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SEPTEMBER/OCTOBER 2023

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SEPTEMBER/OCTOBER 2023

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Micaela Crowley, O.D.
Lexington, MA

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1. CVI data on file as of May 2023 vs. leading manufacturers. **2.** CVI data on file 2020. Prospective, double-masked, bilateral, 1-week dispensing study with MyDay daily disposable multifocal; n=104 habitual MFCL wearers. **3.** CVI data on file 2020. Prospective, double-masked, bilateral, one-week dispensing study UK with MyDay® multifocal; n=104 habitual multifocal contact lens wearers. **4.** CVI data on file 2021. Prospective, subject-masked, randomized, bilateral, two-week dispensing study at 5 US sites with MyDay® multifocal; n=58 habitual multifocal contact lens wearers. **5**. CVI Data on file 2022. Based on global product sales and internal estimates of products using Aquaform® Technology over 12 months in 2022.

New OCT-based Keratoconus Staging System Performs Well

The proposed tool takes epithelial and stromal parameters into account, setting it apart from other grading techniques.

While detecting and grading keratoconus can be challenging, especially in cases of subclinical disease, a recent study developed and tested a new staging system that uses OCT. The five-stage numerical system evaluates ocular parameters on SD-OCT and shows a strong agreement with existing systems. It is also the first to consider both epithelium and sublayer stroma information, which led its creators to name it the "STEP" staging system [ST (stroma) + EP (epithelium)].

The researchers conducted Scheimpflug tomography, tonometry and SD-OCT (RTVue-XR, Visionix) on 567 eyes of 567 patients (331 with varying stages of keratoconus and 236 controls). Parameters that performed best in grading keratoconus were used to develop the new staging system.

The parameters with the highest sensitivity derived from the stroma and epithelium included stroma overall minimum thickness (sensitivity 90%, specificity 67%) and epithelium overall standard deviation (sensitivity 75%, specificity 78%). The STEP system strongly agreed with the two Belin ABCD staging systems; in normal patients, more than 85% were in the same stage in all comparisons between the three systems. In keratoconus patients, the staging agreement was still relatively high, ranging from 47% to 77%.

The team pointed out in their study, published in the *Journal of Cataract and Refractive Surgery*, that these outcomes "aligned well with prior studies using an alternative SD-OCT device (MS-39, CSO Italia), which showed a good correlation between the degree of visual limitation (and keratoconus severity) and stromal and epithelial thickness parameters."

Though these data suggest the STEP system may be a reliable tool to stage keratoconus, the researchers note a few limitations, one being that no progressive cases were included in the study. This analysis also involved only one SD-OCT model, so future research will need to assess the system's universal application.

"In conclusion," the researchers wrote, "we propose a digital, automated, and comprehensive OCT-based keratoconus staging system that is compatible with existing keratoconus staging systems and offers additional clinical relevance. This system could be incorporated into daily clinical practice and in research, as it has the potential to help treatment decision-making and monitor keratoconus progression."

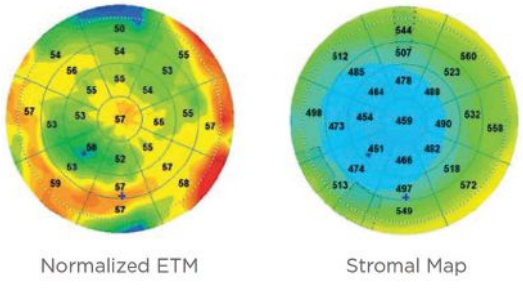

Photo: Visionix

A newly developed OCT-based system that uses both epithelial (left) and stromal (right) thickness mapping showed staging agreement in 85% of normal cases and between 47% and 77% of keratoconus cases.

Lu NJ, Hafezi F, Koppen C, et al. A novel keratoconus staging system based on optical coherence tomography. J Cat Refract Surg. August 1, 2023. [Epub ahead of print].

IN BRIEF

■ A recent study examined the corneal tomography and biomechanical features of 88 parents of 44 keratoconus patients and **found evidence to support a potential predisposition for the development of keratoconus in their offspring.**

Logistic regression analysis noted the following three major influential factors for keratoconus with 73.3% accuracy in identifying affected offspring: **parental corneal tomographic and biomechanical index, Corvis biomechanical index and thinnest point pachymetry.**

"Though these findings did not manifest clinically, **the parents' corneas had characteristics such as reduced stiffness and thickness compared to healthy individuals,"** the researchers wrote. They added, "The use of Pentacam and Corvis ST in our study effectively captured the hereditary traits associated with keratoconus."

Li J, Zhang BN, Jhanji V, Wang X, Li D, Du X. Parental corneal tomographic and biomechanical characteristics of patients with keratoconus. Am J Ophthalmol. August 9, 2023. [Epub ahead of print].

■ Researchers in China compared axial elongation and treatment zone characteristics in children wearing either 5mm or 6mm back optic zone diameter (BOZD) ortho-K lenses over two years and found that **lenses with smaller BOZD can create a smaller treatment diameter, resulting in less axial elongation.** The most dramatic changes for treatment zone diameter, choroidal thickening and axial elongation occurred in the first six months, which researchers suggest is due to the stabilized treatment zone diameter. However, the effect still lasted over the two-year study.

The researchers pointed out that a very weak association was found between choroidal thickness changes and axial elongation, with the effect size close to zero.

The study also found that **smaller BOZD ortho-K lenses neither affected visual performance nor caused significant visual signs/symptoms in children wearing them compared with conventional 6mm BOZD lenses.**

Guo B, Cheung SW, Kojima R, Cho P. Variation of Orthokeratology Lens Treatment Zone (VOLTZ) Study: a two-year randomized clinical trial. Ophthalmic Physiol Opt. August 6, 2023. [Epub ahead of print].

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SMILE Not Found Superior to LASIK in Corneal Biomechanics

Study shows no major differences in corneal hysteresis and corneal resistance factor three months after surgery.

Among corneal refractive surgery options, SMILE and LASIK are the main ways to correct myopia, but there is no consensus on whether SMILE is superior to LASIK in corneal biomechanics, which play an important role in the preoperative screening of the patients and the optimization of postoperative visual quality. A new systematic review and meta-analysis in the journal *Medicine* used results of Ocular Response Analyzer (Reichert) and Corvis ST (Oculus) data on patients and found no major differences in corneal biomechanics between the two surgical methods.

Sixteen studies (three randomized clinical trials and 13 non-randomized controlled trials) were included, reflecting a total population of 1,396 eyes treated surgically. Across the literature, there was no statistical difference in corneal biomechanics, including corneal hysteresis and corneal resistance factor, at three months post-surgery between patients who received SMILE vs. LASIK.

Studies have shown mixed results, though. One concluded that in axial stress-strain measurements, corneal biomechanical impairment after SMILE and LASIK was comparable. A three-year follow-up study showed less hysteresis and corneal resistance factor changes after SMILE compared with LASIK.

One study, with only one month of follow-up, found that the change after SMILE was significantly higher than that after LASIK in terms of the percentage of change in corneal hysteresis, corneal resistance factor and deformation amplitude. "However, a study showed that the flap caused more weakening than the cap intraoperatively," the authors noted in their journal article. "Biomechanical differences between LASIK and SMILE eyes were similar after removal of tissue and ongoing wound healing." The basic characteristics such as age, mean keratometry, intraocular pressure and central corneal thickness were closely associated with corneal biomechanics, they further explained.

"Whether SMILE is superior to LASIK in biomechanics is a subject of debate, which may vary due to differences in follow-up time, inspection instruments and basic patient characteristics between studies," the authors concluded.

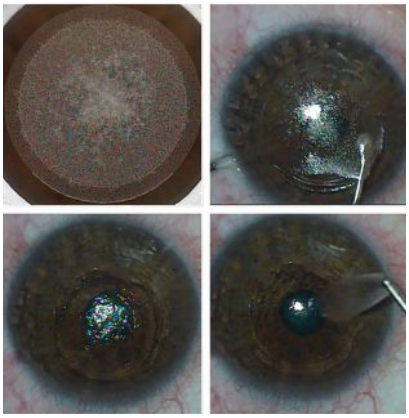

Photo: Bobby Saenz, OD

SMILE's smaller corneal incision is presumed to offer greater post-op stability than LASIK. At least by some measures of corneal integrity, that was not borne out in a recent meta-analysis.

Chen S, Ma H, Zhao C. Corneal biomechanics after small incision lenticule extraction and femtosecond laser in situ keratomileusis. Medicine. August 11, 2023. [Epub ahead of print].

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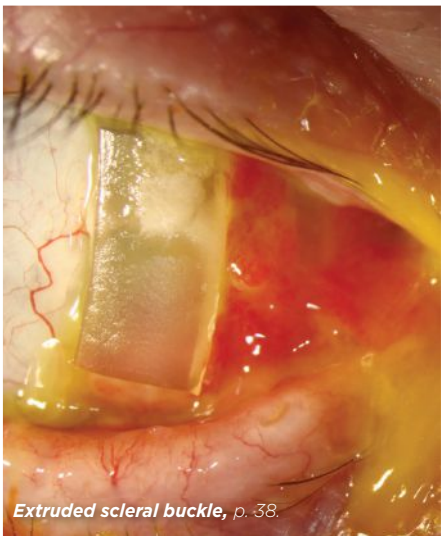

Extruded scleral buckle, *p. 38.*

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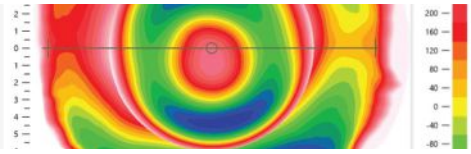

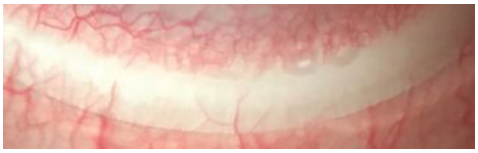

The Paradigm Shift in Keratoconus Treatment

Daniel G. Fuller, OD, FAAO Dipl, FSLS
Memphis, TN

KEY TAKEAWAYS

- Only iLink® cross-linking can slow or halt the progression of keratoconus.
- Referring progressing patients to a cornea specialist prior to vision loss is ideal.
- Slowing or halting keratoconus progression may allow patients to continue to tolerate contact lenses.

Ten years ago, there was little reason to refer a patient with keratoconus to a cornea specialist early in the course of their disease. All we could do was manage patients' vision as long as possible, hoping they didn't progress to needing a corneal transplant.

The approval of iLink® cross-linking marked a major paradigm shift in keratoconus management. Professional societies have adjusted treatment guidelines to reflect the ability of cross-linking treatment to slow or halt progression of the underlying disease. The American Academy of Ophthalmology, for example, now states in its Preferred Practice Pattern (PPP) that referral prior to vision loss is ideal, and that when keratoconus is suspected, more frequent follow-up to look for progression is warranted.[1] Any signs of progression or onset of keratoconus at a young age should lead to a prompt referral.[1]

Optometry is very good at helping patients with keratoconus see better with gas permeable (GP), hybrid, and scleral lenses. But as rewarding as it is to help the vision-impaired, we can have an even greater impact by catching this disease early and referring progressing patients for cross-linking before they lose vision, just as we refer glaucoma patients for treatment as soon as the disease is detected. For patients who are still in their peak earning and learning years, early treatment could mean 50+ years of functional vision.

Cost-effective and FDA approved

A discrete-event simulation model showed that, compared to conventional treatment, iLink cross-linking would reduce the rate of penetrating keratoplasty by 26%, and result in patients spending 28 fewer years in the advanced stages of keratoconus—all while saving money for patients, insurers, and society.[2]

The iLink procedure is an epithelium-off treatment that has undergone the scrutiny of randomized controlled clinical trials as part of the FDA approval process, demonstrating proven efficacy and safety. It is important to refer patients to doctors who use iLink, the only cross-linking procedure approved by the FDA. I believe that good science promotes good patient care and, in the case of iLink, also allows patients to use their insurance.

Vision correction post cross-linking

Slowing or halting keratoconus progression may allow patients to continue to tolerate contact lenses.[3,4] Typically, patients can resume contact lens wear within one to three months of the cross-linking procedure, although I find that corneal remodeling may continue for up to 12 months post-treatment. During this time, lens parameters may need to be adjusted. About one-third of eyes are able to continue in habitual contact lenses after cross-linking, while two-thirds require a new contact lens fit.[5]

With iLink cross-linking and modern specialty contact lenses, we have the best keratoconus management options now that I've ever seen. This represents not just a business opportunity, but the chance to have a life-changing impact on our patients. ■

Contact Lens Fitting Post Cross-Linking[5]

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Toxicity: Easy as ADC

Look out for corneal changes caused by certain therapeutic agents used for cancer.

Fortunately, most patients with cancer today have therapeutic options. Antibody-drug conjugates (ADCs) deliver chemotherapy agents to cancer cells avoiding damage to healthy cells in many cases.[1-4] ADCs are assembled with a "warhead payload" for destroying cancer cells, a bridge between antibody and drugs to control the release inside cancer cells, and the guidance system (antibody) to recognize the targeted cancer cells.[2,4] Despite the miraculous results many patients achieve, some will have to deal with the associated complications.

AVAILABLE DRUGS

Different parts of the eye are preferentially affected by ADCs.[1] A review of what is current and readily available along with the distinct cornea adverse effects might prove helpful to clinicians in the trenches. These three have been reported to cause corneal changes.

• ***Blenrep (belantamab mafodotin, GlaxoSmithKline)*** is an ADC used primarily for multiple myeloma and is only available for compassionate use at this time.[5] Of course, that may change by the time this goes to print.

• ***Tivdak (tisotumab vedotin, Seagan)*** is used in adult patients with recurrent or metastatic cervical cancer with disease progression on or after chemotherapy. It is approved based on tumor response rate and durability of response. Continued approvals may be contingent upon verification and description of clinical benefit in additional trials.[6]

• ***Elahere (mirvetuximab soravtansine, ImmunoGen)*** is an ADC used for ovarian, fallopian tube or primary peritoneal cancer patients who have not responded to or are no longer responding to treatment with chemotherapy.[7]

Corneal changes when using ADCs, such as keratopathy, are not uncommon and generally start as microcystic changes in the periphery and move toward the center of the cornea with advancing toxicity. They are commonly referred to as microcystic-like epithelial changes (MEC). Loss of best-corrected acuity is possible and can be averted with scrutiny on each follow-up visit. Hyperopic shifts have been reported with noted peripheral MECs following the use of Blenrep.[3] When MECs are noted in the central/mid-periphery, a steepening effect has also been noted.[3]

ADCs have a long half-life, so it will take a long time for corneal changes to improve, and patients will continue to show progression even when the ADC is stopped. Of course, any suggestion of discontinuation or administration with a reduced dose of drug should be made among all the stakeholders (oncologist, eyecare provider and patient). When to suggest drug cessation is a matter of debate since stopping life-saving therapy is difficult, but preserving vision is important, too.

PROPHYLAXIS

Baseline examinations are essential in patient management to rule out any previously unrelated insult to the ocular surface. Follow-up examinations are suggested prior to each dose. Depending on the ADC used, recommendations range from the use of topical cortiocosteroids, preservative-free tears and ocular decongestants/vasoconstrictors (such as phenylephrine) around treatment dates.[4] Use of cooling pads/compresses the day of therapy may aid in minimizing corneal drug absorption.[2] Most adverse events associated with ADCs are not severe and fortunately seem to improve and are reversible with cessation or ameliorative measures.[1,2,8]

FUTURE DIRECTIONS

The future for new treatment options for cancer is promising, but along with the encouraging reports with new approvals, continued surveillance is necessary to identify adverse side effects (some predictable and others unforeseen). Focus should be directed at emphasizing the importance of ocular examinations and recognizing patient-related factors, improvements in tumor modeling and giving more attention to the dynamics of pharmacokinetics to lessen risk for toxicity.[8]

As we look forward to new treatment approvals in our fight against cancer, remaining vigilant in our clinical observations will hopefully minimize morbidity and avoid potential vision loss. RCCL

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

The Optometric PB&J

This case of high, yet symmetrical, astigmatism fit perfectly for bitoric GPs.

A 25-year-old female presents for a contact lens fitting. She was specifically interested in pursuing orthokeratology, having previously had a consultation for LASIK, but was nervous about potential side effects. This patient had never worn contact lenses and her main goal was freedom from spectacle wear.

The patient presented with visual acuities of 20/20 OD and OS in her current spectacles. Her manifest refraction was -1.25 -4.75x180 OD and -0.75 -4.25x175 OS. Scheimpflug tomography (Pentacam, Oculus) showed high regular astigmatism in both eyes with corneal astigmatism measuring 4.10D OD and 4.70D OS. On slit lamp examination, there were findings consistent with dry eye, including inferior scleral show, lagophthalmos and inferior superficial punctate keratitis. The conjunctiva was white and quiet, indicating that the exposure effect was localized to the cornea.

CONSIDERATIONS

Here, we highlight our thought process and consider how we would proceed:

Dr. Pfeifer: My first thought when seeing this patient's refraction was how difficult frame selection must have been. Due to the potential cosmetic concerns of a thicker lens edge in the vertical direction as well as a limited field-of-view, it is reasonable to think this patient will appreciate better vision in contact lenses, even if she is seeing 20/20 in glasses. Topography showed relatively symmetric, yet elevated corneal astigmatism with no apparent thinning or abnormal elevations or depressions, so corneal disease is likely not present at this time.

It is easy to jump to soft lenses for a young, healthy patient who is seeing well in glasses. However, the lenses available to correct her level of astigmatism are limited and the steps between powers don't allow a great deal of customization. This leads to the option of custom soft lenses, offering a much greater customization level. Custom soft lenses, though, rely heavily on how the lens conforms to the shape of the cornea, which may not provide the best optics for this patient. Scleral lenses could also be a great option, as they are highly customizable. In addition, their stability ensures good vision, as a well-fitting lens should not move or rotate on blink. The downside with scleral lenses is added maintenance, insertion and removal technique, and a reduction in oxygen that reaches the cornea.

This leaves us with what I believe to be the best option for this patient, which are bitoric GPs. With her level of corneal astigmatism, a spherical GP would only rock along the patient's steep meridian, leading to potential discomfort and poor vision. Conversely, a bitoric GP will align with the patient's cornea and provide excellent vision. It is worth noting that because the patient's right eye has less corneal astigmatism than accepted during refraction, a back toric lens with a spherical front surface may suffice. Of course, one important factor in fitting a new wearer into any corneal GP is the education that the lenses may take a little getting used to, like a new watch or a new pair of shoes would.

Dr. Su: In this case, we have an array of options at our disposal—custom soft lenses, corneal GPs, hybrids and scleral. Custom soft lenses offer a versatile solution for most astigmatic cases with various base curves, diameters and central thicknesses. In many cases, a custom soft lens with increased central thickness may effectively mask some level of corneal astigmatism. As the central thickness increases, there is a corresponding reduction in draping, leading to a more heightened masking effect; I would want to start here. These lenses use stabilized toric haptics on the front surface to provide optimal vision correction, but in a case with 4D of cylinder, I may be more cautious of potential fluctuations caused by lens rotation.

Rigid lenses, such as corneal GPs, scleral and hybrid lenses, all rely on the tear layer to correct astigmatism which can be more forgiving for visual fluctuations on movement. When considering hybrids for over 4D of cylinder, however, concerns can arise with lens flexure. Making a toric back surface design is more appropriate to align with the corneal shape, so a bitoric corneal GP lens can be an excellent start, too. Sclerals can work as well, but in this case of a normal cornea free from pathology, handling and maintenance may not necessarily be worth it with the other great options.

Regardless of the chosen lens, it's essential to address dry eye concerns proactively since contact lens wear can exacerbate existing dryness. Implementing dry eye treatment alongside the lens fitting can enhance overall patient comfort and satisfaction.

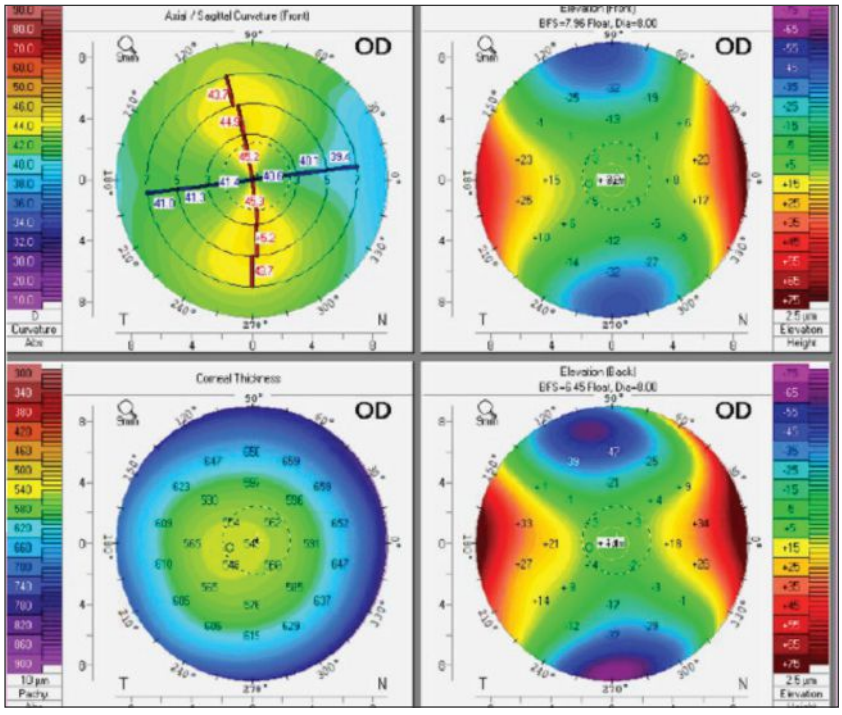
Dr. Noyes: It can be easy to first jump to the suspicion of corneal ectasia when seeing patients with high astigmatism; corneal topography or tomography can be vital to ensure a correct diagnosis. This tomography reading does not imply corneal ectasia

(*e.g.*, regular astigmatic pattern, no posterior surface ectasia), just moderate to high astigmatic values. Because the patient is correctable to 20/20 in spectacle correction, my first reaction would be to try a toric soft contact lens. If vision isn't adequate from there, I would consider moving into specialty lenses. Having said that, a scleral may be the best choice for this patient in particular, pending the level of dryness. Remember, the patient was also diagnosed with lagophthalmos and dry eye.

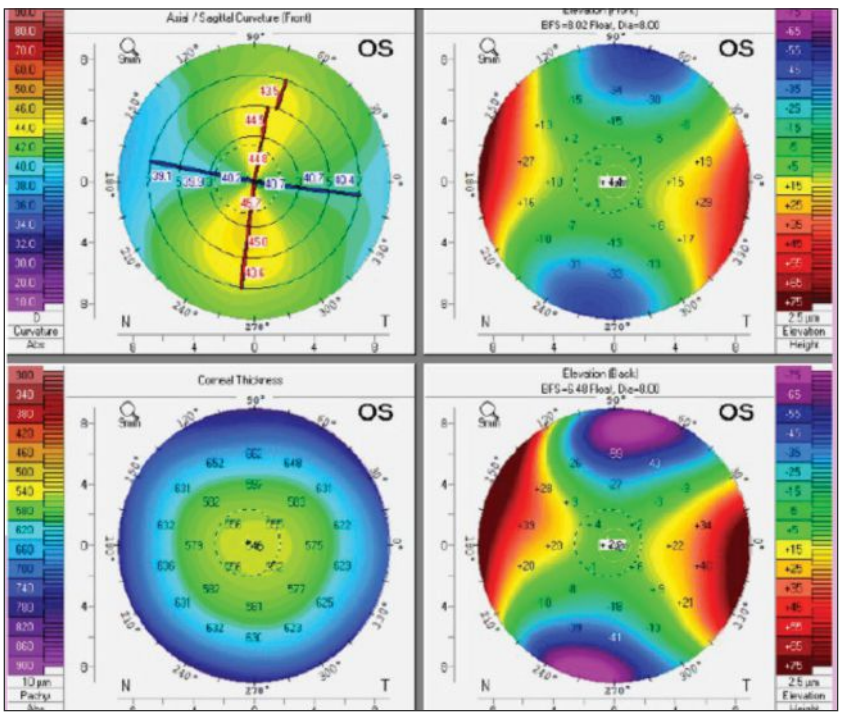
Dr. Gelles: High astigmatism can be a challenge. The first step, in this case, is to get topography to ensure the astigmatism isn't corneal disease-related. Just based on the refraction, which is similar in each eye, the rule astigmatism and correctability to 20/20 make it unlikely, but at 4D of cyl, you have to check. The tomography shows no signs of corneal disease, pachs are thick, no abnormal elevations are present, and the astigmatism is symmetric. It's just good ol' symmetric with the rule corneal astigmatism, which mostly matches the refractive cylinder, so we know it's normal and nearly all corneal.

There are a ton of options, but only a couple good ones. These days it's easy to find high astigmatism soft lenses due to the vast custom soft lens options. However, lens drape and lens stability will challenge success; the optics will be very sensitive to any rotational movement.

GP lenses are an ideal first choice, but let's discuss hybrid lenses first. We know GPs can be very successful at masking corneal cylinder, and the center of a hybrid can provide just that, but the advantage of a hybrid is all in the bonded soft skirt to provide



Corneal tomography of the patient's right (top) and left eyes (bottom).



The Optometric PB&J

(Continued from p.11)

improved centration and reduced edge awareness over its corneal GP counterpart. In this case, the limbal-to-limbal astigmatism may be too much to be successful with a hybrid, potentially leading to three-nine staining due to rubbing on the nasal and temporal cornea, but you may be pleasantly surprised. If only a GP existed that could align to that cornea… bitoric to the rescue!

This would be my first choice. The toric back surface will provide corneal alignment and lens stability. I prefer a large intralimbal diameter for increased stability and minimized lid interaction. Another consideration could be a scleral lens. Though much less used for simple refractive error patients with high cyl, it can certainly be successful in this modality. As Dr. Noyes pointed out, the dryness is a consideration, and these can work wonders for dry eye patients. I typically wouldn't start here, as there are simpler options, plus dryness is not a primary complaint and likely can be effectively managed with ointment.

I'm going with a bitoric GP on this one. It's a classic combo: the optometric equivalent of peanut butter and jelly, milk and cookies, or coffee and doughnuts.

DISCUSSION

Patients with a high level of corneal astigmatism can be challenging to fit with contact lenses despite the wide array of options. Contact lens correction relies on stability, and the high cyl power in the lenses can deteriorate vision if they rotate or displace. Due to the corneal alignment demonstrated by well-fitting bitoric GPs, they will stay relatively stable on blink and provide good vision. It is important to assess rotation and movement and adjust the lens, such as increasing diameter or modifying the edges to ensure stability. The wide range of fitting parameters available allow ODs to design bitoric lenses that can fit a wide presentation of corneal astigmatism.

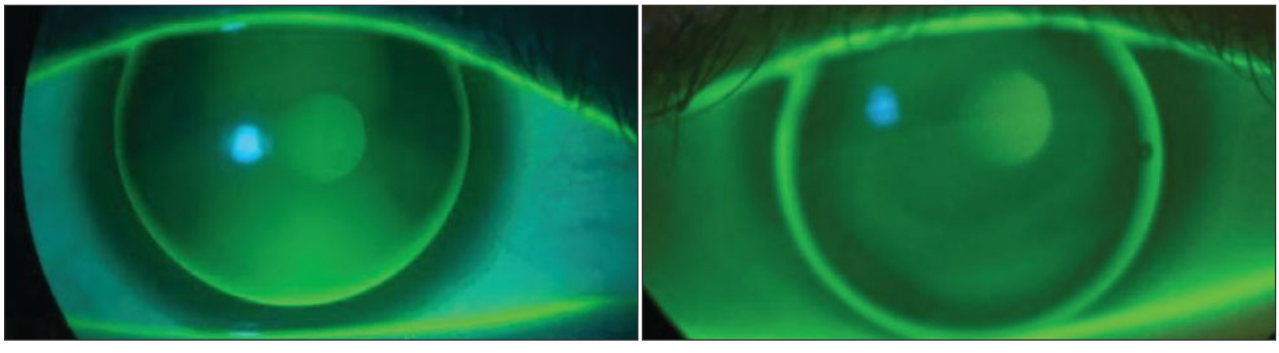
Corneal topography can be very helpful in fitting high corneal astigmatism. Not only is it useful in ensuring there is no corneal pathology, but it can predict how a corneal GP will likely fit on the eye. It is also important to continue to perform topography scans over time to monitor for changes that may affect vision or lens fit.

RESULTS

This patient has higher than average corneal astigmatism in both eyes. After educating her on the options, she was fit empirically using K readings and manifest refraction in bitoric RGP lenses OU (Visions Bi-Toric, X-Cel). Though the patient was able to achieve 20/20 OD and OS, the initial lenses displayed movement of 1.5mm, leading to the patient reporting ghosting of images. The diameter of both lenses was increased from 9.6mm to 10.0mm to help with stability; the ghosting was eliminated.

Using a more spherical lens with this patient would have caused bearing on the nasal and temporal cornea with greater vertical movement. Use of a more toric lens increases corneal alignment and improves lens stability. When choosing a lens, it is important to consider whether the eye possesses apical astigmatism or limbus-to-limbus astigmatism. Apical astigmatism predicts greater success with spherical peripheral curves, while limbus to limbus astigmatism will likely require toric peripheral curves. With a bit of vault, a spherical base curve can be used, but with a greater amount of corneal astigmatism, a toric base curve will perform best by increasing corneal alignment and improving lens stability. RCCL

Dr. Su is the Cornea and Contact Lens Fellow at the Cornea and Laser Eye Institute Center for Keratoconus in Teaneck, NJ. She has no financial discloses.



Patient fit in a spherical RGP (left). Note three o'clock to nine o'clock bearing and excessive vertical clearance vs. in a bitoric RGP (right) with symmetric alignment.

CONCENTRATION POWER AND MULTIFOCAL SUCCESS

BEN GADDIE, OD, FAAO

KRISTEN HOVINGA, MS

PRESBYOPIA EXPECTATIONS

With increases in life expectancy come increases in the amount of time during which people experience presbyopia. And as presbyopes look to multifocal contact lenses for either full or part-time wear, fitting this population can be more complex than for younger demographic segments.[1] Advancing age can affect the ocular surface, tolerance for contact lenses, and consequently, contact lens retention rates.[2,3]

Given that as few as 45% of presbyopes may be aware of multifocal or bifocal contact lenses,[4] initial conversations with eyecare practitioners may have a lasting impression. Approaching the topic of multifocal contact lenses with candidates can provide crucial understanding of how the lenses can benefit the wearer at different distances. Even more so, it is critical that eyecare practitioners recommend a first trial lens that can help drive fitting success and long-term wearer satisfaction.[3] The lens design team at Bausch + Lomb has developed a multifocal contact lens designed to deliver an easy, reliable fit, and provide a comfortable presbyopic lens-wearing experience.

CLARITY WITHOUT COMPROMISE

Bausch + Lomb's 3-Zone Progressive™ Design features consistent power distribution across each zone, in combination with power transitions between zones that were designed to optimize visual clarity for a variety of patients. With seamless transitions between near, intermediate, and distance zones, the 3-Zone Progressive™ Design is designed to meet the dynamic vision needs of today's presbyopic patients. This allows patients to conduct daily tasks that fit their active lifestyles and do activities that may not be easily accommodated with reading glasses.

Power distribution across the optic zone affects the quality of vision in multifocal contact lenses. The 3-Zone Progressive™ Design is a center-near lens design that delivers clear near and intermediate vision without compromising distance.[5] The 3-Zone Progressive™ Design features three zones of consistent power in its profile, with seamless transitions across all distances. Multifocal contact lens power profiles with sharp transitions between zones can cause a shadow effect or a "ghost image."[6]

FITTING WITH CONFIDENCE

A simplified fitting guide can help increase eyecare practitioners' confidence in the initial stages of a lens recommendation. The 3-Zone Progressive™ Design incorporates factors beyond pupil size for optimized performance.[7] When eyecare practitioners followed the fitting guide for 3-Zone Progressive™ Design lenses, 87% of patients were successfully fitted in one visit, and 99% of patients were successfully fitted in two visits.[5] In addition to a straightforward first fit, a simple 2-ADD system provides comprehensive multifocal coverage for wearers' needs.

Bausch + Lomb has developed a novel one-day multifocal contact lens featuring this 3-Zone Progressive™ Design.

Bausch + Lomb INFUSE® Multifocal lenses also feature breakthrough ProBalance Technology™ — a proprietary combination of ingredients infused into the lens material and released to help maintain ocular surface homeostasis.[5] The material properties of INFUSE® contribute to a comfortable wearing experience and help minimize impact on the ocular surface.

Eyecare practitioners may strongly consider options that consistently provide both comfort and visual acuity at all distances. Bausch + Lomb INFUSE® Multifocal lenses combine the 3-Zone Progressive™ Design with a next-generation silicone hydrogel material (kalifilcon A) to ensure wearers do not have to compromise their everyday activities when using multifocal contact lenses.

As presbyopes become eligible for multifocal contact lenses for longer portions of their lives, eyecare practitioners can depend on Bausch + Lomb's INFUSE® Multifocal for a predictable fit and outstanding optical design.

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BUMPS Along the Way

With scleral lens usage growing, it's imperative to understand the potential complications you may encounter during fitting. Here's how to recognize and rectify them.

By Trevor J. Fosso, OD

Since the re-emergence of scleral lenses, optometrists prescribing them have grown at an exponential rate. According to the *Contact Lens Spectrum* Annual Market Share Review, scleral lens prescribing contributed approximately 5% of the overall contact lens market in 2022—up from 2% in 2021.[1] Within the gas permeable (GP) lens market, scleral lens usage grew from 14% in 2021 to 21% in 2022.[1] Even reports outside optometry predict growth of scleral lenses. Fortune Business Insights predicts the global scleral lens market to grow from $240 million in 2021 to $646.8 million by 2028.[2] Many believe that several factors contribute to continued growth, including rising prevalence of ocular disorders, improving insurance coverage and reimbursement, and advancing technology that increase scleral lenses accessibility.[2]

Scleral lenses were originally viewed as a last resort therapy, reserved for the most severe cases of corneal ectasia or ocular surface disease. Patients who otherwise would require surgical intervention could wear scleral lenses, allowing them to forgo or delay corneal transplantation and other invasive, life-altering surgeries. But as the technology and usage have expanded, scleral lenses have become the first-line option for practitioners regardless of the condition or severity. Survey data reported has demonstrated this shift in prescribing trends among scleral lens practitioners, favoring scleral lenses over traditional corneal GP lenses for cases of corneal irregularity.[3]

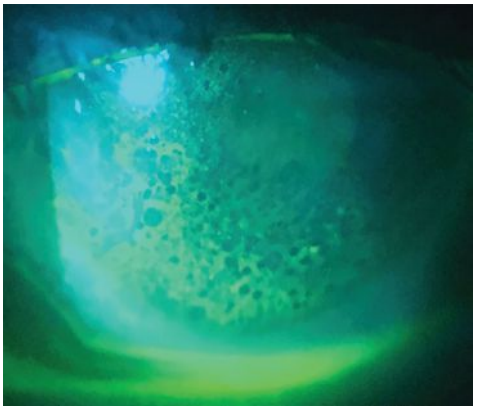

Fig. 1. Corneal edema presenting with microcystic edema and negative fluorescein staining.

While scleral lenses offer great opportunity—and undoubtedly their usage will only grow—they do come with unique complications and concerns. This article will review several potential complications one may encounter while working with scleral lenses, evaluating their clinical presentation and management.

BASELINE TESTING

For both the initial evaluation and long-term management of scleral lens wearers, certain baseline measurements are very beneficial to obtain. Corneal tomography or topography provides an assessment of the entire corneal shape that can aid in the initial scleral lens design, as well as tracks disease progression such as for patients with keratoconus. When available, scleral profilometry provides scleral shape analysis and thus can aid our scleral haptic design improving our success.

Corneal pachymetry should be obtained whenever possible, preferably global pachymetry rather than a single measurement point. By measuring and tracking the corneal thickness, one can track the

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Dr. Fosso serves as the director of contact lens services at PineCone Vision Center in Sartell, MN. He joined the practice in 2017 after completing a residency in anterior segment disease and medical contact lens management at Davis Duehr Dean in Madison, WI. He lectures and writes on topics of anterior segment disease management, surgical comanagement and contact lenses, with a special interest in keratoconus and scleral lenses.

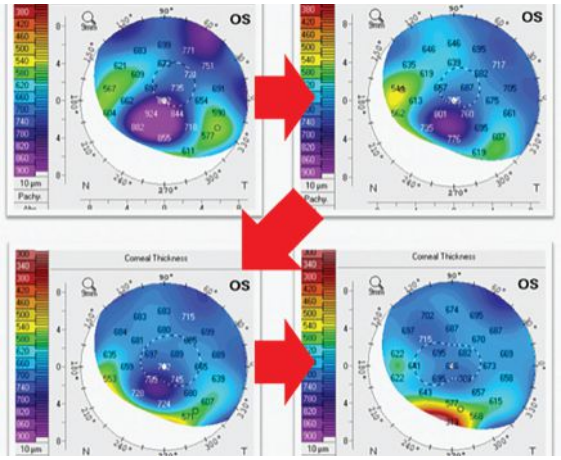

Fig. 2. Corneal pachymetry maps of a patient with corneal edema who was started on topical rho-kinase inhibitor showing gradual improvement on edema.

functional capacity of the cornea specifically related to corneal edema. Specular microscopy is another helpful baseline to obtain, particularly when working with a patient who has a history of corneal transplant or endothelial dystrophy. By knowing an endothelial cell count, we can determine whether a patient may or may not be a good candidate for scleral lens wear. It is currently believed that endothelial cell counts below 800 cells/mm^2 may be more susceptible to developing corneal edema and thus may not be good candidates for scleral lens wear.

Other useful imaging options include external photos for documentation of findings such as neovascularization, corneal opacities and conjunctival vessels, allowing for better future comparison. External photography of lenses can also be helpful when working with consultation on fit adjustments. Anterior segment OCT imaging is another helpful instrumentation that can provide high definition corneal and lens imaging to aid in fit assessment.

CORNEAL EDEMA

Possibly the most debated and controversial complication associated with scleral lens wear is corneal edema, accumulation of fluid within the cornea typically without inflammation. Currently, it is thought that a mild degree of corneal edema—less than 4%—occurs during daily scleral lens wear and resolves following lens removal.[5] But in cases where the degree of edema surpasses this limit or fails to resolve following lens removal, we have a complication.

As corneal edema develops, patients may complain of blurred vision, halos around lights and photophobia. If the edema progresses to greater than 10%, patients may begin to experience pain and discomfort.[4] Clinically, one may find an assortment of corneal changes including epithelial bullae or detachments, microcystic edema, corneal haze, stromal striae or Descemet's folds, steepening of the corneal curvature and increased corneal thickness (*Figure 1*).

Corneal edema may develop as an underlying disease process such as keratoconus or Fuchs' endothelial corneal dystrophy progresses, or it may develop as a result of scleral lens wear directly. The physical presence of a scleral lens may induce mechanical stress on the cornea through lens bearing or a tightly fitting lens leading to corneal edema. Similar to other contact lens modalities, scleral lens wear may result in corneal hypoxia that can lead to edema secondary to contact lens-induced endotheliopathy.[5]

While corneal edema may not always be avoidable, there are several steps that can be taken to limit its incidence. Initial evaluation with corneal pachymetry and specular microscopy can help determine if a patient is a scleral lens candidate. To avoid corneal hypoxia, choosing a high or hyper Dk material to maximize oxygen transmissibility is beneficial. Also minimizing lens thickness and post-lens tear reservoir thickness are advantageous goals that will help reduce the risk of hypoxia. During scleral lens fitting, avoiding limbal bearing and tight scleral landing zones will limit the mechanical stress of a lens on the eye. The use of fenestrations or channels within the lens design can improve corneal oxygenation through improved tear exchange as well as eliminate lens suction and adhesion.[5]

When corneal edema does develop, management should be dictated by patient symptoms and clinical findings. Mild and asymptomatic cases may benefit from reduced lens wear until proper lens adjustments are made to alleviate the causative stress, but for non-resolving or symptomatic cases of corneal edema, therapeutic intervention is warranted. Hypertonic solutions or ointments may be beneficial for more mild cases of edema but are difficult to use during scleral lens wear. Using prior to and following scleral lens wear may

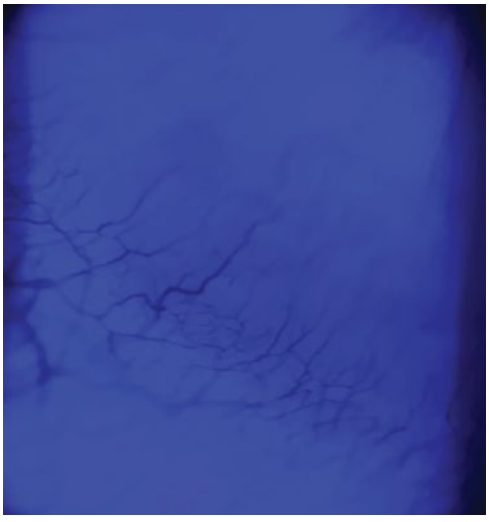

Fig. 3. Corneal neovascularization resulting from scleral lens extended wear visualized with cobalt light filter.

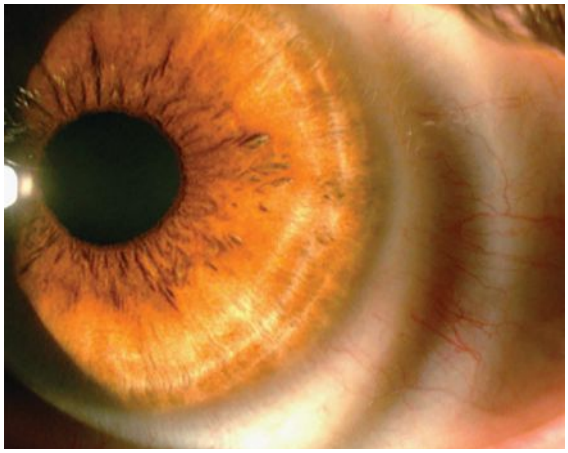

Fig. 4. Conjunctival compression ring following scleral lens removal in a tight fitting scleral lens.

provide some reduction in corneal edema but typically has minimal effect. Patients with endothelial cell dysfunction rho-kinase inhibitors have shown to promote endothelial cell proliferation and suppress its apoptosis thereby improving endothelial cell count and function, providing a more long-term solution for corneal edema management.[6] Take a look at the global pachymetry maps of this scleral patient, for example, post-corneal transplant (*Figure 2*). His transplant began to develop edema near the graft-host junction and eventually progressed to 924µm thick. He was then started on a topical rho-kinase inhibitor once daily and gradually the edema resolved.

Short-term management of symptomatic cases should include discontinuation of all lens wear, initiation of topical corticosteroid therapy, topical antibiotic if epithelial compromise is present and possible use of topical aqueous suppressant medications which can aid in reducing endothelial cell stress. For cases that are unable to recover with topical therapy, surgical intervention via endothelial keratoplasty may be warranted as well.

NEOVASCULARIZATION

Another very concerning possible complication is corneal neovascularization, which results from the ingrowth of blood vessels from the limbal vascular plexus into the cornea (*Figure 3*).[4,5] As it develops, the risk of corneal opacification increases, threatening the patient's vision. Neovascularization can happen from scleral lens wear and is typically associated with corneal hypoxia, poor lens compliance or lens bearing.[4,5]

Depending on the severity of neovascularization, patients may be asymptomatic or complain of reduced vision as corneal clarity diminishes. Clinically, the presence of blood vessels extending into the cornea will be noted. More superficial blood vessels are commonly associated with hypoxia, while deeper, larger vessels are suggestive of inflammation, possibly related to an underlying disease process.

Maximizing corneal oxygenation by using highly oxygen permeable materials and optimizing lens and post-lens tear reservoir thicknesses again will aid in avoiding a hypoxic corneal state that may drive neovascularization. Pressure induced by limbal bearing or a tight scleral landing zone can trigger the development of neovascularization as well, thus lens adjustments should be made to minimize such mechanical stressors. Neovascularization may also arise from scleral lens overwear or extended wear, therefore emphasizing proper lens wear to patients is imperative to maintain proper corneal health.

LENS BEARING

When working with scleral lenses, sometimes a lens may settle more than expected over time or a patient's condition may progress resulting in the lens directly resting on the cornea. The physical stress of a lens compressing the cornea can lead to corneal compromise and various complications depending on the region of bearing. Patient's symptoms and clinical appearance may also differ depending on the area of bearing, dictating the proper lens modification.

Beginning peripherally, tight fitting lenses, which may be squeezing within the scleral landing or limbal zones, can result in complications such as corneal edema, neovascularization and keratitis. This is typically the result of a lens whose scleral landing zone is too steep,

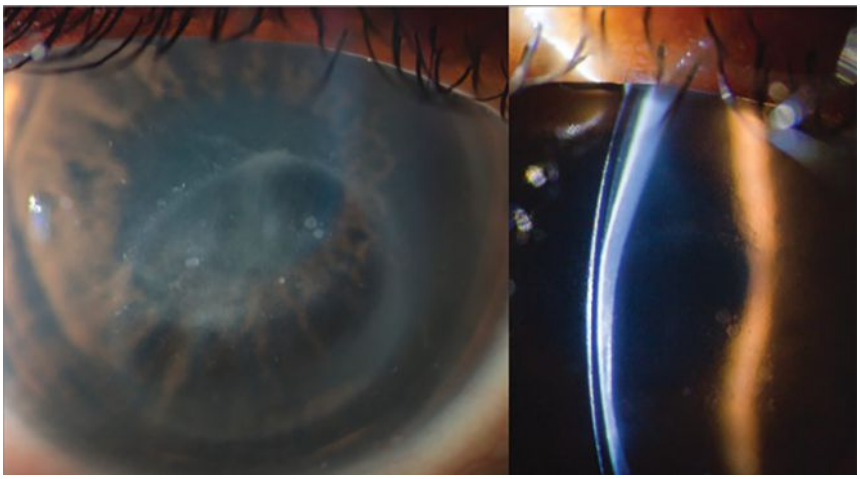

Fig. 5. Slit beam illumination demonstrating contact of a scleral lens with cornea (left). Direct visualization of scleral lens bearing on central cornea (right).

thus compressing the eye more than intended. Patients often will complain of discomfort, pain, photophobia, and pressure and/or tightness while wearing the lens. In many cases, these symptoms will worsen with prolonged wear and patients will report a sense of relief following lens removal.

Patients may struggle with lens removal due to the tightness and suction and complain of prominent conjunctival and/or limbal compression rings following removal (*Figure 4*). Lens evaluation will demonstrate blanching or impingement of the circumlimbal vasculature within the scleral landing zone and no lens movement. Adjusting the scleral landing zone to relieve the compression will solve the problem. If available, scleral topography or profilometry obtained prior to lens fitting can help avoid a tight-fitting lens.

Moving inward, limbal bearing results when a scleral lens directly lands on the limbus and may again give rise to corneal edema, neovascularization, keratitis and limbal stem cell deficiency.[5] Patients with more oblate shaped corneas such as post-refractive surgery and post-penetrating keratoplasty may be more susceptible to this due to the increased relative peripheral elevation. Because of this, assessing corneal diameter and corneal elevation prior to lens fitting can be helpful to ensure proper lens diameter and design are used to avoid this peripheral contact. When this does occur, patients may be asymptomatic or complain of discomfort, fatigue and pain similar to a tight-fitting lens. Following lens removal, a compression ring over the limbal/conjunctival area may be seen as well as circumlimbal punctate epithelial erosions and injection. To mitigate this issue, lens fit should be adjusted to reduce harsh bearing over the limbus by improving lens centration and increasing limbal clearance.

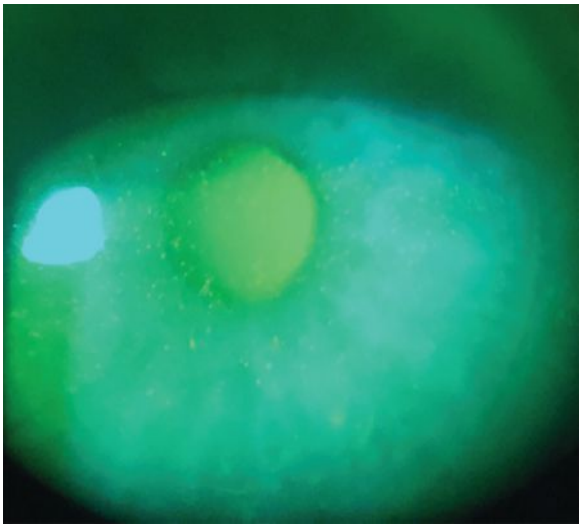

Fig. 6. Punctate epithelial erosions from a patient wearing a scleral lens filled with multipurpose soft contact lens solution.

Central bearing occurs more commonly with prolate shaped corneas such as keratoconus and other ectatic conditions. Again, unexpected lens settling or progression of a patient's underlying condition can lead to this unwanted contact. Patients may complain of reduced acuity, foreign body sensation and pain that is worse after scleral lens removal. Lens evaluation will reveal an area of lens-cornea contact that can be visualized with both direct illumination and slit beam (*Figure 5*). The cornea underneath is best evaluated with sodium fluorescein and may demonstrate an epithelial swirl pattern that results from lens compression in that area. Harsher examples of bearing can erode through the epithelium resulting in a corneal abrasion, which may be associated with infiltrates and stromal haze. In such cases, discontinuation of lens wear and therapeutic management with topical antibiotic and corticosteroid drops until resolution of the abrasion should be done. Once corneal compromise has been managed, the lens fit should be adjusted to increase sagittal depth and provide proper clearance. For cases of progressed corneal ectasia, referring the patient for corneal cross-linking to help avoid any further progression is warranted.

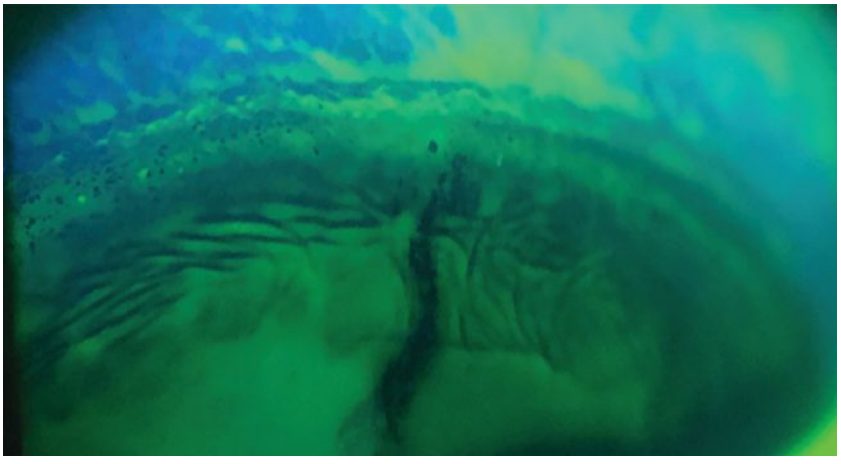

Fig. 7. Limbal epithelial bogging and epithelial wrinkling.

TOXIC EPITHELIOPATHY

With the post-lens tear reservoir bathing the corneal epithelium completely during scleral lens wear, proper lens filling solution is required. Preservative-free saline or preservative-free artificial tears are commonly agreed upon as the ideal options for scleral lens filling; however, patients may forget or encounter instances where they are

without one of those options giving rise to toxic epitheliopathy. This can range from mild sensitivity reactions to more severe chemical burns depending upon the offending agent. Mild reactions often are asymptomatic while more severe cases can present with pain, photophobia and blurred vision. Mild cases occur most commonly and often include instances of patients using various multiple purpose contact lens solutions or preserved artificial tears to fill their lenses for application. This can also occur in patients who use more viscous GP lens solutions to store their scleral lenses in and are not thoroughly rinsing the scleral chamber prior to application. Clinically, patients may present with diffuse punctate epithelial erosions, ranging from one to four more typically with a uniform distribution (*Figure 6*). Prescribing appropriate lens filling solutions and preparation techniques when first dispensing lenses and reviewing at follow-up appointments can help remind patients what solutions they should use. More severe cases need to be treated as a chemical burn and possible ocular emergency. Identification of the offending agent and its pH will drive the course of management.

Fig. 8. Limbal epithelial bogging and epithelial wrinkling.

EPITHELIAL BOGGING

Visible following lens removal, epithelial bogging presents as a water-logged appearance of the peripheral epithelium (*Figure 7*).[4,5] Best visualized following fluorescein application, one may find raised, irregular epithelium and circumlimbal punctate stippling. Patients are typically asymptomatic, and this condition is considered benign, resolving with continued wear and adaptation of the epithelium to the new environment. If after continued wear it has not resolved, adjusting the prescribed scleral lens filling solution may be necessary. Patients could also use a name brand solution compared to generic, or a buffered vs. non-buffered formulation. In some instances, using a formulation that contains electrolytes to mimic the natural tears more closely may be beneficial for patients.[7]

CONJUNCTIVAL PROLAPSE

This occurs when redundant, loose conjunctiva is drawn into the transition or limbal zone under the lens (*Figure 8*), believed to be the result of negative pressure forces.[4,5] Conjunctival prolapse is more commonly seen in older patients who naturally have more loose conjunctival tissue, but can happen within any age group. It's typically considered a benign finding, but in some circumstances can become problematic. Should enough tissue be drawn into the scleral chamber, it could interfere with vision and thus require intervention. In cases of persistent conjunctival prolapse, corneal neovascularization has been noted underneath the conjunctival flap, so careful monitoring with lens removal and thorough corneal evaluation is indicated. For problematic conjunctival prolapse, decreasing limbal clearance can help reduce the negative pressure force drawing the tissue into that area, thereby reducing or eliminating it. In some cases, anti-inflammatory therapies including cyclosporine, liftegrast, topical corticosteroid pulse or amniotic membrane therapy can help to tighten the conjunctival tissue as well. When there is excessive amounts of conjunctivochalasis, surgical resection could be considered.

TAKEAWAYS

While scleral lenses come with their own unique array of potential complications, mitigating them typically comes down to three goals: maximizing corneal oxygenation, ensuring proper lens fit and emphasizing proper lens compliance. Implementing these fundamental traits when fitting scleral lenses can help one avoid potential complications or drive appropriate management should they arise. RCCL

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IMAGING THE SCLERAL PROFILE
FOR ENHANCED RESULTS

Advanced technologies can be of value in the design and fitting process.

By Joseph DiGiorgio, OD

Adding scleral profilometry to our practice was a game changer for creating more complexly customized scleral lenses, based on individualized image-driven guidance. The initial fitting challenges were now much easier to overcome, particularly for those new to providing these lenses. Even for experienced fitters, this system can be beneficial.

Scleral topography and profilometry can supplement the traditional process of scleral lens fitting—empirically providing a best-fit lens that matches the ocular surface on a micron scale. This can help save time and cost while providing optimum comfort and vision for your patients. Without profilometry, we do not have the big picture of the scleral shape.

This article will review the fitting process as done in our office and encompass initial conversations to initial follow-up. In my office, we use an Eaglet Eye Surface (ESP) Profiler in particular.

Scleral shapes are highly variable, and only about 5% to 6% are simple spheres, based on data found in the Scleral Shape Study.[1] In fact, the Scleral Shape Study Group reported that a relatively small percentage of eyes are described as regularly toric (28.6%), with the remaining 40.7% classified as asymmetrical toric and 26% as irregular toric. The Scleral Shape Study Group looked at the pattern of scleral shapes and found that a minority of patients (roughly one-third) had rotationally symmetric scleral shape patterns and the majority of patients (roughly two-thirds) had irregular patterns with either asymmetric depressions or elevations.

We generally follow a decision tree for each patient based on key findings, including how much toricity they have at about the 12.0mm to 13.0mm corneal scleral junction and the magnitude of the delta at about 15.0mm, generally in agreement with the Scleral Shape Study.

TYPICAL WORKUP FLOW

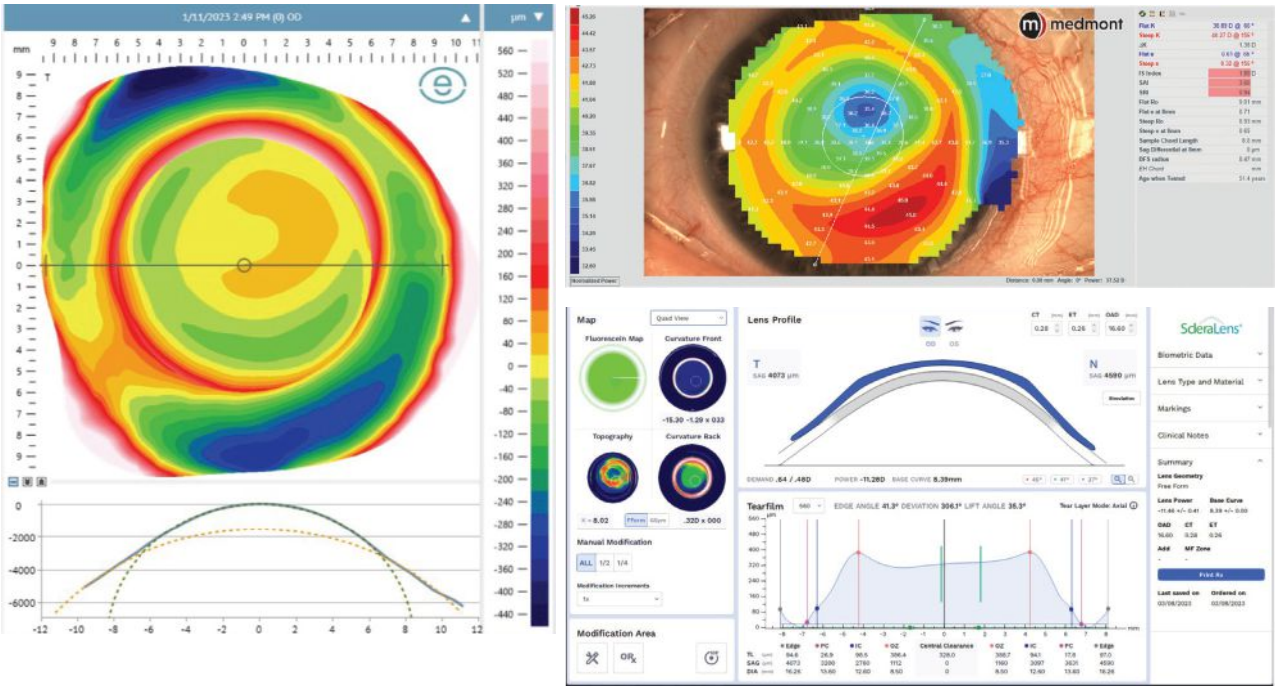
In my practice, we have traditional topography as well as Eaglet ESP profilometry and AS-OCT imaging easily accessible.

On the initial visit, my team performs a comprehensive eye exam, corneal topography and refraction. We also do an OCT-based corneal pachymetry map on initial visit to gain more information about the corneal status. After this discussion and when we mutually decide to proceed with a scleral lens solution, we schedule the patient for a second visit and ask that they stay out of currently worn hybrid or scleral lenses from Friday evening until we see them next Monday morning to minimize any impression effects their current lenses may have on their sclera that may adversely affect our evaluation and future design.

The first step at this visit in our office has now become scleral profilometry, otherwise we have no idea what scleral shape or irregularities we will have to manage. Before we begin imaging, we have each patient wash their eyelids with ocular foam cleanser to reduce slipperiness when we hold their lids. The ESP uses NaFl for

ABOUT THE AUTHOR

Dr. DiGiorgio practices at Vision Source-Orland Park in Orland Park, IL. He has served as president of the Chicago South Suburban Optometry Society and as a director for the Executive Council of the Illinois Optometric Association in Springfield. He is a charter member of the Contact Lens section of the American Optometric Association. He has no financial disclosures.



Case 1. Medmont topography and Eaglet ESP profilometry of a post-LASIK patient with irregularity and significant glare. A Wave freeform scleral lens was designed.

image acquisition. It is usually applied to the superior, nasal, temporal and inferior scleral surfaces. We instill a hyaluronic acid-based tear drop. We add a drop of proparacaine to gently anesthetize the eye. We then wet fluorescein strips with preservative-free saline and gently apply them to the scleral surface. We use a UV penlight to inspect to make sure we have carefully painted the scleral surfaces. From there, the eyelids are opened and a single image is acquired while the patient is in primary gaze.

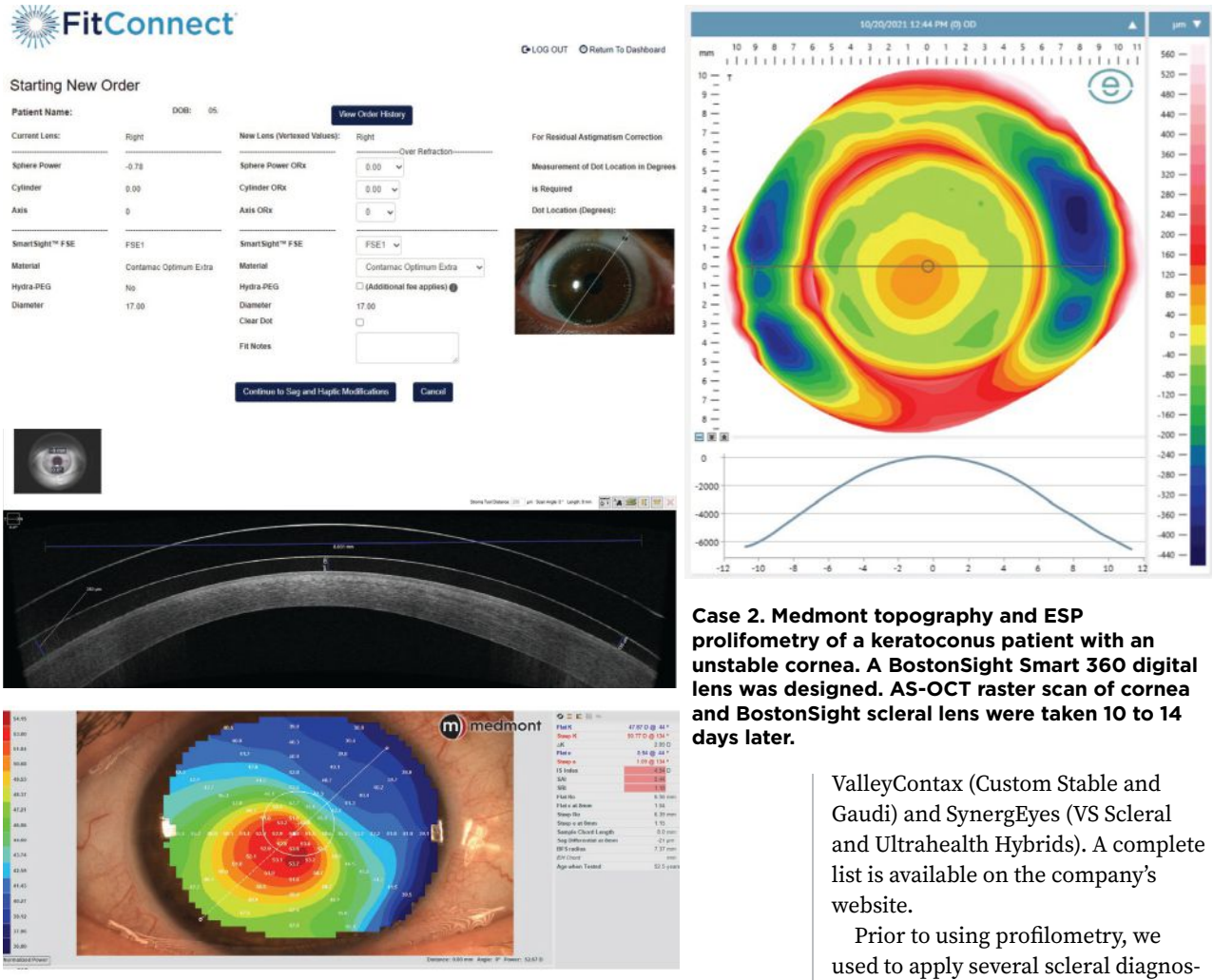
We typically have the doctor shoot the images and direct the process while a staff member helps retract the eyelids. Position the patient into the instrument. I have a staff member assist with holding the upper lid while wearing purple nitrile gloves. For some patients, we use an Oculus Lid Stick, which has a specially-shaped silicone tip shaped to conform to the external lid and is helpful for retracting the upper lid. We usually have the patient retract their lower lid, as we observe the result on the video monitor of the Eaglet ESP. We use a joystick to carefully align and bring the image into focus. Eaglet has recently added quality indicators for image centration, eye surface coverage and focus. They display red, yellow or green for a quick assessment of image quality. We want a nice full image to capture as much of the sclera as possible.

In my practice, we acquire several images with the goal of having three very high-quality images based on image centration, coverage and focus. We flag the best images, then mark one of them as our baseline image that will be used for our scleral lens design.

Review the profilometry results with each patient, looking at the elevation difference at or about a chord equal to the patient's horizontal visible iris diameter (HVID). We also look out at the 15mm and about 16.5mm chords, to see how much irregularity and elevation difference is present on a micron scale. I like to do this for my three favorite images for each eye to make sure the data is repeatable.

I explain the color elevation map to the patient and tell them the blue areas are like the Atlantic and Pacific oceans, way down at sea level. The green and yellow areas are moderately elevated, for example, like the states Illinois or Iowa. The red areas are most elevated, for example, like Colorado. We let them know that our goal is to sculpt their lenses to fit these areas of their eyes like a tailor-made suit. A simple spherical haptic, a symmetric toric haptic, a highly customized digital haptic, or in some cases, a bi-elevation or dual-sagittal haptic can be the solution to their problems. The goal is to understand for each patient what type of corneal and scleral shape they happen to have so that we can match the ideal lens design to their eye.

We generally apply only a single diagnostic scleral lens of known base curve and power, then perform a spherical overrefraction (OR) and



Case 2. Medmont topography and ESP prolifometry of a keratoconus patient with an unstable cornea. A BostonSight Smart 360 digital lens was designed. AS-OCT raster scan of cornea and BostonSight scleral lens were taken 10 to 14 days later.

sphero-cylindrical over refraction (SCOR) to assess for best visual acuity and lens power calculations needed to design our new custom scleral lens. Then, a quick compilation of the key findings is done on a worksheet that I created for in-office use that is used for lens type selection and for designing the desired lens.

TIME TO DESIGN

After the patient leaves, begin work on the custom scleral design. We use the HVID/ vertical VID measurements, profilometry results and refractive data to design a custom scleral lens made based on these findings. We consider several design options, including a simple toric haptic, a lens with a dual sag at the corneal-scleral junction or a full 360° digital haptic in some cases.

One of the things I enjoy with our scleral profilometry system is the ability to select and design scleral lenses from several different vendors based on my particular patient's eye shape characteristics. Eaglet Eye does not manufacture scleral lenses in-house but instead has partnered with more than 20 scleral lens labs worldwide. Some in particular include ZenLens (all sclerals), BostonSight (BostonSight Scleral), Blanchard (all Onefit designs), EyePrint Prosthetics (ScanFit Pro), Acculens (Maxim), X-Cel (Atlantis), Advanced Vision Technologies (Naturalens Scleral), ValleyContax (Custom Stable and Gaudi) and SynergEyes (VS Scleral and Ultrahealth Hybrids). A complete list is available on the company's website.

Prior to using profilometry, we used to apply several scleral diagnostic lenses to try to judge how much sagittal depth was needed, how much, if any, toricity was needed and if we needed to make the haptic steep or flat to align the patient's scleral shape and prevent unwanted edge standoff or excessive tightness that would lead to blanching and vessel compression. During our new fit process, we prefer to design the "best fit sphere" instead of an "off the rack" design, which may have too little or excessive mid peripheral clearance that would provide a suboptimal result and possibly lead to conjunctival prolapse. The best fit sphere data helps us design a lens that has an optimized curve that better aligns to each patient's unique corneal curvature, whether average, steep (prolate) or flat (oblate).

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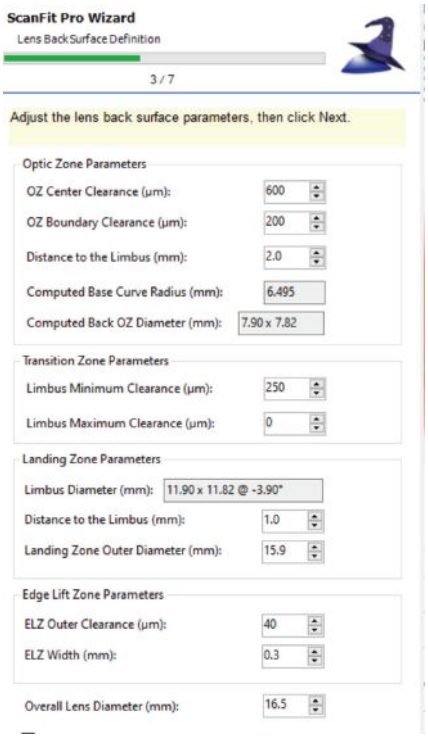

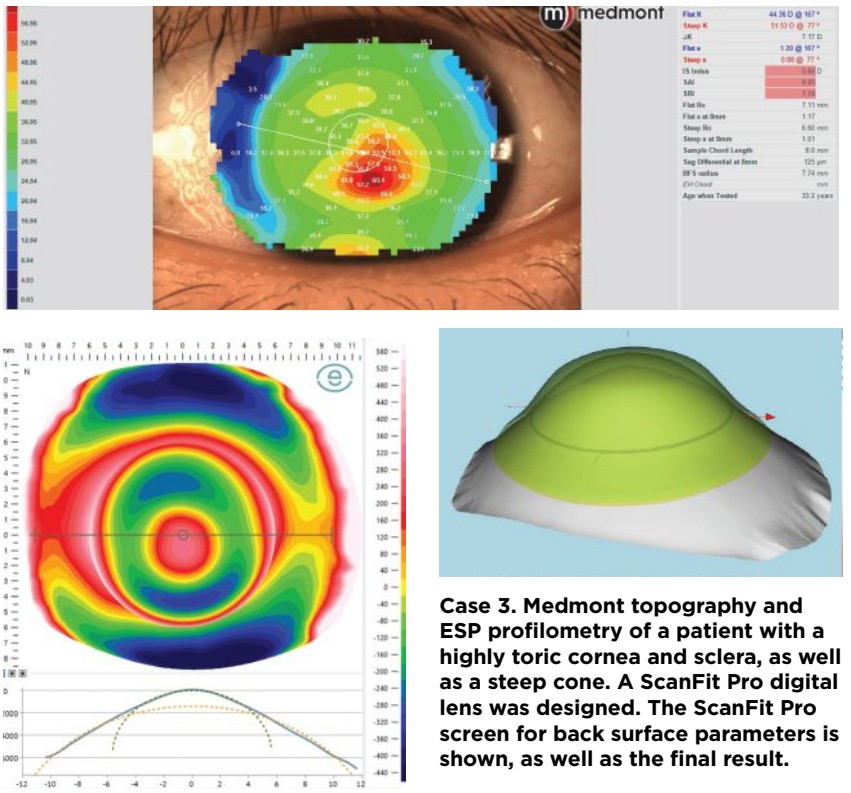

Case 3. Medmont topography and ESP profilometry of a patient with a highly toric cornea and sclera, as well as a steep cone. A ScanFit Pro digital lens was designed. The ScanFit Pro screen for back surface parameters is shown, as well as the final result.

TROUBLESHOOTING AND FOLLOW-UP SCHEDULING

Once the patient's lenses are received from the selected lab, we schedule the patient to come in and apply their new lenses with NaFl in the bowl. Our staff uses a blue UV penlight to assess the lens to make sure there is no air bubble and to assure that there is no inadvertent corneal touch. The patient is then escorted to an exam room, where we assess with the slit lamp, check initial visual acuities and do a spherical and sphero-cylindrical over-refraction. In most cases, the VA is quite acceptable, and we design the initial central clearance to be a bit generous, anticipating the lens will settle.

Discuss with the patient that the sclera is spongy, like a memory foam mattress, and that the lens will settle over several days of wear. The trouble is that you will not know how much their lens may settle until you see them back.

It's important to have your staff give the patient detailed personal and written instructions regarding scleral lens care and handling, and be sure to schedule the patient back in about 10 to 14 days, at which time the staff will continue to do AS-OCT imaging of the lens at several key points, including central clearance, mid peripheral clearance, limbal clearance and haptic alignment, as well as viewing with our slit lamp biomicroscope. After AS-OCT imaging the patient is brought into an exam room, VA is checked again and we perform a careful spherical OR and SCOR. If necessary, we make any fine tuning adjustments to optimize the physical fit and the lens power.

After the lens has gone through a settling period, we determine at this point if there is any need to adjust and optimize lens power. If there is significant residual cylinder after ruling out lens flexure, we may add a front surface toric and carefully note the position of lens orientation marks for cylinder axis calculation. If needed, we also adjust the lens central clearance, mid peripheral clearance (via a base curve change), limbal clearance and alignment of the haptic, based on AS-OCT imaging and slit lamp findings. The first lens is generally remarkably close and typically only needs mild refinements to optimize and enhance the physical fit and lens powers.

Scleral profilometry has helped us elevate our scleral lens design to a higher level, streamline our process and has reduced the number of revisions needed to achieve a beautiful fit. With the right technology, practitioners can provide their patients faster fits, less chair time and better visual outcomes. RCCL

1. DeNaeyer G, Sanders D, van der Worp E, et al. Qualitative assessment of scleral shape patterns using a new wide field ocular surface elevation topographer: The SSSG Study. JCLRS. 2017;1(1):12-22.

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10 Scleral Lens Design Tips *from the Pros*

Experts share their advice and best practices to help you optimize your own approach.

By Catlin Nalley, Contributing Editor

Designing scleral lenses can seem daunting at first, and while there is certainly a learning curve, optometrists interested in this area of practice can find success with dedication and a well-informed approach.

Scleral lenses have become a valuable tool that can benefit a variety of patients such as those with irregular corneas, ocular surface disease and high levels of refractive error, including astigmatism and presbyopia. Since no two cases are the same, designing a scleral lens that meets the needs of your patients will take time and patience, though there are ways to streamline the process.

"Whether you are a novice or experienced, it is important to remember that you don't know what you don't know," notes Christine Sindt, OD, professor of optometry at the University of Iowa. "We are constantly learning and evolving, and as we learn more about scleral lenses and the conditions we are treating, we will continue to refine our approach. It is important to cut yourself some slack and recognize where you are right now."

Photo: Brooke Messer, OD

Fig. 1. Scleral lenses are often the best choice to fit irregular corneas.

Below, experts share their experiences with scleral lens design and discuss the various aspects of scleral lens fitting, including parameters of lens design as well as considerations for atypical corneas and patient communication. They offer 10 tips and tricks—in no particular order—to help you optimize your own technique.

TIP #1: Determine if your patient is a candidate. Before you even start designing a scleral lens, it is important to make sure that your patient is the right fit for this approach. Dr. Sindt advises taking a step back and asking yourself, "Is this the best option for the individual? Where is the patient mentally and emotionally in this journey?"

Additionally, consider whether the patient requires other care before you begin a lens fitting. Dr. Sindt notes that she often sees clinicians "initiating the scleral lens process before addressing the patient's other physical needs because the patient is pushing for this." In these cases, give yourself permission to say no to the patient and explain to them why a different approach is the better option right now, she suggests.

When determining if a patient is a good candidate, Shalu Pal, OD, who practices in Toronto, starts with a specialty lens assessment. "I make sure that the ocular surface is safe for a scleral lens to be worn and that scleral lenses are truly the best optical solution for the patient, in comparison to other, potentially less expensive options," she says. "Before starting, I advise the patient of any conditions that need to be treated before we begin, such as blepharitis, meibomian gland dysfunction or allergies.

"To ensure the patient is ready for a fit, I review the fitting process, the time it takes to fit these lenses and the cost," she adds. "I need the patient's full agreement and understanding before we begin."

TIP #2: Start with diameter. Selecting the lens's overall diameter is the first consideration in any scleral lens fitting, according to Melissa Barnett, OD, principal optometrist at the University of California Davis Eye Center, who notes that this is important for determining sagittal height.

One of the primary considerations when choosing the diameter is a patient's topographic patterns and ocular anatomic factors, including height and length of the eyelids and

eyelid spacing. Other aspects that can impact diameter are horizontal visible iris diameter (HVID), vertical visible iris diameter (VVID), limbus width and corneal sagittal height.[1,2]

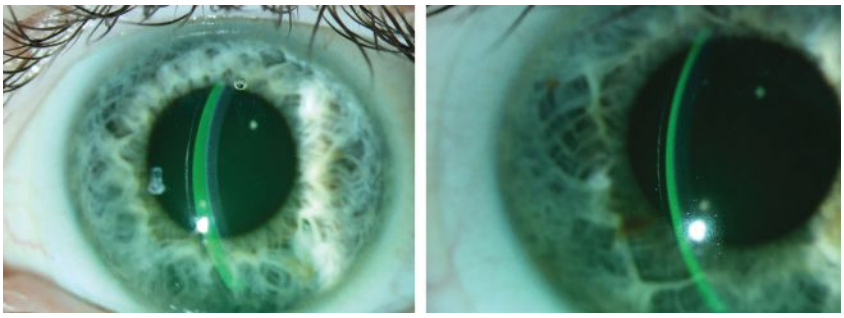
"The practitioner should keep in mind that corneal sagittal height determines the width of the landing zone. The scleral peripheral zone width (landing zone and last peripheral zone width) is the last parameter that may affect the total diameter," Dr. Barnett and specialty contact lens innovator, Daddi Fadel, DOptom, wrote in their Clinical Guide for Scleral Lens Success.[1]

When discussing scleral lens design tips, Dr. Barnett says, "Don't be afraid to go larger in diameter. Often, you will see practitioners using a 14.5mm or 15mm lens; however, many patients will do quite well with a 16mm to 17mm lens." This can be especially valuable for patients with dry eye, she notes. "In these patients, a larger lens is often better than smaller lens because anything under the lens will be bathed with fluid. So, even in a patient with a normal cornea, I would select a larger diameter lens to help them achieve greater relief from dry eye."

A diameter of 16mm to 16.5mm is going to fit most eyes, emphasizes Greg DeNaeyer, OD, who practices optometry in Columbus, OH. However, he notes, there are always exceptions to the rule, one being the patient who has an exceptionally large corneal diameter (*i.e.*, 12.2mm to 12.5mm). "Those patients are going to require a bigger diameter scleral contact lens for the fluid reservoir to be able to adequately vault from limbus to limbus," he explains.

The other exception, beyond just a large corneal diameter, is keratoglobus, according to DeNaeyer, who notes that to vault the eye and have enough sagittal depth of the contact lens, you typically need a larger diameter lens.

For John Gelles, OD, who specializes in keratoconus and contact lenses at The Cornea and Laser Eye Institute of Teaneck, NJ, , his rule of thumb is to fit lenses proportionate to the disease. "If a patient has extensive dry eye that is all over the conjunctiva and covering the entire cornea, I'm going to fit the biggest diameter that I can fit onto that eye," he explains.



Photos: Jeffrey Sterling, OD

Fig. 2. (Left) A lens with proper clearance. (Right) A different lens showing excessive clearance, which could lead to decreased vision, post-lens debris and conjunctival impingement.

"Now, for someone whose dry eye or other corneal pathology is limited to the cornea, I will opt for a smaller lens," he adds. "A diameter of 21mm or 22mm is unnecessary in an eye where you are only dealing with corneal pathology."

In addition to the size of the cornea (HVID) and choosing a large lens for dry eyes to cover more of the ocular surface and exposed conjunctiva, corneal shape also plays a role in determining the proper lens size, according to Dr. Pal. "A very steep cornea with a large sagittal height will require a larger lens so that it can gradually lift off the scleral and reach the apex of the cornea," she explains. "If a smaller lens is chosen, the lens will 'smash' into the limbus and mid-peripheral cornea," she says, causing discomfort and corneal damage.

"If the shape of the scleral is more spongy and irregular, opt for a lens that is further away from the limbus," continues Dr. Pal. "When putting on a large-diameter lens, it will 'sink' more over time. A larger lens is also heavier and may decenter more due to the asymmetrical shape and the weight of the lens. The natural decentration of a lens is inferior and temporal."

TIP #3: Corneal clearance depends on the condition. Typically, less central corneal clearance is needed for normal eyes, while more clearance is preferred in cases of ocular surface disease and irregular corneas. Optometrists can adjust corneal clearance by changing the base curve or by independently increasing or decreasing the lens sagittal height, Dr. Barnett explains (*Figure 2*).

In Dr. Gelles's practice, he considers most fits successful with 100µm to 400µm of clearance over the apex. However, he notes that less clearance can also be acceptable in some cases. "If I see a patient at the end of the day and the lens is fully settled after two weeks of wear, I would consider 50µm of clearance fair, but generally my goal is to keep them within that 100µm to 400µm range. This is variable based on condition."

The tear reservoir or clearance of a lens will be very uniform across the cornea of a normal patient or a dry eye patient who has no underlying corneal irregularity, explains Dr. Pal, while also noting that the clearance of an irregular cornea, such as a keratoconic patient, will vary depending on the location and severity of the cone shape (*Figure 4*).

"You need to ensure that you look at the entire cornea to determine corneal clearance. The advancements in lenses today allow us to adjust corneal clearance with the use of quad-specific limbal curves, mid-peripheral curves

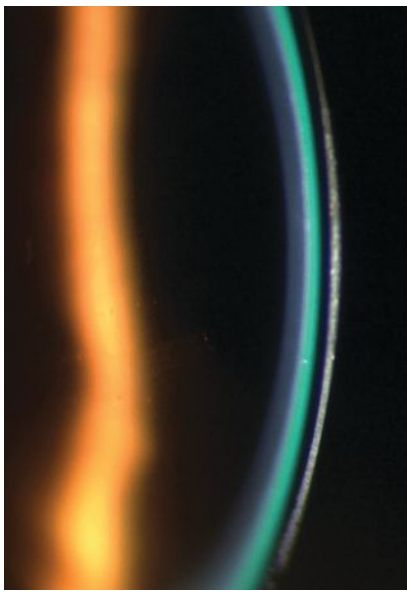


Photo: Irene Frantzis, OD

Fig. 3. A scleral lens demonstrating a 1:1 ratio of lens thickness (dark band) to tear layer (green band).

and, in some cases, central curves. The key is to make sure you look at the whole cornea from edge to edge and top to bottom to look for areas of excessive clearance or inadequate clearance."

Since lenses will continue to settle over several months of wear, it is important to keep watching this drop in clearance, Dr. Pal recommends, while adding that patients should "return for follow-ups before their warranties are complete and six months after a fit is complete to ensure we do not have touch of the lens over time."

TIP #4: Understand the disease and lens geometry. Before you can design a lens, you must have a clear picture, not only of the condition you are addressing, but also the lens geometry, according to Dr. Gelles. This is especially important in cases of atypical anatomy. "ODs need a topographer at the very least—and ideally, a tomographer—to not only understand the geometry, but also follow the disease state. Most patients are using these lenses for progressive corneal diseases like keratoconus or post-refractive ectasia."

It is important to have a clear understanding of the lens geometry and the ocular contour for optimal lens design. "You need to know the corneal diameter, the difference between an oblate and hyperprolate cornea, the contour of the sclera and be aware of any abnormality on the conjunctiva," he notes. "This is going to determine which scleral lens you use. For instance, some of the available lenses have fixed zones, no ability to add advanced haptic features or do not allow you to control the profile of the inner geometry of the lens, so I may end up with almost no clearance or touch or compression over the areas that I wanted clearance and large amounts of clearance over the area that I don't (*Figure 5*)." This is why, according to Dr. Gelles, having knowledge of the design is very important.

TIP #5: Take advantage of available tools. There are a number of options available for getting the information you need to properly design and fit a scleral lens. One that can be particularly helpful is scleral topography and profilometry.

This can help streamline the scleral lens fitting process and empirically provide either the best-fit lens or free-form lens that match the ocular surface on a micron scale, according to Marcus Noyes, OD, who practices in Columbus, OH. He noted in a previous *Review of Optometry* article, "This can help you save time and money while ensuring optimum comfort and vision for your patients. These tools can also be combined with existing technologies such as HOA correction and decentered optics to create truly personalized options per patient, per eye."[3]

Dr. DeNaeyer, who has been fitting scleral lenses based on corneoscleral topography since 2015, has found that there are multiple ways to approach the use of this technology. For one, he explains, ODs can gather data on corneal and sclera shape, and those measurements can then help them to more efficiently use their diagnostic lens sets of choice.

"For instance, if the data shows that the sclera is toric, you will want to use a scleral lens with the toric landing zone, even diagnostically," he says. "Additionally, you are also given the direction and amount of toricity. This is a much faster way to get the fitting process started, because without this data, the very first lens you put on the eye is really just a blind diagnostic trial." Because of this, Dr. DeNaeyer says, "I always encourage practitioners to try to get that type of measurement."

After using corneoscleral topography, Dr. DeNaeyer then uses software to design the scleral lens. "You can either customize a standard design that is available from one of the various manufacturers or you can use that three-dimensional model dataset to design a 'free-form' scleral contact lens that is completely customized to a patient's eye surface."

That being said, practitioners shouldn't be discouraged if they don't

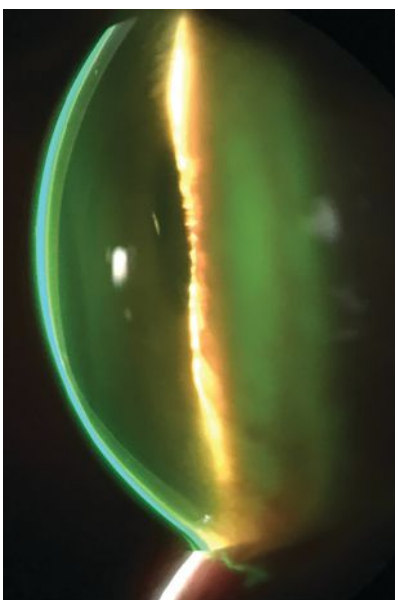


Photo: Melissa Barnett, OD

Fig. 4. A fluorescein pattern of a scleral lens on an eye with keratoconus. Note complete clearance of the cornea.

have the latest technology at their disposal right now. Use the fitting guide and connect with your laboratory consultants for additional support, suggests Dr. Barnett.

"My recommendation for practitioners new to scleral lens fitting is to become an expert in one or two diagnostic fittings and then branch out from there," she says. "If you aren't sure where to begin, look at your patient population and their needs. In your practice, do you see a lot of irregular corneas, post-surgical, dry eye, etc.? This will help shape your scleral lens practice."

When investing in more advanced equipment such as profilometry or impression-based designs, Dr. Sindt recommends that ODs who are just starting out consider their options. While it may seem overwhelming or costly, there can be value in investing in the right equipment sooner rather than later.

"While it may feel less expensive to start solely with trial-and-error fitting, you will spend more time and make more errors, which comes at a cost as well," says Dr. Sindt. "Chair time is very expensive, and I think we often underrate what our actual chair time is worth."

TIP #6: Use consultants as a resource. The design and fit of every scleral lens are unique, which is why optometrists should take advantage of every resource, including laboratory consultants. "Lab consultants are your partners to help you with your fits and most importantly give you the confidence in their products to help you make changes on your own," says Dr. Pal. "They enjoy working with ODs and should always be treated with respect. We couldn't do our job without them."

Successfully working with consultants depends on effective communication, emphasizes Dr. Gelles. "Verbal or written descriptions are open to interpretation," he notes. "The best way to ensure consistency and clear understanding is to share photos and videos with your consultants when troubleshooting a lens design."

Photo: Marcus R. Noyes, OD, and John D. Gelles, OD

Fig. 5. This scleral lens landing zone displays severe (fine and large vessel impingement) conjunctival compression. The left edge of the lens is too flat (note the 0.5mm band of compression located 0.5mm from the lens edge), and the right edge is too steep (note the compression starts at the edge and extends 1mm inward). To improve this landing zone fitting relationship, steepen the left side and flatten the right side by using a toric periphery.

"Your style of communication is important to match with your consultant and learning to speak the same language is vital," adds Dr. Pal. "I always design my lenses late at night via email. If a consultant wants to only discuss fits on the phone, we won't work well together because our 'working times' won't overlap."

While consultants are an invaluable resource for the optometrist, Dr. Gelles urges ODs not to expect the laboratory to do your work for you. "They are a helping hand that will guide you to success, but it is up to you to take the lead and design the lens that will best fit your patient."

TIP #7: Contend with pinguecula and other obstacles. Another challenge optometrists may face during the scleral lens fitting process is scleral and conjunctival elevation. Some examples include pinguecula (*Figure 6*), pterygia, tube shunts and scarring due to prior injury or surgery. Without the optimal fit, lenses can cause discomfort, redness and other issues for these patients.

There are a number of ways to address these obstacles, such as making the diameter smaller or larger, adding a focal area of vault or notching the lens edge. Impression-fit lenses may also be an effective approach depending on the individual case.[4]

Assessing the vault of a pinguecula or a conjunctival obstacle can be tricky at first, acknowledges Dr. Pal. "I used my slit lamp reticle to determine the number of degrees that the elevation spans and I use conjunctival photos, OCT images, good estimations and, most importantly, my consultants to help determine how large to design a vault or channel."

Pinguecula are very common, and optometrists must be prepared to take that into consideration, notes Dr. DeNaeyer. "Depending on the patient, it may be mild enough not to cause an issue; however, any pinguecula that is 200µm in elevation or more is potentially problematic, so ODs will have to troubleshoot." He recommends adjusting the diameter if the cornea allows, or you could do a localized vault. "This is another example where corneoscleral topography can be valuable. However, if you don't have this data, as mentioned above, 200µm is a good number to keep in mind and a good

Photo: Marc Bloomenstein, OD

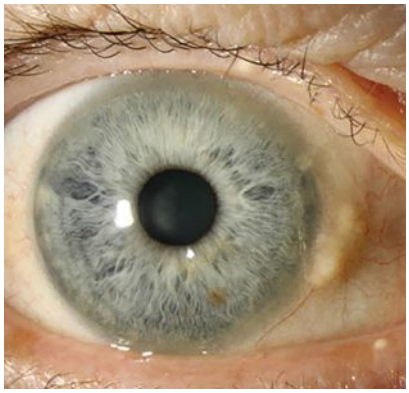


Fig. 6. To accommodate a scleral or conjunctival elevation due to abnormalities such as pinguecula, clinicians have several options, such as adjusting the diameter, adding a focal area of vault or notching the lens edge.

place to start if you think you need a localized vault or other adjustments to improve the fit for this type of patient," says Dr. DeNaeyer.

TIP #8: Don't make adjustments too soon. Practitioners, especially those just beginning to fit sclerals, may have a tendency to make changes to the lens fit too early in the fitting process, suggests Dr. DeNaeyer. "This can lead to unnecessary changes that might actually make the fit worse rather than better."

When dispensing lenses, Dr. DeNaeyer's philosophy is that the patient needs to have acceptable vision that meets standards for driving, and the lens has to fit in a healthy way. "If I meet those two objectives, I am not changing the lens that day. I will train the patient, if they haven't already been trained on scleral lenses, and send them home."

This allows patients the opportunity to start wearing the lenses in their "real life," and when they come back to the office, "we know that it has fully settled," he adds. "At that point, adjustments can be made depending on the practitioner's objective assessment as well as what the patient tells us subjectively."

TIP #9: Know when advanced lens designs are needed. When faced with advanced anatomical challenges or more complicated cases, optometrists will likely have to look beyond what a traditional scleral lens can offer.

"Take, for instance, my two patients this week who had bilateral filtering procedures for glaucoma (Ahmed valves) in both eyes," says Dr. Gelles. "The tissue that overlays the tube in those eyes can be fragile, and if you don't have the technology that can contour to that area, you're going to be in a position where you're going to put unwanted and dangerous amounts of pressure and rubbing over that area. This will lead to the breakdown of that tissue and significant complications."

In cases like this, it is important to have advanced tools such as scan or impression-based design to create free-form geometries, suggests Dr. Gelles. "Even if you don't adopt these more advanced technologies, you should know the technology exists. You can either adopt this approach yourself or refer to a colleague who does have the technology to take care of these patients."

TIP #10: Ask for patient feedback. Dr. Barnett always asks her patients about their vision and how the lens feels to get a complete picture. "The patient perspective is critical," she says. "I ask my patients if the lens is comfortable and how they perceive their vision.

"For example, a patient with keratoconus whose vision is 20/20 may report blurry vision. In that case, we probably need to correct the HOAs," says Dr. Barnett. "This is why getting subjective feedback in addition to objective evaluations is so important."

Both positive and negative feedback is needed to help the fitting process. If a patient is happy with the comfort and vision of the lens and it is not causing any harm, we can stop, notes Dr. Pal.

"If troubleshooting vision or discomfort, it is important to have a clear understanding of where the discomfort is coming from and if the discomfort is felt when the eyes are open or closed," she says. "This will help you pinpoint where the problem is where to make changes to improve the lens fit."

There is no one-size-fits-all approach to scleral lens design and every practitioner has their own unique philosophy. With the right tools and knowledge, ODs who have a passion for—and recognize the nuances of—scleral lens design can help their patients thrive.

No matter where you are on your scleral lens journey, there is always room for growth. With more experience comes more confidence. Given the ongoing advancements in the field, it is also important to stay informed on the latest technologies and research.

"I never fit the same lens twice. By the time a patient returns for a new lens, either I have learned something new, enhanced my skills or new technology is available to improve on the previous lens design," says Dr. Pal.

"We are in a very exciting time of fitting lenses with so much advancement in technology," she concludes. "I am always pushing to improve a patient's comfort and vision. Refitting patients is beneficial to both the patient and myself. They get a better fitting lens and I improve my skills and experience. With the use of scleral lenses, we have an incredible ability to change the lives of our patients." RCCL

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Step Into SCLERALS

These tips will help you master initial lens care for new patients.

By Manveen Bedi, OD

The use of scleral lenses has dramatically expanded over the past decade. Their applications have gone beyond visual rehabilitation of corneal irregularities and into the management of ocular surface disease as well as prosthetic devices. As more eyecare professionals continue to expand the scope of scleral lens wear and fit patients with a wide range of ocular pathologies, it is crucial to delve deeper into the importance of having effective communication with patients about scleral lenses. This encompasses teaching patients the dos and don'ts of the care of this lens and providing training on lens application and removal techniques to ensure successful outcomes and reduce rates of dropout. Below are some of my best tips.

Photo: Aleena Chaudhary and Manveen Bedi, OD

An easy way to streamline the training process is to gather all needed tools.

COMMUNICATION AND PREPARATION

Effective relaying of information is the cornerstone of successful scleral lens wear outcomes in patients. A structured approach to teaching patients, initiated by providing information on scleral lens applicators, products used during the application and removal process, managing insertion bubbles and providing written instructions on lens care hygiene can make the training process more efficient. Start by assessing a patient's current level of experience with contact lenses. Patients may present with varying levels of experience with handling lenses, so it is important to explore a patient's comfort level, familiarity with contact lens handling and history of lens wear. This helps establish a baseline to build off of and can help you to tailor their contact lens application and removal training appropriately.

A specialty lens consult is a great opportunity to start preparing the patient for lens handling techniques. Providing graphics and video links to the patient as homework prior to their training session can help them become comfortable with the process of handling the lenses. Asking patients to practice good lid-holding or instilling eye drops are good exercises to perform at home prior to the in-office training. Repetition is key—it is vital to invest time at the beginning so training can run efficiently.

Scleral lens wear can be intimidating for a new contact lens wearer. Using plain language can help ease understanding for patients. Compared with

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other contact lens training, the process of scleral application and removal is quite rigorous, requiring suction cups and separate solutions for the lens chamber and disinfection. Therefore, it is crucial that before training initiation you familiarize patients with and explain the purpose of the suction tools, preservative-free saline solution and disinfection products involved in the scleral lens wear. Doing so in simple terms can make the process easier to follow and feel less intimidating for a first-time contact lens wearer.

DO'S AND DON'TS OF SCLERAL CARE

Scleral lens care is complex and involves multiple components: hygiene, lens disinfection, solutions, suction cups and more. It can be difficult for patients to retain all information about these factors during just one clinic visit. Providing written content can ease patients into the process and act as a reliable source to refer to at their own discretion.

APPLICATION AND REMOVAL TRAINING

The scleral lens training process can definitely be challenging for patients. Here is a step-by-step guide to teach application and removal techniques to patients. Before starting training, ensure that the following products are readily available and the work station has been prepared. Included should be a lens cleaning solution, preservative-free saline, DMV application and removal suction cup, contact lens case, a mirror and tissue paper.

Outlined below are the steps to take for the scleral application process:

1. Start with thorough hand washing with a mild, non-irritating soap and ensure your hands are dry prior to lens handling.

2. Place the mirror flat on the table's surface where you will be applying the lens. Have tissue on the table to prevent lens scratches in case the lens falls.

3. Place the lens on the application suction cup and fill the bowl of the lens to the brim with preservative-free saline solution.

TABLE 1. DOS AND DON'TS TO DISCUSS WITH PATIENTS DURING THE FITTING PROCESS

LENS CARE	DOS	DON'TS
Hand hygiene	Make sure the patient is thoroughly washing hands with a mild, non-irritating soap.	Avoid hand lotions or other products that can cause eye irritation.
Lens filling solution	Only use preservative-free saline to fill the bowl of the lens prior to application.	Soft/RGP lens solution, tap water or unpreserved saline can result in corneal insults.
Lens cleaner	Only use prescribed lens cleaner solution by your eyecare professional.	Generic preserved saline solution is not good with lens disinfection.
Lens case	Replace lens case frequently to prevent microbial contamination.	Overuse or poor hygiene can increase risk of infections.
Wear schedule	Adhere to the recommended wear schedule and gradually increase wear time.	Therapeutic overnight use of scleral lens with serum tears in ocular surface disease management needs to be approved by an eyecare professional.

Replacement schedule: Follow the replacement schedule recommended by your eyecare professional. Do not use tap water with scleral lenses.

4. Tilt your head parallel to the ground and look straight into the mirror lying flat on the table.

5. Use one hand to hold both the upper and lower eyelids while maneuvering the suction cup and lens with the other hand closer to the eye.

Tip: Ask the patient to bring the suction cup with the lens upward towards the eye while looking at the hole in the vented suction cup; it provides a good visual target for the patient.

6. Gently release eyelids after the lens is on the eye.

7. Check: After scleral lens application, ensure that there are no bubbles in the lens chamber before proceeding to apply the lens on the other eye. Insertion bubbles are a common issue that can arise when initially learning to apply these lenses and can cause discomfort as well as vision issues. The lens will need to be removed and reapplied if bubbles do form.

Tip: Use the flashlight of your phone to check for bubbles in the mirror for better viewing.

When the patient is ready to continue with removal, this is how the process continues:

1. Start again with thorough hand washing with a mild, non-irritating soap and ensure your hands are dry prior to lens removal.

2. Place the mirror directly in front of you while you are seated.

3. Place your index finger over the lower lid then gently nudge the lower edge of the lens to release suction of the lens. This will introduce bubbles in the lens chamber.

4. Use the DMV removal tool by applying it at the bottom portion of the lens while holding the eyelids with the other hand.

Tip: Do not apply the DMV removal tool on the center of the lens, as this puts more pressure on the cornea during the removal process.

5. Pivot the DMV tool up and out to remove the lens.

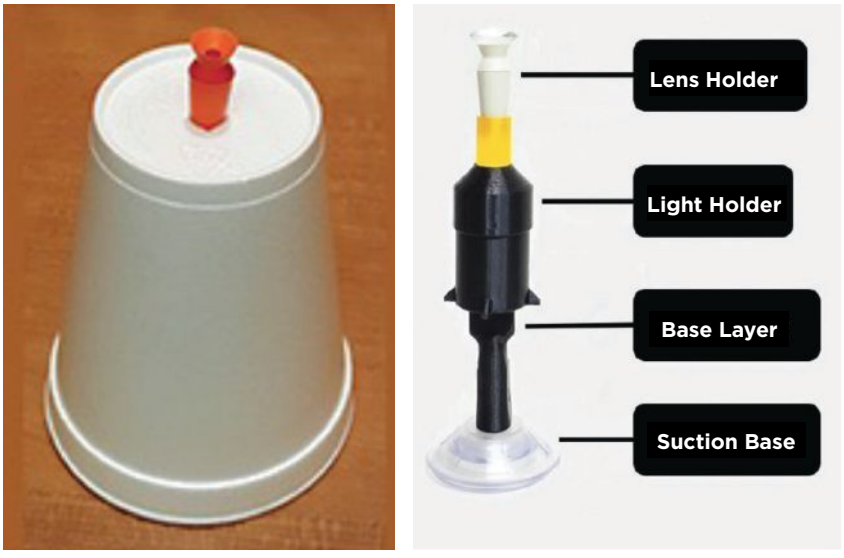
6. Remove the lens from the DMV removal tool and place it in the contact lens case filled with fresh lens cleaner solution.

RECOMMENDATIONS AND RESOURCES

When dispensing lenses to a first-time scleral lens wearer, the following recommendations can be provided to allow patients to ease into the process. First is to slowly build wear time. Start with four to five hours of lens wear and as the comfort increases, increase the maximum wear time accordingly. Asking patients to wear lenses specifically during your clinic's hours for the first week is great. This helps in cases where the patient is struggling and may need assistance with lens removal. Other questions they may have about the process can also be answered with a phone call during office hours.

Secondly, provide backups when necessary. The process can be tricky, requiring greater assistance. If a patient is unable to use the hole in the vented DMV cup as a target, whether due to poor vision or struggling with hand tremors, discussing scleral lens stands may be beneficial. There is a way to make your own scleral lens stand, if patients would like to opt for this instead of buying one. To do so, place the DMV application tool at the base of a Styrofoam coffee cup and place an LED light inside the cup. The light will appear through the vented portion of the DMV application tool.

Another backup option is the S5 Inserter. It is a great tool for patients who have back issues or who prefer to stand during lens application. Since the tool can be elongated, it provides the patient greater ease of application while in an upright position. The LED light is an excellent target for patients with poor vision, helping to guide them during the application process.



Photos: Brooke Messer, OD, and Thomas Arnold, OD

A DIY scleral lens stand (left) and S5 Inserter (right).

TAKEAWAYS

Scleral contact lenses are a great option for providing visual rehabilitation, management of ocular surface disease and improving patient quality of life. However, proper care and hygiene is critical to ensure eye health safety and optimal results. As eyecare professionals, engaging in effective conversations about the do's and don'ts of handling scleral lenses and teaching insertion and removal techniques are integral to help patients be successful in their wear. RCCL

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Dystrophy Dilemma

Distinguishing between the many corneal types that exist can be a challenge.

A 25-year-old male presented complaining of longstanding poor vision. He had no systemic, ocular or family history. Entering acuity was 20/25- OD and 20/25 OS. His extraocular muscles were full, and no afferent pupillary defect was present. On slit lamp examination in the deeper part of the stroma, translucent, scaly polygonal opacities were seen appearing centrally; however, the peripheral intervening tissue was clear. His manifest refraction OD was -0.25D and -0.25D OS. He was correctable to 20/20 in both eyes. Intraocular pressure was 15mm Hg OU. The rest of his ocular health was unremarkable. Upon questioning, the patient reported previous eye exams but no mention of irregular findings.

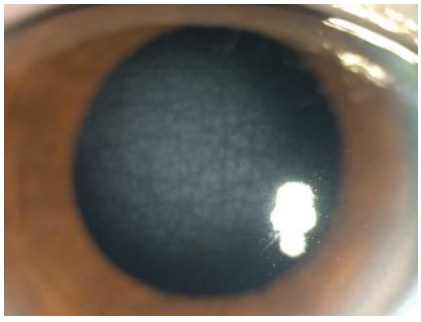
CORNEAL DYSTROPHIES

Given the bilateral and symmetric nature of this presentation, it was believed that this patient had a corneal dystrophy (CD). CDs are a rare group of genetic eye disorders and regularly present in early childhood. They are not associated with systemic or environmental factors, nor are they caused by inflammation, infection or trauma. Instead, they are caused by a genetic mutation. CDs are hereditary, bilateral and symmetric and are typically slow-progressing, starting early in life but may not become clinically apparent until later.[1,2] Most CDs affect men and women equally, with the exception of Fuchs' dystrophy, which affects more women.

The cornea has five layers: the epithelium, Bowman's membrane, the stroma, Descemet's membrane and the endothelium. CDs are caused by a build-up of foreign material in one or more of these five layers. They are usually confined to one layer, thus most commonly classified by corneal location. More than 20 different CDs exist, and in 2008, the International Committee for Classification of Corneal Dystrophies (IC3D) was created to devise a current and accurate nomenclature for them. The IC3D classified CDs in order to reflect genetic, clinical and histological characteristics and created four categories.

- ***Category 1:*** A well-defined corneal dystrophy in which the gene has been mapped and identified with specific mutations known.
- ***Category 2:*** A well-defined corneal dystrophy that has been mapped to one or more specific chromosomal loci, but the genes remain to be identified.
- ***Category 3:*** A well-defined corneal dystrophy in which the disorder has not yet been mapped to a chromosomal locus.
- ***Category 4:*** Reserved for a suspected new or previously documented corneal dystrophy, although the evidence of it being a distinct entity is not yet convincing.

In 2015, the IC3D reviewed the new information on corneal dystrophies reviewed between 2008 and 2014. It proposed reclassification, that based categorization on cellular origin of dystrophies. This sorting uses the anatomical level affected, more accurately classifying the transforming growth factor beta-induced (TGFBI) dystrophies that affect multiple layers, instead of residing in one. With this classification, histopathologic and confocal images have been added to the templates. The IC3D found that confocal microscopy emerged as extremely helpful in discovering features of several CDs that previously required histopathologic examination. The dystrophies represent four categories: epithelial and subepithelial, epithelial-stromal, stromal and endothelial.[1] This updated version has provided more clarity when diagnosing patients with a CD (*Table 1*).



An example of central cloudy dystrophy of François.

Some of these dystrophies cause the cornea to lose transparency, which can cause blurred or lost vision. Other symptoms may include pain, tearing and foreign body sensation, but they can also present with none. Treatment of CDs ranges and is based on signs and symptoms. While some patients are asymptomatic, mild signs are often managed with early observation. If they progress, lubrication is recommended. Often, bandage lenses are used to help with recurrent erosions, while phototherapeutic keratectomy and corneal transplantation are reserved for persistent recurrent erosions and severely decreased vision.

DIAGNOSIS

Our patient was diagnosed with a stromal CD, central corneal dystrophy of François (CCDF). CCDF possesses autosomal dominant inheritance with onset during the first or second decade of life.[2] Often, it is described as appearing similar to crocodile shagreen.[1] Signs of CCDF include translucent,

scaly polygonal or rounded opacities residing deep within the stroma and are surrounded by clear tissue.[4] It has also been described as a fluffy opacity, appearing as cracked ice. Pathologic findings include collagen of deep stroma, but anterior segment OCT findings are not conclusive at this time. Confocal microscopy in reported cases has revealed small, highly refractile granules and deposits throughout the stromal layers.[5]

Given that the stroma is a sizeable portion of the cornea, there is a large array of dystrophies affecting this area. The classification of stromal dystrophies was particularly affected in 2015 when the IC3D came out with new guidelines. The old classification had the following all listed as stromal dystrophies: lattice, granular, Avellino, macular, gelatinous drop-like, Schnyder, François-Neetans fleck and congenital hereditary corneal dystrophies. As the IC3D has learned more about these dystrophies' cellular nature, the grouping was broken up and divided into the classification above.

CDs are mostly autosomal dominant diseases and present from the first to the third decade of life. Symptoms are initially not present; however, they can result in bilateral recurrent erosions, causing pain, tearing, foreign body sensation and eventually decreased vision. Signs are often recurrent erosions, bilateral corneal stromal deposits in various patterns and/or diffuse haze and for some, central corneal opacities or crystalline deposits with surrounding arcus. Treatment for stromal dystrophies often starts with observation and lubrication. In time, recurrent erosions can demand the need of bandage contact lenses and topical antibiotics. More severe cases can call for phototherapeutic keratectomy and even corneal transplantation. Even with corneal grafts, these dystrophies can reoccur.

TABLE 1. IC3D CLASSIFICATION SYSTEM OF CDs BY CELLULAR ORIGIN[3]

Epithelial and subepithelial dystrophies	• Epithelial basement membrane corneal dystrophy, previously known as map-dot-fingerprint dystrophy, Cogan microcystic dystrophy and anterior basement membrane dystrophy. • Epithelial recurrent erosion dystrophies, which include Franceschetti corneal dystrophy, dystrophia smolandiensis and dystrophia helsinglandica. • Subepithelial mucinous corneal dystrophy. • Meesmann corneal dystrophy, also known as juvenile epithelial corneal dystrophy. • Lisch epithelial corneal dystrophy. • Gelatinous drop-like corneal dystrophy.
Epithelial-stromal dystrophies (still included under epithelial and subepithelial dystrophies)	• Lattice corneal dystrophy (LCD) with its subtypes: type I (TGFBI mutation) and type II (familial amyloidosis Finnish type), including LCD variants. • Granular corneal dystrophy types I and II (Avellino-type). • Reis-Bückler's corneal dystrophy. • Thiel-Behnke corneal dystrophy (honeycomb dystrophy).
Stromal dystrophies	• Macular corneal dystrophy. • Schnyder corneal dystrophy. • Congenital stromal corneal dystrophy. • Fleck corneal dystrophy. • Posterior amorphous corneal dystrophy. • Pre-Descemet corneal dystrophy. • Central cloudy dystrophy of François.
Endothelial corneal dystrophies	• Fuchs' endothelial corneal dystrophy. • Posterior polymorphous corneal dystrophy. • Congenital hereditary endothelial dystrophy. • X-linked endothelial corneal dystrophy.

In day-to-day clinical care, a careful slit lamp examination with the use of optic section is recommended. Slit-lamp photography will also contribute significantly to documentation of and the ability to detect progression of CDs. The use of anterior segment OCT and confocal microscopy will, unquestionably, be a part of the future management of these conditions as more evidence is found. RCCL

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By Christine W. Sindt, OD

Buckle Up

Scleral thinning due to systemic granulomatosis complicates an already tricky case.

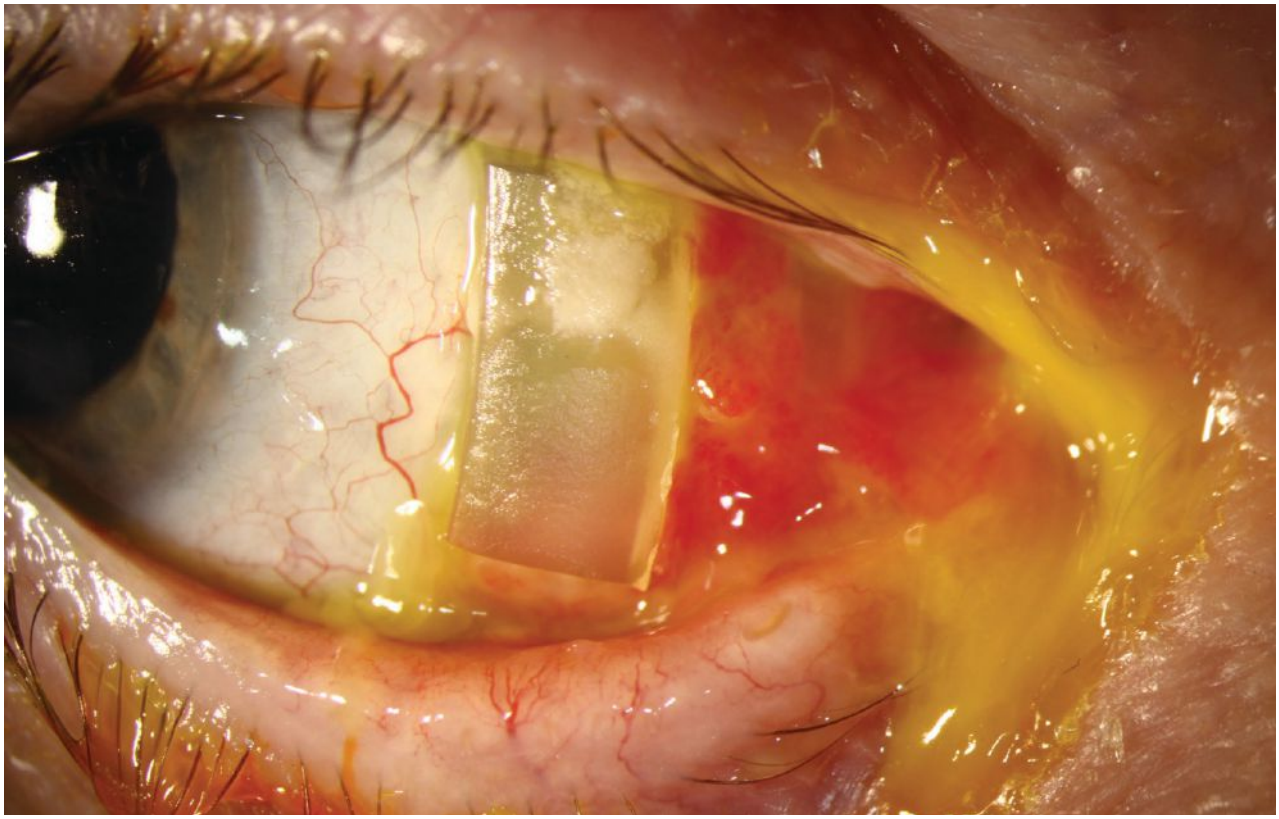
A 66-year-old male presented with a complicated ocular history starting with a scleral buckle procedure in the right eye 40 years prior. He later underwent LASIK (in its early years) for the anisometropia and developed ectasia with 20/150 BCVA. Due to progressive visual field loss, he was diagnosed with glaucoma. However, because of breathing issues, a Baerveldt implant with scleral patch graft was placed in hopes of getting him off beta-blockers.

Subsequently, while hospitalized for respiratory failure, he was diagnosed with Wegener's granulomatosis and developed peripheral ulcerative keratitis and necrotizing scleritis with superficial erosion at his tube site. He was diagnosed with neurotrophic scleral keratitis OD and a lateral tarsorrhaphy was placed, which maintained conjunctival coverage for nearly a decade.

However, he eventually complained of increasing discomfort—the buckle was extruding nasally. It was removed without disruption to the tube shunt. The patient was referred for placement of a scleral cover shell for protection of the ocular surface and vision correction. An impression-based lens device was designed to vault the tube shunt and align with the irregular conjunctiva and he achieved 20/40 vision.

Wegener's granulomatosis, now called granulomatosis with polyangiitis (GPA), is an uncommon autoimmune disorder characterized by asthma, blood and tissue eosinophilia, and small-vessel vasculitis. It is often associated with kidney and lung involvement but can affect any small vessels. Up to 60% of patients have ocular involvement, which can include episcleritis, scleritis, conjunctivitis, keratitis, uveitis, retinal vasculitis, retinal arterial or venous thrombosis, retinal exudates, retinal hemorrhages, blurred vision, blindness, proptosis and orbital granulomatous masses and epiphora.

GPA is considered an autoimmune disease with a prevalence of 1:20,000, with a predilection for Caucasians with Northern European descent. It affects both sexes equally. Treatment includes a combination of glucocorticoids, cyclophosphamide and rituximab, achieving remission in 80% to 90% of patients. Our patient is maintained on oral prednisone and rituximab. RCCL



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