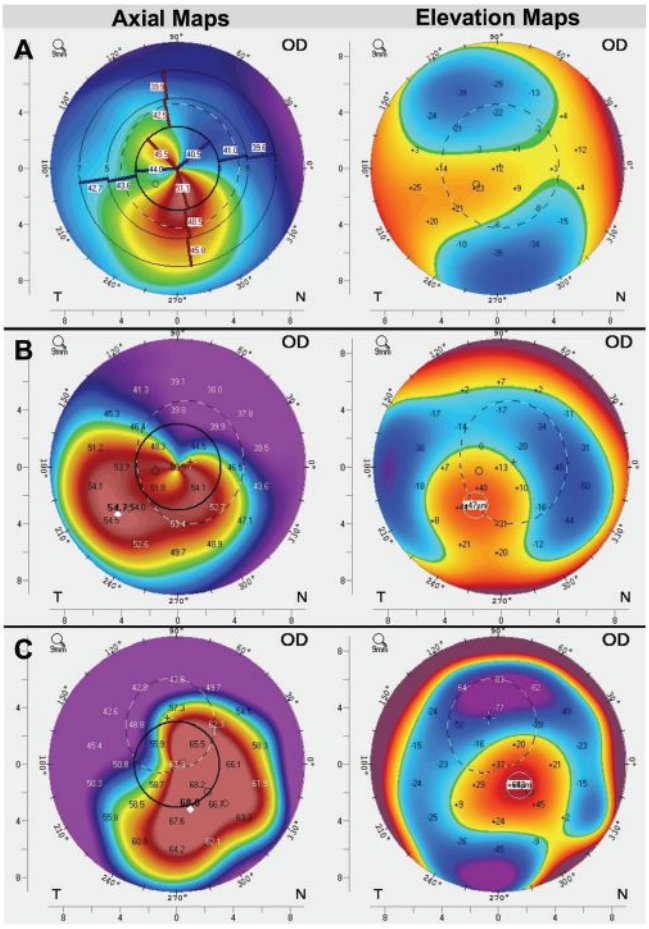


Fig. 1. Assess corneal elevation maps for scleral lens suitability. Here, corneal topography from three patients with irregular astigmatism shows one patient (A) with relatively mild elevation differences (~60um) and a relatively symmetric shape. Another patient (B) shows moderate elevation differences (~95um) as well as greater asymmetry, and a third patient (C) with severe elevation differences (~150um) as well as high amounts of asymmetry. Our rule-of-thumb is that if there is greater than about 90um of elevation differences between peak and trough on the cornea, scleral lenses should automatically be the priority choice. While all of these patients could be good candidates, patient B and C are particularly indicated due to high asymmetry and elevation differences on the anterior cornea.

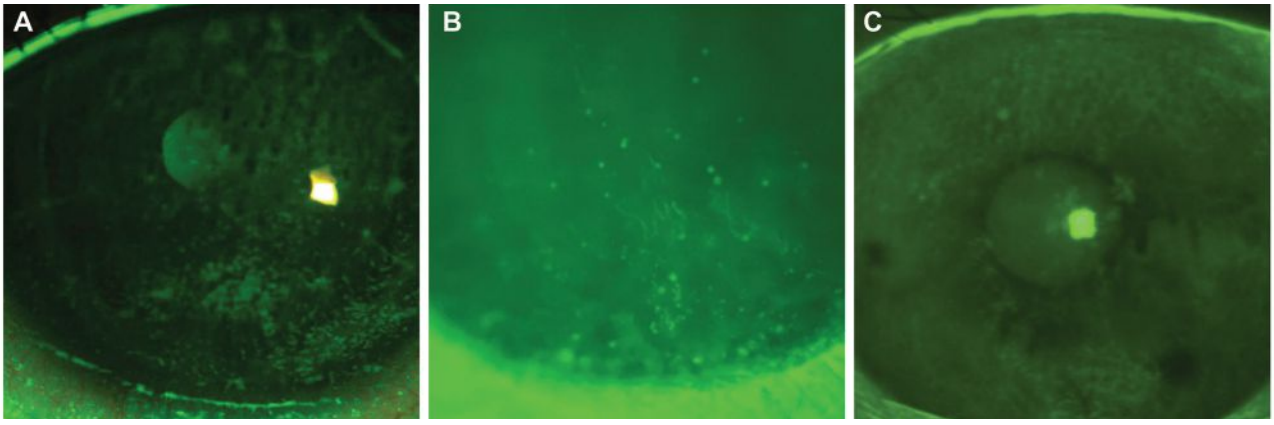


Fig. 2. In corneal staining post-lens removal, punctate staining is often observed after scleral removal, seen in a post-transplant patient (A) and to a lesser extend in a keratoconus patient (B). Epithelial bogging (C) is also a common finding that does not appear to have any adverse effect on the cornea but is not well understood. Each example was within the normal acceptable range for these patients but underlies the importance of baseline testing to monitor changes in staining.

their understanding of vision and comfort improvements that the lenses provide.

A PRIOR EVALUATION

Once a scleral is predicted to be the best option for a patient, evaluate and carefully document a baseline level of anterior segment and ocular surface disease. Corneal topography and a slit lamp to assess the ocular surface, including eyelid margin and palpebral conjunctival assessment, are all that are necessary for basic baseline testing. Documentation should include staining patterns, scarring, tissue thinning/thickening and all other normal and abnormal findings.

Many features of the ocular surface, such as tear parameters, staining and corneal curvature and thickness, have been shown to be altered post-scleral lens wear and thus should be carefully assessed prior to wear (*Figure 2*).[17-23] Especially when managing dry eye, features like tear volume, osmolarity, tear break up time, as well as symptom surveys (*e.g.*, OSDI, SPEED) can be helpful in the baseline assessment for lens suitability as well as in monitoring changes with scleral lenses.

FITTING A LENS

Let's consider the multiple-step process and different methods to fit a scleral on a patient.

Diagnostic fitting. This method has been streamlined with easy-to-use lens fitting sets and detailed guides providing step-by-step instructions. Start by choosing an appropriate lens diameter; this is often dependent on the horizontal visible iris diameter, palpebral aperture size and severity of disease. Larger corneal diameters with more severe disease may benefit from a larger lens (*i.e.*, >16mm), whereas patients with small palpebral apertures may require a smaller lens for ease of application. Note that these are common guidelines, but many practitioners develop a preference for one or two diameters and only use smaller or larger lenses for special cases. After selecting the lens diameter, the fitting guide should direct to a starting sagittal depth and or lens shape (*i.e.*, prolate vs. oblate) depending on the patient characteristics.

Slit lamp assessment and (optional) OCT. Once the diagnostic lens has been selected, clean and condition it well and apply to the eye using preservative-free saline and add sodium fluorescein to visualize the fluid reservoir. Confirm that no application bubbles are present, the lens is wetting properly and that the cornea appears adequately vaulted by viewing the eye in low mag, full illumination cobalt blue light (*Figure 3*).

After that initial assessment, the amount of lens vault and the apposition of the landing zone can be more specifically evaluated. A high illumination, white light optic section is the best at determining corneal vault (*Figure 4*). Aim for approximately 250µm to 300µm of initial vault pre-lens settling, as scleral lenses will settle into the conjunctiva and vault will be reduced. While the amount of settling is variable among different lens designs and eyes, practitioners should anticipate at least 75µm to 100um settling, about 50% of which will likely occur within the first hour.[24-28]

To assess the landing zone, low magnification, dim white-light is the best technique to evaluate vessel blanching, edge-lift and other subtle landing zone findings. The scleral lens should land on the conjunctiva outside of the limbal margin and should have minimal

impingement of conjunctival blood vessels. Many patients will need a toric- or quadrant-specific landing zone to accommodate toric or asymmetric scleral curvatures; therefore, fitting sets often include lenses with toric landing zones, which can be useful to determine how a toric lens will rotate on the eye and where the relatively flat and steep meridians lie.[29-31]

Areas of uncertainty when assessing the scleral lens fit using the slit lamp can be more precisely evaluated using anterior segment optical coherence tomography (AS-OCT), which provides a high-resolution view of the lens-to-cornea relationship in primary and extreme gazes. This technique can be helpful in providing exact measurements of corneal vault and revealing subtle edge misalignments but is not essential for a beginning scleral lens practitioner.

Empirical fitting. The advent of scleral topography (*i.e.*, profilometry) has paved the way for empirical scleral fitting and is especially beneficial when fitting an eye with prominent conjunctival elevations or rotational asymmetry.[30,32]

Scleral shape data drives the lens customization process and is directly transmitted to manufacturers who can design more precise toric or quadrant-specific curvatures and even more advanced freeform lens designs.[29,31,33,34] When using this type of fitting system, an initial profilometry scan is taken and a diagnostic lens is applied to determine the over-refraction. This data is sent to the lab where the lens shape is designed using software and power is determined based on the over-refraction.

Empirical scleral lens fitting can reduce chair time and may become the predominant method of choice as scleral profilometry becomes more readily available. While this could be quite useful for beginners in lens design, is not essential and should not be considered necessary for a basic scleral fitter.

Refractive considerations. Determining the scleral lens power during the fit is similar to that done with other diagnostic lenses. Although empirical power determination is possible with normal corneal shapes, the calculations are not reliable for irregular corneas. Best practice is to apply a diagnostic lens to the eye to determine the lens power. Spherocylindrical over-refraction should be done, but we recommend starting with the spherical equivalent power in the first lens order unless the residual astigmatism is convincing (*e.g.*, >0.75D with a strong visual improvement). When in doubt, order a spherical equivalent first, and front surface toricity can be added to the lens after post-settling lens rotation is established.

Although it is possible, our experience is that flexure is rare with scleral lenses in the currently available materials and standard lens thicknesses. More commonly, lens decentration, which will typically be greatest when there is high nasal-temporal scleral asymmetry or excessive lens vault, can induce aberrations that will be reduced if better centration can be achieved (*i.e.*, using toric, quadrant-specific, or other advanced landing zone technology).[6]

TIPS FOR INITIAL FITTING:

- Apply a scleral lens to the eye early in the decision-making process to gauge patient tolerance and ease of fit.
- Use proparacaine if there is any difficulty with applying the lens.
- To get a dry diagnostic lens to wet properly on the eye, best practice is to clean well with a (sudsy) surfactant cleaner followed by a short soak in conditioner.

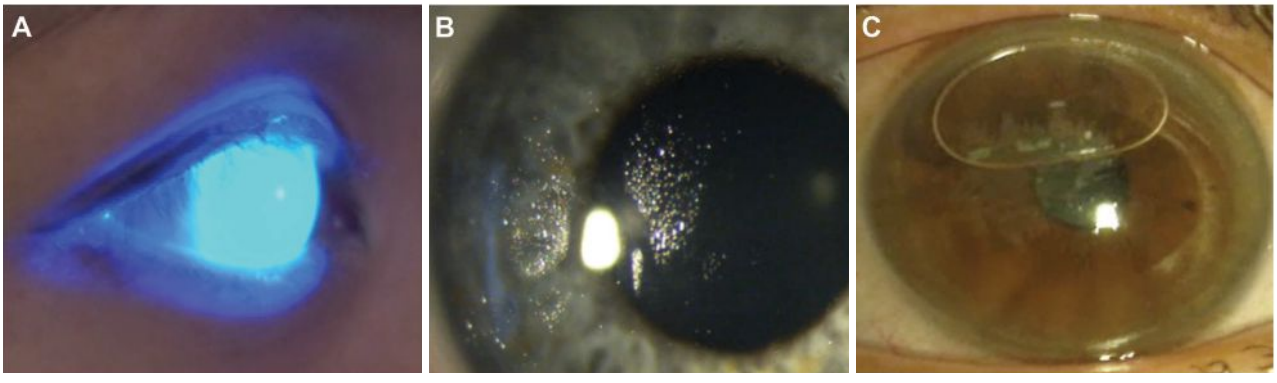


Fig. 3. When using sodium fluorescein for an initial assessment of a scleral lens on the eye, a widefield, low mag view of the lens in cobalt blue light (A) will allow a first view of the lens fit, which appears adequate here with no areas of darkness that would indicate touch or a bubble. This can be observed using a slit lamp or using a handheld light source. Non-wetting lenses (B) and application bubbles (C) are common and can often be viewed outside of the slit lamp. Both indicate that a lens should be removed, reconditioned if needed, and reapplied carefully.

- When first starting with scleral lenses, if there is no scleral topography available, avoid using quadrant specific landing zone designs unless there is a very obvious need for one. Toric landing zones are much easier to troubleshoot and manage.
- Perform retinoscopy over the lens to determine the best starting point for over-refraction, which will improve refractive efficiency and allow a deeper understanding of the amount of irregularity that the lens is truly masking (based on the quality of the reflex).

DISPENSING AND MANAGEMENT

Scleral lenses are customarily ordered at the completion of the fitting visit and the customized lens is dispensed at a follow-up visit scheduled one to two weeks later. This period is a good time to direct the patient toward materials to learn about wearing SL and the process of application and removal. The SLS has several fitting videos and resources for patients (www.sclerallens.org). Additionally, patients can be directed to social media platforms, blogs and other online resources that can be helpful to connect them with peers and prepare them for wearing SLs.

The purpose of the dispensing visit is to confirm that the lenses are a good starting point, teach application and removal and hopefully dispense the scleral lens to the patient. In addition, a specific plan for lens hygiene should be developed. While many practitioners develop preferences for certain disinfection, conditioning and application solutions, is it good to remember that at least some personalization for different patient attributes must be considered.

We recommend starting with a peroxide or one-step multipurpose cleaner for disinfection and conditioning, along with an available preservative-free application solution. The lens care routine should be re-evaluated and changed as needed at each follow-up visit to determine to best plan for each patient.

FOLLOW-UP

The follow-up schedule for scleral patients is somewhat specific to the disease being managed. During the initial fitting process, a patient should be monitored one to two weeks after initial dispense, sooner for patients who are high-risk or who are having difficulties

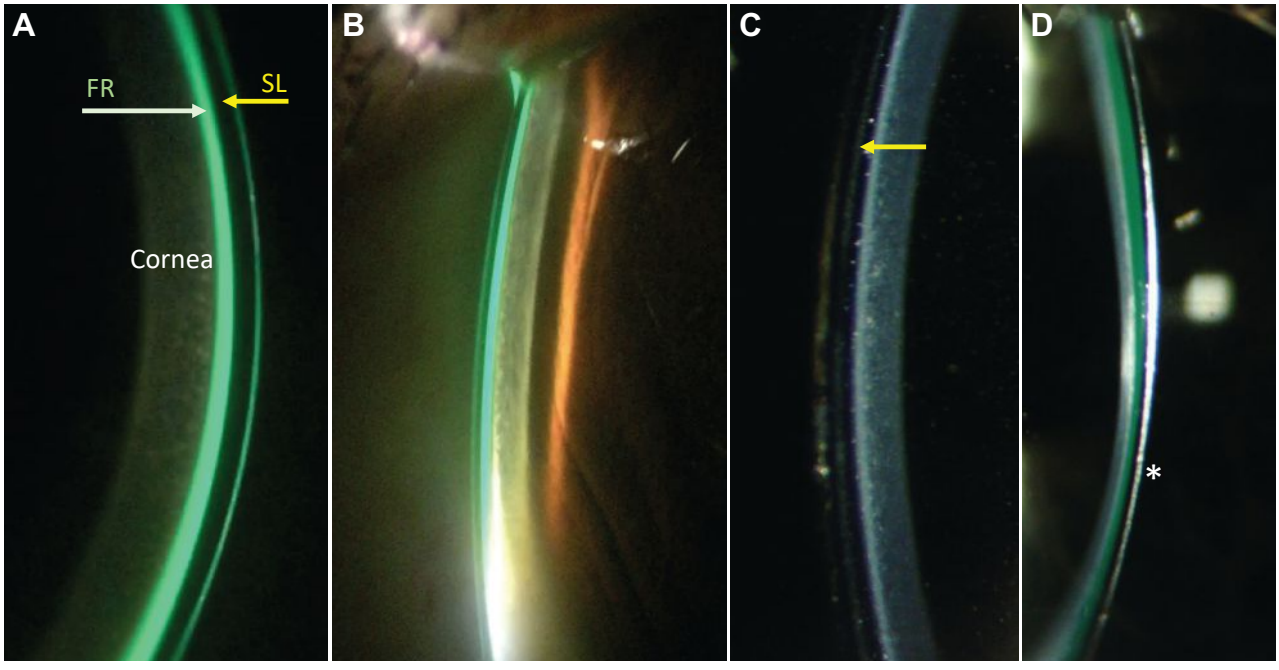


Fig. 4. To evaluate corneal vault in scleral lenses, measure the vault of a lens using a high illumination, medium/high magnification, optic section white light. Starting with the central cornea, estimate the lens vault by comparing the thickness of the lens to the fluid reservoir, labeled in (A) showing that the vault is approximately 150um superiorly (*i.e.*, half the lens thickness), and slightly greater, approximately 200um, inferiorly. The optic section can be moved out toward the limbus (B) to likewise estimate the corneal vault. As an observer becomes more experienced they will gain proficiency in assessing the vault without sodium fluorescein in the fluid reservoir (C), where the back surface of the lens (arrow) can be detected best with the same slit lamp optic section technique. In highly irregular corneas such as keratoconus (D), the asymmetry of the vault may be more apparent with the lowest vault usually occurring at the apex of the ectasia (star).

with the application or removal process, and then again a few weeks after the final lens has been dispensed for a final check. It is not uncommon to need several additional visits between to modify lens power and parameters; most lens manufacturers have at least a 90-day warranty in which three or more lenses can be made with modifications until the final lens is determined.

Once established, SL wearers can often be monitored yearly, although some should be monitored at bi-annual or more frequent intervals to manage their underlying disease. Scleral lenses should be replaced every one to two years, although in some cases they can last longer if maintained well.

Testing at the follow-up visits are also somewhat disease-specific but should be considered for all scleral wearers. Patients should always be asked to apply their scleral lenses at least four hours before coming in for all follow-up visits, and the ocular surface should be assessed for staining and compared with the baseline.

In initial wearers, we recommend re-measuring corneal topography and intraocular pressure immediately after removing lenses, since these sensitive outcomes can be affected.[35-37] Refer to the many resources on management of scleral lens complications for a more thorough description of the problems that can occur with sclerals and how to manage them.

Scleral lens fitting is rewarding for both patients who wear them and the eye care practitioners who manage them. Through this guide on basic scleral lens management, we hope to help novice practitioners gain confidence with scleral lens management and bring these remarkable devices to patients in their community that can benefit from their use. RCCL

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ADVANCED AND ADDITIONAL USES OF SCLERALS

Insights into the future of this modality.

By Melissa Barnett, OD, and Lynette Johns, OD

Scleral lenses have myriad indications beyond the correction of irregular astigmatism. Sclerals are commonly used for rehabilitation of the ocular surface, even in cases of severe exposure and non-healing epithelial defects. Since scleral lenses are rotationally stable with minimal movement with blinking, they are currently being used as a stable platform for a range of optical applications.

DRUG DELIVERY

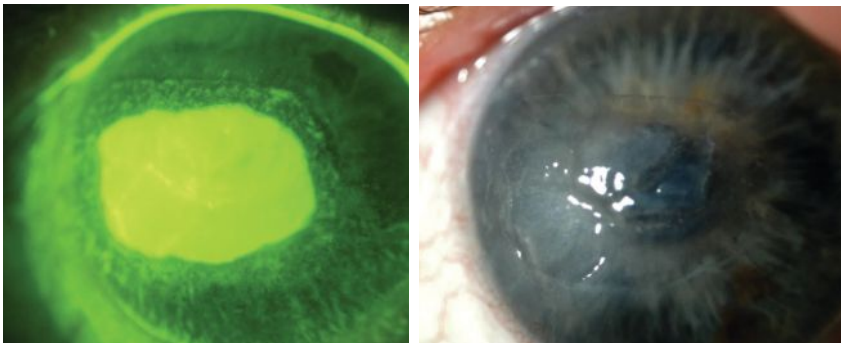
Scleral lenses for this purpose are an exciting possibility that can have far-reaching benefits across a multitude of ocular conditions. Interestingly, it is not a new concept. One of the first reports of using modern gas permeable scleral lenses as a vehicle for therapeutic topical drug delivery and antibiotic prophylaxis was described in 2000.[1] They noted that fluorescein applied to the surface of the lens slowly seeped into the post-lens fluid reservoir and remained up to 24 hours later. Tear dynamics and scleral lenses were even studied in the early 1970s and referenced the phenomenon of fluorescein entrapment from work done in 1952.[2] In fact, many studies have examined the turnover rate of fluorescein, or lack thereof, especially when it comes to midday fogging.[3-6] This quality of slow turnover of tears underneath a scleral lens suggests that the drug may maintain its constant ocular contact during the entire duration of scleral lens wear with minimal loss.

Constant contact of topical ocular medications is an ideal situation, especially considering that most of the ocular medications are lost to drainage after 15 to 30 seconds.[7] The tear turnover rate is approximately 16% per minute. Therefore, all of the drug should disappear within ten minutes after initial administration. Furthermore, the instilled drop is diluted to approximately one-third of the original strength—that is, if the drop even makes it onto the ocular surface.[8] Compliance is always an issue with all forms of prescription medications, and ocular medications are no exception. Correct application of topical ocular medications is not always properly performed.[9-11] There are a variety of limitations to the optimal usage of topical medications. Patients with poor dexterity, hand tremors and problems with grip may make the administration of medications challenging. Topical medications may require more frequent administration and doses can easily be missed or forgotten even under the best intentions and circumstances. Therefore, single administration of topical medications in the reservoir of a scleral lens seems like an ideal solution as long as the patient can successfully apply the lens.

ABOUT THE AUTHORS

Dr. Barnett is a principal optometrist at the UC Davis Eye Center. She is immediate past chair of the American Optometric Association's Contact Lens and Cornea Section, past president of the Scleral Lens Education Society, a Fellow of the American Academy of Optometry, a Diplomate of the American Board of Certification in Medical Optometry, a fellow and global ambassador of the BCLA and a board member of the GPLI. Dr. Barnett has consulting and/or lecturing relationships with ABB, Acculens, Bausch + Lomb, Contamac, CooperVision, EveryDay Contacts, Johnson & Johnson Vision Care, SynergEyes and Tangible Science, among others.

Dr. Johns practices at Massachusetts Eye and Ear and is a research associate in the department of Ophthalmology at Harvard Medical School. She is a fellow of the American Academy of Optometry, Scleral Lens Education Society and the BCLA. She has no disclosures.



One study reported treating longstanding retinal pigment epithelial detachment with extended-wear scleral lenses using moxifloxacin in the scleral lens reservoir, and none of the eyes developed microbial keratitis.

In the literature, there have been examples of drug delivery with scleral lenses. Extended wear of scleral lenses was used to resurface persistent epithelial defects. In the first retrospective review of epithelial defects, there were four cases of microbial keratitis in 19 eyes with a variety of antibiotics used including ciprofloxacin, ofloxacin, trimethoprim polymyxin B sulfate, and polymyxin B gramicidin.[1] Subsequently, twenty eyes with epithelial defects were treated with extended wear using moxifloxacin in the scleral lens reservoir, and none of the eyes developed microbial keratitis.[12] The advantage of using moxifloxacin, a fourth-generation fluoroquinolone, is that it is self-preserved, with no added preservatives that can be toxic to the corneal surface.[13] This is consistent with the importance of using non-preserved filling solutions in the scleral lens reservoir.

The treatment of persistent epithelial defects with scleral lenses using antibiotic (moxifloxacin) prophylaxis was published in different case series studies.[14-16] Additional supplements were also administered in the lens including autologous serumand amnion in some cases.[16]

Scleral lenses have also been used to deliver compounded preservative-free bevacizumab, which is a recombinant, monoclonal antibody that binds to and deactivates vascular endothelial growth factor (VEGF). Topically, bevacizumab has been used to reduce active neovascularization and improve comfort in patients with Stevens-Johnson syndrome.[17] Drug delivery of bevacizumab for corneal neovascularization was first reported in 2009 in five patients with success.[18] Later reports looked at long-term status of 13 patients where only one patient had progression of neovascularization.[19] While it has been shown to be successful, great care must be taken when using bevacizumab due to complications of poor wound healing and systemic absorption of the medication.

In animal studies, drug delivery of ofloxacin demonstrated corneal and aqueous humor concentrations higher than the minimum inhibitory concentration for *Staphylococcus epidermidis*, *Staph. aureus*, *Haemophilus influenzae*, *Streptococcus pneumoniae* and *Pseudomonas aeruginosa*.[20] Cultivated adipose-derived stem cells were cultured on the back surface of scleral lenses and administered to rabbits with alkaline burns. Those treated with the stem cells had less neovascularization, no symblepharon formation and less haze.[21]

This is an exciting time for the potential uses of scleral lenses for drug delivery, but there is a need for research in this area. The current

Where to Turn for Scleral Lens Fabrication

By RCCL Staff

There are over a dozen US scleral lens manufacturers to choose from, depending on the needs of your patients. Whether you're already fitting sclerals or just now ramping up to add the modality, check out the list of labs below that currently manufacture scleral lenses. The names listed after each company represent the person of contact for inquiries on product offerings or sales.

ABB Optical Group: Andy Jackson, Ann Shackelford

AccuLens: Troy Miller

Advanced Vision Technologies: Keith Parker

Alden Optical: Sam Ewing

Art Optical Contact Lens: Jill Anastor

Blanchard Contact Lens: Jean Blanchard

BostonSight: Sara Yost

Custom Craft Lens Service: Daren Nygren

Essilor Custom Contact Lens Specialists: Jeff Birk

Metro Optics: Steve Webb

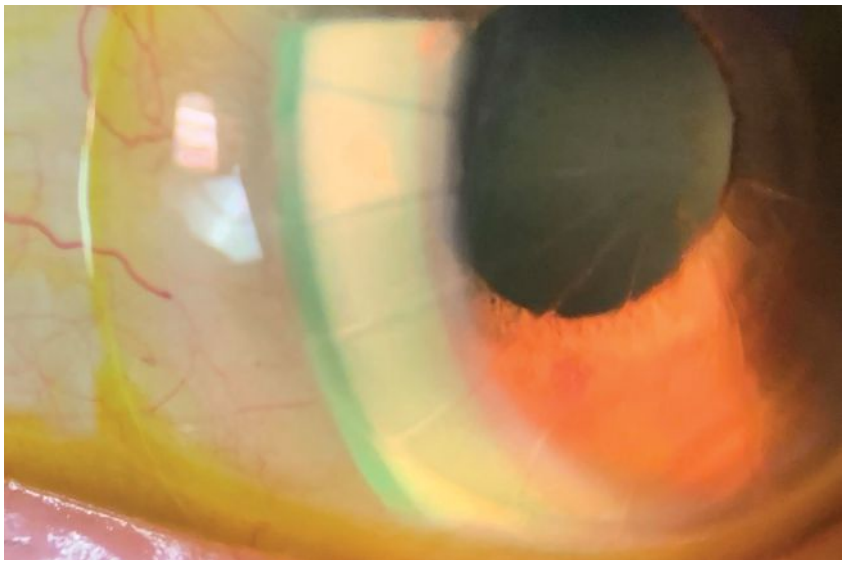
TruForm Optics: Jan Svochak, George Mera

Valley Contax: Josh Adams

Visionary: Cindy Belliveau

Visionary Optics: Monica Sanders

X-Cel Specialty Contacts: Derrell James



Studies have reported on the use of anti-VEGF agents in the bowl of a scleral lens to treat corneal neovascularization.

topical drugs applied in the scleral lens reservoir are diluted with the filling solution. The appropriate concentrations of medications must be determined, and the length of exposure may also need to be examined. Furthermore, some of the medications themselves may be toxic to the corneal surface. Despite these considerations, the potential to treat a variety of ocular conditions and reduce concerns about compliance is exciting.

AUGMENTED REALITY

One innovative new technology developed by Mojo Vision is a smart scleral lens that features augmented reality (AR).[22] A 14,000 pixel-per-inch MicroLED display measuring less than 0.5mm in diameter with a pixel-pitch of 1.8µm provides a small and dense display. The Mojo lens has custom application specific integrated circuit designs that incorporate a 5GHz radio and an ARM Core M0 processor that transmit sensor data off the lens and stream AR content to the display. A custom-configured accelerometer, gyroscope and magnetometer continuously tracks eye movements, so that the AR imagery is stable with eye movement.

The lens is controlled with a unique and intuitive interface based on eye tracking that allows users to access content and select items using the natural movement of the eyes. The anatomy of this lens includes an optic zone, transition zone and landing zone similar to commercially available scleral lenses. The technology may also help presbyopes so that they may experience sustained clear vision at all distances as well as patients with low vision.

ELECTROLYTE-SENSING LENS

It is well established that dry eye disease is complex in its etiology and management while also being debilitating to patients. Scleral lenses are often used as a palliative treatment for dry eye and severe ocular surface disease, but with sensor integration, they may become diagnostic as well. One study reported on a unique scleral lens that can measure pH, sodium, potassium, calcium, magnesium and zinc levels.[23]

A carbon dioxide laser ablated the scleral lens and created microconcavities, and the sensors were fluorescent probes for the electrolytes. A silicone hydrogel film was bonded to the lens to create a sealed and leakproof lens that protected the probes from evaporation. The electrolytes that were measured were free to diffuse through the system. By using a combination of LEDs, optical filters and an imaging unit, the concentrations and pH were able to be quantified.[23] The ophthalmic system allows the assessment of dry eye severity stages and the differentiation of its subtypes. Hopefully, this technology will become readily available to assist the diagnostic process of dry eye disease.

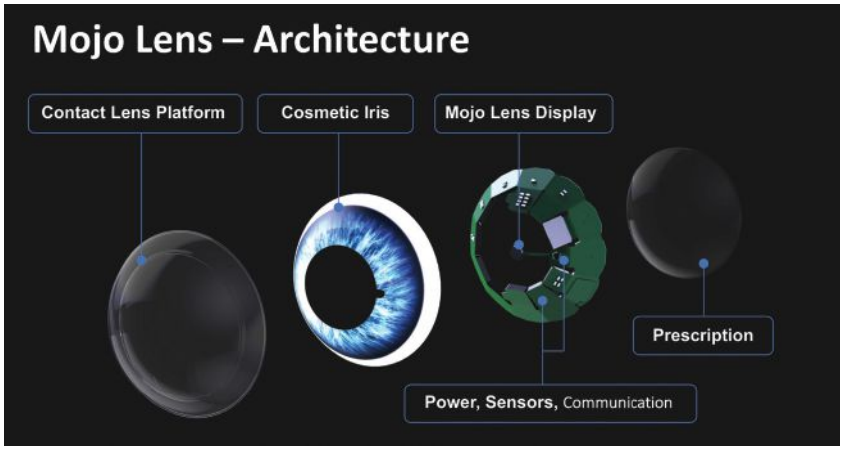


Photo: Mojo Vision

This scleral lens in development uses an LED display to incorporate AR into a patient's vision.

Resources for Scleral Fitting

Scleral lenses have been gaining momentum and popularity; however, just like their size, they may be intimidating. There are many resources available to practitioners with all levels of experience. A comprehensive textbook, *Contemporary Scleral Lenses: Theory and Application* that we've developed details the extensive history of scleral lenses, examines all of the indications for use and describes scleral lens shape as well as ocular shape. Readers will learn how to assess the fit of scleral lenses and recognize complications. Troubleshooting scleral lens problems, practice management, and a wide variety of topics are included in this textbook.[1]

Another valuable textbook was written by Daddi Fadel entitled *Scleral Lens Issues and Complications: Their Recognition, Etiology and Management*. She explores the use of different dyes in the assessment of scleral lens fits, scleral shape evaluation using diagnostic lenses and slit lamp evaluation. Various scleral lens issues and complications from ill-fitting relationships , handling and patient compliance are described and clinical pearls to troubleshoot these problems are provided.[2]

There are three informative and introductory scleral lens guides that are available for free download. "A Guide to Scleral Lens Fitting" by Eef van der Worp was one of the first modern scleral lens resources written in 2010. It is still available for download in numerous languages.[3] To date there are over 38,000 downloads of this original guide and resource. The guide had since been updated in 2015.[4]

Melissa Barnett and Daddi Fadel collaborated on a "Clinical Guide to Scleral Lens Success." This guide can also be downloaded and is available in English, Italian, Portuguese, Russian and Spanish and has numerous photos of scleral lens fits and complications.[5]

The "Scleral Lens Fit Scales" is a valuable tool that is available for download from Ferris University Michigan College of Optometry that is both in English and Spanish. The images demonstrate set amounts of clearance ranging from 50µm to 600µm. Images of fitting relationships of the landing zone and edge relative to the conjunctiva are also demonstrated in this resource.[6]

"The Scleral Lens Education Initiative" is a downloadable scleral lens e-resource featuring published research, evidence-based clinical recommendations and expert-backed insights.[7] Clinically relevant information is applicable to practitioners with all levels of experience.

The BCLA CLEAR scleral report provides a brief historical review of scleral lenses and a detailed account of contemporary scleral lens practice including common indications and recommended terminology.[8] The report illustrates recent research on the ocular surface in addition to a comprehensive account of modern scleral lens fitting and on-eye evaluation. This report summarizes the latest research and clinical understanding of scleral lens fit assessment.

The Scleral Lens Education Society (SLS) has numerous resources on their website (sclerallens.org). Patients can be directed to an instructional video teaching them about proper application and removal of their scleral lenses. There is a practitioner locator for scleral lens practitioners that have earned their fellowship in the organization. For practitioners, there are videos and fitting tips. It is free to join and access the resources on the site.

The Gas Permeable Lens Institute website, gpli.info, is an educational resource for all types of gas permeable and specialty contact lenses—including scleral lenses. The site offers resources on billing and coding medically necessary contact lenses, archived videos and webinars. It also has printed materials including application and removal laminated instructions for the office and patients.

On Facebook, there is a dedicated group called the Scleral Lens Practitioners that welcomes everyone interested in scleral lenses. Colleagues collaborate with one another, sharing their experiences and seeking advice for interesting and complicated cases.

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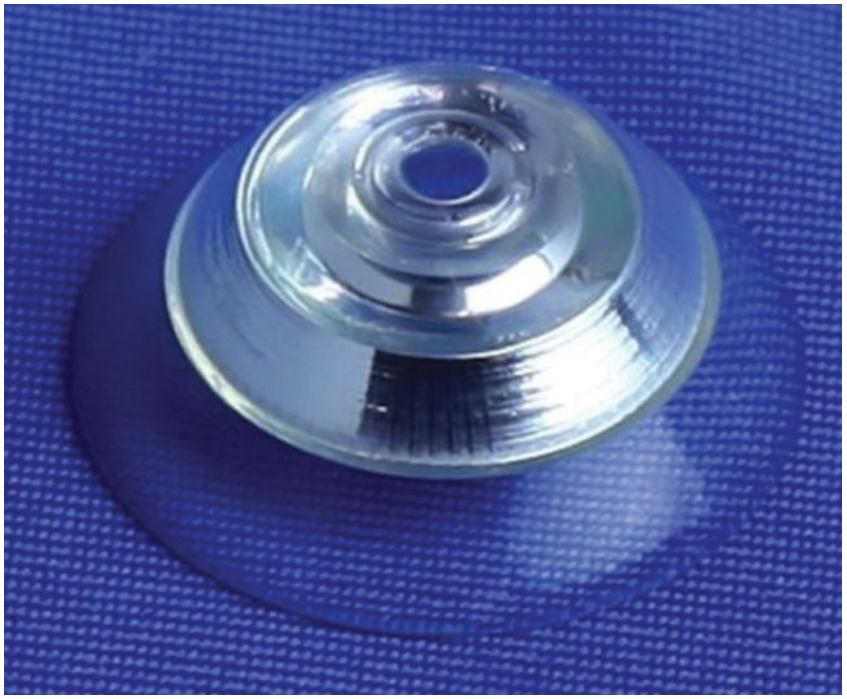

Photo: Jacobs School of Engineering/University of California San Diego

An image of a scleral lens telescope.

SCLERAL LENS TELESCOPES

Contact lens reflecting telescopes are an alternative to spectacle-contact lens refracting telescopes, which eliminate the need for a high-powered spectacle lens.[24] A combination of mirrors called a Cassegrain reflector and polarizers embedded within a scleral lens allows the wearer to alternate between distance refractive correction and 2.8x magnification triggered by a forced blink sensed by a detector mounted on a pair of spectacles, which alters the polarization state of the spectacles.

A scleral lens including a reflecting telescope is currently under development, to provide up to approximately three-times magnification and does not require a high-powered spectacle lens objective.[24-26] The proposed lens design has a total lens thickness over 1,000µm. Thus, providing adequate corneal oxygenation during lens wear remains a design challenge to minimize corneal hypoxic stress.

Many patients and practices today can benefit from fitting scleral lenses, which can be improved further upon and solve many issues. Sclerals may function as an ideal drug delivery system to provide a therapeutic level of drug to the desired target tissue. We are one step closer to incorporating augmented reality and contact lens telescopes to assist our patients' vision. The future of this modality is bright, as many researchers and innovators continue to demonstrate the amazing uses it can provide in the modern era. RCCL

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TAKE A SCLERAL LENS VIRTUAL WORKSHOP

Let's work through several cases to better understand how to navigate common challenges that can arise during the fitting process.

By Manveen Bedi, OD

Scleral lens fitting can appear daunting at first; however, if a systematic approach is taken, it can become easier to fit patients more successfully. Various challenges may occur during the fitting process such as midday fogging, conjunctival prolapse, suboptimal lens clearance over the cornea and conjunctival lumps and bumps. Here, we will cover a few cases and address how to overcome fitting challenges that may arise. Be sure to look for the videos of these cases online, too!

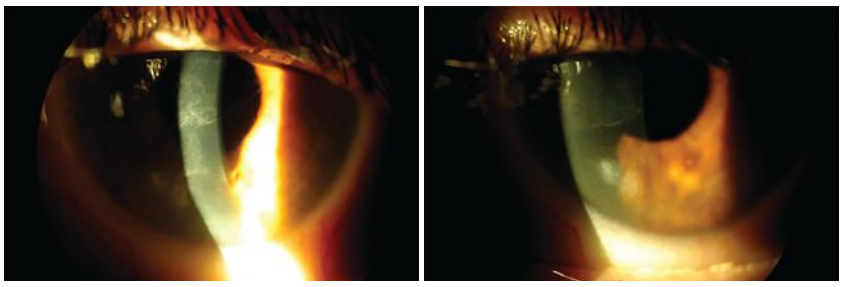

Fig. 1. Slit lamp images of the left eye show central haze on the corneal surface from recurrent epithelial defects and EBMD (left). The image on the right shows a Salzmann's nodule located inferior nasally on the left eye.

MIDDAY FOGGING

This side effect occurs when there is excessive debris buildup in the scleral lens reservoir resulting in reduced vision as the day progresses. These patients typically complain of blurred vision in the middle of the day with the need to remove and reapply the lens for better vision multiple times throughout the day.

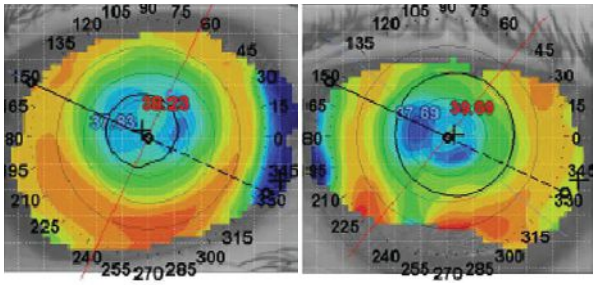

Fig. 2. Topographical images of the right (left) and left eye (right).

Case 1. A 56-year-old female patient was referred to the clinic for a scleral lens fitting. She had a long-standing history of epithelial basement membrane disorder (EBMD) and Salzmann's nodular degeneration in both eyes. Her surgical history was positive for LASIK and cataract surgery. She had undergone successful cataract surgery in the right eye; however, she had complications in the left including a retinal detachment and a subsequent pars plana vitrectomy. She had a resulting surgical pupil and a neurotrophic cornea (*Figure 1*). With recurring epithelial defects in the left eye that were unresponsive to traditional lubrication therapy, she was referred to a corneal specialist for a scleral lens fitting for corneal rehabilitation.

ABOUT THE AUTHOR

Dr. Bedi's optometry practice in Mississauga, ON, focuses on specialty contact lens fitting for corneal pathology, dry eye management and myopia control. She is a Fellow of the Scleral Lens Society and the American Academy of Optometry. She has no relevant financial interests to disclose.

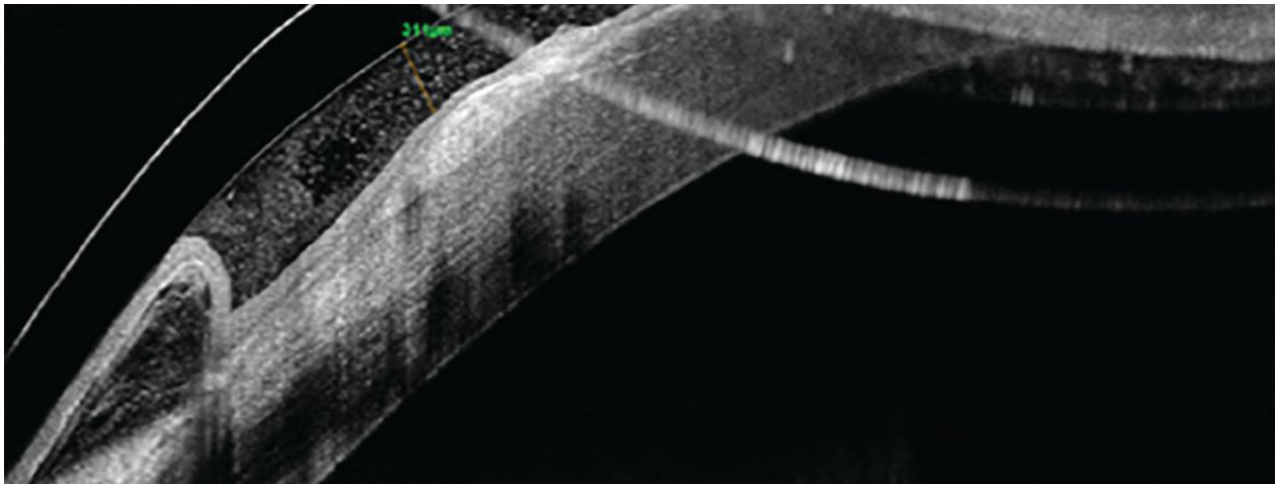

Fig. 3. Excessive conjunctival tissue over the limbal region with fogging in the tear chamber.

The patient had an uncorrected visual acuity of 20/25 OD and 20/30- OS. The pupil was reactive to light and had no afferent pupillary defect OD and was fixed and dilated OS. Topography revealed central corneal flattening consistent with the history of LASIK surgery in both eyes and midperipheral irregularity secondary to a Salzmann's nodule in the left eye (*Figure 2*).

An oblate scleral lens was fitted in the left eye to treat the persistent epithelial defects and preserve corneal integrity while improving visual acuity. With the initial lenses, there was significant conjunctival prolapse and midday fogging (*Figure 3*).

Conjunctival prolapse can act as an "oxygen sink" and reduce oxygen supply to the tissue underneath. This can propagate neovascularization in the corneal tissue. In addition, conjunctival prolapse can introduce debris from the eye surface causing midday fogging.

Overall, there are a few ways to address midday fogging:

- Reducing limbal and midperipheral clearance can help reduce negative pressure that results in debris entrapment underneath the lens surface. This also helps with reducing prolapsed conjunctival tissue.
- Adding Celluvisc (Allergan) can increase the viscosity in the lens chamber to reduce midday fogging.
- Initiating treatments such as gel drops, ointments, lid hygiene and heat compresses can improve eye pathology. Such was the case with this patient, as those with ocular surface disease are more prone to midday fogging due to tear film imbalance.
- Managing conjunctival prolapse can help reduce midday fogging.

LENS DIAMETER

This is a crucial aspect of scleral lens parameter selection especially in cases of ocular surface disease. While larger-diameter scleral lenses provide lubrication over a larger area, they may not be the best option for all patients. Horizontal visible iris diameter (HVID) can be used as a tool in selecting the most appropriate lens diameter for the patient.

Case 2. A 52-year-old female patient was referred to the clinic for scleral lens management due to limbal stem cell failure. She had been using aggressive lubrication, steroids and doxycycline to manage severe surface inflammation. She presented with extreme light sensitivity and reduced palpebral fissure opening (8mm to 9mm).

Uncorrected visual acuity was 20/30 in both the right and left eye. Extensive pannus was noted 360° with 3+ punctate epitheliopathy in

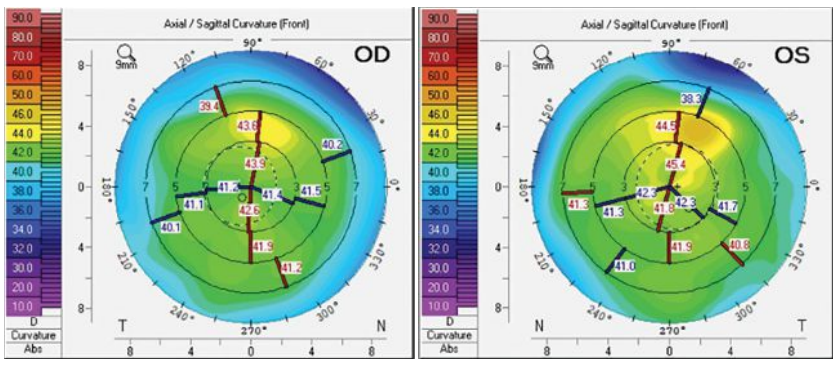

Fig. 4. Topography of the patient's eyes shows a symmetrical profile in the right eye (left) and slight steepening superiorly in the left (right).

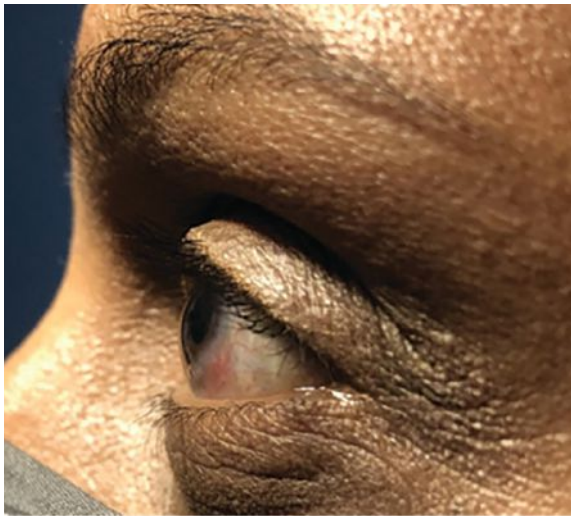

Fig. 5. Imaging of the patient's left eye shows a flat corneal profile.

both eyes. The patient had mild superior steepening from extensive pannus and scarring (*Figure 4*). She was advised to continue with preservative-free artificial tears, ointments, lid hygiene, warm compresses and a round of platelet-rich plasma.

Scleral lens fitting was initiated in both eyes not for visual correction, but for ocular surface management. With a 16mm trial lens, there was extensive bubbling and poor centration. Large-diameter lenses are a great option for patients with extensive ocular surface disease as they provide constant lubrication and protection across a larger surface area. However, in cases of patients with smaller eye fissures or a smaller HVID such as in this case (10.8mm OD, 10.9mm OS), a smaller lens diameter can allow for better centration and a more optimal fit. In this case, the patient was switched to a smaller 14.8mm diameter lens with a SAG height of 3400µm due to a flatter eye profile (*Figure 5*).

After two to three months of scleral lens wear, the patient reported better comfort, less light sensitivity and increased fissure height (*Figure 6*). We continued with nighttime use of gels and ointments after lens removal to prevent any discomfort and to continue hydrating the cornea for the best overall results.

CLEARANCE

The goal of scleral lens fitting is normally to clear the cornea by 200µm to 250µm so that after settling there is sufficient clearance to prevent touch but at the same time provide sufficient oxygenation to the tissue underneath. In cases of patients with irregular corneal profiles, this may not always be possible to achieve. With advanced and asymmetric elevations, there are concerns of excessive clearance vs. minimal clearance that practitioners often run into. With advances in scleral lens technology, options such as S-map guided scleral lenses or EyePrint Pro can offer a better fit for more complicated corneal profiles.

Case 3. A 61-year-old male patient presented to the clinic for a contact lens evaluation. His ocular history was pertinent for penetrating keratoplasty (PKP) in both eyes, the right graft was 30 years old and the left was 37 years old (*Figure 7*). The right eye had epithelial cysts at the graft-host junction, and the left presented with Urrets-Zavalia syndrome (*Figure 8*). In addition, the left corneal profile was prolate, as a larger-diameter corneal graft was used which resulted in severe thickening of the graft tissue at the graft-host junction in the left eye. Extensive neovascularization was also noted on the host tissue OU.

The patient was asymptomatic for glare, and no tinted lenses were pursued. Spectacle prescription and vision was -3.75-5.50x030, 20/20-OD and -19.00DS, 20/80 OS. The pupil was reactive to light and had no afferent pupillary defect OD

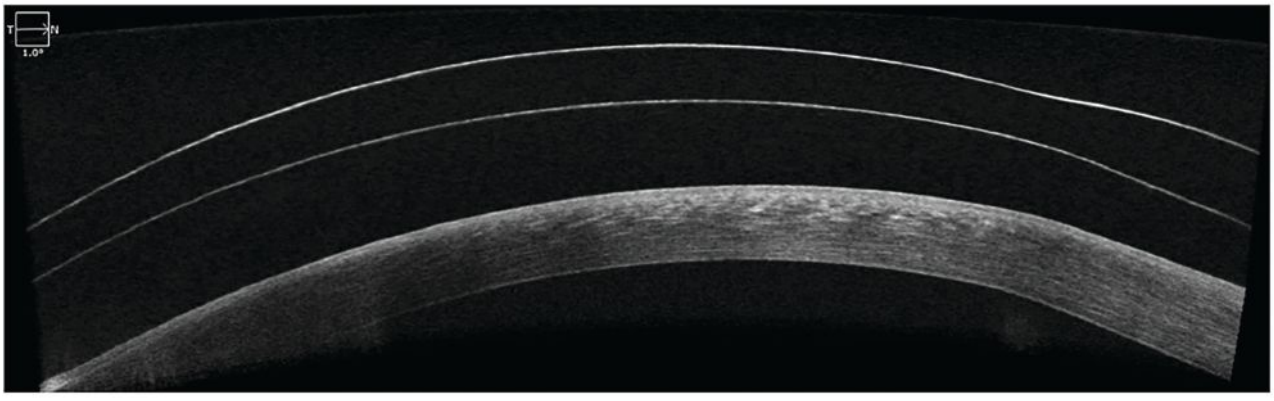

Fig. 6. OCT imaging of the patient's left eye shows good central clearance over the corneal surface.

For videos of these cases, visit www.reviewofcontactlenses.com or scan the following QR code:

and was fixed and dilated OS. The patient was fitted in scleral lenses to vault over the graft with best-corrected vision of 20/20-3 OD and 20/30 OS.

With an initial prolate lens, touch was noted nasally where the graft had the highest elevation, so vault was increased to accommodate the nasal portion and prevent any touch and mechanical trauma to the graft tissue (*Figure 9*). However, with clearance over the nasal portion, there was increased midperipheral and limbal clearance despite efforts to adjust the lens parameters. With excessive clearance, there is a risk of induced hypoxia to the underlying tissue and graft rejection or failure. In such cases, there are several strategies that can be employed. First, switching to a fully customized lens such as EyePrint Pro can help provide a better fit. Second, managing the peripheral curve system to obtain some tear exchange can help minimize neovascularization. In this case, since the patient declined a customized lens, a flatter peripheral curve system was used to encourage tear exchange and minimize the risk of neovascularization progression on the graft tissue.

Given the high minus prescription and concerns about peripheral thickness of the lens limiting oxygen supply at the limbal area, the issue of hypoxia was combated with selection of a hyper-Dk material, thinner lens design to reduce the average thickness of the lens, reduced tear layer underneath the scleral lens, reduced overall wear time and flatter peripheral curve system.

Rigid gas permeable lenses are tremendously beneficial for patients with postoperative residual refractive error to aid vision rehabilitation. However, contact lens use increases the risk of infections, microcystic edema and neovascularization that can potentiate graft rejection. Therefore, it is important to understand the complications resulting from scleral lens wear to minimize the risk of graft failure. It is crucial to routinely monitor patients for clarity and compactness of the graft, assess the extent and caliber of neovascularization with photo documentation and evaluate the endothelial cell count and other adverse events such as the stability of epithelial cysts and thickening or thinning at the graft-host junction. Routine monitoring is important in ensuring graft health and detecting the earliest signs of graft failure.

LUMPS AND BUMPS

Scleral lens landing zone curvature is crucial in optimizing the fit and enhancing patient comfort. Conjunctival growths such as pinguecula and pterygium and surgical blebs in glaucoma patients can pose a challenge in scleral lens fitting. Employing notches and other peripheral modifications can overcome these concerns and provide an overall improved scleral lens fit.

Case 4. A 34-year-old Hispanic male presented to the clinic for a specialty contact lens examination and evaulation. The patient had previously been prescribed corneal gas permeable lenses. However, he reported that, due to contact lens discomfort, he only used contact lenses occasionally. The patient's presenting unaided visual acuity at distance was 20/50+2 with a pinhole acuity of 20/20-2 OD and 20/250 with a pinhole acuity of 20/70-1 OS.

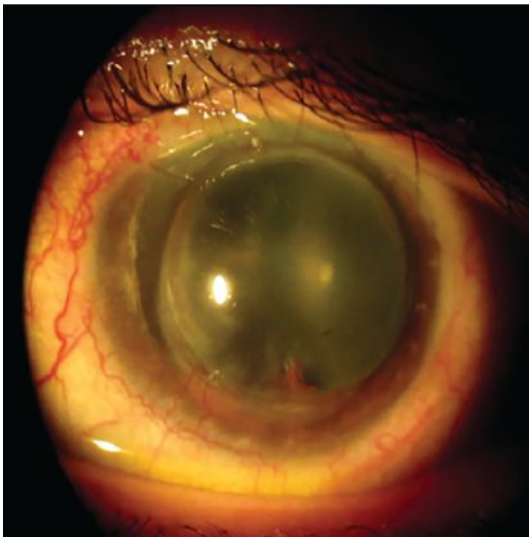

Fig. 7. A steeper profile inferior nasally in the left eye post-PKP.

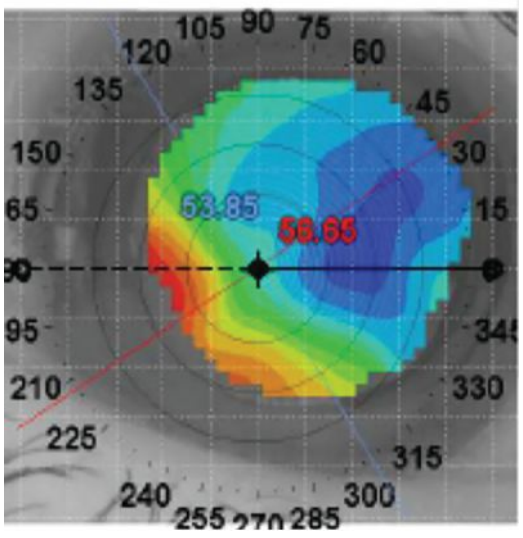

Fig. 8. Urrets-Zavalia syndrome in the left eye.

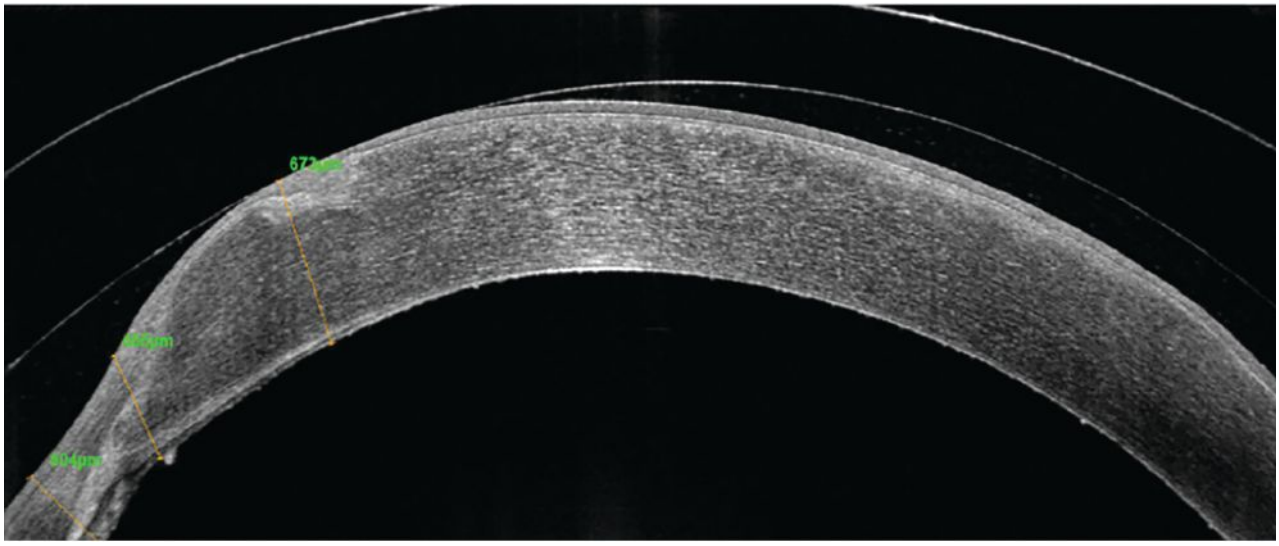

Fig. 9. OCT imaging of the left eye with scleral lens wear shows nasal touch on the graft tissue.

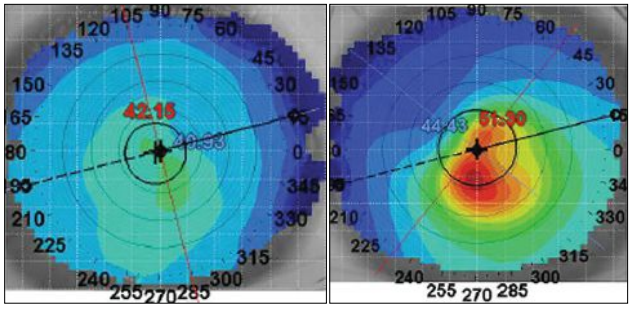

Fig. 10. Corneal topography of the right eye of the patint in Case 4 depicts the presence of subclinical keratoconus (left), and a scan of the left eye demonstrates keratoconus (right).

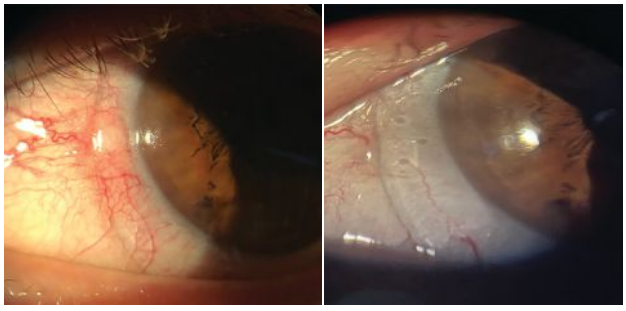

Fig. 11. Redness noted with the landing zone impinging nasally on the pinguecula (left), and improvement noted with the addition of a microvault as marked by the three dots nasally (right).

His spectacle prescription at the time of the visit was -1.25-1.25x042 with a visual acuity of 20/20 OD and -1.25-7.50x122 with a visual acuity of 20/50- OS. Corneal topography demonstrated asymmetric inferior corneal steepening consistent with keratoconus (*Figure 10*).

The ectasia was not advanced, and only a slight protrusion was present in the left eye. As such, a prolate lens design was picked for the trial lens. The patient had nasal pinguecula which resulted in impingement and rebound redness upon removal of the trial lens after 40 minutes of in-clinic lens wear (*Figure 11*). In this case, a microvault was ordered over the pinguecula for better alignment and comfort for the patient.

For other ways to alleviate such concerns:

- Increase the lens diameter to go over the pinguecula.
- Decrease the diameter to avoid contact with the pinguecula.
- Add a microvault.
- Add a notch to avoid interaction with the pinguecula.

Scleral lenses play a significant role in the management of complex ocular surface pathologies. Notches and a microvault built into the lens can allow for better alignment with conjunctival toricity and obstacles.

TAKEAWAYS

Sclerals are an excellent option for visual and ocular surface rehabilitation for patients with ocular pathologies. By following a systematic approach to lens fitting and parameter manipulation, you can troubleshoot a wide variety of issues that may arise. When initially starting to fit lenses, it is important to lean on fitting guides and consultants. With increasing complexity of cases, such as when working through advanced anatomical challenges where traditional scleral lenses may not be a sufficient option, it is important to expand your options to profilometry and impression technology to optimize the lens fitting. RCCL

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Cell Dysfunction

The effects of trabeculectomy with mitomycin C led to this diagnosis.

A 90-year-old Caucasian male presented complaining of chronic irritation and soreness in his right eye (OD). His ocular history was significant for pseudoexfoliative glaucoma OD>OS, status post-SLT, followed by a trabeculectomy with mitomycin OD in 2016. In 2018, he underwent a vitrectomy, intraocular lens exchange and Ahmed glaucoma valve OD, followed by a central retinal vein occlusion for which he received monthly intravitreal injections OD. His entering uncorrected acuity was 20/800 OD, 20/60 OS. He was taking Lumigan.

On slit lamp exam he had meibomian gland dysfunction, a superior temporal trabeculectomy and suture. The cornea had whorl staining, superior filaments and inferior superficial punctate keratitis (*Figure 1*). The filaments were debrided and Prokera Slim was inserted OD. The patient reported relief in his symptoms for one to two months until he returned with irritation. At this time, he was given the options of another amniotic membrane, bandage contact lens, scleral shells or initiation of a low-grade steroid. After speaking with his glaucoma specialist, loteprednol etabonate 0.5% QID was started; however, the patient received no relief. Due to his age and dexterity, he was not comfortable using a scleral shell and opted to have a monthly bandage contact lens inserted.

DIAGNOSIS

The patient underwent trabeculectomy with mitomycin C for glaucoma, which uses a technique that is fornix-based conjunctival incision and leaves the possibility of damaging

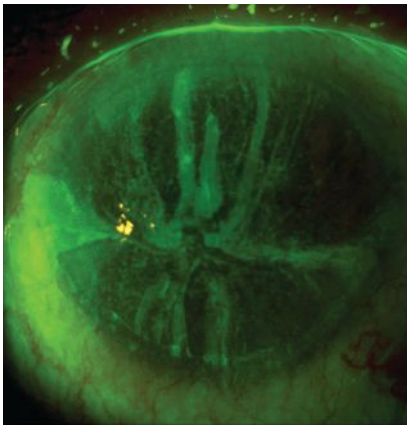

Fig. 1. This patient has fluorescein staining with an evident whorl pattern.

cells at the limbus.[1,2] 5-Fluorouracil and mitomycin C (MMC) are often used, which are cytotoxic drugs applied to the sclera during surgery.

Limbal stem cell deficiency (LSCD) has been reported after the use of topical MMC, and it's been proposed that dry eye disease after trabeculectomy supplemented with MMC is due to LSCD.[1,3] Therefore, this patient has an iatrogenic cause of LSCD.

LSCD

The Limbal Stem Cell Working Group formed by the Cornea Society defines LSCD as "an ocular surface disease caused by a decrease in the population and/or function of corneal epithelial stem/progenitor cells; this decrease leads to the inability to sustain the normal homeostasis of the corneal epithelium."[4]

Limbal stem cells are essential in maintaining the normal homeostasis of the corneal epithelium, resulting in a transparent cornea and opaque sclera. The limbus and limbal stem cells act as a barrier against invasion of unwanted conjunctival epithelial cells onto the cornea. The process of differentiation of the limbal stem cells occurs by transit-amplifying cells. These have a controlled ability for self-renewal and undergo a limited number of cell divisions. Around 25% to 33% of the limbus must be intact in order to guarantee normal ocular resurfacing. When there is a deficiency, a pathological condition results in the dysfunction or inadequate quantity of limbal stem cells, resulting in migration of conjunctival cells onto the ocular surface.[5]

LSCD results from either a primary (genetic) or secondary insults. The etiology can be classified into six categories: idiopathic, traumatic, iatrogenic, autoimmune, eye disease and congenital/ hereditary.[5,6]

Patients may initially be asymptomatic. Those experiencing symptoms may describe ocular discomfort, irritation, conjunctival redness, dryness, photophobia, decreased vision, foreign body sensation and tearing.[4] The common clinical findings of LSCD are recurrent ulceration, decreased vision, corneal neovascularization and wavelike irregularity of the ocular surface emanating from the limbus. The wavelike irregularity is usually seen emanating from the limbus and can be observed easiest when fluorescein is instilled (*Figure 2*).[6] Diagnostic tests used for detection include impression cytology, *in vivo* confocal microscopy and AS-OCT of the cornea and limbus.[1]

Partial LSCD is characterized by a sectoral conjunctivalization of the corneal surface, the presence of residual limbal and consequent corneal epithelial cells. Total LSCD

is described as conjunctivalization of the entire cornea due to complete loss of corneal epithelial stem/progenitor cells.[4]

The Cornea Society created this classification for staging LSCD:

Stage I: normal corneal epithelium within the central 5mm zone of the cornea.

(a) less than 50% of limbal involvement

(b) more than 50% but less than 100% limbal involvement

(c) 100% of limbal involvement

Stage II: central 5mm zone of the cornea is affected.

(a) less than 50% of limbal involvement

(b) more tan 50% but less than 100% limbal involvement

Stage III: the entire cornea is affected.[4]

Another way to classify LSCD is mild, moderate and severe. Mild findings include a dull/irregular cornea surface, corneal epithelial opacities, loss of limbal palisades of Vogt. Moderate findings include abnormal epithelium causing fluorescein staining and a vortex pattern that can be visualized. These patients might be more prone to erosions and have underlying mild anterior stromal haze. Superficial neovascularization and peripheral pannus may be present at this stage. If the central visual axis is involved, patients may report decreased vision. Severe findings include persistent corneal epithelial defects, corneal stromal scarring and corneal neovascularization.[5]

MANAGEMENT

The approach to treating LSCD differs depending on the level of severity. For all cases, if possible the inciting cause should be discontinued, such as contact lenses or topical medications. For mild cases, a low-grade topical steroid may be helpful. If the LSCD is focal, consider debridement and allow for resurfacing from healthy intact limbal epithelium.[5,6] A limbal or conjunctival autograft can be considered. Options for severe or extensive cases include an amniotic membrane, bandage contact lens, scleral contact lens or a limbal transplant.

Non-surgical treatments include:

• *Autologous serum drops.* Promotes migration and proliferation of a healthy epithelium, and improves lubrication of the epithelial surface.

• *Therapeutic bandage contact lens*. Prevents new epithelial defects and promotes healing.

• *Therapeutic scleral lens.* Promotes corneal healing while improving vision. Reduces pain and photophobia, and prevents new corneal epithelial defects.

• *Lubrication*. Prevents epithelial adhesion and shear stress.

Conservative surgical options include:

• *Corneal scraping*. Removes overgrown conjunctival enabling reepithelization of function corneal epithelial stem cells.

• *Amniotic membrane transplantation*. Promotes proliferation and migration of limbal epithelial stem cells.

Limbal epithelial stem cell transplantation includes conjunctival limbal autograft, conjunctival limbal allograft and keratolimbal allograft.[7]

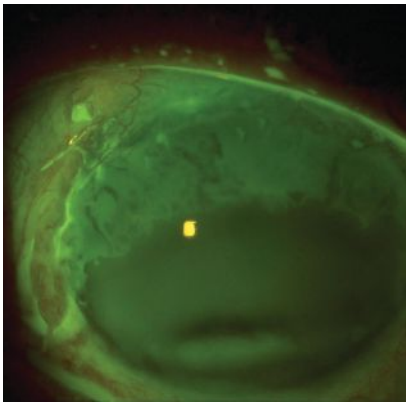

Fig. 2. This patient post-trabeculectomy is treated with mitomycin C.

LSCD is a condition that is in our clinics daily, which is why keeping it as part of your differential for patients who are asymptomatic to symptomatic is important. Currently, diagnostic materials and criteria are based on clinical examination and impression cytology. In the future, the characterization of cellular structure of the healthy cornea and limbus will come more into play with advancements using molecular markers. RCCL

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By Christine W. Sindt, OD

An Unexpected Twist

Corneal drug deposition in the classic whorl-like pattern looks ominous. Is it?

An 84-year-old Caucasian woman presented for evaluation of "fuzzy vision." She had a history of bilateral sequential anterior ischemic optic neuropathy with no subsequent recovery of vision. She denied symptoms of giant cell arteritis. Medical history was significant for hypertension, hyperlipidemia and Atrial fibrillation. Her current medications included metoprolol, coumadin, amlodipine and amiodarone.

Exam revealed visual acuities of 20/30 OD and HM OS, with a 1.2-1.5 log unit RAPD OS. Anterior segment exam revealed vortex keratopathy OU and 2-3+ nuclear sclerotic cataracts with cortical cataract OU.

Dilated exam revealed a hazy view to the fundus OU. There was bilateral optic disc pallor with cupping, OS>OD, with soft drusen in the maculae OU. Critical flicker fusion was moderately decreased OD and could not be obtained (due to poor vision) OS. Visual fields revealed an inferior altitudinal cecocentral scotoma with inferonasal constriction OD and a dense cecocentral scotoma with nasal constriction OS. Compared to past exam, visual field differences were mainly due to changes on the total deviation rather than pattern deviation, likely due to refractive change or media opacity rather than significant progression of her optic neuropathies.

Amiodarone treats cardiac dysrhythmias; all patients taking this drug will develop corneal verticillata (vortex keratopathy). Patients are generally asymptomatic, although some complain of halos. Verticillata appear as fine grey-brown opacities in a whorl-like pattern, branching out from the inferior cornea. The drug deposits happen at the level of the basal epithelium. While the deposits will fade if the drug is stopped, generally it is not recommended to alter systemic treatment in response.

Our patient was advised that her inflammatory markers are within normal limits and, based on our ocular findings, we did not advise a change in her meds. RCCL

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